Lecture Notes in Networks and Systems 471

Deepak Gupta · Ashish Khanna · Siddhartha Bhattacharyya · Aboul Ella Hassanien · Sameer Anand · Ajay Jaiswal *Editors*

International Conference on Innovative Computing and Communications

Proceedings of ICICC 2022, Volume 2

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Editors
Deepak Gupta
Department of Computer Science Engineering
Maharaja Agrasen Institute of Technology
Rohini, Delhi, India

Ashish Khanna
Department of Computer Science Engineering
Maharaja Agrasen Institute of Technology
Rohini, Delhi, India

Siddhartha Bhattacharyya
Rajnagar Mahavidyalaya
Birbhum, West Bengal, India

Aboul Ella Hassanien
Department of Information Technology
Cairo University
Giza, Egypt

Sameer Anand
Department of Computer Science
Sukhdev College of Business Studies
University of Delhi
Delhi, India

Ajay Jaiswal
Department of Computer Science
Shaheed Sukhdev College of Business Studies
University of Delhi
Delhi, India

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Dr. Deepak Gupta would like to dedicate this book to his father Sh. R. K. Gupta, his mother Smt. Geeta Gupta for their constant encouragement, his family members including his wife, brothers, sisters, kids and to my students close to my heart.

Dr. Ashish Khanna would like to dedicate this book to his mentors Dr. A. K. Singh and Dr. Abhishek Swaroop for their constant encouragement and guidance and his family members including his mother, wife and kids. He would also like to dedicate this work to his (Late) father Sh. R. C. Khanna with folded hands for his constant blessings.

Prof. (Dr.) Siddhartha Bhattacharyya would like to dedicate this book to Late Kalipada Mukherjee and Late Kamol Prova Mukherjee.

Prof. (Dr.) Aboul Ella Hassanien would like to dedicate this book to his wife Nazaha Hassan.

Dr. Sameer Anand would like to dedicate this book to his Dada Prof. D. C. Choudhary, his beloved wife Shivanee and his son Shashwat.

Dr. Ajay Jaiswal would like to dedicate this book to his father Late Prof. U. C. Jaiswal, his mother Brajesh Jaiswal, his beloved wife Anjali, his daughter Prachii and his son Sakshaum.

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Dr. Suresh Chavhan, Vellore Institute of Technology, Vellore, India
Dr. Mona Verma, SSCBS, University of Delhi

Preface

We hereby are delighted to announce that Shaheed Sukhdev College of Business Studies, New Delhi in association with National Institute of Technology Patna, University of Valladolid Spain and Korea Institute of Digital Convergence South Korea has hosted the eagerly awaited and much coveted International Conference on Innovative Computing and Communication (ICICC 2022) in Hybrid Mode. The fifth version of the conference was able to attract a diverse range of engineering practitioners, academicians, scholars and industry delegates, with the reception of abstracts including more than 3,600 authors from different parts of the world. The committee of professionals dedicated towards the conference is striving to achieve a high-quality technical program with tracks on Innovative Computing, Innovative Communication Network and Security, and Internet of Things. All the tracks chosen in the conference are interrelated and are very famous among present-day research community. Therefore, a lot of research is happening in the above-mentioned tracks and their related sub-areas. As the name of the conference starts with the word 'innovation', it has targeted out of box ideas, methodologies, applications, expositions, surveys and presentations helping to upgrade the current status of research. More than 850 full-length papers have been received, among which the contributions are focused on theoretical, computer simulation-based research, and laboratory-scale experiments. Amongst these manuscripts, 200 papers have been included in the Springer proceedings after a thorough two-stage review and editing process. All the manuscripts submitted to the ICICC 2022 were peer-reviewed by at least two independent reviewers, who were provided with a detailed review proforma. The comments from the reviewers were communicated to the authors, who incorporated the suggestions in their revised manuscripts. The recommendations from two reviewers were taken into consideration while selecting a manuscript for inclusion in the proceedings. The exhaustiveness of the review process is evident, given the large number of articles received addressing a wide range of research areas. The stringent review process ensured that each published manuscript met the rigorous academic and scientific standards. It is an exalting experience to finally see these elite contributions materialize into three book volumes as ICICC 2022 proceedings by Springer entitled "International Conference on Innovative Computing and Communications". The articles are organized into three volumes in some broad categories covering subject matters on machine learning, data mining, big data, networks, soft computing, and cloud computing, although given the diverse areas of research reported it might not have been always possible.

ICICC 2022 invited five keynote speakers, who are eminent researchers in the field of computer science and engineering, from different parts of the world. In addition to the plenary sessions on each day of the conference, 10 concurrent technical sessions are held every day to assure the oral presentation of around 200 accepted papers. Keynote speakers and session chair(s) for each of the concurrent sessions have been leading researchers from the thematic area of the session. A technical exhibition is held during all the 2 days of the conference, which has put on display the latest technologies, expositions, ideas and presentations. The research part of the conference was organized in a total of 42 special sessions and 1 international workshop. These special sessions and international workshops provided the opportunity for researchers conducting research in specific areas to present their results in a more focused environment.

An international conference of such magnitude and release of the ICICC 2022 proceedings by Springer has been the remarkable outcome of the untiring efforts of the entire organizing team. The success of an event undoubtedly involves the painstaking efforts of several contributors at different stages, dictated by their devotion and sincerity. Fortunately, since the beginning of its journey, ICICC 2022 has received support and contributions from every corner. We thank them all who have wished the best for ICICC 2022 and contributed by any means towards its success. The edited proceeding volumes by Springer would not have been possible without the perseverance of all the steering, advisory and technical program committee members.

All the contributing authors owe thanks from the organizers of ICICC 2022 for their interest and exceptional articles. We would also like to thank the authors of the papers for adhering to the time schedule and for incorporating the review comments. We wish to extend my heartfelt acknowledgment to the authors, peer-reviewers, committee members and production staff whose diligent work put shape to the ICICC 2022 proceedings. We especially want to thank our dedicated team of peer-reviewers who volunteered for the arduous and tedious step of quality checking and critique on the submitted manuscripts. We wish to thank my faculty colleagues Mr. Moolchand Sharma for extending their enormous assistance during the conference. The time spent by them and the midnight oil burnt is greatly appreciated, for which we will ever remain indebted. The management, faculties, administrative and support staff of the college have always been extending their services whenever needed, for which we remain thankful to them.

Lastly, we would like to thank Springer for accepting our proposal for publishing the ICICC 2022 conference proceedings. Help received from Mr. Aninda Bose, the acquisition senior editor, in the process has been very useful.

Delhi, India

Ashish Khanna
Deepak Gupta
Organizers, ICICC 2022

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Editors and Contributors

About the Editors

Dr. Deepak Gupta received a B.Tech. degree in 2006 from the Guru Gobind Singh Indraprastha University, Delhi, India. He received M.E. degree in 2010 from Delhi Technological University, India, and Ph.D. degree in 2017 from Dr. APJ Abdul Kalam Technical University (AKTU), Lucknow, India. He has completed his Post-Doc from National Institute of Telecommunications (Inatel), Brazil in 2018. He is the recipient of 2021 IEEE System Council Best Paper Award and Highly Cited Paper Award in Applied Sciences Journal. He has been featured in the list of top 2% scientist/researcher database in the world consecutively for the second time [Table-S7-singleyr-2019, Table_T1_2020]. He is the Treasurer of the IEEE ComSoc-Delhi Executive Committee. He has co-authored 189 journal articles including 150 SCI papers and 51 conference articles. He has authored/edited 59 books, published by IEEE-Wiley, Elsevier, Springer, Wiley, CRC Press, DeGruyter and Katsons. He has filed four Indian patents. He is Convener of ICICC, ICDAM, and DoSCI Springer conferences series. Currently, he is Editor-in-Chief of ICSES Interdisciplinary Transactions on Cloud Computing, IoT, and Big Data and Associate Editor of Expert Systems (Wiley) and Intelligent Decision Technologies (IOS Press). He is also working toward promoting Startups and also serving as a Startup Consultant. He is also a Series Editor of "Elsevier Biomedical Engineering" at Academic Press, Elsevier, "Intelligent Biomedical Data Analysis" at De Gruyter, Germany, "Explainable AI (XAI) for Engineering Applications" at CRC Press, and "Computational Intelligence for Data Analysis" (Bentham Science). He is appointed as Consulting Editor at Elsevier.

Dr. Ashish Khanna has 16 years of expertise in Teaching, Entrepreneurship, and Research & Development. He received his Ph.D. degree from National Institute of Technology, Kurukshetra. He has completed his M.Tech. and B.Tech. GGSIPU, Delhi. He has completed his Post-Doc from Internet of Things Lab at Inatel, Brazil, and University of Valladolid, Spain. He has published around 55 SCI indexed papers in IEEE Transaction, Springer, Elsevier, Wiley, and many more reputed Journals with cumulative impact factor of above 100. He has around 120 research articles in top SCI/Scopus journals, conferences, and book chapters. He is the co-author of around 30 edited and textbooks. His research interest includes Distributed Systems, MANET, FANET, VANET, IoT, Machine learning, and many more. He is Originator of Bhavya Publications and Universal Innovator Lab. Universal Innovator is actively involved in research, innovation, conferences, startup funding events and workshops. He has served the research field as a Keynote Speaker/Faculty Resource Person/Session Chair/Reviewer/TPC member/post-doctorate supervision. He is Convener and Organizer of ICICC conference series. He is currently working at the Department of Computer Science and Engineering, Maharaja Agrasen Institute of Technology, under GGSIPU, Delhi, India. He is also serving as Series Editor in Elsevier and De Gruyter publishing houses.

Prof. Siddhartha Bhattacharyya FIET (UK) is currently the Principal of Rajnagar Mahavidyalaya, Birbhum, India. Prior to this, he was a Professor in Christ University, Bangalore, India. He served as Senior Research Scientist at the Faculty of Electrical Engineering and Computer Science of VSB Technical University of Ostrava, Czech Republic, from October 2018 to April 2019. He also served as the Principal of RCC Institute of Information Technology, Kolkata, India. He is a Co-author of 6 books and a Co-editor of 75 books and has more than 300 research publications in international journals and conference proceedings to his credit. His research interests include soft computing, pattern recognition, multimedia data processing, hybrid intelligence, and quantum computing.

Prof. Aboul Ella Hassanien is the Founder and Head of the Egyptian Scientific Research Group (SRGE) and a Professor of Information Technology at the Faculty of Computer and Artificial Intelligence, Cairo University. Professor Hassanien is an Ex-dean of the faculty of computers and information, Beni Suef University. Professor Hassanien has more than 800 scientific research papers published in prestigious international journals and over 40 books covering such diverse topics as data mining, medical images, intelligent systems, social networks, and smart environment. Prof. Hassanien won several awards, including the Best Researcher of the Youth Award of Astronomy and Geophysics of the National Research Institute, Academy of Scientific Research (Egypt, 1990). He was also granted a scientific excellence award in humanities from the University of Kuwait for the 2004 Award and received the scientific—University Award (Cairo University, 2013). Also, He was honored in Egypt as the best researcher at Cairo University in 2013. He also received the Islamic Educational, Scientific and Cultural Organization (ISESCO) prize on Technology (2014) and received the State Award for excellence in engineering sciences 2015. He was awarded the medal of Sciences and Arts of the first class by the President of the Arab Republic of Egypt, 2017.

Dr. Sameer Anand is currently working as an Assistant professor in the Department of Computer science at Shaheed Sukhdev College of Business Studies, University of Delhi, Delhi. He has received his M.Sc., M.Phil., and Ph.D. (Software Reliability) from the Department of Operational Research, University of Delhi. He is a recipient of "Best Teacher Award" (2012) instituted by Directorate of Higher Education, Govt. of NCT, Delhi. The research interest of Dr. Anand includes Operational Research, Software Reliability, and Machine Learning. He has completed an Innovation project from the University of Delhi. He has worked in different capacities in International Conferences. Dr. Anand has published several papers in the reputed journals like IEEE Transactions on Reliability, International journal of production research (Taylor & Francis), International Journal of Performability Engineering, etc. He is a Member of Society for Reliability Engineering, Quality and Operations Management. Dr. Sameer Anand has more than 16 years of teaching experience.

Dr. Ajay Jaiswal is currently serving as an Assistant Professor in the Department of Computer Science of Shaheed Sukhdev College of Business Studies, University of Delhi, Delhi. He is Co-editor of two books/Journals and Co-author of dozens of research publications in International Journals and conference proceedings. His research interest includes pattern recognition, image processing, and machine learning. He has completed an interdisciplinary project titled "Financial Inclusion-Issues and Challenges: An Empirical Study" as Co-PI. This project was awarded by the University of Delhi. He obtained his masters from the University of Roorkee (now IIT Roorkee) and Ph.D. from Jawaharlal Nehru University, Delhi. He is a recipient of the best teacher award from the Government of NCT of Delhi. He has more than 19 years of teaching experience.

Contributors

Abdul Razaak M. P. Department of Computer Application, B.S. Abdur Rahman Crescent Institute of Science and Technology Chennai, Chennai, Tamil Nadu, India

Adarsh S. Indian Institute of Information Technology and Management, Kerala (IIITM-K), Thiruvananthapuram, India

Aggarwal Alok School of Computer Science, University of Petroleum and Energy Studies, Dehradun, India

Aggarwal Shruti Department of Computer Science and Engineering, Chandigarh University, Gharuan, Punjab, India

Agrawal Alok Kumar Department of Computer Science and Engineering, Chitkara University Institute of Engineering and Technology, Chitkara University, Himachal Pradesh, India

Ahed Kaoutar IMAGE Laboratory, School of Technology (EST), Moulay Ismail University, Meknes, Morocco

Alam Naved Department of Computer Science and Engineering, Delhi, India

Anand R. Sona College of Technology, Salem, India;
Sri Eshwar College of Engineering, Coimbatore, India

Annapoorani S. Sona College of Technology, Salem, India

Anoop V. S. Indian Institute of Information Technology and Management, Kerala (IIITM-K), Thiruvananthapuram, India

Ansari Gufran Ahmad Department of Computer Application, B.S. Abdur Rahman Crescent Institute of Science and Technology Chennai, Chennai, Tamil Nadu, India

Arul Jebastin S. Sona College of Technology, Salem, India

Asharaf S. Kerala University of Digital Sciences, Innovation and Technology, Thiruvananthapuram, India

Ashu Mehta Lovely Professional University, Phagwara, Punjab, India

Asmitha U. Center for Computational Engineering and Networking (CEN), Amrita School of Engineering, Coimbatore, India

Bakshi Gaytri School of Computer Science, University of Petroleum and Energy Studies, Bidholi, Dehradun, Uttrakhand, India

Barot Apoorva K. J. Somaiya Institute of Engineering and Information Technology, Sion, Mumbai, India;
University of Mumbai, Mumbai, India

Batra Tanya Maharaja Agrasen Institute of Technology, New Delhi, India

Bedi Punam Department of Computer Science, University of Delhi, Delhi, India

Benamar Maria IMAGE Laboratory, School of Technology (EST), Moulay Ismail University, Meknes, Morocco

Bhargava Shubhangi Department of Computer Science and Engineering, MAIT, GGSIPU, Delhi, India

Bharti Vishal Chandigarh University, Punjab, India

Bhasin Vandana Lal Bahadur Shastri Institute of Management, Delhi, India

Bhatnagar Ashima JaganNath University, Haryana, India

Bindle Abhay Maharishi Markandeshwar Deemed to be University, Mullana, Ambala, Haryana, India

Birundha N. Sona College of Technology, Salem, India

Butt Muheet Ahmed Department of Computer Sciences, University of Kashmir, Srinagar, India

Chakib Darraz Applied and Marine Geosciences, Geotechnics and Geohazards Laboratory (LR3G), Faculty of Sciences Tétouan, Department of Geology, Abdelmalek Essaadi University, Tétouan, Morocco

Chakraborty Pinaki Department of Computer Science and Engineering, Netaji Subhas University of Technology, New Delhi, India

Chande Swati V. IIIM Jaipur, Jaipur, India

Chandrasekaran K. National Institute of Technology Karnataka, Surathkal, Karnataka, India

Chaudhry Rohil Deloitte USI, Hyderabad, India

Chauhan Surender Singh Department of Computer Science and Engineering, MAIT, GGSIPU, Delhi, India

Chawla Sunil Department of Computer Science and Engineering, Chandigarh University, Gharuan, Punjab, India

Chethana Savarala Department of Computer Science Engineering, Amrita School of Engineering, Amrita Vishwa Vidyapeetham, Bengaluru, India

Chhabra Yogesh CT University, Ludhiana, Punjab, India

Chitre Pravir School of Computing Science and Engineering, Galgotias University, Greater Noida, UP, India

Das Ayan Kumar Department of CSE, Birla Institute of Technology, Ranchi, India

Dhamija Ankit University of the People, Pasadena, USA

Dhamija Deepika Directorate of Online Education, Manipal University Jaipur, Jaipur, India

Dileep Kumar M. Faculty of Management Sciences, Nile University of Nigeria, Abuja, Nigeria

Diogo Ibrahima Applied and Marine Geosciences, Geotechnics and Geohazards Laboratory (LR3G), Faculty of Sciences Tétouan, Department of Geology, Abdelmalek Essaadi University, Tétouan, Morocco

Divakarla Usha NMAM Institute of Technology, Nitte, Karkala, Karnataka, India

Dwivedi Prateek Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh, India

Ebenezer V. Department of Electronics and Communication Engineering, Sona College of Technology (An Autonomous Institution), Salem, India

Edara Tharun Department of Computer Science and Engineering, M. S. Ramaiah Institute of Technology (Affiliated to, Visvesvaraya Technological Unversity), Bangalore, India

Edmond Kantagba Sharda University, Greater Noida, Uttar Pradesh, India

El Ouazzani Rajae IMAGE Laboratory, School of Technology (EST), Moulay Ismail University, Meknes, Morocco

Fayaz Sheikh Amir Department of Computer Sciences, University of Kashmir, Srinagar, India

Fouziya Sulthana S. SRMIST, Chennai, Tamilnadu, India

Ganugapati Sree Pranavi PES University, Bengaluru, India

Garg Bindu Department of Computer Engineering, Bharati Vidyapeeth's College of Engineering, Pune, India

Gautam Ritu Department of CSA, DAV University, Jalandhar, India

Gautam Shivani Department of Computer Science and Applications, Chitkara University School of Computer Applications, Chitkara University, Himachal Pradesh, India

Goel Rati ComputerScience-Data Science (AI) Department, ABES (IT) College of Engineering, Ghaziabad, India

Goel Ruchi Maharaja Agrasen Institute of Technology, New Delhi, India

Goud Suraj Gokaraju Lailavathi Womens Engineering College, Hyderabad, India

Gulati Tarun Maharishi Markandeshwar Deemed to be University, Mullana, Ambala, Haryana, India

Gupta Deepak Department of Computer Science and Engineering, MAIT, GGSIPU, Delhi, India

Gupta Ketan University of the Cumberlands, Williamsburg, USA

Gupta Pooja Department of Computer Science and Engineering, Maharaja Agrasen Institute of Technology, Delhi, India

Gururaj Manjula NMAM Institute of Technology, Nitte, Karkala, Karnataka, India

Habib Gousia Department of Computer Science and Technology, National Institute of Technology Srinagar, Srinagar, India

Harini S. Sona College of Technology, Salem, India

Harirajkumar J. Department of Electronics and Communication Engineering, Sona College of Technology (An Autonomous Institution), Salem, India

Hatode Pranali K. J. Somaiya Institute of Engineering and Information Technology, Sion, Mumbai, India;
University of Mumbai, Mumbai, India

Hemanth Kumar Reddy K. NMAM Institute of Technology, Nitte, Karkala, Karnataka, India

Honnavalli Prasad B. PES University, Bengaluru, India

Hussain Syed Zeeshan Department of Computer Science, Jamia Millia Islamia, New Delhi, India

Indhuja B. Department of Electronics and Communication Engineering, Sona College of Technology (An Autonomous Institution), Salem, India

Jadhav Shital Department of Computer Engineering, Bharati Vidyapeeth's College of Engineering, Pune, India

Jagedish Sakthivel Avinash School of Computing, SASTRA Deemed University, Thanjavur, Tamil Nadu, India

Jahnavi Davuluri Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Andhra Pradesh, India

Jain Sweta Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh, India

Jaswanth Kunisetty Department of Computer Science Engineering, Amrita School of Engineering, Amrita Vishwa Vidyapeetham, Bengaluru, India

Jatana Abhishek Lal Bahadur Shastri Institute of Management, Delhi, India

Jha Shiv Swaroop Amity College of Commerce, Amity University Haryana, Gurgaon, Haryana, India

Jitesh Department of Computer Science and Engineering Technology, Sharda University, Greater Noida, Uttar Pradesh, India

Jiwani Nasmin University of the Cumberlands, Williamsburg, USA

Joshi Nisheeth Department of Computer Science and Engineering, Banasthali University, Radha Kishnpura, Rajasthan, India

Kamboj Dalip M. M. Institute of Computer Technology and Bussiness Management MCA, Maharishi Markandeshwar (Deemed to Be University), Mullana, Ambala, Haryana, India

Kang Sandeep University Institute of Engineering, Chandigarh University, Ajitgarh, Punjab, India

Kashyap Abhijnana PES University, Bengaluru, India

Kathiravan K. Department of Electronics and Communication Engineering, Sona College of Technology (An Autonomous Institution), Salem, India

Kaul Sameer Department of Computer Sciences, University of Kashmir, Srinagar, India

Kaur Kamaljeet Star Academy, Yamunanagar, Haryana, India

Kaushal Priyanka Chandigah Group of Engineering College, Sahibzada Ajit Singh Nagar, Punjab, India

Kavya Duvvuri Department of Computer Science Engineering, Amrita School of Engineering, Amrita Vishwa Vidyapeetham, Bengaluru, India

Khalid Syed Sibtain Department of Computer Science and Engineering, Delhi, India

Kishor Kaushal Department of Information Technology, ABES Institute of Technology, Ghaziabad, Uttar Pradesh, India

Kishore Neha Department of Computer Science and Engineering, Chitkara University Institute of Engineering and Technology, Chitkara University, Himachal Pradesh, India

Kishore P. V. V. Department of ECE, Koneru Lakshmaiah Education Foundation, Guntur (DT), Andhra Pradesh, India

Kochhar Akanksha Department of Computer Science and Engineering, Maharaja Agrasen Institute of Technology, Delhi, India

Kotecha Radhika K. J. Somaiya Institute of Engineering and Information Technology, Sion, Mumbai, India;
University of Mumbai, Mumbai, India

Kothari Mrinal Department of Computer Science and Engineering, Maharaja Agrasen Institute of Technology, Delhi, India

Kumar Adarsh Department of Computer Science and Engineering, MAIT, GGSIPU, Delhi, India

Kumar Ambeshwar School of Computing, SASTRA Deemed University, Thanjavur, Tamil Nadu, India

Kumar D. Anil Department of ECE, PACE Institute of Technology and Sciences, Ongole, Andhra Pradesh, India

Kumar Pankaj Govt. College For Woman, Shahjadpur, Ambala, Haryana, India

Kumar Rahul Department of Computer Science and Engineering Technology, Sharda University, Greater Noida, Uttar Pradesh, India

Kumar Rishabh VIT Vellore, Vellore, India

Kumar Santosh Department of Computer Science, Himachal Pradesh University, Shimla, India

Kumari Tulika Shaheed Rajguru College of Applied Sciences for Women, University of Delhi, Delhi, India

Lavanya Dasetty Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Andhra Pradesh, India

Majithia Kinjal K. J. Somaiya Institute of Engineering and Information Technology, Sion, Mumbai, India;
University of Mumbai, Mumbai, India

Mathur Iti Department of Computer Science and Engineering, Banasthali University, Radha Kishnpura, Rajasthan, India

Mehdi Syed Ali Department of Computer Science, Jamia Millia Islamia, New Delhi, India

Meli D. Department of Mathematics and Computer Science, University of Catania, Catania, Italy

Milotta F. L. M. Department of Mathematics and Computer Science, University of Catania, Catania, Italy

Mishra Ankit VIT Vellore, Vellore, India

Mittal Kavita Department of Computer Science, JaganNath University, Haryana, India

Mittal Sarthak Department of Computer Science and Engineering, MAIT, GGSIPU, Delhi, India

Mittal Sumit M.M. Institute of Computer Technology and Business Management, Maharishi Markandeshwar (Deemed to Be University), Mullana, Haryana, India

Mohammed Ahmed Department of Computing Technologies, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Chennai, Tamil Nadu, India

Mudgil Pooja Department of Computer Science and Engineering, Banasthali University, Radha Kishnpura, Rajasthan, India

Nand Parma Sharda University, Greater Noida, Uttar Pradesh, India

Nandhini M. Department of Electronics and Communication Engineering, Sona College of Technology (An Autonomous Institution), Salem, India

Narain Tanushree Infosys Limited, Bangalore, India

Natarajan Rakshashri PES University, Bengaluru, India

Nayak Padmalaya Gokaraju Lailavathi Womens Engineering College, Hyderabad, India

Nayar Nandini Department of Computer Science and Engineering, Chitkara University Institute of Engineering and Technology, Chitkara University, Himachal Pradesh, India

Nguyen Quoc Hung University of Economics Ho Chi Minh City (UEH), Ho Chi Minh City, Vietnam

Pal Debdutta Department of CSE, Brainware University, Kolkata, India

Pandey Ayushi Computer Science -Data Science Department, NIET, Greater Noida, India

Pandey Dilkeshwar Department of Computer Science and Engineering, KIET Institute of Technology, Ghaziabad, India

Pandian A. Department of Computing Technologies, Faculty of Engineering and Technology, SRM Institute of Science and Technology, Chennai, Tamil Nadu, India

Parkash Dinesh M.M. Institute of Computer Technology and Business Management, Maharishi Markandeshwar (Deemed to Be University), Mullana, Haryana, India

Paul Subhra Prosun Department of Computer Science and Engineering, Chandigarh University, Gharuan, Punjab, India

Pawar Siddharth Department of Computer Science and Engineering, MAIT, GGSIPU, Delhi, India

Pham Van Hai Hanoi University of Science and Technology, Hanoi, Vietnam

Qureshi Shaima Department of Computer Science and Technology, National Institute of Technology Srinagar, Srinagar, India

R. Abhiram Gokaraju Lailavathi Womens Engineering College, Hyderabad, India

Raj Pragati Lovely Professional University, Phagwara, Punjab, India

Ramachandran Manikandan School of Computing, SASTRA Deemed University, Thanjavur, Tamil Nadu, India

Rambabu S. Department of ECE, Koneru Lakshmaiah Education Foundation, Guntur (DT), Andhra Pradesh, India

Rani Sita Department of Comuter Science and Engineering, Gulzar Group of Institutions, Khanna, Punjab, India

Ranjan Ravi Amity College of Commerce, Amity University Haryana, Gurgaon, Haryana, India

Rao Naseem Department of Computer Science and Engineering, Delhi, India

Rastogi Parth Department of Computer Science and Engineering, Maharaja Agrasen Institute of Technology, Delhi, India

Rattan Punam School of Computer Applications, Lovely Professional University, Phagwara, India

Renu Department of Commerce and Business Studies, Central University of South Bihar, Gaya, India

Riccobene S. Department of Mathematics and Computer Science, University of Catania, Catania, Italy

Rojal Shivam Lal Bahadur Shastri Institute of Management, Delhi, India

Roshan Tushar S. Center for Computational Engineering and Networking (CEN), Amrita School of Engineering, Coimbatore, India

Roy Kaustav Department of CSE, Brainware University, Kolkata, India

Sabeenian R. S. Department of Electronics and Communication Engineering, Sona College of Technology (An Autonomous Institution), Salem, India

Sachdeva Priya Amity School of Communication, Amity University, Noida, India

Sah Mithila Bihari Maharishi Markandeshwar Deemed to be University, Mullana, Ambala, Haryana, India

Sahu Deepti Department of Computer Science and Engineering Technology, Sharda University, Greater Noida, Uttar Pradesh, India

Sahu Priyanka University School of Information, Communication, and Technology, Guru Gobind Singh Indraprastha University, New Delhi, India

Sameer Rejeti Hima Department of ECE, Koneru Lakshmaiah Education Foundation, Guntur (DT), Andhra Pradesh, India

Santoro C. Department of Mathematics and Computer Science, University of Catania, Catania, Italy

Santoro F. F. Department of Mathematics and Computer Science, University of Catania, Catania, Italy

Sarada Jayan Department of Mathematics, Amrita School of Engineering, Amrita Vishwa Vidyapeetham, Bengaluru, India

Saritha Sri Khetwat Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh, India

Sasirekha N. Department of Electronics and Communication Engineering, Sona College of Technology (An Autonomous Institution), Salem, India

Saxena Naval Lal Bahadur Shastri Institute of Management, Delhi, India

Shanthi T. Sona College of Technology, Salem, India

Sharma Ankita Chandigarh University, Punjab, India

Sharma Manik Department of CSA, DAV University, Jalandhar, India

Sharma Moolchand Department of Computer Science and Engineering, MAIT, GGSIPU, Delhi, India

Sharma Pankaj Sharda University, Greater Noida, Uttar Pradesh, India

Sharma Ravish P.G.D.A.V. College, University of Delhi, Delhi, India

Sharma Sheetal Research Scholar, Rajasthan Technical University, Kota, India

Sheikh Tariq Hussain Department of Computer Science Institute, Government Degree College, Poonch, India

Shetty Rithvik Department of Computer Science and Engineering, M. S. Ramaiah Institute of Technology (Affiliated to, Visvesvaraya Technological Unversity), Bangalore, India

Shidaganti Ganeshayya Department of Computer Science and Engineering, M. S. Ramaiah Institute of Technology (Affiliated to, Visvesvaraya Technological Unversity), Bangalore, India

Shruti P. Department of Computer Science Engineering, Amrita School of Engineering, Amrita Vishwa Vidyapeetham, Bengaluru, India

Sidibe Diaka Minister of Higher Education, Scientific Research and Innovation, Former Higher Geology and Mines Institute, Boké, Guinea

Singh Amarpreet University Institute of Engineering, Chandigarh University, Ajitgarh, Punjab, India

Singh Amit Prakash University School of Information, Communication, and Technology, Guru Gobind Singh Indraprastha University, New Delhi, India

Singh Amritpal Lal Bahadur Shastri Institute of Management, Delhi, India

Singh Baljeet Lovely Professional University, Phagwara, Punjab, India

Singh Lakhvinder M. M. Institute of Computer Technology and Bussiness Management MCA, Maharishi Markandeshwar (Deemed to Be University), Mullana, Ambala, Haryana, India

Singh Ravinder Department of Computer Science, Himachal Pradesh University, Shimla, India

Soman K. P. Center for Computational Engineering and Networking (CEN), Amrita School of Engineering, Coimbatore, India

Sood Manu Department of Computer Science, Himachal Pradesh University, Shimla, India

Sowmya V. Center for Computational Engineering and Networking (CEN), Amrita School of Engineering, Coimbatore, India

Sridhar S. S. SRMIST, Chennai, Tamilnadu, India

Srinivas Prashanth Department of Computer Science and Engineering, M. S. Ramaiah Institute of Technology (Affiliated to, Visvesvaraya Technological Unversity), Bangalore, India

Sriramulu Srinivasan School of Computing Science and Engineering, Galgotias University, Greater Noida, UP, India

Srivastava Utkarsh Department of Computer Science and Engineering, Maharaja Agrasen Institute of Technology, Delhi, India

Suganthi S. PES University, Bengaluru, India

Sujatha M. Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Andhra Pradesh, India

Suneetha M. Department of ECE, Gokaraju Rangaraju Institute of Engineering and Technology, Kukatpall, India

Tammineni Sai Chandu Department of Computer Science and Engineering, M. S. Ramaiah Institute of Technology (Affiliated to, Visvesvaraya Technological Unversity), Bangalore, India

Tanveer Safdar Department of Computer Science and Engineering, Delhi, India

Tanwar Rashi CT University, Ludhiana, Punjab, India

Thanigaivelu P. S. SRMIST, Chennai, Tamilnadu, India

Thomas J. V. Department of Electronics and Communication Engineering, Sona College of Technology (An Autonomous Institution), Salem, India

Tilioua Amine Thermal and Applied Thermodynamics (2.T.A.), Mechanics, Energy Efficiency and Renewable Energies Laboratory (L.M.3.E.R.), Faculty of Sciences and Techniques Errachidia, Department of Physics, Moulay Ismael University of Meknès, Errachidia, Morocco

Tiwari Sarvesh Nath Maharaja Agrasen Institute of Technology, New Delhi, India

Tran Le Phuc Thinh University of Economics Ho Chi Minh City (UEH), Ho Chi Minh City, Vietnam

Truong Viet Phuong University of Economics Ho Chi Minh City (UEH), Ho Chi Minh City, Vietnam

Varshney Devina VIT Vellore, Vellore, India

Vasudeva Amol Department of Computer Science and Engineering, Jaypee University of Information Technology, Waknaghat, Himachal Pradesh, India

Verma Ritika Department of Computer Science and Engineering, MAIT, GGSIPU, Delhi, India

Verma Romil Deloitte India, Gurugram, Haryana, India

Vikram N. Department of Electronics and Communication Engineering, Sona College of Technology (An Autonomous Institution), Salem, India

Visweeshwaran V. Department of Electronics and Communication Engineering, Sona College of Technology (An Autonomous Institution), Salem, India

Vora Viraj K. J. Somaiya Institute of Engineering and Information Technology, Sion, Mumbai, India;
University of Mumbai, Mumbai, India

Walia Pavitra Maharaja Agrasen Institute of Technology, New Delhi, India

Whig Pawan Vivekananda Institute of Professional Studies, New Delhi, India

Yadav Savita Department of Computer Science and Engineering, Netaji Subhas University of Technology, New Delhi, India

Yatender Department of Computer Science and Engineering Technology, Sharda University, Greater Noida, Uttar Pradesh, India

Zaman Majid Directorate of IT & SS, University of Kashmir, Srinagar, India

Comparative Analysis of Image Segmentation Techniques for Real Field Crop Images

Shital Jadhav and Bindu Garg

Abstract Nowadays various applications are available for plant disease identification using images. Early-stage disease identification can reduce losses and cost in cultivation. Efficient image segmentation is required to improve the performance of plant disease identification. Selecting appropriate segmentation techniques to extract an accurate object of interest while preserving original image properties is a challenging task. This paper presents the principle of image segmentation covering different techniques from traditional thresholding to the latest convolutional neural network-based approach. We reviewed the selected paper based on image segmentation and crop disease identification. Various algorithms are grouped based on the working principles like edge-based, region-based, and combining both properties. Performance evaluation of these algorithms was carried out using factors like time required, accuracy, and similarity to the original image. Holistic image segmentation based on convolutional neural network, K means clustering, etc. algorithms applied to real field crop images. The grab cut algorithm proves very useful for real field crop image segmentation as it preserves original image properties. Combining region and boundary-based techniques and automating segmentation need to be explored in future research work.

Keywords Machine vision · Image processing · Deep learning · K means clustering · Grabcut

S. Jadhav (✉) · B. Garg
Department of Computer Engineering, Bharati Vidyapeeth's College of Engineering, Pune 411043, India
e-mail: shital.jadhav@bharatividyapeeth.edu

B. Garg
e-mail: brgarg@bvucoep.edu.in

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1 Introduction

The digital image provides several techniques for the interpretation of images using the computer. Data captured through different image sensors are inadequate for processing due to capturing conditions like distance, lighting, and noise. Depending on the type of application algorithms are applied to extract useful information with different steps in image processing like pre-processing, image transformation, segmentation, and classification. Image segmentation is the process of partitioning digital images into multiple regions and extracting meaningful regions which are known as a region of interest (ROI) specific to the application. Separating the foreground from the complex background is a challenging task. Till now there is no specific algorithm present that can be universally applied to all images. Depending on the requirement it is required to select the appropriate algorithm [1].

The image segmentation problem is well addressed by various methods based on pixel and edge properties. Image segmentation requires an in-depth understanding of image representation and the principle behind various algorithms. Real field crop image segmentation is challenging due to the complex background around leaves of interest.

The paper will help in answering the following research questions.

i. What are the standard practices of image segmentation?
ii. What are different image segmentation techniques for the real field crop images?
iii. How to do a comparative analysis of various segmentation techniques?
iv. How does the Convolutional Neural Network (CNN) based model work in image segmentation?
v. Which major challenges in present segmentation techniques need to be explored in the future?

This paper in the first section presents a comparative analysis of image segmentation, and how it could be used in agriculture. In the second section feature and segmentation-based paper is reviewed. The third section presents the algorithm working principle. The fourth and fifth section covers the evaluation of all categories of algorithm, results, and future challenges.

Categories of Image Segmentation

See (Table 1).

2 Literature Survey

Image processing is used for the early identification of plant disease and severity levels. Jayme categorically evaluated techniques in the present literature [12]. During

Table 1 Popular algorithm for image segmentation

Approach	User interaction	Technique
Non-contextual/boundary based	Automatic threshold detection with histogram analysis	Thresholding [2]
	Automatic object boundary detection with threshold	Edge detection [2, 3]
	Semi-automatic application-specific shape knowledge in advance	Active contour /snake model [4]
Contextual/region-based	Semi-automatic user required to initialize seed point	Region growing [5, 6]
	Semi-automatic user required to initialize the number of cluster K	KNN, K means clustering [6]
	Semi-automatic users should know the number of clusters in advance	FCM clustering [7, 8]
	Semi-automatic require to select seed point for an object as well as for background	Watershed [4]
Both contextual, non-contextual/region and doundary based	Semi-automatic user required to draw a bounding box around the object	Grab cut/min cut/maxcut [9, 10]
	Automatic segmentation with the training of a large number of images	Deep neural network [11]

a literature survey, we identified papers on segmentation techniques, and plant disease classification using segmentation and analyzed them categorically.

2.1 Edge-Based Segmentation Using Thresholding and Histogram Analysis

Kusuma Mega et al. perform a comparative analysis of edge detection algorithms by Sobel, Prewitt, Robert, and laplacian. Berkeley segmentation data set is evaluated in different color space hue, saturation, and value (HSV). In the first stage, the image was transformed from RGB to HSV color space, in the next stage four types of edge detectors were applied to the image, and finally mean square error and root mean square error peak signal to noise ratio and extraction time were used for comparison. Evaluation of four algorithms proved Robert edge detectors produce less error in the hue channel compared to other algorithms [2]. Meenakshi Sood et al. applied histogram equalization to highlight disease signatures for seven types of capsicum diseases. Texture-based features like homogeneity, contrast, correlation, energy, and entropy to extract features [13].

Hong Shen et al. used binarization of image gray color histogram to filter noise using a median filter. This masked image was applied to the original image to extract leaves. Color ranges for specific diseases set and extracted leaves analysis carried out to detect types of disease [14]. Sausbrol et al. used texture, color, as well as shape-based features to classify using traditional decision tree algorithms [15]. Petrellis [16] used the threshold and histogram-based segmentation method and developed a lightweight model for mobile phones. Mask applied to plant leaves to analyze each pixel, where if the grey level of pixel exceeds threshold identified as disease spot. Images labeled with 0 background color, 1 normal leaf, and 2 for a spot called background normal spot (BNS). Colored histogram analysis was used for three types of specific diseases powdery mildew. The number of images considered for feature selection was five from each category. Practically it is not possible to address multiple categories of disease by using this technique. Yu Yang et al. used real field maize images for tassel detection, in the first stage light saturation correction algorithm later ltti salience-based method was used to preprocess image texture-based features used to identify an area of interest [17].

Muhammad khan proposed a multistage approach for apple disease identification. Thresholding is used to segment images and correlation between color extract features later support vector machine (SVM) classifiers used to identify the type of disease [18]. Elysse Joy et al. efficiently used the approach of masking green pixels for segmenting leaves [19]. SVM is a fast and accurate classifier Pawar et al. used to classify cotton disease for texture and color-based features [20].

2.2 Region-Based Segmentation

Contour and clustering-based algorithms are popular for the analysis of images since contextual information is preserved in these algorithms. Yashwant Kurmi et al. proposed an improved algorithm to extract information with segmentation for crop disease identification. The seed point of the image is identified with the thresholding and region growing algorithm used to find the object boundary. A new localization-based algorithm with stages is proposed to enhance accuracy [5]. Qi Zhang carried out work to automatically determine the value of K in a K-means clustering algorithm. The input RGB image is transformed to L*a*b where L is the lab color space. Transformation converts A component lab color space to red and C.M.Y color space. Instead of setting the initial value of K manually, the traditional K means clustering algorithm improved for automatic detection of K value. Initially, K is set to two and the resultant image is compared for intraclass similarity, if this similarity is greater than the threshold then the split image. Apart from providing an automatic selection of K, the proposed algorithm gives more segmentation accuracy but in the future work could be carried out to improve the value of K [6].

Guoxiong Zhou et al. detect rice disease using real field images. The first stage of the proposed algorithm denoise images using 2D FM-AMMF (Two-dimensional filter mask with a weighted multilevel median filter). The traditional 2D otsu algorithm decomposes into two 1D dimensional otsu algorithms, in order to reduce storage and improve speed [7]. FCM-KM clustering algorithm generates cluster images, used for training RCNN. Results prove preprocessing and segmentation improve the performance of R-CNN. Vijai Singh et al. used features extracted by color contrast, Energy, and Homogeneity. Extracted features used to identify regions of interest are based on clustering chromosomes, the principle of the genetic algorithm [21]. Bai X et al. remove background from real field leaf images using morphological features and watershed algorithms. Solidity parameter established which is nothing but the ratio of extracted area and convex area for leaf Integrity checking. The fuzzy C mean (FCM) clustering algorithm determines membership fuzziness based on the grayness of the pixel. The constraint for the input image is that it should place the infected leaf in the center, otherwise the algorithm would not work correctly [22]. Bin Liu et al. speed up FCM clustering by implementing an algorithm on distributed computing platform Apache Spark to speed up the processing of agriculture big data [23].

2.3 Edge and Region-Based Segmentation

2.3.1 Grab Cut

Jayme Garcia et al. identified various challenges in real field crop disease identification. Different image-capture conditions of in-field images affect the accuracy of training and testing models. Manual segmentation is applied for real field images, and this separates leaves from the background which is complex due to the green and soil in the surrounding [24]. Dina Khattab et al. improved segmentation results by automating the grab cut algorithm. To identify bounding boxes around region K means or FCM clustering algorithms are used. Initially, the image is considered as one region. By applying clustering it separates foreground and background. Then initialized covariance in a gaussian mixture model with five color components in a clustered image. Most likely the color component was selected to draw a graph around the object. Then this graph is used as a bounding box for the GrabCut algorithm [9]. Yonghua Xionga et al. considered real field conditions, and the requirement of analyzing images captured in a field with a complex background. Rectangle box initialized near to entire image size ten Grab cut algorithm modified by using hyper green pixel algorithm to adjust around the object of interest. Since leaves have more green components than the background. Augmented dataset with lab and field images fed to Mobilenet CNN for identifying the type of disease [10].

Christian Ries et al. proposed an automatic approach for detecting bounding boxes around the object of the image. Pixel color features and local visual features used by structured learning proposed algorithms evaluated for real field images [25].

2.3.2 Convolutional Neural Network

Plant disease classification using neural network-based approaches requires a large amount of data; for training, it is divided into the train, validate, and test sets. Different standard architectures like VGG are trained and validated for performance and accuracy by many researchers in the field of agriculture data. Muhammad Saleem et al. in their survey paper evaluated around twenty CNN architectures[11]. Nagaraju et al. tried to answer how CNN improved by fine-tuning hyperparameters like activation function, optimizers, etc. The current limitation of CNN is the huge amount of training data and time [26]. Marko Arsenovic et al. proposed a model to expand limited training data with help of a generative adversarial network (GAN) for different plant species [27]. Alvaro F. Fuentes et al. performed preprocessing and fine-tuning of AlexNet and VGG16 Net for six diseases data for Tomato crop for 13,262 images [28]. Amara J et al. proposed a method using LeNet for banana crop disease identification, images pre-processed with Red, Blue, Green (RBG), and gray color scale. LeNet extracts features automatically by applying layers of convolution and pooling with relu activation function. The final fully connected layer uses the softmax activation function to map extracted features to classes [29]. Brahimi et al. used pre-trained ImageNet architecture to reduce training time [30]. Srdjan Sladojevic et al. in their work used CaffeNet for three types of crops peach, apple, and grape and augmentation was performed to expand the dataset [31].

Vishal Raman et al. identified possible challenges in object detection using segmentation with deep learning. Lens flare, blurring of the image, darkening of image corner, blending and viewpoint of person capturing image affect results [32]. Emanuel Cortes et al. in his work used twenty-five crop species and unnecessary background removed with help of segmentation and semi-supervised GAN [33]. Saining Xie et al. proposed holistic edge detection performs better than traditional canny edge detection, deepNet, deepContour algorithms, etc. This approach based on a deep convolutional neural network requires more training time [34]. Sharada P. Mohanty et al. classified fourteen crop types and twenty-six diseases for an image in laboratory environments with an accuracy of 99%. If the same model is used for real field images accuracy reduces drastically to 31% [35]. DeChant et al. worked on real field maize crop images. Five CNN algorithms were used in three stages to analyze heat maps of images taken from the distance of the entire plant [36]. Apeksha Thorat et al. proposed an Internet of things (IoT) based prototype to capture images from the field and raspberry pi to deploy models in the agriculture field [37]. Bindu Garg et al. comparatively analyzed the scope of using IoT and cloud computing for agriculture data collection and processing [38].

3 Segmentation Techniques Details

3.1 Thresholding

In Simple thresholding.

a. In Binary thresholding Image g scan all pixels g (i, j)
b. If pixel property g (i, j) > Threshold then it is an object otherwise background.

Bimodal histogram and multimodal histogram analysis are threshold selection methods. Otsu thresholding comparatively fast, analyses threshold value using the histogram. Threshold selection maximizes the variance between classes and minimizes within the class. Adaptive thresholding selects multiple threshold values within the image for local property selection instead of a single global threshold [1].

3.2 Edge Based Segmentation

This technique uses various edge detection operators applied to image and construct object boundaries. A prerequisite for applying the algorithm is to convert a color image to a grayscale image [1].

a. 8 connectivity determines the direction of edges.
b. Each non-zero intensity pixel examines neighboring pixel intensity.
c. If a neighboring pixel has a larger intensity pixel under consideration marked for deletion.
d. After scanning all pixel rescan images to delete all non-edge pixels marked for deletion.

By differing approaches of using connectivity and pixel intensity selection, many variations of this algorithm exist such as edge relaxation, border tracing, border detection as graph search, and dynamic programming. Prewitt, Robert, Laplacian, canny, etc. are initially popular algorithms [2].

3.3 Region-Based Segmentation

K means clustering is unsupervised learning used to identify color clusters [6].

a. Assign K data points to K different clusters.
b. Reassign all points to the nearest random cluster center.
c. Recalculate cluster centers.
d. Iterate steps b and c till the cluster center stops changing.

3.4 *Both Boundary and Region-Based Techniques*

3.4.1 Holistic Edge Detection

a. Formulate training data set S = { (I_n, G_n), n = 1,2,——N}where I is the set of input images G is the set of ground truth binary Image edge maps.
   M is a number of output classes.
b. Activation functions in algorithms adjust the weight of intermediate layers to map I input to M output with several iterations. Each image holistic edge detector introduces class balancing weight B which is offset to balance between edge and non-edge. This is a fusion with the regular algorithm. Each hidden layer generates an edge map for the next layer.
c. Backpropagation readjusts the fused weight and ground truth map.
d. During the testing phase, the regular output layer and weight fusion layer aggregated to generate the final edge map [34].

3.4.2 Grab Cut Algorithm

In algorithms based on iterative graph cut algorithms, the user defines a rectangle bounding box around the object. This box is treated as an image with background and foreground, and the task is to separate the background from the foreground [9, 10].

a. Gaussian mixture model (GMM) is used to build objects, where in image 0 for the background and 1 for the foreground.
b. Vector u = (u1, u2, …,ui) represents the independent GMM parameter of each image pixel.
c. Gibbs energy function expressed with

E (, u, , k) = L (, u, , k) + G (, k) (1)

L is the regional energy, G is the boundary energy that can be obtained by euclidean distance, and k is the pixel intensity.

4 Evaluation and Discussion of Segmentation Techniques

The execution platform is Ubuntu 18.04, Jupyter Notebook, Intel Core i5 7400 CPU 3.00 GHz, RAM: 7 GB. We took a real field true-color RGB image to experiment with a popular image segmentation method. We evaluated results with time and accuracy. Four types of images are considered for experimentation of resolution 224*224. Images vary in size from 21 to 150 kb depending of information content.

Original Image	**Simple Thresholding**	**Otsu Thresholding**	**Adaptive Thresholding**	**Gaussian Adaptive Thresholding**
				
Processing Time	2.217 292	0.00013	0.000259	0.00112

Fig. 1 Output of different Thresholding techniques

4.1 Boundary Based Techniques

4.1.1 Thresholding

The original image after applying simple thresholding generates an image that has a thickening boundary effect and slows since each pixel is evaluated individually. Ostu is comparatively faster but fails to detect local image edges. Adaptive thresholding improves results within region-specific edge detection. Gaussian mixture with adaptive thresholding improves results for the identification of image boundaries (Fig. 1).

4.1.2 Histogram Analysis

Color histogram plots red, green, and blue (RGB) color channel frequency of pixels separately. Leaf image has a single object image with a uniform background that generates a single peak in each color channel. Whereas a fruit bunch image two peaks identifying fruit and stem (Fig. 2).

4.1.3 Comparison of Edge Based Segmentation and Neural Network-Based Technique

Input images with uniform background algorithms generate edge borders, for given two images canny edge detection losses some part of border information. Convolutional neural network-based holistically-nested edge detection (HED) identifies boundaries correctly (Fig. 3).

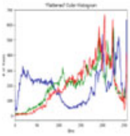
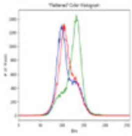
Fruit bunch Image	Fruit bunch Image Color Histogram	Leaf Image	Leaf Image Histogram
			

Fig. 2 Output of color histogram analysis

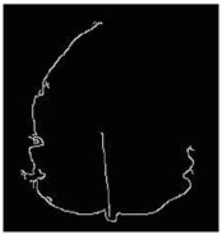
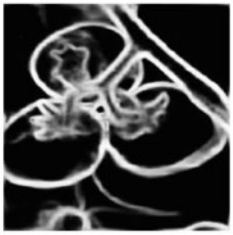
Original Image	Canny Edge detection	holistically-nested edge detection (HED)
		
		

Fig. 3 Output of canny and holistically-nested edge detection (HED)

4.2 Region-Based Techniques

4.2.1 K Means Clustering

Four images Leaf Healthy, Leaf Diseased, Fruit bunch, and real field Crop with Complex background evaluated by changing the value of K. When K is two algorithms generate binary images. When K is ten it is near to the original. When K is sixteen the error is very small, sometimes zero too. The disadvantage of this method is that for a real field complex images taken from longer distances lose many color features (Fig. 4).

4.2.2 Performance Evaluation of K Mean Clustering

Computed execution time, the mean squared error (MSE), and structural similarity index for the images (SSIM).

Two images with the same dimension use the sum of the squared difference to calculate Mean Squared Error

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i, j) - K(i, j)]^2 \tag{1}$$

where m is the number of rows and n is the number of columns. I is the original image, and K is the clustered image.

The structural similarity index (SSIM) of images uses structural features. Values of MSE and SSIM are different but effective in correlating the two images.

$$SSIM(a, b) = \frac{(2\mu_a\mu_b + c_1)\left(2\sigma_{xy} + c_2\right)}{\left(\mu_a^2\mu_b^2 + c_1\right)\left(\sigma_a^2 + \sigma_b^2 + c_2\right)} \tag{2}$$

where (a, b) is the location of the M*M window in each image. All data points (a, b) pixel intensities mean, variance, and covariance were used for calculating SSIM (Table 2).

4.3 Both Boundary and Region-Based Techniques

Grab Cut Algorithm

The algorithm was evaluated first for leaves with uniform background and fruit bunch. Foreground extraction is fast but accuracy gets affected if an image is not symmetric and has overlapping regions. For leaf health, the foreground is extracted correctly but for leaf disease in which the object is slanted, the background is also detected as the foreground. In the fruit bunch, little space between overlapping region algorithms is detected as foreground (Fig. 5).

Real-time field images can be isolated from the background by using a palm. This input image is applied with a grab cut algorithm to extract the foreground leaf image. Users must specify a rectangle around the area of interest (Fig. 6).

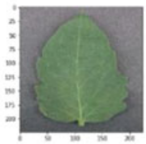
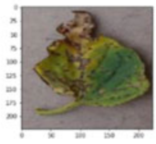
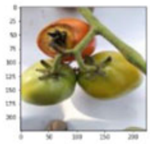
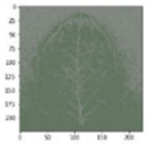
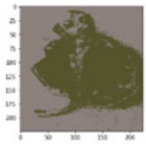
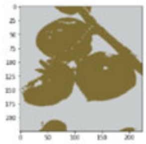
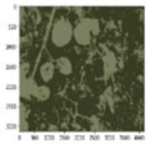
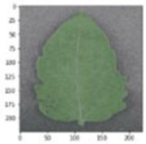
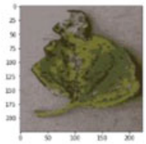
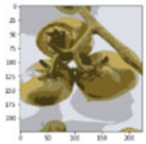
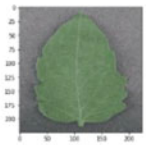
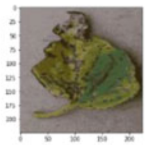
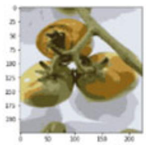
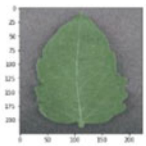
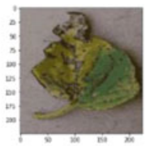
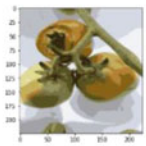
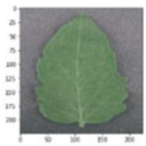
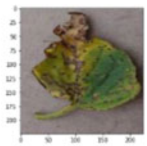
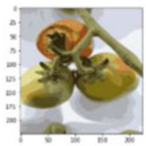
Time Required	Leaf Healthy	Leaf Diseased	Fruit bunch	Field Crop
Original Image				
Single Image K=2				
Single Image K=6				
Single Image K=10				
Single Image K=12				
Single Image K=16				

Fig. 4 Original and output of comparative analysis of K mean clustering

Table 2 Performance evaluation of K mean clustering

No. of clusters	Leaf healthy			Leaf diseased			Fruit bunch		
	Time	MSE	SSIM	Time	MSE	SSIM	Time	MSE	SSIM
K = 2	0.061	107.9	0.80	0.044	190.6	0.71	0.051	624.6	0.72
K = 6	0.24	129.4	0.88	0.49	36.08	0.90	0.18	129.8	0.88
K = 10	0.40	80.19	0.89	0.50	21.40	0.93	0.34	80.19	0.89
K = 12	0.43	54.62	0.90	0.65	18.05	0.94	0.35	54.62	0.90
K = 16	0.60	39.95	0.91	0.89	00.00	1.00	0.53	39.95	0.91

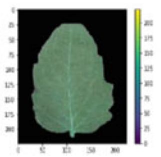
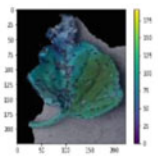
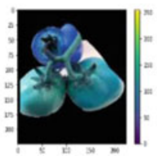
	Leaf Healthy	Leaf Diseased	Fruit bunch
Original Image			
Result of Grab Cut Algorithm			
Time	0.6457	0.6619	0.572

Fig. 5 Output of Grab cut algorithm for uniform background images

5 Future Scope

a. The Majority of work addressed gray-level thresholding and optimizing threshold value. Biomedical and crop disease identification require extracting features based on color. Multilevel thresholding and optimizing multiple values are challenging for a variety of images [16].

b. Color histogram analysis is used by the majority of applications but two different images can have the same histogram. Histogram analysis could be used with other shape and texture-based algorithms for future work [2].

c. Region and edge-based algorithms have inherent pros and cons. Clustering-based algorithm complex to implement for multi-object image, as well as result vary due to change of image capture condition. Edge-based techniques generate

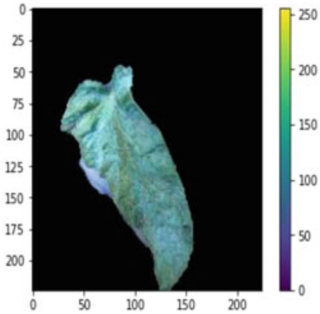
Original In Field Image without detaching from plant	Leaf detected after Grabcut algorithm
	
Time Required	0.5571

Fig. 6 Output of Grab cut algorithm for real field image

ambiguous results due to noise in the image, objects proportionally smaller than the background, and non-uniform lighting. A combination of both techniques improves image segmentation quality since region-based methods focus on context and edge-based methods on boundary information [39].

d. Semi-automated algorithms require initial information from users like a bounding box or value of number of clusters. Fully automating image segmentation with help of machine learning is the latest research arena [25].

e. The convolutional neural network-based algorithm gives more accurate results but requires an understanding of complex algorithms. Training time is large and computational resources must be available [11, 40].

f. Problem of plant disease identification is explored by many researchers but the majority of work uses images captured under uniform lighting, and coherent background in the lab. Segmenting areas of interest from the image in the real field need to be addressed for a huge variety of images [10, 24].

6 Conclusion

This paper has reviewed and analyzed different segmentation algorithms for crop disease identification. Standard practices of image segmentation like thresholding are fast and simple to use. Adaptive thresholding methods remove inference in the image due to background. Multicolor histogram analysis improves the performance of the region-based segmentation algorithm. A convolutional neural network-based holistic edge detector identifies boundaries near to human observers. K means clustering can identify image clusters near to the original image. But for complex images, it deteriorates image information. The grab cut algorithm preserves original image information but image angle and rectangular bounding box affect accuracy. Therefore future work will be conducted on automating grab cut algorithms for bounding box selection using graph or clustering-based techniques.

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Sentiment Analysis of COVID-19 Vaccines

Amritpal Singh, Vandana Bhasin, Abhishek Jatana, Naval Saxena, and Shivam Rojal

Abstract Social media is invariably being used these days for exchanging information and views on global affairs including COVID-19 pandemic. In this study, we have worked to understand the public attitudes of people in different countries towards COVID-19 vaccines using social media platform Twitter. We have applied natural language processing techniques of sentiment analysis to get an insightful outlook on people's views. Hence, we categorized our results into fine-grained polarities to grasp the exact sentiment. For analyzing the sentiments, we have taken tweets that expressed sentiments for all countries, as well as for four countries that had higher fatality rates are United States of America, Mexico, Brazil and India. The people have expressed a neutral opinion towards the vaccines. Based on the sentiment, the vaccines were also ranked in which the people have expressed more faith in Sputnik V and Covishield vaccines.

Keywords COVID-19 · COVID-19 vaccine · Sentiment analysis · Vaccines · Tweepy · Twitter

A. Singh · V. Bhasin (✉) · A. Jatana · N. Saxena · S. Rojal
Lal Bahadur Shastri Institute of Management, Delhi, India
e-mail: vandanabhasin@lbsim.ac.in

A. Singh
e-mail: amritpal_singh-mca20@lbsim.ac.in

A. Jatana
e-mail: abhishek-mca20@lbsim.ac.in

N. Saxena
e-mail: naval_saxena-mca20@lbsim.ac.in

S. Rojal
e-mail: shivam_rojal-mca20@lbsim.ac.in

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1 Introduction

The world has gone through a tremendous turmoil with the outbreak of pneumonia-like disease, coronavirus. This unprecedented health issue has brought forth uncalled lockdowns and marked effect on the economies of the world. In December 2019, the virus SARS-COV-2 became a public health emergency whose outbreak had started in Hubei Province, Wuhan, China. In February 2020, WHO (World Health Organization) called the disease COVID-19 and declared it a global pandemic [1]. The two major reasons that led to the spread of the disease were its highly contagious nature and its numerous variants along with public's nonadherence to guidelines related to wearing masks and maintaining social distance. This distress increased with many asymptomatic cases who were carriers of disease and resulted in the infection spreading over a period of time [2]. The coronavirus resource center of John Hopkins University indicates that virus has infected over 243 million people all over the world and has taken lives of more than 4.9 million people [3]. This outbreak became so difficult to handle that the only feasible solution visible was to develop vaccines. Pfizer/BioNtech Company made the first vaccine, which was approved for usage amongst all communities. It was authorized for use by the people of United Kingdom. The authors in these papers have put forth the development process of the vaccines, their different varieties and the front runner vaccine candidates [4, 5]. The vaccination drives worldwide have been able to vaccinate 68.02 million people [3]. The Indian government has also achieved a feat of being able to vaccinate 100 crore people.

As such the governments' only hope of controlling the viral spread was public acceptance of safe and efficacious vaccines. The vaccination process has been under tremendous pressure due to hesitancy, distrust and debate. This hesitancy of the public towards the vaccine has been projected by WHO as one of the top 10 global health threats. This hesitancy clubbed with substantial rumors is the biggest obstacle in achieving mass vaccinations of population to bring in herd immunity [6, 7].

The original method of gauging the opinions of people was through surveys and other traditional methods. Even though these traditional methods could be used to gauge the willingness of individuals to get vaccinated but the dynamic nature of the sentiment would be missing. Hence, instead of applying the traditional methods of data collection, we have explored the data from social media, so that public sentiments and attitudes could be gauged in real time [8]. This study is conducted to understand the general public psychological frame of mind towards vaccines using social media. As is reflected, half of the world population is on social media, where India itself has 448 million active social media users [9]. However, the data on social media are largely unstructured, and hence we have used natural language processing to extract tweets from Twitter. We have initially taken tweets from all over the world to perform sentiment analysis. Then we have retrieved tweets for four countries where the fatality rates were high. These countries include—India, United States of America (US), Brazil and Mexico including sentiment analysis for entire dataset.

Sentiment analysis is a process where the subjective opinions are extracted and categorized using text, audio and video sources to determine polarities and subjectivities, feelings, or states of mind towards target issues, themes or areas of relevance [10]. These approaches can be used by the medical arena as well as by the government for public policy research. The main contribution of this study can be summarized as.

- To classify the sentiments of people around the globe for COVID-19 vaccines—AstraZeneca, Sputnik V, Covishield, Covaxin, Moderna and Pfizer including four countries—India, US, Mexico and Brazil.
- To perform word cloud mapping to monitor the frequency of highly used words.
- Rank the vaccines according to the sentiment of the people.

2 Related Literature

The posts on social media express the views and opinions of the public in an unadulterated and unstructured form. So, the researchers have been using this platform extensively as the unbiased opinion of public is available easily. Twitter is amongst those social media platforms that have received posts reaching up to millions. A lot of research work has been carried out using twitter dataset on different areas of COVID-19 pandemic.

In this paper, the authors have applied an artificial intelligence-based approach using 3,00,000 social media posts from Facebook and other platforms for United Kingdom and United States [8]. They have used the natural language approach to predict average sentiments, trends and have also found their topics/themes. They have identified the positive, negative and neutral sentiments for both the countries and correlated their findings. They have identified the optimism of the public related to vaccines as well as their safety and economic viability. They even compared their results with nationwide surveys.

Glowwacki et al. analyzed the Twitter dataset to examine the addiction concerns during COVID-19 pandemic in US and other countries [11]. Their work was focused on two keywords—covid and addiction. They were able to bring forth 14 topics prevalent during that time using 3301 tweets. The authors highlighted the public discussions that were happening on Twitter related to addiction for consideration from the health management authorities but did not base their study on addictions due to COVID-19.

The authors have performed an exploratory study to find out the public sentiment towards the effectiveness of a mask for prevention of COVID-19 [12]. They performed this analysis using tools like natural language processing, sentiment analysis and clustering. The clustering technique helped in classifying high-level themes and fifteen subtopics within each of these themes. They found that initially there were negative trends towards wearing masks in each of the themes. These trends are an indication for gaining deeper insights to public fears and address them appropriately by government bodies.

The authors have carried out a study where they collected sentiment of people of Filipinos from the social networking site, Twitter. They used Naïve Bayes model to annotate and train their data for English and Filipino languages using the RapidMiner data science software [13]. They were able to achieve an accuracy of 81.77% for classifying tweets into positive, negative and neutral polarity.

This work is closest to our work but the authors have performed it only for their country, Filipinos whereas we have targeted countries on the basis of their highest death rates. In our work, we have analyzed 4000 live tweets for six vaccines from four countries as well as textual data pertaining to all countries to comprehend the public opinions. The swing of the public mood towards vaccines would bring an important insight for governments specially for countries where the fatalities have been very high.

3 Methodology

Researchers all over the world want to understand erratic aspects of COVID-19 pandemic. In our study, we have explored the sentiment of people towards COVID-19 vaccines. The workflow of our research methodology is shown in Fig. 1. We have first collected 24,000 live tweets in English language from Twitter that were related to COVID-19 vaccines initially without bifurcating tweets for any country. We were interested in exploring six vaccines–Moderna, AstraZeneca, Sputnik V, Covishield, Pfizer and Covaxin and for each vaccine we retrieved 4000 tweets.

In the first phase of data collection, we first collected tweets on a global basis to understand an overall perspective throughout the globe. Then, we retrieved tweets by filtering them with their countries to perceive cross-cultural polarity. The four countries that we selected were India, United States, Mexico and Brazil as the fatality rates in these countries were high.

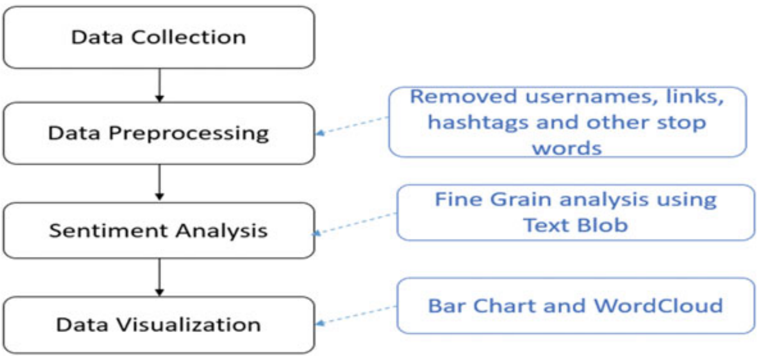


Fig. 1 Different phases of sentiment analysis in our study

The data were then preprocessed to collect hashtags required for sentiment analysis. Fine-grained sentiment analysis is then performed on the tweets to get different classification of the vaccines. Finally, the data were visualized using different representations. In the next section, we explain each step in detail that we have taken to perform the sentiment analysis.

3.1 Twitter Authentication

In order to retrieve data from the Twitter account, we extracted tweets using Twitter API, Tweepy. This involved an authentication process where in a Twitter developer account was created. Tweepy was accessed using Python (V 3.7.3) programming language.

The authentication object was subsequently invoked to facilitate the authentication process. It fetched two values—access token and its corresponding token key. Hence the token secret was created, completing the authentication process. Figure 2 illustrates the Twitter authentication process using a flowchart and, in the next section, we describe data collection.

3.2 Data Collection

After extracting tweets related to vaccines from Twitter, we collected hash tags related to various vaccines. For each country, we have collected 4000 live tweets for each vaccine, which implies that 24,000 tweets were collected for each country. Since we have collected tweets for four countries the total tweets that we extracted was 96,000. In addition, we also extracted tweets for all countries which were again 4000 live tweets for six vaccines, hence a total of 120,000 tweets were extracted. We have used Tweepy library for mining of data. The hashtags related to vaccines are listed below.

- Moderna–#moderna. #modernavaccine
- AstraZeneca–#AstraZeneca, #astrazenecavaccine, #oxfordvaccine
- Sputnik V–#SputnikV, #sputnik, #SputnikLight
- Covishield–#covishield, #covishieldvaccine, #covishieldsideeffects
- Pfizer–#Pfizer, #PfizerVaccine
- Covaxin–#Covaxin, #Covaxinvaccine

Next, we discuss the preprocessing of the extracted tweets.

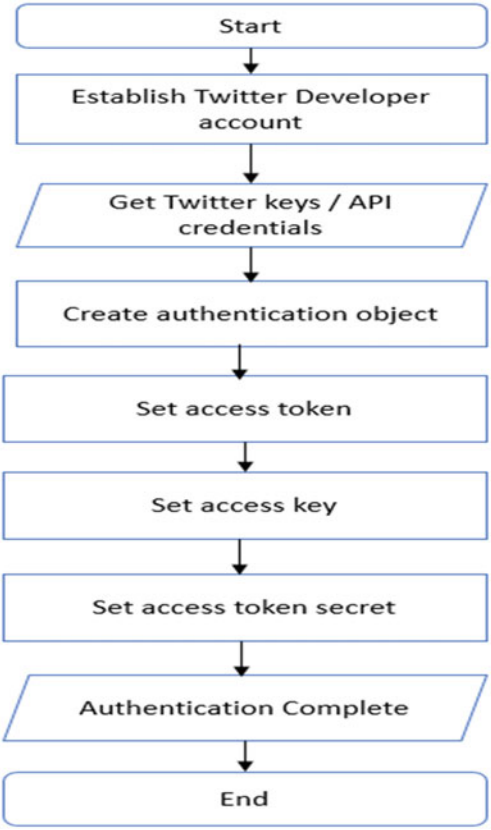


Fig. 2 Steps to create a Twitter authentication developer account

3.3 Preprocessing Dataset

The data sets acquired from social media were raw and hence highly unstructured. Hence, in this form, their adaptation to machine learning algorithms was not possible. Hence, we have prepared and cleaned data. The data cleaning activities that we have performed are.

- Removal of stop words.
- Removal of HTML tags.
- Removal of special characters like hash, @ that normally add noise to text.
- Tokenized the retrieved data.
- Converted all root words into their lemmas.
- Standardized any accented characters into ASCII characters.
- Converted all upper-case words into lower case so that feature set complexity gets reduced.

3.4 Sentiment Analysis

Sentiment analysis is an analysis of subjective judgments of an entity on different aspects. It allows to extract and analyze those judgments [14]. Being a machine learning process, it uses natural language processing so that emotions of people could be understood through their written words [15]. Hence, it brings out a computational distinction and classification of opinion that is expressed by the author of the text about the subject that the premise is built upon.

Sentimental analysis is used to measure polarity and subjectivity. Subjectivity calculation helps us to find facts, opinions and desires whereas the rate of polarity determines the positive negative and neutral tone of an author in a particular data corpus. We have performed this work using Python library, Text blob to process the tweets collected. Text blob processes textual data using natural language processing to define the overall sentiment based on lexicons.

We have used fine-grained polarity of extracted tweets as the positive tweets have been further classified into highly positive and weakly positive tweets. The polarity range is between [0.5, 1] and (0, 0.5) for highly positive and weakly positive tweets, respectively. Positive polarity is an indication that people were highly appreciative of COVID-19 vaccines and willingly got vaccinated. People with weakly positive polarity were those who were aware that vaccines would make them safe. Similarly, we have classified the negative tweets into highly negative and weakly negative tweets with their polarity range lying between [−0.5, 1] and (0, −0.5), respectively. Tweets that indicated negative remarks and a refusal to get vaccine were marked as weakly negative and those tweets where people claimed about the adverse side effects after vaccination were taken as highly negative.

The polarity of neutral tweets was taken as 0. Tweets where the user did not have a negative or a positive opinion about the vaccine were classified as neutral.

We also created word clouds to visualize important words based on their occurrence.

4 Results

In our work, we have analyzed the tweets for four different countries and comprehend the sentiment of overall population of the world. The live tweets were collected to analyze the polarity of four different countries and the overall sentiment of the people throughout the world. We have analyzed and compared the tweets for different countries for different types of vaccines as illustrated in Tables 1, 2, 3, 4, 5 and 6.

Table 1 Polarities for AstraZeneca for four countries and entire world

	AstraZeneca polarity				
	Highly positive	Weakly positive	Neutral	Highly negative	Weakly negative
Mexico	200	124	476	32	20
India	201	242	651	83	31
United States	157	185	373	89	21
Brazil	92	85	536	32	12
World	288	300	1498	135	100

Table 2 Polarities for Covishield for four countries and entire world

	Covishield polarity				
	Highly positive	Weakly positive	Neutral	Highly negative	Weakly negative
Mexico	200	124	476	32	20
India	196	241	647	99	24
United States	139	243	399	86	26
Brazil	92	88	536	32	12
World	460	902	1394	793	300

Table 3 Polarities for Pfizer for four countries and entire world

	Pfizer polarity				
	Highly positive	Weakly positive	Neutral	Highly negative	Weakly negative
Mexico	196	124	480	32	20
India	154	212	739	143	25
United States	145	176	368	71	33
Brazil	110	68	540	36	24
World	300	70	953	251	50

Table 4 Polarities for Covaxin for four countries and entire world

	Covaxin polarity				
	Highly positive	Weakly positive	Neutral	Highly negative	Weakly negative
Mexico	200	124	476	32	20
India	192	217	672	89	34
United States	143	226	400	93	37
Brazil	92	88	538	32	12
World	120	281	1091	400	184

Table 5 Polarities for Moderna for four countries and entire world

	Moderna polarity				
	Highly positive	Weakly positive	Neutral	Highly negative	Weakly negative
Mexico	196	124	480	32	20
India	182	205	729	145	23
United States	131	207	372	98	21
Brazil	111	69	532	36	16
World	814	520	1506	450	218

Table 6 Polarities for Sputnik V for four countries and entire world

	Sputnik V polarity				
	Highly positive	Weakly positive	Neutral	Highly negative	Weakly negative
Mexico	196	124	480	32	20
India	163	208	730	146	24
United States	219	270	607	111	46
Brazil	108	67	535	36	24
World	757	400	1507	460	100

4.1 Overall Sentiments

We have analyzed the sentiments of four countries—India, United States, Mexico and Brazil as well as the entire dataset containing countries all over the world as they have suffered the highest fatalities related to COVID-19. In Table 1, the polarity for Astra Zeneca is shown, and the numbers in the table clearly indicate a neutral sentiment for a large population.

Similarly in Table 2, the different polarities for Covishield vaccines have been given for four different countries and the world. The sentiment of the people is more towards the granular tone of neutral.

Tables 3, 4, 5 and 6 depict the polarities computed using Text blob for Pfizer, Covaxin, Moderna and Sputnik V, respectively.

We have then constructed histograms to help us visualize the data collected for fine-grained polarities for all vaccines under examination. Figure 3, 4, 5, 6, 7 and 8 are the visual representations for sentiments of AstraZeneca, Covishield, Pfizer, Covaxin, Moderna and Sputnik V, respectively. It can be seen in Fig. 3 that the neutral sentiment for all countries is the highest even if we would combine weakly and highly positive polarity. These data in table 1 represented the polarities for AstraZeneca vaccine, which was used to create a bar graph shown in Fig. 3. Similarly Figs. 4, 5, 6, 7 and 8 represent the polarity datasets given in Tables 2, 3, 4, 5 and 6, respectively.

The results obtained for sentiment analysis using Text Blob have been represented using confusion matrix. The confusion matrix was constructed using the Decision Tree classifier of Text Blob. It has been constructed for all six vaccines and their

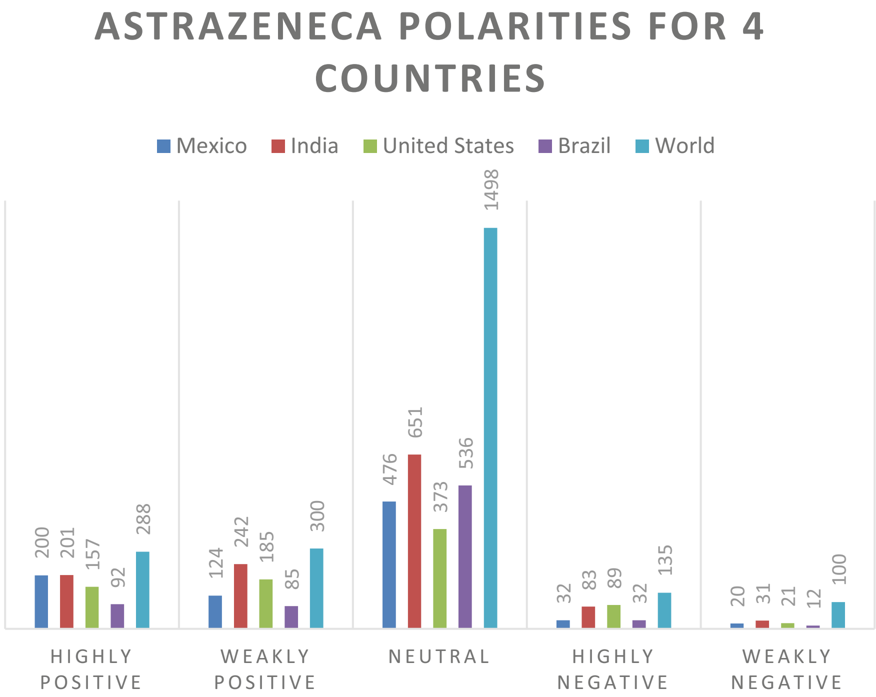


Fig. 3 Visual representation of polarities for AstraZeneca of four countries and the entire world

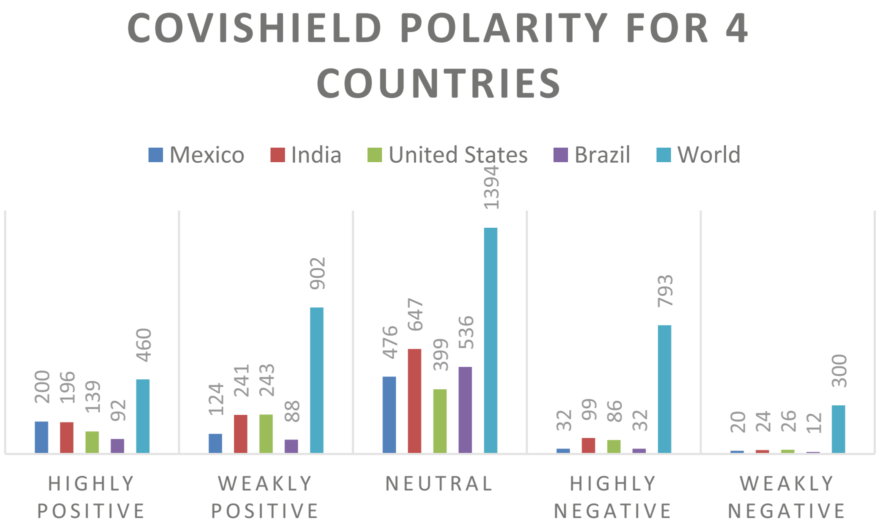


Fig. 4 Visual representation of polarities for Covishield for four countries and the entire world

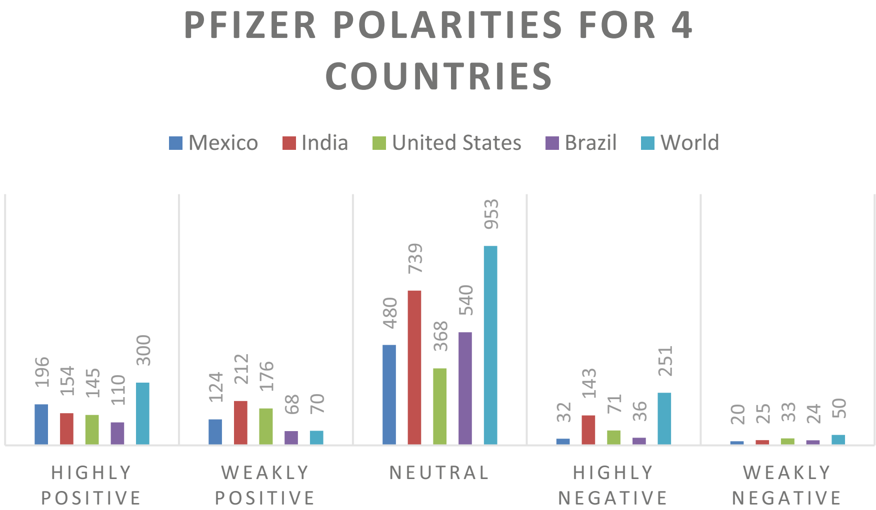


Fig. 5 Visual representation of polarities for Pfizer for four countries and the entire world

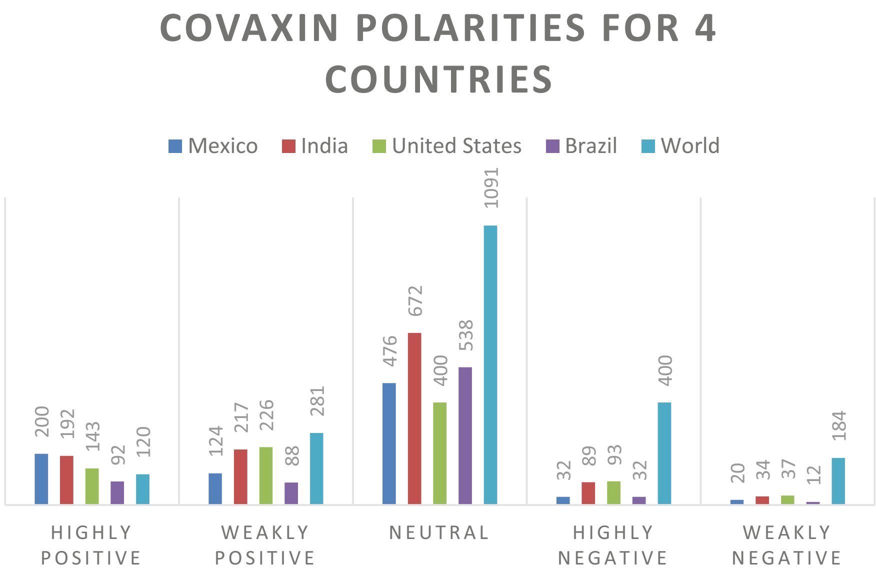


Fig. 6 Visual representation of polarities for Covaxin for four countries and the entire world

respective countries. In Fig. 9, the confusion matrix for AstraZeneca vaccine has been illustrated along with accuracy scores for different countries and world. We have also tabulated the accuracies for different vaccines in Table 7. However, due

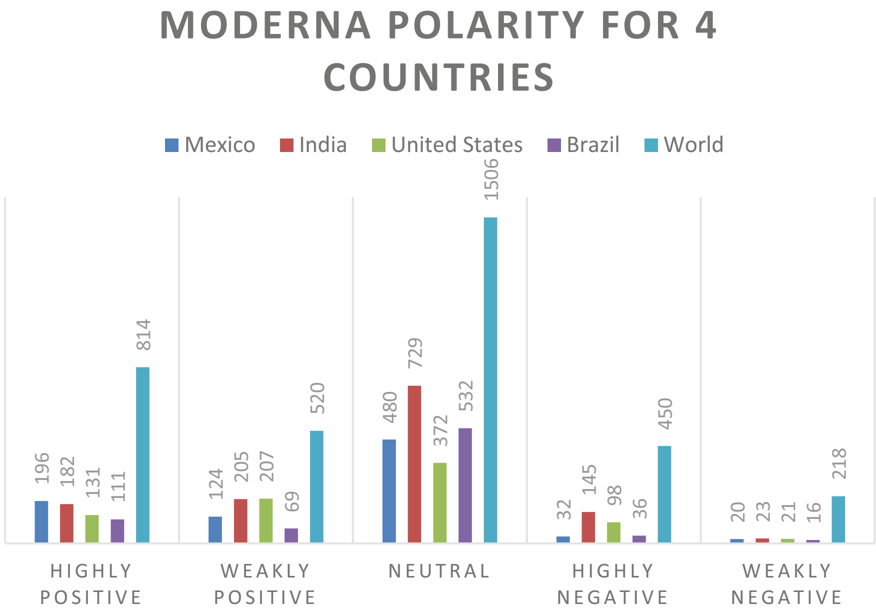


Fig. 7 Visual representation of polarities for Moderna for four countries and the entire world

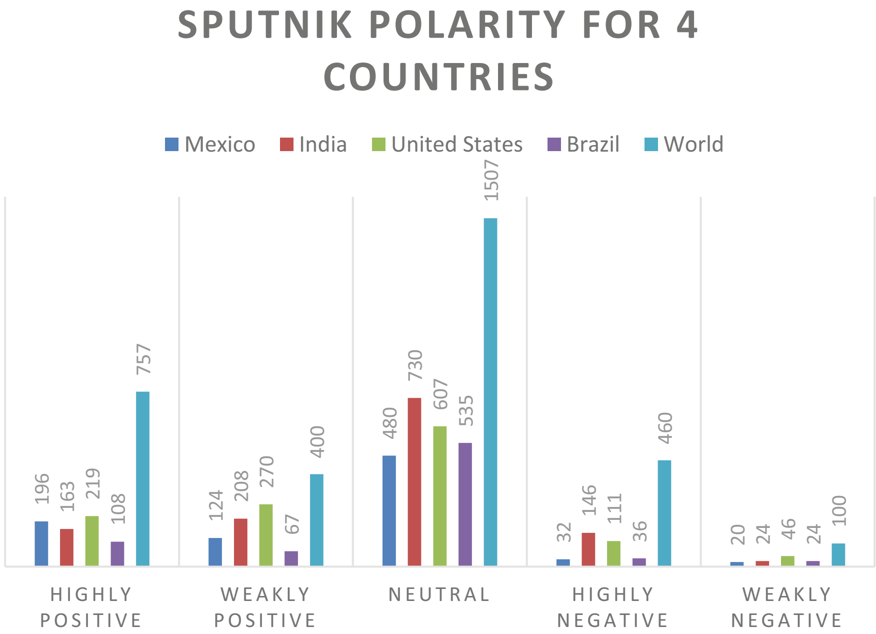


Fig. 8 Visual representation of polarities for Sputnik V for four countries and the entire world

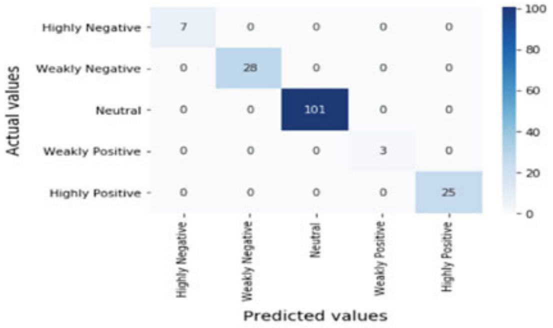
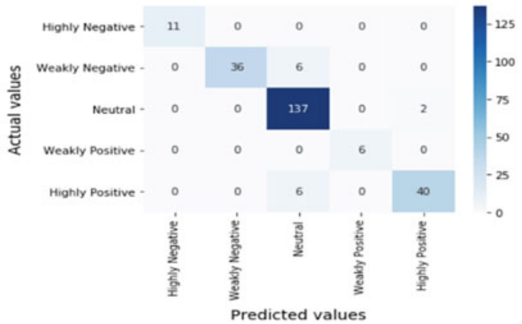
<table>
<tr><th>Name</th><th>Testing Accuracy</th><th>Confusion Matrix</th></tr>
<tr><td>Mexico</td><td>100.0</td><td>
</td></tr>
<tr><td>India</td><td>94.26</td><td>
</td></tr>
</table>

Fig. 9 AstraZeneca confusion matrix

to paucity of space, the rest of the results are available in Appendix 1 for all other vaccines.

4.2 WordCloud

WordCloud has been generated for three polarities where the highly positive and weakly positive tweets have been clubbed together to generate the positive cloud. Similarly, the highly negative and weakly negative tweets have been combined to generate the negative cloud. The WordCloud has been generated for all vaccines and their related sentiments for different countries. In Figs. 10, 11 and 12, we have shown the WordCloud for AstraZeneca, Covishield and Covaxin for Mexico respectively.

The WordCloud helps us visualize different occurrences of a word. The word whose frequency is higher is highlighted and categorized by different sizes for different scores [15, 16]. The words that reflected the highly positive sentiment

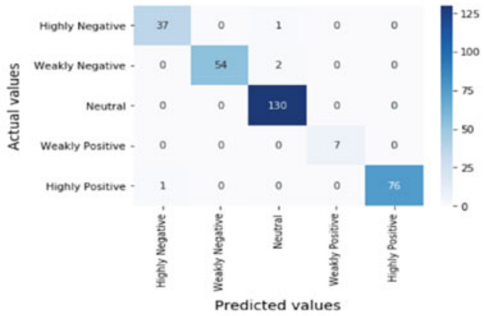
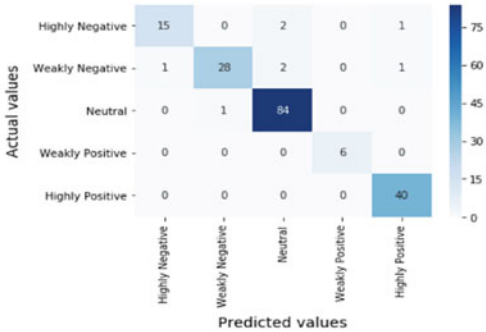
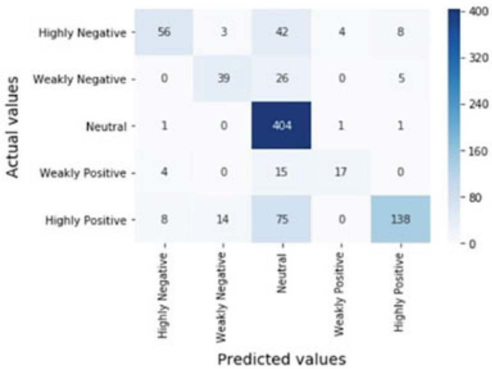
United States	98.7	
Brazil	95.5	
World	78.95	

Fig. 9 (continued)

included Pfizer, vaccine, good, Covaxin, like, safe, dos, get, variant and so on. The WordCloud for other vaccines has been given in Appendix 2 for further reference.

Table 7 Accuracy scores for all countries and the world

Country	Sputnik V	Covishield	Covaxin	AstraZeneca	Moderna	Pfizer
Mexico	99.39	100	100	100	99.39	99.39
United States	95.25	96.56	94.05	98.7	96.63	94.64
Brazil	99.43	98.9	99.60	95.5	99.43	99.5
India	99.59	99.17	96	94.26	96	99.80
World	71.55	80.05	74.6	78.95	74.6	80.05

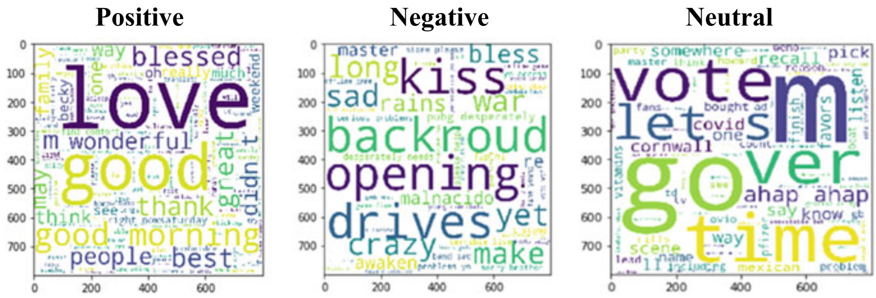


Fig. 10 WordCloud for AstraZeneca in Mexico

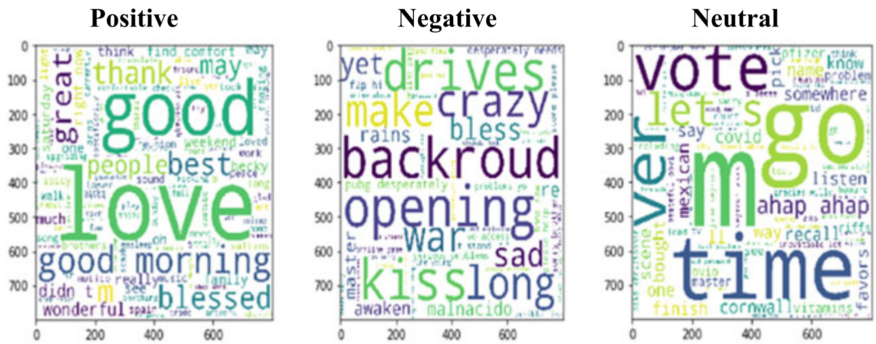


Fig. 11 WordCloud for Covishield in Mexico

4.3 Ranking of Vaccines

Considering the positive polarity tweets that we had categorized, we also used it to rank the popularity of different vaccines. However, this ranking is on the basis of the tweets that we have extracted. The percentage of positive tweets for different vaccines is shown in Fig. 13, and we have used this percentage to rank the vaccines in order of their popularity. We have ranked the vaccines based on the tweets dataset

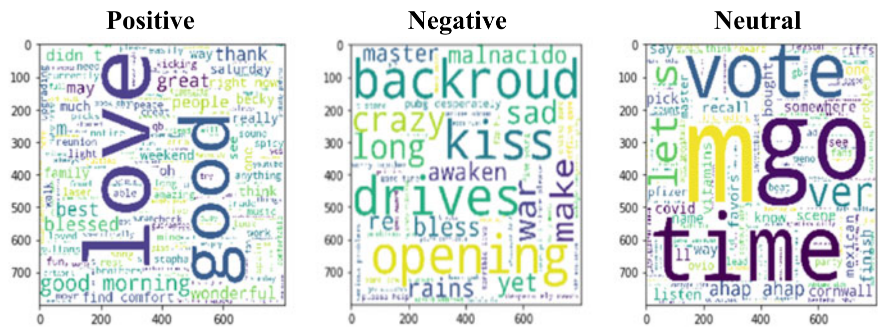


Fig. 12 WordCloud for Covaxin in Mexico

Fig. 13 Ranking of vaccines on the basis of positive tweets collected

Name	Positive Tweets %
AstraZeneca	25.30%
Covishield	35.30%
Covaxin	19.30%
SputnikV	35.90%
Pfizer	22.80%
Moderna	33.12%

that we have collected. The public clearly favors Sputnik V and Covishield vaccines ask can be clearly seen in Fig. 14.

5 Discussion

With the setting in of this disease, the world has entered into a continuous phase of lockdowns and disruptions. The vaccines that were put forth by the governments were the only solace in this scenario. The vaccines have been rolled out in every country and it is good to examine the role of vaccines in fighting the disease. Hence, we have carried out sentiment analysis of people attitudes towards different vaccines.

We have categorized the vaccine into fine-grained polarities and compared the sentiment within different countries and overall world. The classification accuracy using decision tree classifier for AstraZeneca vaccine was 100% for Mexico, 94.26% for India, 98.7% for United States and 95.5% for Brazil and similarly for other vaccines. It was found that though there are many negative theories floating about

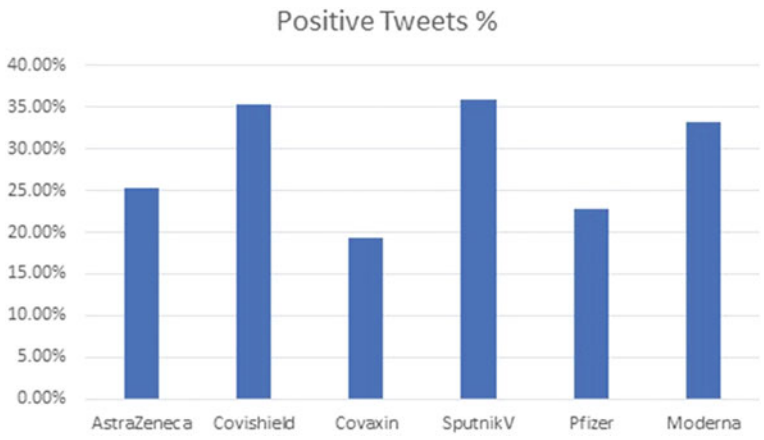


Fig. 14 Visual representation of the rankings of the vaccine

the vaccines but still people have a neutral opinion about them. Though the highly positive tweets were low as compared with the weakly positive and neutral tweets, but the general sentiment seems to be in favor of vaccines. However, this study was limited as we examined the tweets of only English language. Another limitation being only live tweets were scrutinized but they could also be studied over a period of time. This study could be very beneficial to the governments to build policies to handle such global health crisis.

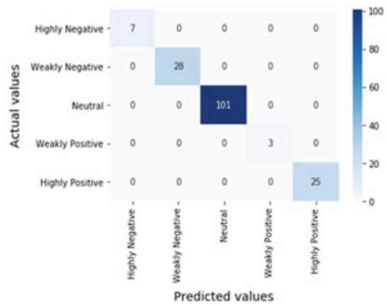
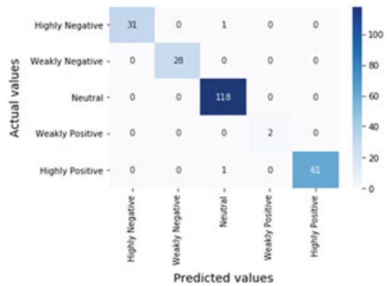
Appendix 1

The accuracy scores and confusion matrix for Covishield, Covaxin, Moderna, Sputnik V and Pfizer vaccines with their respective countries are shown in Tables 8, 9, 10, 11 and 12, respectively.

Appendix 2

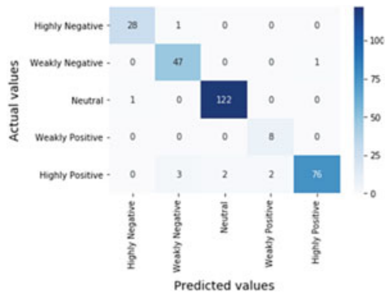
See (Figs. 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36).

Table 8 Covishield confusion matrix

	Testing accuracy	Confusion matrix
Mexico	100.0	
India	99.17	

(continued)

Table 8 (continued)

	Testing accuracy	Confusion matrix
United States	96.56	
Brazil	98.9	

(continued)

Table 8 (continued)

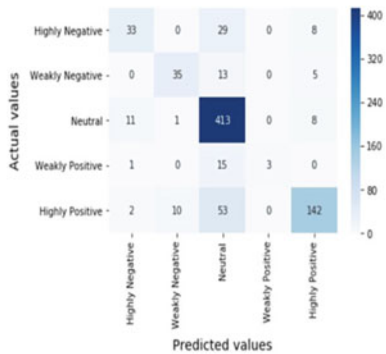
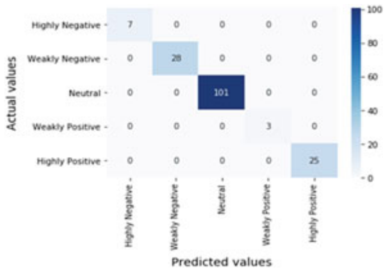
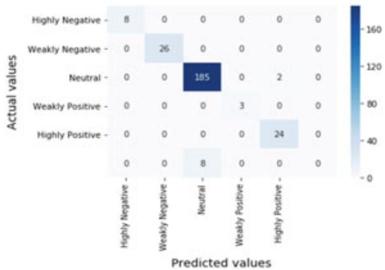
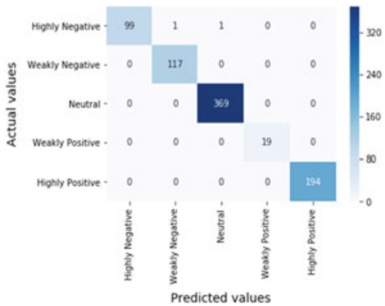
	Testing accuracy	Confusion matrix
World	80.05	

Table 9 Covaxin confusion matrix

	Testing accuracy	Confusion matrix
Mexico	100.0	
India	96.00	

(continued)

Table 9 (continued)

	Testing accuracy	Confusion matrix
United States	94.05	
Brazil	99.60	

(continued)

Table 9 (continued)

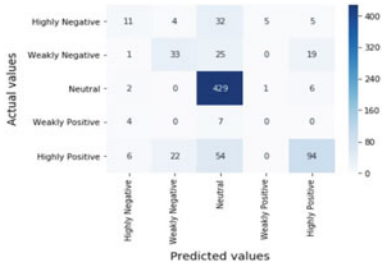
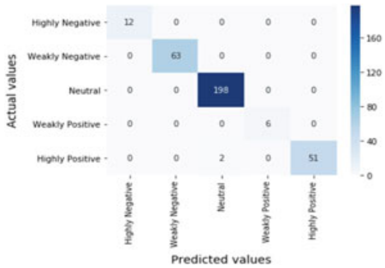
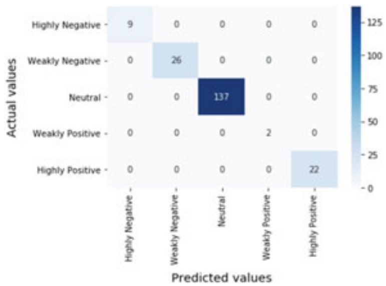
	Testing accuracy	Confusion matrix
World	74.6	

Table 10 Moderna confusion matrix

	Testing accuracy	Confusion matrix
Mexico	99.39	
India	96.00	

(continued)

Table 10 (continued)

	Testing accuracy	Confusion matrix
United States	96.63	
Brazil	99.43	

(continued)

Table 10 (continued)

	Testing accuracy	Confusion matrix
World	74.6	

Table 11 Sputnik V confusion matrix

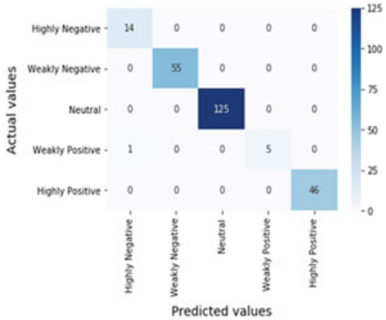
	Testing accuracy	Confusion matrix
Mexico	99.39	
India	99.59	

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Table 11 (continued)

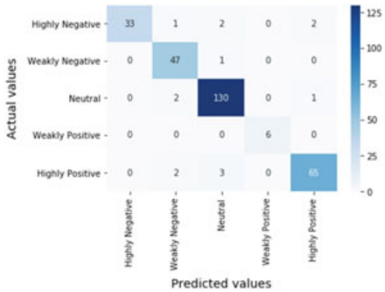
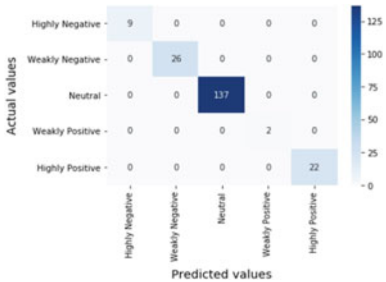
	Testing accuracy	Confusion matrix
United States	95.25	
Brazil	99.43	

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Table 11 (continued)

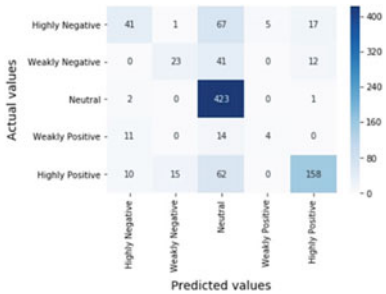
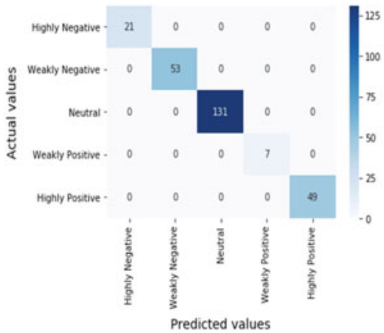
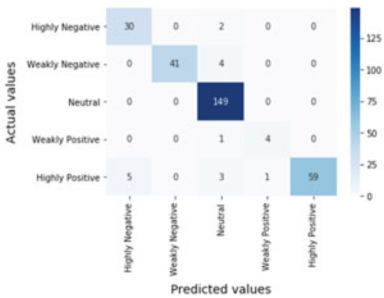
	Testing accuracy	Confusion matrix
World	71.55	

Table 12 Pfizer confusion matrix

<table>
<tr><th></th><th>Testing accuracy</th><th>Confusion matrix</th></tr>
<tr><td>Mexico</td><td>99.39</td><td>


</td></tr>
<tr><td>India</td><td>99.80</td><td>


</td></tr>
<tr><td>United States</td><td>94.64</td><td>


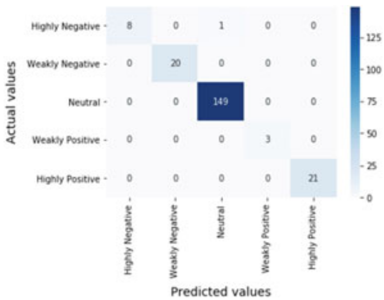
</td></tr>
<tr><td>Brazil</td><td>99.5</td><td>


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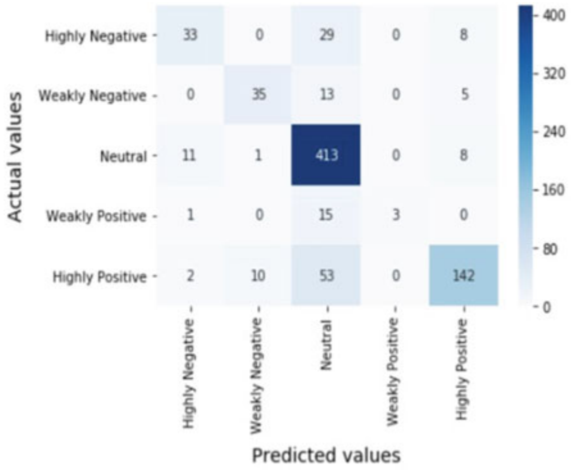
Table 12 (continued)

	Testing accuracy	Confusion matrix
World	80.05	

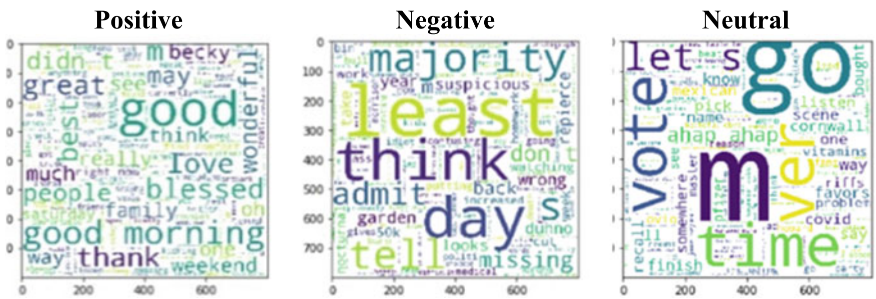


Fig. 16 WordCloud for Moderna in Mexico

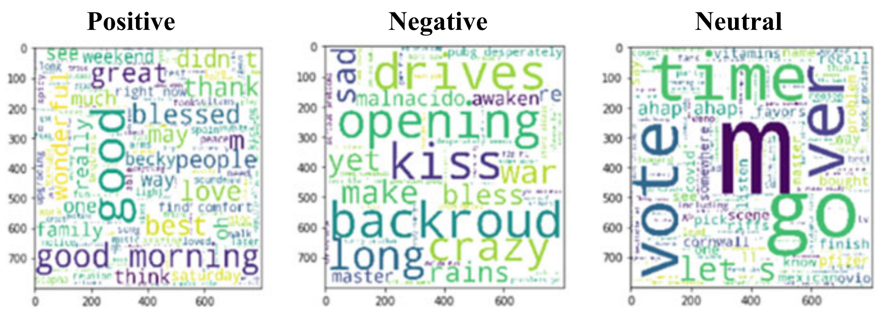


Fig. 17 WordCloud for Sputnik V in Mexico

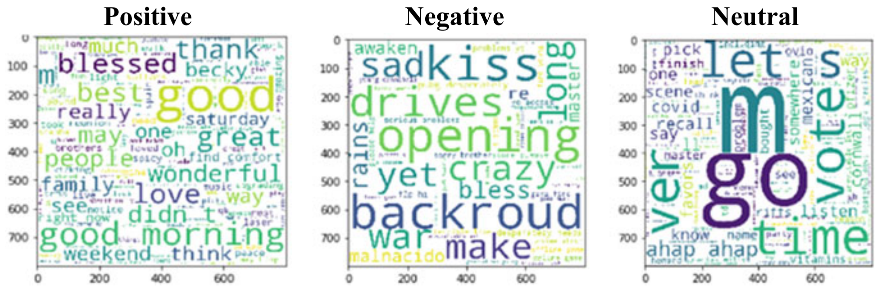


Fig. 18 WordCloud for Pfizer in Mexico

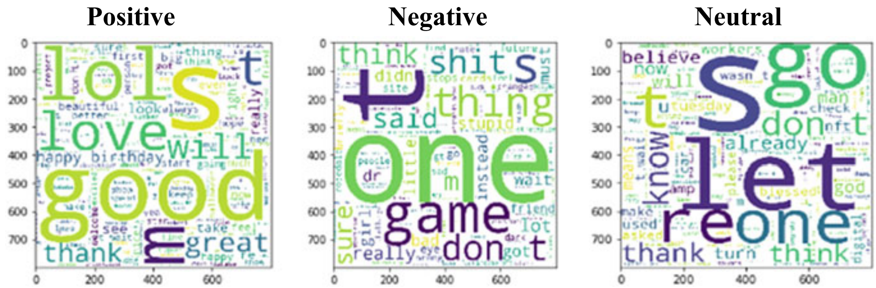


Fig. 19 WordCloud for AstraZeneca in USA

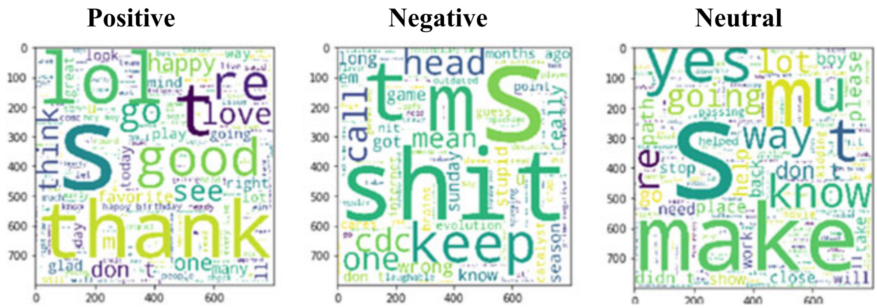


Fig. 20 WordCloud for Covishield in USA

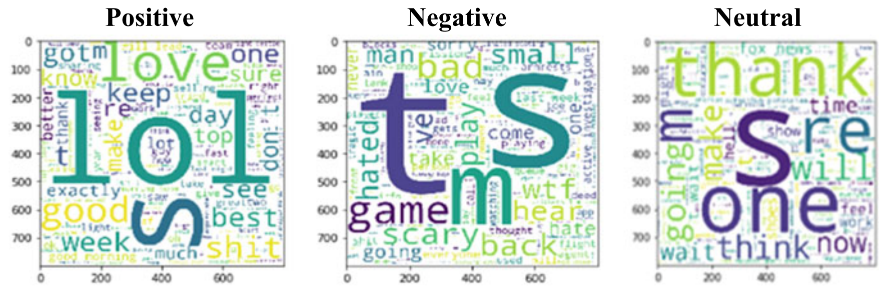


Fig. 21 WordCloud for Covaxin in USA

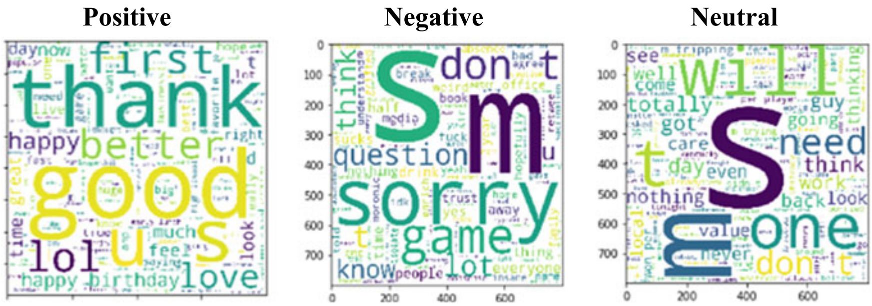


Fig. 22 WordCloud for Moderna in USA

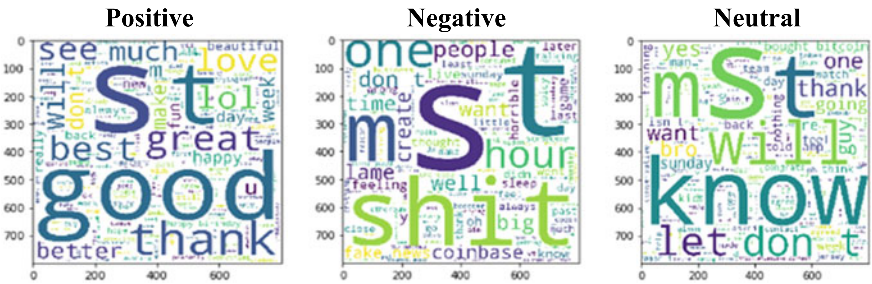


Fig. 23 WordCloud for Sputnik in USA

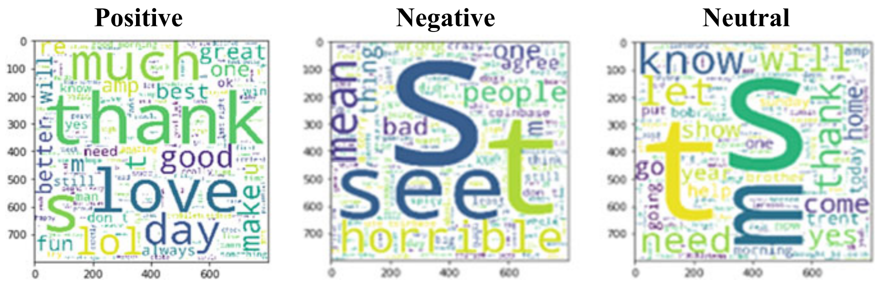


Fig. 24 WordCloud for Pfizer in USA

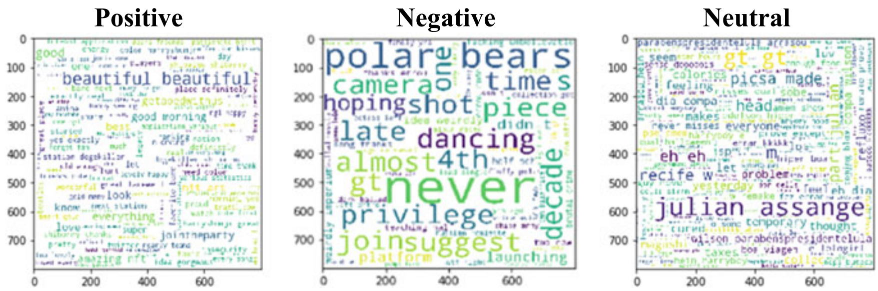


Fig. 25 WordCloud for AstraZeneca in Brazil

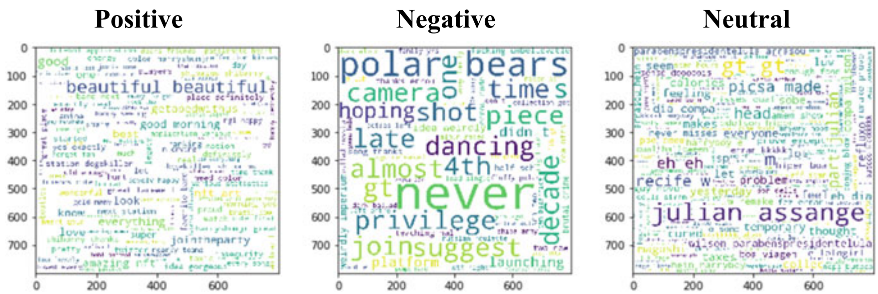


Fig. 26 WordCloud for Covishield in Brazil

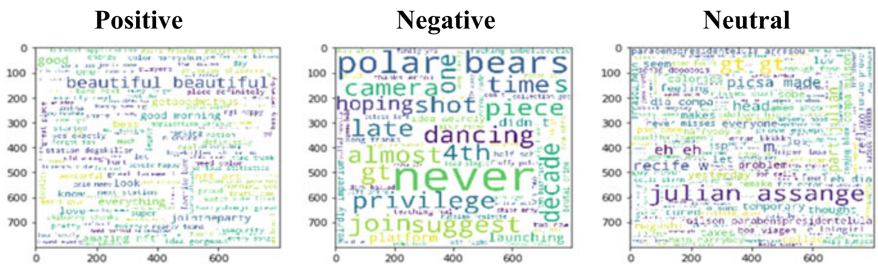


Fig. 27 WordCloud for Covaxin in Brazil

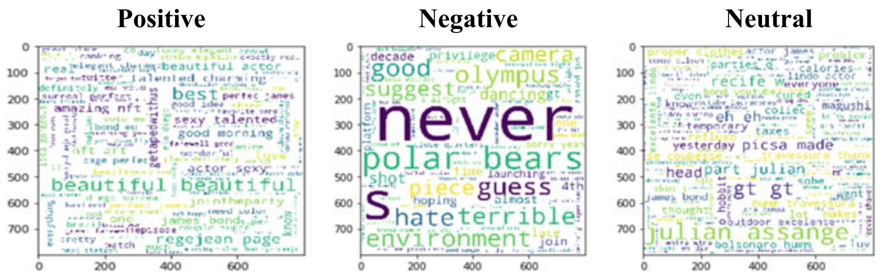


Fig. 28 WordCloud for Moderna in Brazil

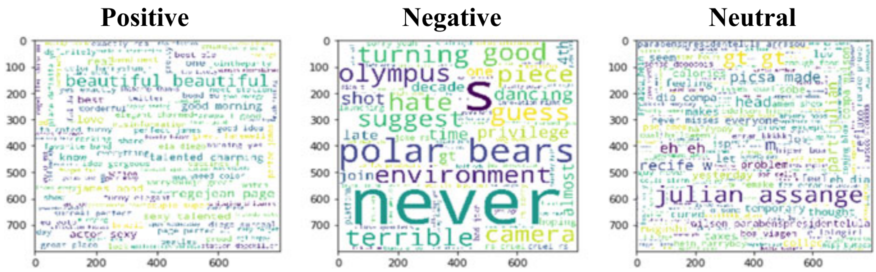


Fig. 29 WordCloud for Sputnik in Brazil

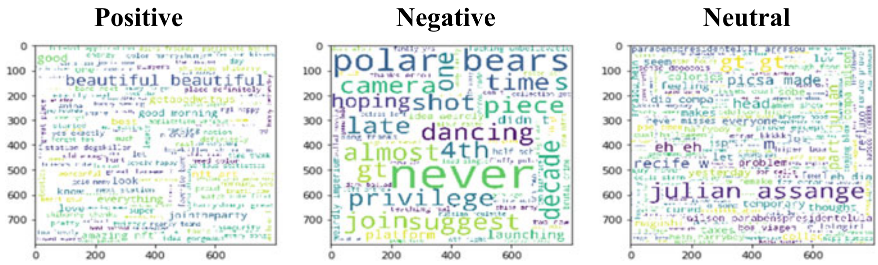


Fig. 30 WordCloud for Pfizer in Brazil

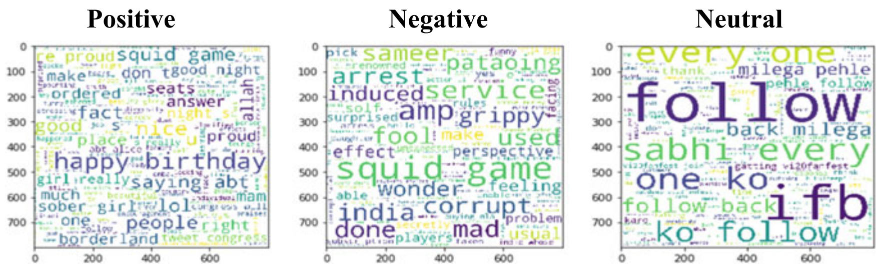


Fig. 31 WordCloud for AstraZeneca in India

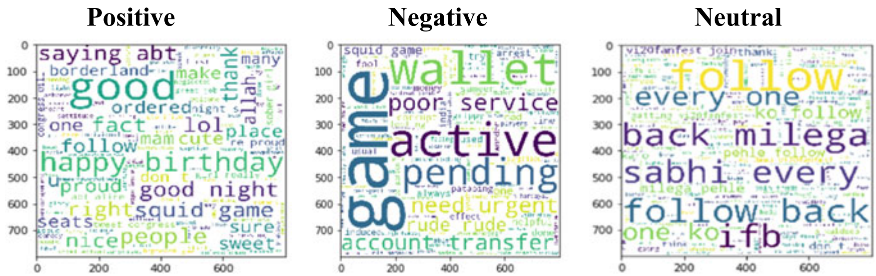


Fig. 32 WordCloud for Covishield in India

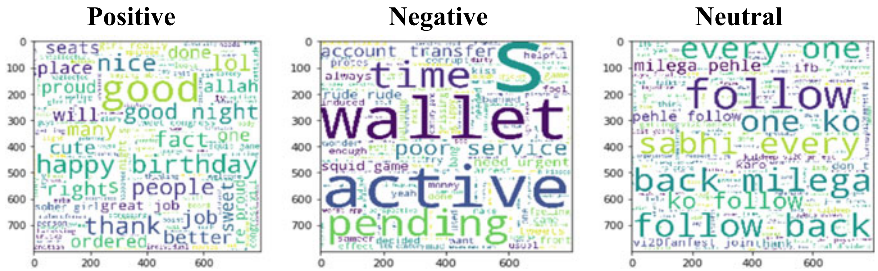


Fig. 33 WordCloud for Covaxin in India

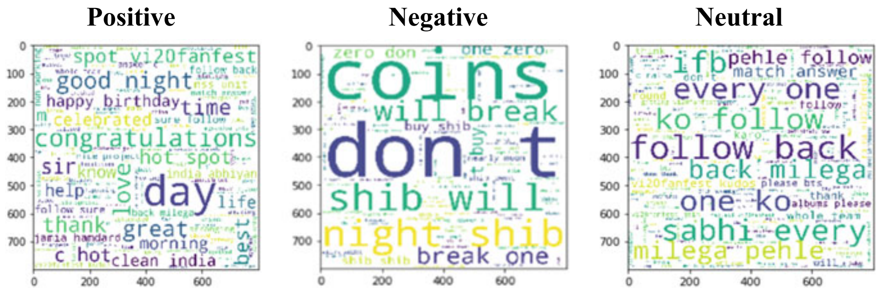


Fig. 34 WordCloud for Moderna in India

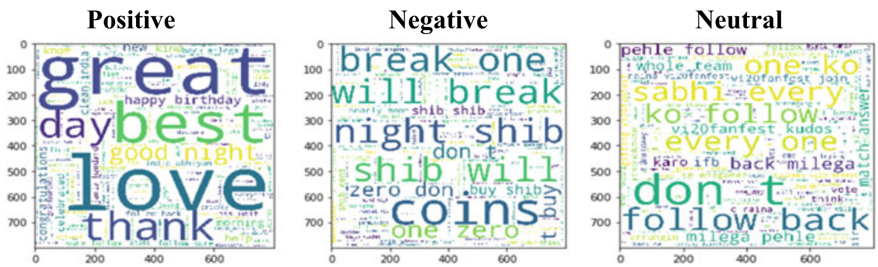


Fig. 35 WordCloud for Sputnik V in India

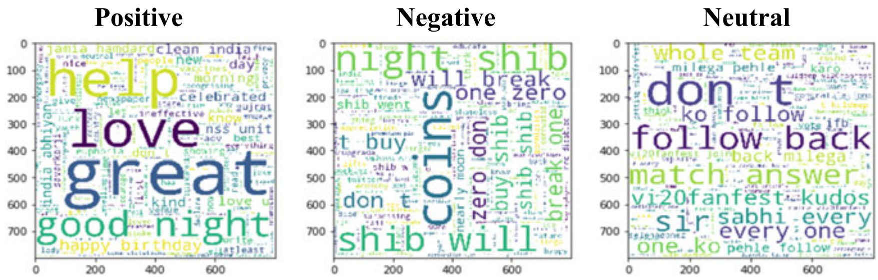


Fig. 36 WordCloud for Pfizer in India

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Plant Disease Classification Using Siamese Convolutional Neural Network

Tanushree Narain, Priyanka Sahu, and Amit Prakash Singh

Abstract Through the years, plant diseases have been a consistent risk to food security. Hence, their rapid identification could significantly mitigate the economic losses around the world, also reducing the harmful effect of manures and pesticides on the climate. When the disease is recognized, matching the characteristic trait, appropriate supervision measures can be applied. The idea of Precision Agriculture provides well-timed automation of agricultural processes by applying the methods of computational engineering in the agronomical domain, machine learning being the most researched and deployed technology. Furthermore, the authors have implemented a customized siamese neural network (SNN) for the originally collected tomato leaves dataset of 155 images with the achieved accuracy of 83.749% and 80.4% for training and the testing set respectively.

Keywords Image processing · Convolutional neural network · Precision agriculture · Plant diseases · Siamese neural network · Deep learning

1 Introduction

India is the second-largest producer of fruits and vegetables among its global competitors [1]. The diseases that affect the crops are the major cause of concern as monitoring such large production can be a complex task for humans. Through the years of evolution, various varieties of crops are being cultivated which has also led to a significant increase in different types of diseases that affect the crop. These diseases

T. Narain
Infosys Limited, Electronic City, Hosur Rd, Bangalore, India

P. Sahu (✉) · A. P. Singh
University School of Information, Communication, and Technology, Guru Gobind Singh Indraprastha University, New Delhi, India
e-mail: er.priyankasahu40@gmail.com

A. P. Singh
e-mail: amit@ipu.ac.in

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could be difficult to identify as many of these have similar symptoms [2]. Hence an efficient system is required for timely detection of disease in order to save the produced yield. The concept of Deep Learning (DL) can help in identifying and predicting the diseases present in crops. Through the years the trends depict that DL results in high accuracy rates when trained with large datasets. The main advantage of DL comes with its ability to learn features of the data without human intervention [3]. Disease detection through the concept of DL such as image processing is an easy task and an efficient substitute for the identification of disease through human effort. The image analysis of leaves, fruits, and vegetables can help us identify the disease [4]. The Convolutional Neural Network (CNN) has more exceptional execution than conventional artificial intelligence and is broadly utilized in computer vision and recognition of the pattern. CNN consists of one or more convolutional layers and is mainly used for the processing, classification, and segmentation of images. There are many different CNN architectures such as GoogLeNet, ResNet, AlexNet, VGG16, and Siamese neural network (SNN) [5, 6]. These CNN architectures are similar though these differ in a few features such as depth, dropout rate, units, non-linear functions, and learning rate. All these models are used in the context of plant disease recognition, and these are used all over the world by various researchers [18, 19]. In this study, the authors have proposed an SNN with a few layers and implemented the model to classify and predict tomato plant diseases. The authors have also presented a survey of prediction models based on Image Processing for the detection of tomato plant diseases. Section 2 gives a brief overview of the most commonly encountered diseases in tomato plants. Section 3 describes the dataset detail and network specifications. Section 4 accentuates the result and discussion. Section 5 gives the conclusion.

2 Related Work

Researchers have tried most of the DL techniques in order to find out the best prediction model for the early detection of plant disease using images of the diseased and healthy leaves. Some of the techniques worked upon were artificial neural network (ANN), support vector machine (SVM), and CNN. The most widely used technique comes out to be CNN because of its high accuracy rates as compared to other DL techniques, especially for Image classification.

Mohanty at el. [12] trained a CNN to recognize 14 harvest species and 26 diseases. In this study, there were 54,306 public dataset images of healthy and infected plant leaves that were utilized. The prepared model achieved 99.35% accuracy on a test set, exhibiting the feasibility of this methodology. Tiwari et al. [1] explored the concept of feature extraction using the model VGG19 with logistic regression classifier. The CNN was deeply trained and tested for image feature extraction and early identification of the disease of the potato leaf. This pre-prepared model VGG19 was utilized for transfer learning in order to obtain suitable features from the image dataset of the leaf of the potato plant. Thereafter, the outcomes with the help of multiple classifiers were concluded which shows logistic regression achieved a high classification accuracy of 97.8% as compared to others. In one of the studies, an aggregate of 126 hyperspectral potato infected leaves was gathered in the trial to detect local spots of potato leaf. There are majorly three kinds of infections, early blight, leaf blight, and anthracnose. The outcome of this experiment suggested that the average accuracy for one-dimensional CNN was found to be higher than that of SVM which was 97.72% and 95.66%, respectively [14]. Another research was carried out to identify disease in potato tubers utilizing CNN for characterizing disease lesions of infected potato tubers into four infection classes and a non-infected class was analyzed. A trained CNN model was used to classify 2,465 pictures of infected lesions, utilizing various minimal expense RGB sensors with specific lighting scenarios. The outcomes uncover that the right classification of completely trained CNN models goes from 83% for the model prepared on 10% of data which goes up to 96% for the model prepared on 90% of the data [16]. Afzal et al. [17] worked on the identification of early blight disease which affects the potato plant. A data set was developed utilizing DL to recognize the infection invasion at various stages all throughout the season. Utilizing the PyTorch framework, the training of three CNNs was done, namely, EfficientNet, VGGNet, and GoogleNet. The experiment revealed that out of the three EfficientNet, VGGNet, and GoogleNet, the one with the least inference time was GoogleNet. Xi et al. [7] demonstrated a further developed Faster R-CNN model for identification of the location of the potato buds. In order to automate the process of cutting out seed potatoes, accurate spotting of the potato buds' location is important. With a pre-prepared ResNet50, the Faster R-CNN was utilized as the base. Test set experiment results showed that the accuracy of the further developed Faster R-CNN was 96.50%. Jahanbakhshia et. al [8] deployed a CNN algorithm to identify and classify images of sour lemons. In order to improve the CNN results, the scholastic polling mechanism and data augmentation were used. Also, to differentiate the proposed model with various techniques, the algorithms for extraction of features such as (local binary patterns (LBP) and histogram of oriented gradients (HOG)) and Fuzzy, k-nearest neighbor (KNN), SVM, ANN, and decision tree (DT) algorithms for classification were utilized. The accuracy came out to be 100% of CNN. Nasir et al. [9] have utilized a classification method that was a hybrid deep convolutional neural network (DCNN) with the pyramid histogram of oriented gradient (PHOG) elements to perform the classification of fruits using cloud technology and 5G. The minimum redundancy maximum relevance technique was utilized to enhance the combined DCNN with PHOG features. The Fruit-360 public dataset was utilized, which was extensively better compared to presently accessible classifiers. With the utilization of numerous classifiers, a precision of up to 99.6% was accomplished on the proposed strategy, which came out better than the past methods. Wu et al. [10] have showcased a technique to detect apple defects using laser backscattering imaging and CNN where a semiconductor laser was utilized to acquire laser backscattering spectroscopic images of apples. CNN was applied to identify apples that are defective. It can accurately and successfully distinguish the deformities in typical areas of apples, stems, and calyxes. For the purpose of classification, similarly, they utilized other algorithms namely, particle swarm optimization (PSO), SVM, and back proliferation (BP) neural networks. The proposed model's results show that the CNN technique which gave out 92.5% accuracy was the highest among the three. Rajbongshi et al. [13] worked on differentiating the mango leaf diseases through CNN. Various CNN models were utilized namely, ResNet152V2, ResNet50, InceptionResNetV2, DenseNet201, InceptionV3, and Xception with techniques of transfer learning in order to achieve improved accuracy from the aimed data sets. A total number of six models (CNN) were used for five various classes of diseases of mango. For the augmentation of the image data, various techniques of image processing were utilized. The most noteworthy accuracy was found for the DenseNet201 model which came out to be 98.00%, while the rest stayed between 94 and 97%. Singh et al. [15] proposed MCNN for the grouping of Mango leaves contaminated by the fungal infection named Anthracnose. The process of training and testing for the proposed model was done using TensorFlow, which is an open-source software framework with the programming language Python. The results were as follows: the highest accuracy was achieved by MCNN which came out to be 97.13%, rest SVM, Radial basis function neural network (RBFNN), and Particle swarm optimization (PSO)'s accuracy were between 88 and 94% (Table 1).

3 Material and Methods

3.1 Dataset Details

Authors have collected a tomato plant leaves image dataset with 76 images of healthy tomato plant leaves and 79 images of diseased (infected with bacterial early blight) tomato plant leaves. Few images of the dataset are shown in Fig. 1. From the initial data, genuine pairs (pairs of either healthy or both diseased leaves) and false pairs (one healthy and one diseased leaf) were obtained. The total dataset consisted of 1000 pairs of 256 $\times$ 256 grayscale image pairs, out of which 700 were used for training and 300 were used for testing. Thus, the shape of the training set and the testing set were (700, 2, 1, 256, 256) and (300, 2, 1, 256, 256) respectively, with images being represented in NCHW (number, channel, height, width) format. The entire dataset contained an equal number of opposite pairs and genuine pairs, thus there was no imbalance.

3.2 Siamese Neural Network (SNN) Model

SNN is a class of neural network architectures that have two identical (twin) networks [16, 17]. The twin networks have the same configuration with the same parameters

Table 1 List of the techniques and deployed approaches for detection of various plant diseases

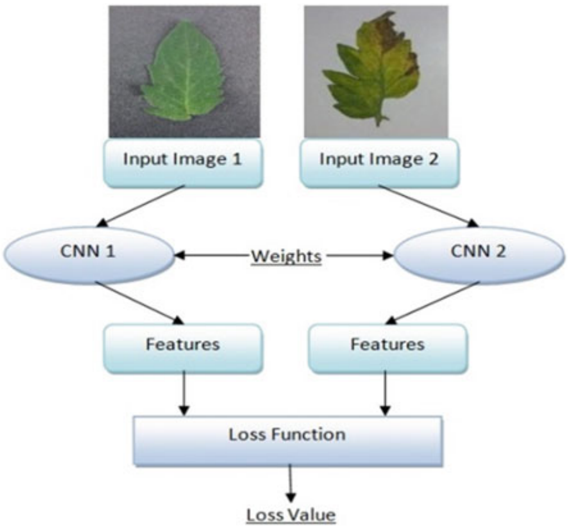
References	Technique	Fruit/vegetable	Disease	# Images	Performance/result
Tiwari et al. [1]	VGG19 (CNN based approach)	Potato	Early blight, Late blight	2152	Accuracy 97.8%
Kumar et al. [2]	CNN	Mango	Anthracnose	3500	Validation accuracy 96.16%
Francis and Deisy. [3]	CNN	Plant Leaf	Diseased or healthy	–	Accuracy 88.7
Ullah et al. [4]	CNN	blueberry	Powdery mildew	5000	Accuracy 97.33%
Xi et al. [7]	Region based CNN	Potato	Potato buds	14,400	–
Jahanbakhshi et al. [8]	KNN, LBP, HOG, DT, SVM, ANN, CNN	Lemons	Sour	5456	Accuracy CNN(BNorm) 100%
Nasir et al. [9]	VGG19, PHOG, Deep CNN	95 fruits	–	65,429	Accuracy 99.6%
Hu et al. [11]	3D infrared imaging system, CNN	Apple	Bruised	-	Accuracy 97.67%
Mohanty et al. [12]	CNN	14 Crops	26 Diseases	54,306	Accuracy 99.35%
Rajbongshi et al. [13]	CNN	Mango leaf	Anthracnose, Gall machi	1500	Accuracy 98.00%
Liu and Xiao [14]	One-dimensional CNN, SVM	Potato	Anthracnose, Leaf blight, Early blight	126	Accuracy (1D-CNN) 97.72%
Singh et al. [15]	Multilayer CNN	Mango leaf	Anthracnose	1070	Accuracy 97.13%
Oppenheimm et al. [16]	CNN developed by the Visual Geometry Group (VGG)	Potato	Black scurf, Silver scurf, Common scab, Black dot	2465	Accuracy (90% data) 96% Accuracy(10% data) 83%
Afzaal et al. [17]	GoogleNet, VGGNet, and EfficientNet	Potato	Early blight	5199	Validation accuracy 0.99–1.00

Fig. 1 Tomato healthy and diseased leaf images from the collected dataset: **a** Healthy (row 1) **b** Diseased (row 2)

and weights. The networks then each output a feature vector, which is a representation of the input of each of the twin networks. Then the similarity of the feature vectors is computed using an energy function. Examples of energy functions include Euclidean distance, cosine similarity, etc. SNN can be used for classification as well by generating true pairs and false pairs of each class. Thus, one of the major advantages of SNN is that it requires fewer examples of each class as the inputs are in pairs (Fig. 2).

There is a possibility to generate $n(n-1)/2$ pairs from n images, which is of the order of $O(n^2)$. The contrastive loss was used during model training, and the plot is given in Fig. 3. Contrastive Loss is utilized to learn the discriminating characteristic of images. A pair of images is passed into the model with their relationship as y:y

Fig. 2 SNN Model



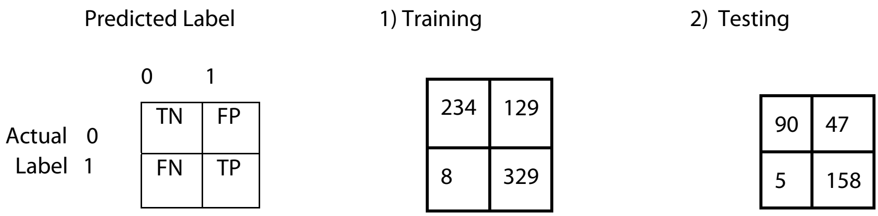


Fig. 3 Confusion matrices of training and testing dataset

Table 2 Parametric configuration of SNN with their used value

Parameters	Train-test Split	# epochs	Optimizer	Learning_rate	beta_1	beta_2
Value	85–15% (17,000–3000)	30	Adam	0.0001	0.9	0.999

being equal to 1 if the images fed are similar and y:y being equal to 0 if the images fed are dissimilar. For a single pair, the loss function can be stated in Eq. 1:

$$yd^2 + (1 - y)\max(\text{margin} - d, 0)^2 \tag{1}$$

where Euclidean distance d between the two image features f_1 and f_2 is

$d = \| f_1 - f_2 \|_2$. If the two images in a pair are found to be dissimilar, then their distance should be at the least margin or a loss is likely to be experienced. Here, the term 'margin' is used to consolidate the constraint (Table 2).

4 Results and Discussion

The process of training and testing for the proposed model was done using Google Colab, which is an open-source software framework with the programming language Python. Accuracy, loss, and confusion matrix were used as performance measuring parameters. The contrastive loss was used during model training, and the plot is given in Fig. 3. A validation split of 20% was used. The confusion matrix is displayed in Fig. 3. In addition, the plot of training and validation accuracy obtained during the model training period is given in Fig. 4. The accuracy obtained for the training and the testing set was 83.749% and 80.4%.

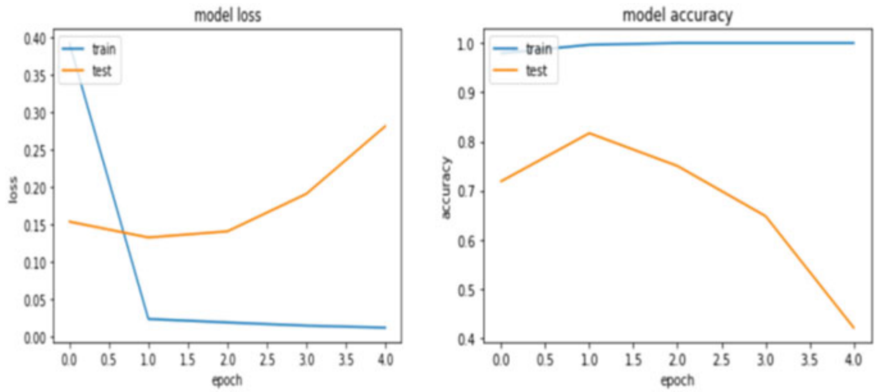


Fig. 4 Accuracy and loss progression

5 Conclusion

In this paper, the authors have presented a review of identification and prediction models for different plant diseases, based on the concept of Image processing. Table 1 summarized the utilized approaches and procedures. The fundamental goal of this paper was to recognize the computational aspect and research work of disease recognition. Along with the study of prediction models, the authors have also implemented a customized SNN for the originally collected tomato leaves dataset of 155 images with the achieved accuracy of 83.749% and 80.4% for training and the testing set respectively. Authors merged and enforced Imaging methods comprehensively and concentrated on the ramifications of both combined.

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Brand Logo Detection Using Slim YOLO-V4

Prateek Dwivedi, Sri Khetwat Saritha, and Sweta Jain

Abstract Images have been a rich source of information in recent years. Images are available in vast quantities, and most solutions necessitate real-time picture processing. This necessitates the creation of images with human-like capabilities for detecting and locating items in images. Object Detection is a branch of Computer Vision that has applications in a variety of domains, including Face Detection, Video Surveillance, Autonomous Driving Cars, and Medical Image Processing. Object detection should be quick and accurate. For accurate detection, all portions of the image should be searched for objects of all types and sizes. This necessitates a large computation cost as well as a significant quantity of time. It is natural and requires little effort for people, and researchers aim to create models that behave similarly to humans.

1 Introduction

Object recognition is the technique of recognising things in movies and photographs. The autonomous vehicles can identify and recognise things in real time using this computer vision technology [1]. An autonomous vehicle is one that is capable of sensing and reacting to its surroundings in order to manoeuvre without the assistance or involvement of a human [2]. Object detection and recognition is regarded as one of the most critical tasks since it aids the vehicle in detecting impediments and determining its future trajectory [2]. As a result, extremely accurate object detection methods are required [4].

P. Dwivedi (✉) · S. K. Saritha · S. Jain
Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh 462003, India
e-mail: dwivediprateekms@gmail.com

S. K. Saritha
e-mail: khethawatsaritha@manit.ac.in

S. Jain
e-mail: jainsweta@manit.ac.in

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1.1 Need of Logo Detection

To ascertain the brand's market visibility, the logo detection process must be used. It is directly related to the revenue generated by the company that owns the specific brand. In the eyes of the public, a brand logo represents the company's brand identity. The brand name will become more well-known as it becomes more ingrained in people's minds. It is critical to understand the brand's online presence and any illegal brand identity usage for illegal purposes, such as counterfeit product manufacturing. As a result, businesses require an algorithm to assist them in tracking their online and offline market presence [5]. This involves searching for and comparing correspondences between two photos of the same object or scene, which is an important task for some computer vision applications. These are only a few [3, 5] of the tools available to help us with photo and article replication, as well as camera alignment.

2 Literature Review

2.1 YOLO

The authors of [15] discovered that Region proposal methods perform categorization and predictions for a given region many times. By recasting object detection as a regression problem, the authors of [15] claim that region proposals can be fully avoided. YOLO—You Only Look Once—was the term used to describe this. It uses a single feed forward network to process images and generate prediction scores and bounding boxes. For a picture, a convolution network generates feature maps. Class scores and bounding box coordinates are directly generated using these feature maps. First, areas are extracted in region proposal-based methods, which makes the network computationally expensive. The cost of calculation is minimised by using the YOLO method. YOLO divides the input image into S x S grid cells, as seen in the Fig. 2.16 left image. Each grid cell predicts B bounding boxes and a "object-ness" score P(Object) indicating whether the grid cell includes an item or not, as seen in Fig. 2.16 middle top image. Each grid cell also forecasts the conditional probability P (Class | Item) of the class to which the object contained by the grid cell belongs, as seen in Fig. 2.16 middle bottom image. YOLO predicts five parameters for each bounding box: x, y, w, h, and a confidence score. The coordinates represent the centroid of the enclosing box in relation to the grid cell (x, y). The values of x and y are restricted to a range of 0 to 1. The bounding box's width w and 24 height h are calculated as a percentage of the entire image's width and height.

3 Proposed Approach

YOLO-V4 is by far the best architecture there if we compare the most optimal trade-off between speed and accuracy. But the FPS (Frames Per Second) it works on is bit slow if we want to implement object detection on mobile and embedded devices. To overcome this limitation of YOLO-V4 [19] algorithm, here the lighter version of the same architecture is present by compromising little bit on the accuracy but a high improvement upon FPS. YOLO-V4 [19] uses backbone, neck, and head in its architecture. YOLO-V4 uses CSPDARKNET 53 network as a backbone which is quite heavy because it uses ResBlock module in the residual network. In the proposed architecture, I have replaced this CSPDARKNET 53 with CSPDARKNET Slim which incorporates CSPBLOCK module instead of RESBLOCK [20]. The following diagram demonstrates the model architecture (Fig. 1).

The data collection was initially labelled with two labels. The dataset is then separated into three sections: train, test and test. To rebuild the pictures, the original training data set was pre-processed. It has a 416X416 pixel resolution. After that, the data was added to the dataset, allowing the data set to be enlarged and the model to be well-trained. Following the test dataset, the trained model was provided.

3.1 *Slim YOLO-V4 Architectural Overview*

The conversion of Dark-net to Py-Torch is YOLO-V4 Slim's Primary contribution. The DARK-NET framework is based on the C programming language. It suggests very comprehensive governors in addition to the work scheduled for connection repair. In many aspects, the rule for less semantic behaviour is a significant benefit

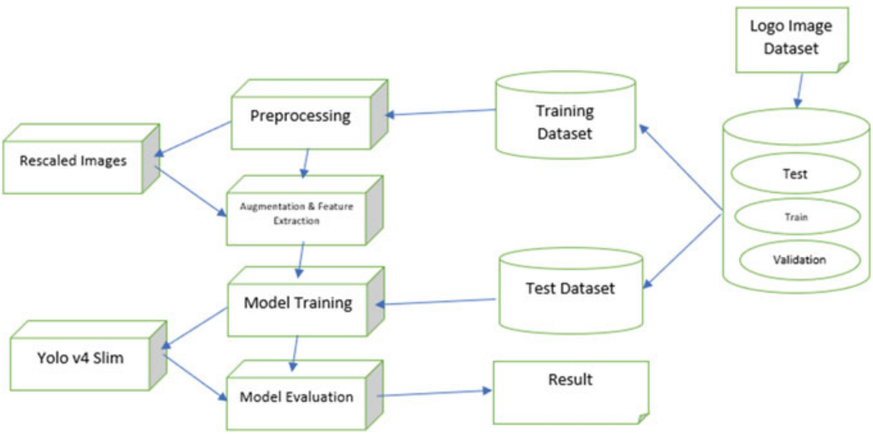

Fig. 1 Proposed model architecture

for investigation; nevertheless, in new research visions, it may still be typed into port by a new-catch-up accumulation via single transcription controls. The three primary components of all YOLO networks are mainly.

3.1.1 Backbone

Feature extractors include models like ResNet, Dense Net, VGG, and others. They've been pre-trained on several image classification datasets, such ImageNet, before to being fine-tuned for use on the detection dataset. Expanding on that, it is discovered that these networks which offer varying degrees of characteristics with more semantics as the network increases in layers really serve as useful resources for the object identification network later.

- **Neck** These are the extra layers that sit between the backbone and the skull. They're utilised to extract various feature maps from various backbone stages. An FPN [1], a PANet [2], or a BiFPN [3] could be found in the neck area, for example. In the instance of YOLOv3, FPN is utilised to extract scale-specific properties from the backbone. For the GPU version, the feature-extractor model is the CSPDarknet53. They are considering employing EfficientNet lite, MixNet, GhostNet, or MobileNetV3 for the VPU (Vision Processing Unit).
- **Head** This is the network in charge of detecting bounding boxes (classification and regression). Depending on the implementation, a single output may look like this: 4 numbers describing the anticipated bounding box (x, y, h, w) and the probability of k classes + 1 (one 30 extras for background). Anchor-based objected detectors, such as YOLO, apply the head network to each anchor box. Single Shot Detector [6] and Retina Net [4] are two more prominent anchor-based one-stage detectors. They employ SPP (Spatial Pyramid Pooling) and the Path Aggregation Network (PAN). The latter is a modified form of the original PAN that substitutes the addition with a concatenation. The Slim YOLO-V4 Object Detector CNN approach includes input as a picture and compression. To bring the chain of links and calculations to a close, these supports remain within the image grouping. Several boundaries are squeezed sideways in order to detect things.

  1. Bag of freebies
  2. Bag of specials
  3. Bag of freebies

  The set of strategies or methods that change the training cost for improvement of model accuracy. The bag of freebies for object detection training strategies are formulated. Bag of specials contains different plugins and the post-processing modules that not only increase the inference cost by a small amount, but can also drastically improve the accuracy of the object detector.

3.2 Implementation and Results

1. The major steps involved to train the detector are as follows [19]:
2. Create the dataset with augmentations.
3. Write the YOLO-V4 andYOLOv4 slim Training configurations.
4. Run YOLO-V4 and YOLOv4 slim training.
5. Evaluate YOLO-V4 and YOLOv4 slim performance.
6. Visualise YOLO-V4 and YOLOv4 slim training data.
7. Choose the best performer and run the inference on test images.

3.3 Dataset

The Flickr Logos 27 dataset is an annotated logo dataset that was acquired from Flickr Logos 27 and has 27 classes. There are three image collections/sets in total. There are 810 annotated photos in the training set, which match 27 logo classes/brands. The bounding boxes of the logo occurrences in each picture are marked on all pictures. Per class image, we enable several logo instances. It has the following 27 classes: Adidas, Apple, BMW, Citroen, Coca Cola, DHL, FedEx, Ferrari, Ford, Google, Heineken, HP, McDonalds, Mini, NBC, Nike, Pepsi, Porsche, Puma, Red Bull, Sprite, Starbucks, Intel, Texaco, UNICEF, Vodafone and Yahoo [18].

3.4 Model Configuration of YOLO-V4 Slim

Here, only 27 classes are used so the number of Classes will be 27 Yolo-V4 slim parameters:

- Number of classes: 27
- Depth of Slim YOLO v4 is 0.67 times YOLO v4
- Width of Slim YOLO v4 is 0.75 times YOLO v4 [2].

Here, the term depth indicates the depth of the model, whereas the term width indicates the channel layer. The standard YOLOv4 network was implemented in this stage. Flickr Logos 27 dataset was used. The image input size was set at 416x416, and images were resized to this size before passing them through the network. Xavier weight initializer was used to initialise the weights of additional layers. Transfer learning was used and weights for darknet layers were taken from the network and not trained. The network was trained for 50 epochs with 2110 iterations. Adam optimiser was used with a learning rate of 0.001 for the first 10 epochs, 0.0001 for the next 20 epochs and then 0.00001 for the rest of the epochs. Loss is calculated as a sum of confidence loss and localisation loss.

3.5 Experimental Results

This section gives an overview of the results generated by each model (Fig. 2).

3.5.1 Experimental Results for YOLO-V4

The testing dataset used was from Flickr Logos 27 and the following results were found. We can see that from the below table obtained that the YOLO-V4 Algorithm performed really well in many of the Logos and resulted in the very good mAP score, but because of some logos on 36, which YOLO-V4 is not able to perform well, reducing the mAP score down to 59.72% which is still much better than all the algorithms' predictions so far (Fig. 3).

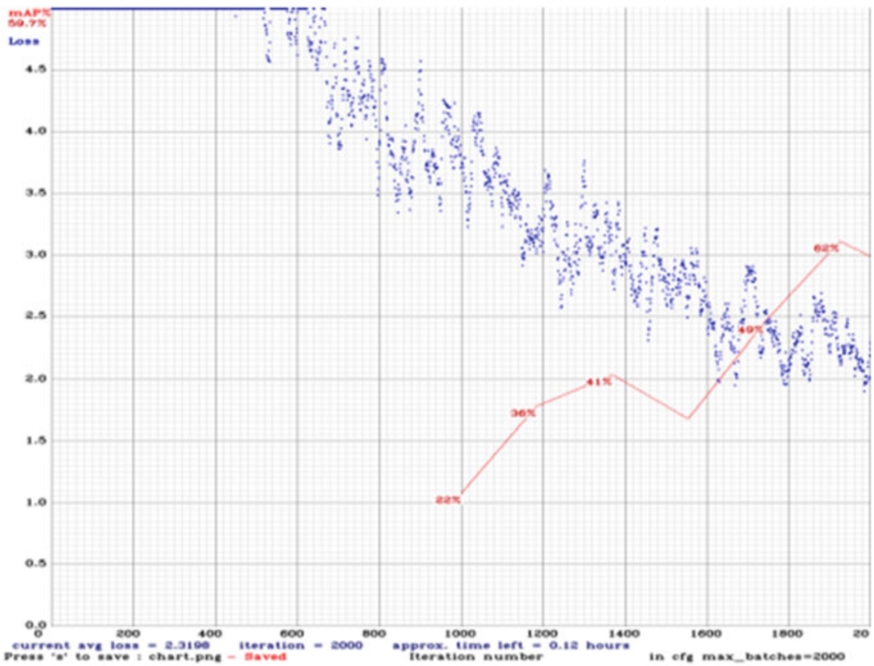

Fig. 2 mAP versus number of iteration for YOLO v4 model

Fig. 3 .

3.5.2 Experimental Results for YOLO-V4 Slim

The YOLOv4 Slim network proposed in Chap. 3 was implemented next. These are the results obtained after applying YOLOv4 slim algorithm on the Flickr 27 Logos dataset. The proposed method obtained 82.4% mAP on Flickr Logo 27 dataset which is better compared to what we have obtained from YOLO-V4 (Figs. 4 and 5).

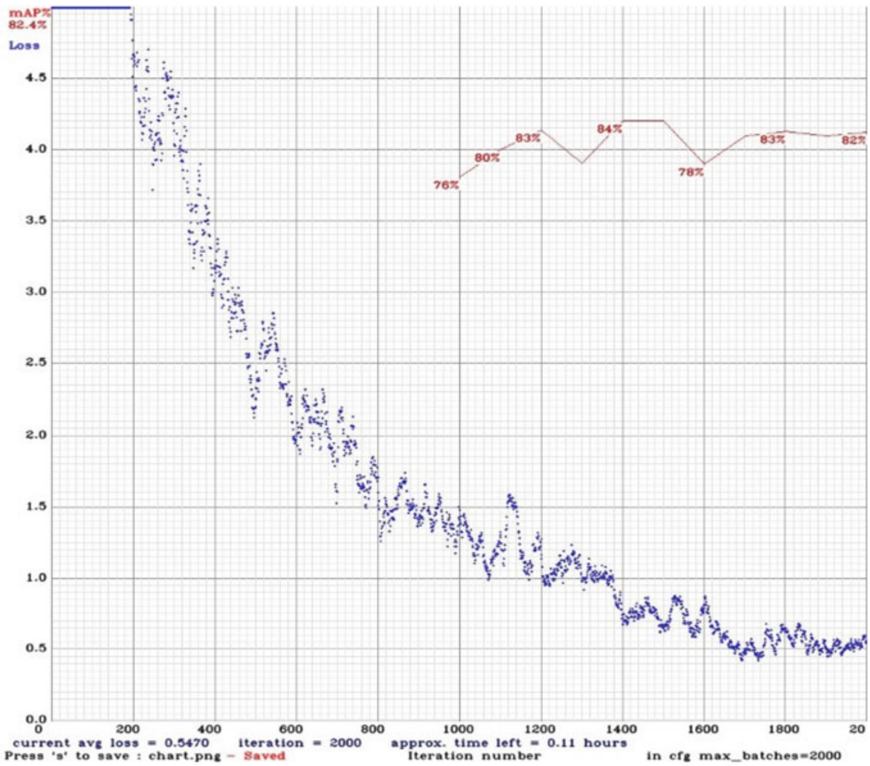

Fig. 4 mAP versus number of iteration for slim YOLO-V4 model

Fig. 5 .

4 Performance Comparison Based on Results

Following is a table that compares the mAP with YOLO-V4 and YOLO-V4 Slim network, and it was found that the proposed methods give better results. Network mAP YOLO-V4 on Flickr Logos 27 dataset is 59.72% and YOLO-V4 Slim on Flickr 27 dataset is 82.4% (Fig. 6).

Slim YOLO-V4 model generates better outcomes than YOLO-V4 model. In terms of accuracy and mAP, the Slim YOLO-V4 model surpasses the YOLO-V4 model. When compared to YOLO-V4, Slim YOLO-V4 loses less objects. Slim YOLO-V4 excels at detecting numerous logos in a single picture.

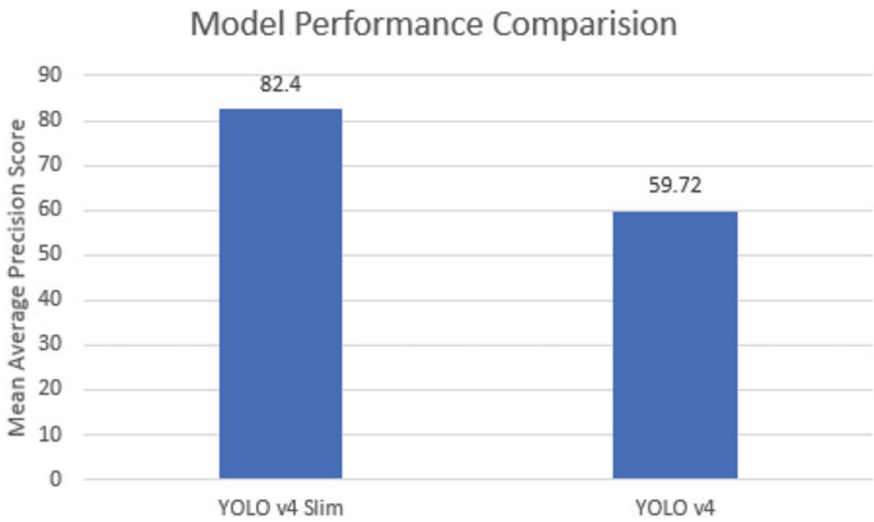

Fig. 6 .

5 Conclusion

Object detection is one of the most common jobs in Computer Vision. Object identification has been revolutionised by deep learning methodologies, and various deep neural networks have been constructed to do so. Logos in photos and live recordings are detected by the proposed technique. It has been discovered that one-phase detector algorithms are far superior to two-phase detector algorithms in terms of speed and accuracy. Perhaps, after some tweaks to the YOLO-V3 algorithm, a new model called YOLO-V4 was created with many variants to make it more suited and easier to manufacture. According to the poll, YOLOv4 Slim had better accuracy and mAP than other models. As a result, the YOLO-V4 and YOLOv4 Slim algorithms are used to recognise logos on the dataset. When compared to YOLOv4 Slim, YOLO-V4 suffers fewer losses. The average accuracy of YOLO-V4 to detect logos is seen to be 59.72% and the mAP of Slim YOLO-V4 is around 82.4%. Therefore, the logo detection system was successfully developed on the dataset with maximum accuracy and mAP in results using YOLO-V4 slim.

The presented work serves as the foundation for Logo Detection and can be utilised to further train the model with additional labels. The dataset size can be increased in order to see how the accuracy increases. The results can be further studied by expanding the dataset size and increasing the number of classes, as just 27 are employed here. The same technique may be applied to the Flickr 32 dataset, which has 32 different logo categories.

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Bomb Box: A Fortified Vault to Prevent Brute Force Attack

Gaytri Bakshi, Romil Verma, and Rohil Chaudhry

Abstract The Internet of things encompasses many devices connected to the Internet including wearable devices or edge devices forming a smart system to manage many tasks without the intervention of humans. Securing such systems, whether it is a part of IoT framework or any industrial software, is a very crucial task to be considered. Protecting them with passwords or even encrypting them still leaves some loopholes in the system. The attacker uses the concept of brute force to predict passwords and hack the system. To protect and prevent the system, many policies related to passwords are adopted. This includes continuous updating of passwords, which creates another stress to memorize them. This paper depicts a novel concept of a bombing algorithm to create a secure system and help remove unnecessary stress. The further section describes the related work done and the methodology adopted. The last section displays the results and evaluation of the proposed system.

Keywords Internet of things (IoT) · Encryption · Bomb Box · Data security · Data stealing · Bombing algorithm

1 Introduction

Security is one of the integral missions of the current world scenario. Sensitive information like passwords and credentials, being the most significant part of our lives, needs to be protected, and for that purpose, we need to carry out various security controls at all places which are involved in dealing with data. The prospects

G. Bakshi (✉)
School of Computer Science, University of Petroleum and Energy Studies, Bidholi, Dehradun, Uttrakhand, India
e-mail: Gaytri.b88@gmail.com

R. Verma
Deloitte India, Gurugram, Haryana, India

R. Chaudhry
Deloitte USI, Hyderabad, India

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focus on the increasing need to keep the data secure. The gradual enhancement in technology has brought advancement in terms of the usage of small, smart, and intelligent gadgets. With these innovations, life has become much easier but has even made more susceptible to attacks [1].

The progression in the field of IT as well as electronics has made the world dependent on smart gadgets which are connected to an inter-connected endless network [2, 3]. These small to big devices act as a node within a network that is managed by many users at any aspect of time. With the accustoming to socialization, a person's life is no more private and is mostly at risk [4, 5]. To protect them from malicious attacks, strong passwords are adopted by the users. But still, attacks such as the Brute Force attack [6–8] are used by the hackers to steal the confidential information. For this reason, the credential modification process is adopted by many firms. Mostly people are habitual of writing down their passwords or other sensitive information as plaintext or storing this information as plaintext on their systems making the information highly vulnerable. To avoid this, the only way is to memorize them. However, in this socially driven culture, people have so many accounts on different social platforms that at some point they lose track of the passwords that were memorized. To counter this situation, this paper presents a system called bomb box which works on the principle of a bombing algorithm.

2 Literature Review

Encryption is the process of encoding information or data to prevent unauthorized access. These days we need to secure the information that is stored in our computers or is transmitted via the Internet against attacks. There are different types of cryptographic methods that can be used. The selecting cryptographic method depends on the application demands such as the response time, bandwidth, confidentiality, and integrity [9].

The combination of a username and password is the most common method for gaining legitimate access to a computer system [10]. Faulty security has cost the global economy immense losses. Oftentimes, the pitfall in such financial loss is due to the security of passwords [11].

A brute force attack could start with dictionary words or slightly modified dictionary words because most people will use those rather than a completely random password. These attacks are called dictionary attacks or hybrid brute force attacks. Brute force attacks put user accounts at risk and flood your site with unnecessary traffic. Hackers launch brute force attacks using widely available tools that utilize wordlists and smart rule set to intelligently and automatically guess user passwords [12]. Attackers even use brute force attack by hit and trial method [13, 14] to guess password combinations and crack the system. To counteract this attack, there is a need for a system that would protect the passwords as well as remove the stress of memorizing the updating passwords.

3 Methodology

With the objective to secure the passwords and reduce the human burden to memorize the updating passwords, many encryption techniques were reviewed. Considering and gathering information about different encryption algorithms and different types of attacks, this paper depicts a system named as bomb box. It creates a secure space in which the encrypted files are stored which helps to overcome the everyday hassle to remember different passwords used in daily life. To access sensitive information (e.g., online financial accounts, social networks, and email services) protected by a computer system, end users often need to provide a password. The unique bombing algorithm used in the Bomb box can prevent brute force attack up to a large extent and also alert the user. **Password encryption** is a third option that combines password protection and encryption. The primary benefit of using both is having two layers of security, and what all the users need to do is to remember the Bomb box's password. The system configuration to deduce this system is as follows:

System Requirements

The following are the requirements that the system would need to run/execute bomb box.

The software requirements are as follows:

1. Operating system Linux.
2. GCC Compiler.
3. Language C.

The Hardware Requirements:

1. Intel Core i3 64-bit Processor.
2. Hard disk—10 GB.
3. RAM—512 MB.

Framework Design

Boom box is an application based on the C language to promote the security of sensitive information. This framework works by the implementation of the following steps:

(a) Making a secure folder where users can keep passwords.
(b) Secure those passwords in encrypted forms.
(c) Providing secure login plus informational alerts on user email during login.

Encryption Algorithms

Various algorithms used for password encryption are as follows:

(1) AES: The Advanced Encryption Standard, or AES, is a symmetric *block cipher* chosen by the U.S. government to protect classified information and is implemented in software and hardware throughout the world to encrypt

sensitive data. AES comprises three block ciphers: AES-128, AES-192, and AES-256. Each cipher encrypts and decrypts data in blocks of 128 bits using cryptographic keys of 128-, 192-, and 256-bits, respectively.

(2) MD5 HASHING: The MD5 hashing algorithm is a one-way cryptographic function that accepts a message of any length as input and returns as output a fixed-length digest value to be used for authenticating the original message.

(3) BOMBING: It is an algorithm that works on the concept of random numbers to prevent brute force attack. If a user enters the wrong credentials, then it randomly allows the attacker to gain entry but the attacker is shown false information.

The system is divided into the following modules such as:

(1) User login section: this module is created to make the system user-friendly. This module has options for both new users to register and old users to choose functionality.

(2) Menu selection: this module has various functionalities related to the addition and updation of records in the bomb box which a user has access to choose.

(3) File system: this module acts as database for the bomb box. The credentials saved by the users get stored and maintained in it.

(4) Email system: this module is used to retrieve the forgotten password of bomb box as well as to send alerts to the user about any sort of attack targeted.

The workflow of the system is depicted in Fig. 1. Step-wise description of each module is well described in the implementation section.

4 Implementation and Results

As the system is divided into modules, the system begins with a welcome page as shown below:

1. **Welcome Page**
   Welcome page shows the login credentials to the user as shown in Fig. 2. The new users will go for option 1 where they will create an account. Users who are already having an account on Bomb Box will directly login in to the account. Already registered users who forgot their passwords will go for option 3 "Forgot Password".
2. **Sign In**
   After creating an account, the user will sign in and if the password is correct, the user will see the functionality. With this, the user gets the authority to register his /her other account details in the bomb box as shown in Fig. 3. The user even gets other options to update the previously entered account details and even view all the data entered by them until now.

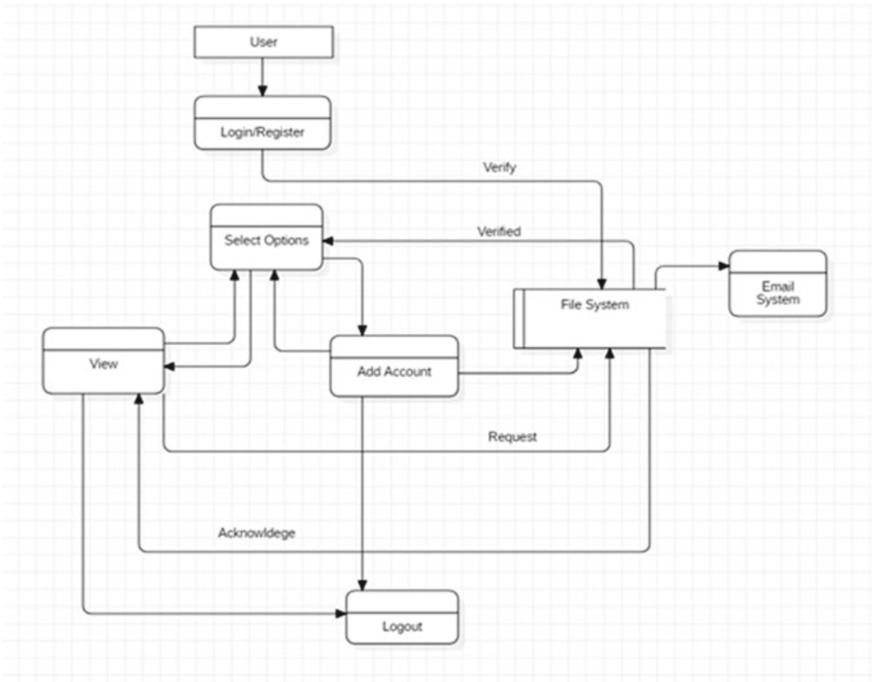

Fig. 1 Block diagram of the workflow

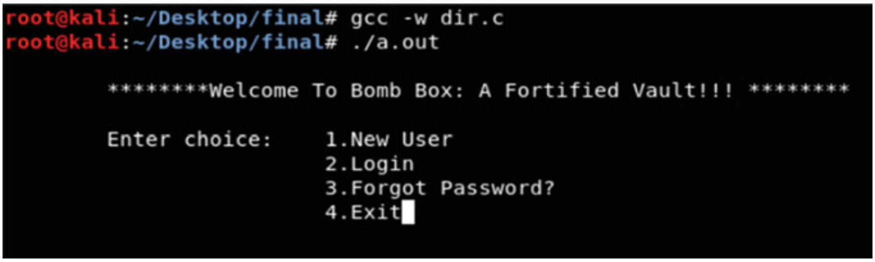

Fig. 2 Login page

3. **Successful Login and Adding Data**
   After successful login, the user will enter the choice of which functionality the user wants to use. Suppose if the user added the data related to other accounts, for example, Instagram as shown in Fig. 4, the password stored is encrypted and saved in the file system of the Bomb box.
4. **View the Registered Account Details**
   After logging the boom box, the user can see the preregistered accounts by giving the functionality "4" as shown in Fig. 5. The bomb box showcases the preregistered account credentials.

Fig. 3 Registering the account details to sign bomb box

Fig. 4 Addition of other account details

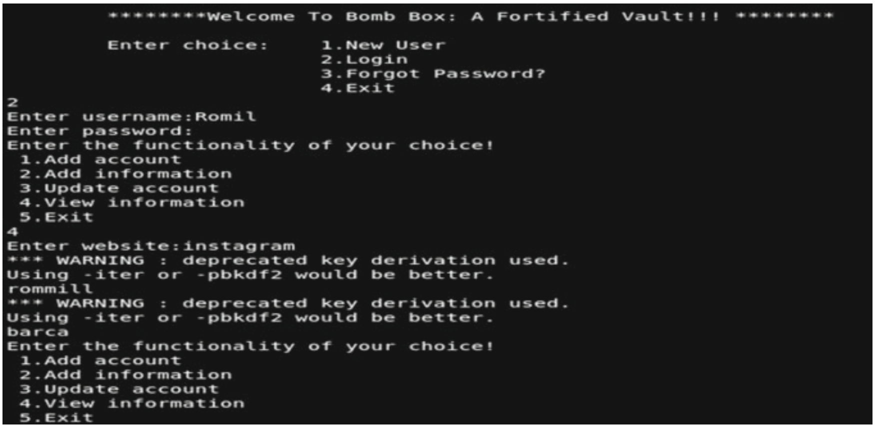

Fig. 5 Showcase the preregistered account details

5. **Forget Password**
   If a user forgets the bomb box password, it can be retrieved with the email module of the bomb box. The user can click on option "3" which states "forget the password". The system then asks the user to enter the user name as shown in Fig. 6. After receiving the user name, the system itself generates the password as shown in Fig. 7.
6. **Bombing Algorithm**
   If any attacker tries to break through the system by applying brute force attack, the bomb box prevents it by providing false information and pretending the attacker to gain false entry as shown in Fig. 8 This shows the prevention of brute force attack.

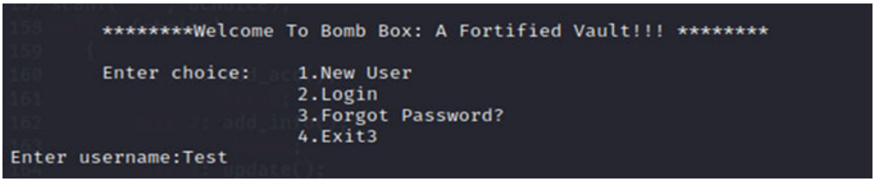

Fig. 6 To retrieve the password

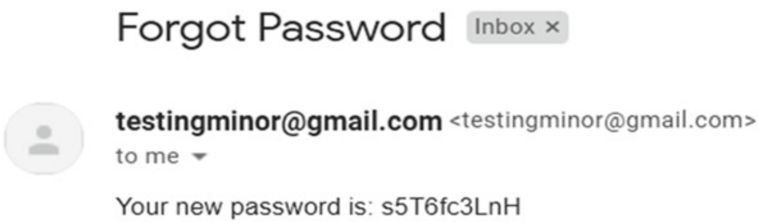

Fig. 7 Bomb box generates the password

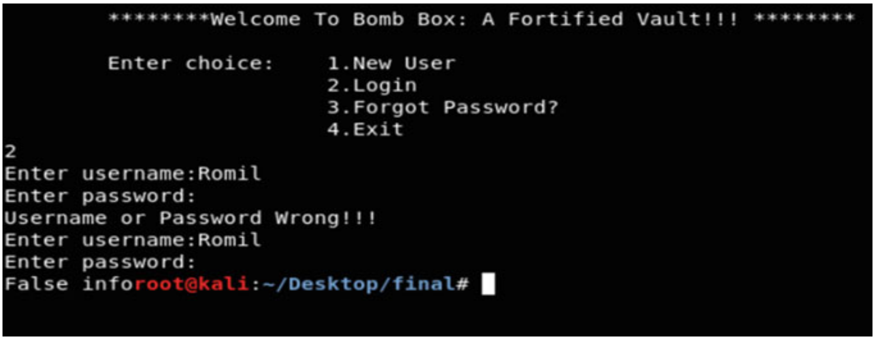

Fig. 8 Working of bombing algorithm

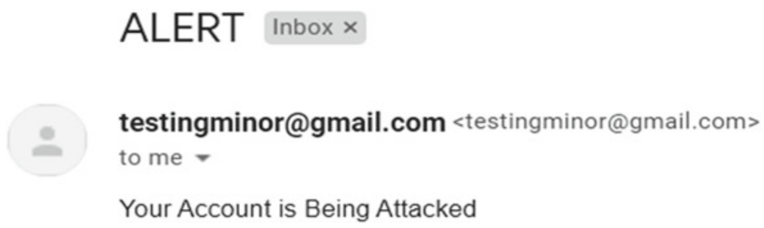

Fig. 9 Attack alert email

7. **Attack Alert**
   The moment the attacker gets the fake access to the system as shown in Fig. 8 at the same time the user gets an alert on the email about the attack as shown in Fig. 9.

5 Conclusion

As an IoT system could have several devices connected within it, it is mandatory to protect them to save the system from any malicious attack. The proposed system takes care of all the devices connected within a network in any organization. The policies implemented to update the passwords after a set period of time could be well managed by the boom box. It is efficient enough to counter the brute force attack and save the important credentials from it and inform the user as well about the attack. The proposed system can be enhanced with the integration of IoT biometrics and machine learning algorithm to give a predicted analysis of the attack and protect the system from further attacks.

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A Review on Virtual Machine Placement with ACO in Cloud Computing

M. P. Abdul Razaak and Gufran Ahmad Ansari

Abstract Cloud computing is an era idea wherein customers use far-off servers to keep statistics and applications. Cloud computing sources are demand-pushed and are used inside the shape of digital machines (VMs) to facilitate complicated tasks. Deploying a digital system is the method of mapping a digital system to a bodily system. This is an energetic study subject matter, and numerous techniques have been followed to cope with this difficulty inside the literature. Virtual system migration takes a sure quantity of time, consumes plenty of sources, influences the conduct of different digital machines at the server, and degrades machine performance. If you've got got a massive variety of digital system migrations on your cloud computing machine, you may now no longer be capable of meet your provider stage contracts. Therefore, the maximum trustworthy manner to lessen statistics middle electricity intake is to optimize the preliminary placement of digital machines. In the deployment method, many researchers use ant colony optimization (ACO) to save you immoderate electricity intake discounts. This is because of its effective comments mechanism and allotted retrieval method. This article information the contemporary techniques for digital system positioning and integration that let you use ACOs to enhance the electrical performance of your cloud statistics centers. The assessment among the techniques supplied here exhibits the value, limitations, and guidelines for improving different techniques alongside the manner.

Keywords Cloud computing · Virtual machine placement · ACO · Energy efficiency · Distributed search method

M. P. Abdul Razaak (✉) · G. A. Ansari
Department of Computer Application, B.S. Abdur Rahman Crescent Institute of Science and Technology Chennai, Chennai, Tamil Nadu, India
e-mail: m.p.abdulrazaak@gmail.com

G. A. Ansari
e-mail: gufran@crescent.education

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1 Introduction

Cloud computing remains the gospel of the records generation revolution of today. This is one of the most powerful examples of carrier web website hosting and on-call for request configuration. Allows cloud carriers to offer digital hardware, runtime environments, and services. It is virtually used to get admission to assets thru the World Wide Web. Virtualization is a key idea in cloud computing. Virtualization lets a bodily machine run more than one running structure and percentage of the underlying hardware assets. This is an pc technique that hosts the appearance of more than one computer [1]. Without virtualization, all machines might want equal strength, equal cooling, and equal bodily space. Installation, maintenance, support, and hardware prices are at once a percentage of the number of machines.

Resource sharing has many advantages, including extended useful resource usage with the aid of sharing bodily assets amongst more than one customer and applications. This reduces prices and affords separation, packaging, hardware independence, and portability [2]. Several research [3] have addressed VM deployment problems using thinking about diverse desires, lowering VM allocation time, lowering the number of bodily servers required, lowering useful resource waste, and enhancing strength efficiency. Some research remembers one or more of the above targets or more than one target to be digital gadget deployments. New in Static Server Assignment Problem (SSAP) Algorithm [4], Static Server Assignment Problem with Variable Workload (SSAPv) Algorithm [4], Dynamic Server Assignment Problem (DSAP) Algorithm, and Static Virtual Machine Deployment Algorithm Vector Method [5] requires an unmarried-cause set of rules to lessen the number of servers required. Yes: A unmarried-cause set of rules to lessen the number of servers required. The multipurpose ant colony optimization (ACO) set of rules [6] is a multipurpose set of rules which can lessen the waste of assets (CPU, memory, bandwidth), strength consumption, and carrier stage agreement (SLA) breaches.

1.1 Architectural Framework of Cloud Technology

The architecture of cloud computing consists of efficient components and subcomponents, which make the technology more reliable. The major components inside cloud computing can be grouped as front-end and back-end components. The front-end components are responsible for client-side connectivity, and the back-end components consist of server-side connectivity (Fig. 1).

The front-end connectivity of the cloud connectivity consists of the client-side environment with the user interface. Even though it is client-side, it also contains the server system. The back-end side is used by the cloud service provider, which includes multiple physical servers and multiple virtual servers. The back-end side of the cloud provides security control to the files in the cloud, and it is the actual phase to provide the communication. The end-user cannot view the back-end side.

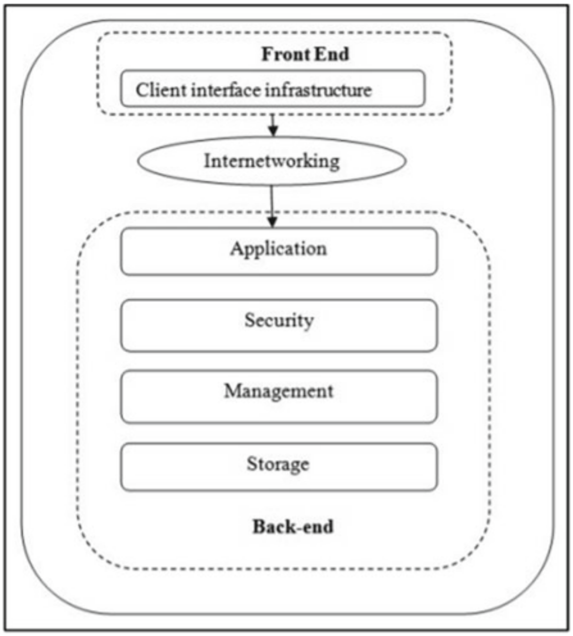

Fig. 1 Architectural framework of cloud computing

2 Taxonomy of Virtual Machine Placement Techniques

There are many digital system technologies to enhance electricity performance, all of which awareness of cloud environments that concentrate on electricity performance and useful resource management. Therefore, this phase compares electricity coverage adaptation, distribution processes, and electricity use.

2.1 Virtual Machine Placement Policy

Some researchers have attempted to increase a hit answers designed to lessen power intake in facts facilities while retaining appropriate provider fines (QoS). VM placement algorithms can normally be categorized into types: Most green and maximum useful resource usage. Depending on the cloud provider, installing QoS-primarily based digital machines relies upon the cloud provider.

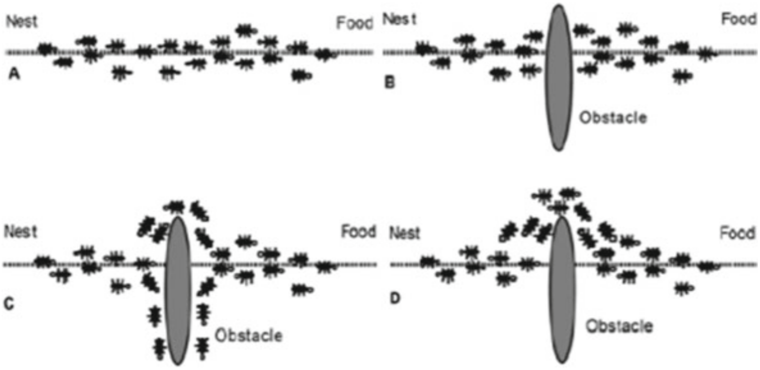

Fig. 2 Structure of Ant colony optimization

2.2 *Bio-inspired Computing—Ant Colony Optimization Algorithm*

Biology-stimulated or biologically-stimulated computing is loosely correlated with the ever-evolving pc and statistics technology, in addition to subjects including connectivity, social conduct, and studies on plants and rising animals. It turns into a subfield. This approach uses pc algorithms to make use of the lifestyles fashion of species and their survival and duplicate mechanisms, and the use of pc algorithms to enhance overall performance signs, including processor utilization, reminiscence utilization, gadget load balancing, and community routing. Ant Colony Optimization (ACO) is a shape of bionic computing (Fig. 2).

3 ACO Approach for VM Placement

Virtual tool placement is a manner that dynamically maps virtual machines to physical machines to optimize beneficial aid utilization. Place virtual machines pretty and gain your power-saving goals through several scheduling algorithms.

The creator of [7] biogeography-primarily based totally optimization approach, thinking about the answer to the hassle through thinking about server load, digital gadget room, strength intake, useful resource waste, and community garage traffic, makes use of Optimization (BBO). In addition to research [8], a brand-new genetic set of rules (GA) will resolve the NP hassle in telecom networks and PM in information centers. Liu et al. [9] proposed a VMP answer that ACO is predicated directly to choose the confined PM to discover information and VMs. In the sort of cloud information center, companies of VMs are located in PM, and method information is saved in PM. One manner in [10] is to apply synthetic ants primarily based totally on worldwide seek statistics to view ACO-primarily based totally VMP results. This set of rules gives the fine answer through assigning the VM to the minimal variety of energetic PMs. The essential aim of this approach is to lessen the strength intake of cloud DCs and save you strength overlap. Through reference [11], the writer proposes an ACO-primarily based totally VMP approach for comparing PMs appropriate for VM migration.

Liu et al. [12] a strength-saving ant colony set of rules for the location of network-conscious digital machines is proposed. The set of rules considers the CPU, reminiscence and bandwidth assets. Under those three constraints, the most value reduces strength costs. Liu et al. [12] Combining the order change and migration nearby seek era, a digital gadget placement primarily based totally on ant colony set of rules is proposed. Experiments have proven that it can run nicely in homogeneous and heterogeneous cloud environments. J et al. no longer expended attention on the goal of keeping assistance utilization [13]. A direct steerage ant colony device was proposed to maximize assist usage and reduce power input. Very accurate effects have additionally been acquired with this set of rules. Saini [14] proposed a fashionable ant colony gadget set of rules for the location of digital machines. The set of regulations establishes a predetermined set of parameters to reduce aid waste and strength intake. [15] A digital gadget format optimization version primarily based totally on digital gadget usage parameters, multi-goal optimization strategies, and practical signs turned into proposed. This is because of the waste of idle assets on bodily machines. Solve the redundant electricity intake problem. Malekloo and Kara [16] proposed a multi-cause ACO format set of rules and compared it with the clouds' single-cause and multi-cause GA algorithms. To enhance the performance of records facilities on the environment. Kumari et al. [17] proposed Fusion ACO set of rules. This could be very beneficial for reminiscence optimization withinside the cloud computing environment.

Tan et al. [18] plan to use the ETCACO method to establish a mathematical model of the VM placement problem for energy perception, flow perception, and connection perception. The focus of this work is to reduce power distribution in cloud data centers. Hossain et al. [19] idle digital machines generally tend to devour 50% to 70% of the server's overall energy, sooner or later turning into imbalanced and jogging energetic machines which is inadequate energy. The above hassle has been solved via way of means of making use of a brand new evolutionary computation technique of the Ant Nest System (ACS) algorithm. Pang et al. [20] state in a study that energy consumption issues are becoming increasingly prominent with the widespread adoption of cloud computing in data centres. Singh J et al. In the look at of [21], presents activity scheduling primarily based totally on heuristic techniques, powerful multi-queue activity scheduling (MQS) and ant colony optimization (ACO), and the time of those techniques. And similarly estimate the strength intake parameters, efficiency, cloud compute (Table 1).

Table 1 Algorithms summary of ACO approach for VM Placement

References	Technique used	Advantages of technique	Limitation/future work
Liu et al. [12]	Energy-saving ant colony algorithm	Reduces energy costs	QoS of VM resources is not taken into account
Pang et al. [20]	LET-Ant Colony Optimization	Effective in terms of energy consumption, communication costs, resource utilization, etc	Didn't consider data center combination issues
Singh and Deepali [21]	Multi-Cue Job Scheduling (MQS) and Ant Colony Optimization (ACO)	Compared to ACO, MQS shows superior performance in terms of time and energy consumption	This algorithm does not consider data center network communication

4 A Taxonomy on VM Consolidation for Energy Efficiency

VM consolidation is one of the promising approaches that conserve energy in cloud data centers. VM consolidation is solving the problem of Vector Bin Packing. Predicting VM resources is important for taking advantage of the high resources of CDs. Two regression-based prediction models have been proposed, including a linear regression and a k-nearest neighbor (KNN) regression [22]. Using these regressions, you can predict VM and PM utilization based on CPU and memory. This regression-based VM merging process is used to solve VectorBin packing problems. VM consolidation is important when users' workloads are unpredictable and required to allocate resources effectively [23] periodically. Feller et al. [24] designed a singular workload consolidation set of rules primarily based totally on ACO, which considers more than one resources (CPU cycles, CPU cores, RAM length, disk length and community bandwidth) in preference to a unmarried useful resource (CPU). Fahimeh et al. [25] proposed a Dynamic consolidation approach, an powerful approach for electricity discount in records facilities via way of means of switching off idle or under-applied servers. Reinforcement Learning-primarily based totally Dynamic Consolidation (RL-DC) set of rules is used to discover host states at runtime via way of means of the usage of the Q-mastering approach. Dilip and Bibhudatta [26] proposed a power-aware heuristic algorithm applied to a centralized controller based on the requirements of the environment. The main aim of this algorithm is to maintain availability and reduce the total power consumed by the cloud. A greedy heuristic algorithm is proposed with a three-task consolidation process.

Monil and Rahman [27] proposed a Fuzzy VM selection method integrated with heuristic-based virtual machine consolidation. The main aim of this algorithm is to enhance the VM selection by using an overload detection algorithm. A fuzzy technique is an attractive approach for solving decision-making problems. Dynamic Power Saving Resource Allocation (DPRA) based PSO algorithm is proposed [28].

Table 2 Algorithms summary of VM consolidation for energy efficiency

References	Technique used	Advantages of technique	Limitation/future work
Farahnakian et al. [22]	Linear Regression and K-Nearest Neighbor (KNN) Regression	Efficiently worked for Vector Bin packing	This method does not take into account the quality of service of network bandwidth resources
Farahnakian et al. [25]	Reinforcement Learning-based Dynamic Consolidation (RL-DC) algorithm	Reduces power consumption in an effective manner	The algorithm does not take into account network traffic in cloud data centers
Dilipkumar and Bibhudattasahoo [26]	Power-aware heuristic algorithm	Reduces the total power consumed by cloud	Run time is significantly longer than any heuristic algorithm
Monil and Rashedur [27]	Fuzzy VM selection method	Improve cost, application performance, energy consumption effectiveness	Running time is high
Chou et al. [28]	Dynamic Power Saving Resource Allocation (DPRA) based PSO	The algorithm has demonstrated better energy efficiency and migration	The algorithm does not take into account the network infrastructure

This mechanism considers the energy consumption of physical machines and VM and handles the energy efficiency ratio of Air-Conditioner (AC) (Table 2).

5 Resource Management in VM Placement

Resource management plays an appreciable part in cloud technology to make it reliable and efficient. Without resource management in a cloud environment, the technology would be a failure element. Resource management is needed on the physical machine and on the virtual machines deployed to meet the customer's requirements.

The maximum vital technology to enhance useful resource usage and remedy the hassle of useful resource over-allocation is (1) virtualization and (2) VM integration. Virtualization is an era that splits a PM into a couple of VMs so that a couple of bodily assets may be used as logical or digital assets [29]. Virtual machines are incorporated via PMs to keep away from the use of extra PMs. In addition, to lessen the variety of energetic bodily machines, close down idle nodes, or preserve them low strength or hibernating [30]. This approach allows lessened strength intake in the course of idle. Since VMs are migrated from one PM to another, VM or server consolidation entails a key activation era referred to as Migration [31]. Domanal et al. [32] 3 bionic (MPSO, MCSO, and HYBRID) algorithms are proposed for green scheduling and useful resource control in cloud environments. Compared to different algorithms, MPSO algorithms are greater powerful in scheduling tasks.

Bousselmi et al. [33] proposed a systematic workflow scheduling QoS-conscious set of rules, which aims to enhance the general nice of service (QoS) by comprehensively thinking about the execution time, statistics transmission time, and cost availability and different indicators like resource and statistics placement restrictions. Ortigoza et al. [34] Proposed and applied a workload generator that lets in distinct VMP trouble times generated for the cloud computing surroundings primarily based totally on distinct configurable parameters. Aruna and Vasantha [35] In this paper, a particle swarm optimization set of rules for digital gadget configuration is studied to attain electricity conservation in cloud statistics centers. To solve the server strength model, we endorse that digital machines configure the strength-conscious PSO set of rules and its results. Gill and Kaur [36] proposed optimizing the electricity performance of the present-day statistics centers on the usage of ant colony optimization. This examine suggests a green energy strategy based mostly on the swarm optimization approach. According to American Environmental Protection Agency's file on statistics middle electricity intake [37], server electricity intake is 40% of statistics middle electricity intake and 80% of general IT load.

Similarly, in keeping with an open computing challenge research [38], 91% of the electricity intake of the statistics middle comes from its computing sources. Therefore, the cause for the excessive carbon dioxide emissions is likewise the low performance of computing sources. The statistics supplied in [39] suggest that, in maximum cases, the running capability of a server exceeds 15–50% of its general capability, main to over-allocation of sources and a boom withinside the general acquisition cost (TCA) [40].

According to reviews from the National Resource Conservation Commission [41, 42], maximum records facilities are unused, and this research focuses on the issue of digital device placement and suggests physiologically stimulated strategies for lowering usable resource waste, power consumption, and language costs within the data centre. Jain et al. [43] studied numerous cloud integration and migration technologies, along with ant colony optimization and K-way regression, and summarized the results.

Devarasetty and Reddy [44] planned a examine on a utile pismire colony improvement set of rules for cloud computing helpful resource allocation. This examine makes a speciality of the issue of digital device placement and proposes biologically stirred techniques for decreasing useful resource waste, power consumption, and language charges withinside the data center. In their examine, Kumar and Sharma [50] say that assets are dynamically tuned, released, and assigned in cloud environments. once and some way to portion many assets could be a horrifying task. Resource improvement and well regular allocation will enhance helpful resource usage and power performance, client satisfaction, and dealer profits. Kumar et al. [45] observed that presently, industries are requesting the adoption of MCC (cellular cloud computing) to motivate consumers to reap the benefits of cloud computing

Table 3 Algorithms summary of resource management in VM

References	Technique used	Advantages of technique	Limitation/future work
Aruna and Vasantha [35]	virtual machine provisioning power-conscious PSO algorithm	Reduced power consumption	The algorithm does not take into account service level agreements (SLAs)
Gill and Kaur [36]	Ant Colony Optimization	Generates reduced consumption of power with throughput	Not considering resource service standards
Devarasetty and Reddy [44]	Multi-Objective Ant Colony Optimization	Record minimal energy consumption, reduce the number of hosts, reduce resource waste, and reduce communication costs	Utilization time is more

in a powerful way. However, cellular cloud computing structure desires gadgets of cellular cloud computing of customers to installation a strong wi-fi hyperlink (Table 3).

6 Research and Challenges for Energy Efficient VM Consolidation

With the development of virtualization, IT organizations and academia have revolutionized by offering new opportunities and opportunities. There are numerous blessings and drawbacks to the usage of digital gadget integration. Now that we have mentioned the advantages of adopting VM integration, here are a number of the demanding situations of adopting VM integration on your statistics middle.

- The VM integration manner places more than one VMs on an bodily gadget to host more than one program. At a few factors, this will result in an factor of failure (SPOF).
- Sharing bodily assets can affect utility overall performance because of aid competition in a merging manner.
- When allocating assets, delay-touchy programs (including online video and voice conferencing, VoIP-IP voice) want unique attention.
- The VM integration migration manner offers server CPU cycles and statistics middle community hyperlink overhead [46].

According to the literature, utility relocation causes poor overall performance. Therefore, the VM integration manner layout has to limit stay VM migration. While VM consolidation has these drawbacks, adoption of this manner is multiplied via way of means of more than one advantage inclusive of decreased operational costs, minimized strength consumption, and multiplied statistics middle aid usage. As noted above, aid sharing minimizes earnings and offers aid competition that violates SLAs.

7 Conclusion

Over the years, the power-saving digital device positioning era has emerged as one of the major studies fields in statistics centers. It defines the energy, first-class of a carrier, and hardware and software power, classifies current literature technologies, and describes their traits and limitations. This white paper evaluates the cloud statistics middle with the aid of classifying the modern ACO digital device placement strategy. The intention is to decide the VM placement necessities for statistics from the cloud statistics middle and offer researchers a foundation for designing scaled answers that offer flexibility, accuracy, and availability in particular areas. It is to suggest a set of rules to extend cloud computing.

The ACO-primarily based set of rules offers a VM deployment answer that may lessen the general fee by decreasing the overall useful resource waste and energy intake at the server and offering fault tolerance thru load balancing at the server. In addition, cloud computing has many cloud carrier users (including cellular applications, online games, social media, and email), assisting enterprise communities. In this regard, cloud offerings want to be extra power-green and sustainable so that you can meet purchaser calls in a well-timed way without affecting the climate. In addition, to gain power-green cloud offerings, power and QoS want to be balanced.

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Locating Potholes with Internet of Things Technology Using Cloud Computing Analysis

Devina Varshney, Rishabh Kumar, and Ankit Mishra

Abstract Many times, when people travel on the road, especially through rain-affected cities, it becomes a constant need to monitor road quality to essentially make sure that there are no unforeseen circumstances. Owing to the gravitation of human needs toward a smart city and the decrepit road infrastructure, the aim of this research is to constantly monitor the road surface to improve the quality and ensure that the car journey is safe. A mobile application has been developed which collects data from the in-built sensors of the phone. The collected data is sent to a database built using Google's cloud platform, using a socket connection. The socket connection enables the data to be sent in real time. Google's Firebase Database offers a real-time database, which can be deemed appropriate for this purpose. The analysis involves fetching the stored data, the fetched data is further cleaned and converted into a suitable form. The Z-Thresh algorithm was used to accurately determine the location of the potholes as it considers the minimum value of the z-axis accelerometer as a threshold. The analysis is done over a cloud-based tool, which further informs the authorities about the locations of potholes via SMS so that they can fix them.

Keywords Accelerometer · Cloud computing · Internet of Things · Pothole detection · WebSocket · Z-Threshold algorithm

1 Introduction

Autonomous driving cars rely on information which is gathered, analyzed, and processed within the car itself. A large variety of information is collected by sensors to

D. Varshney (✉) · R. Kumar · A. Mishra
VIT Vellore, Vellore, India
e-mail: devinavarshney@gmail.com

R. Kumar
e-mail: official.rishabhkumar@gmail.com

A. Mishra
e-mail: ankitofficial1999@gmail.com

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enhance the automated driving experience, which takes into consideration a number of factors. Some of these factors might be timing, safety, and security constraints. Anomalies on the road surface negatively impact the user's experience. Potholes, road surface anomalies, and speed bumps are just a few of the examples, which not only can negatively impact the user experience, but might also be potential threats in terms of user safety and car's performance. Infrastructure management can help deal with such issues, enhancing both user experience and safety. Road quality assessment is a key factor in Infrastructure management, which can help in optimized road maintenance operations. Besides regular obstructions such as potholes, speed bumps, and road anomalies, there also exist other obstructions like railroad crossings and joints. For example, in a railroad crossing, the timing of the train crossings being known by the car can avoid potential accidents, in case the railway crossing is not blocked physically at such time. A pothole as mentioned above refers to a shallow pit on the road's surface. These potholes might be caused due to activities such as erosion, traffic, and weather. It becomes essential to monitor road and surface quality to make sure that there are no unforeseen circumstances. Owing to the gravitation of human needs toward a smart city, and owing to decrepit road infrastructure the aim of the proposed system is to constantly monitor the road surface to improve the quality and ensure that the car journey is safe. Potholes not only degrade the rider's experience, but they also increase the maintenance cost of the vehicle and fuel consumption. The right maneuvers are necessary to be made at every single point, to ensure the safety of the passengers. The reparation of roads in a timely manner ensures a comfortable journey. There has been notably important research in the domain of monitoring road conditions. To help detect the potholes on the road, IoT principles have been used to monitor the quality of roads. Implementing this has been carried out with the help of an accelerometer, further, the aim of the system is to also store the data on a cloud platform. Smartphones used for road condition monitoring have been confined to capturing accelerations, processing them to detect potholes, and monitoring the general state of road surfaces up until now. As a result, before the data can be used, it must be pre-processed. A passband filter, for example, can be used to do this. Low and high frequencies are removed from the measured data. This cleans up the data and makes it easier to process. To make feature extraction and classification easier, data can be separated into tiny segments and standardized to a certain scale. Additionally, this data will be retrieved to perform analysis using different algorithms and compare their performances. The algorithm will be used to initially train on a dataset and then using a particular threshold value, the application checks whether there is a pothole and this would instantly trigger a notification.

The main contribution of the proposed system is

- To build an IoT-based platform to help in the detection of potholes and maintenance of the same.
- Website to track the locations of a pothole, accessible to the authorities.
- Enhanced and safer travel on road.
- Informing authority about the pothole so that it can be repaired as soon as possible.
- Instant alert of a pothole location to the stakeholders.

- Socket connections ensure reliable and quick transmission of data.

2 Literature Survey

The gaps in the existing state-of-the-art methods have been analyzed. Corrective measures have been incorporated to overcome the drawbacks as shown in Table 1.

3 Drawbacks of the Existing Systems

3.1 Speed

Detecting irregularities of the road surface and potholes and humps is only applicable for a certain speed range and is not possible for any given speed which falls outside of this range.

3.2 Accuracy

While Accuracy and Precision are very impressive in terms of machine learning algorithms, these numbers are very hard to work within the real world. A 10% error would mean thousands of "false-positive" detections, which would lead to a range of problems.

3.3 Optimizations

While Scalable IOT–Cloud Infrastructures do exist, the networks are highly unoptimized, which leads to the structures not only being unnecessary complicated but also higher energy consumption overall.

4 Components Used

The accelerometer and GPS sensors of the smartphone are used to fetch the acceleration along all the axes and the position of the user in terms of latitude and longitude. This section explains the working of each of the sensors involved. Smartphone Accelerometer to find the value of the acceleration of the x, y, and z axes and Global

Table 1 Comparative analysis of existing methods for pothole detection

Title	Advantages	Gaps
A three-tier road condition classification system using a spiking neural network model	When compared to a Support Vector Machine (SVM) and Multilayer Perceptron (MLP) [1] trained using the collected datasets and classification models, utilizing a Spiking Neural Network (SNN) produces much better classification results	The system has memory constraints as a lot of memory is consumed in the process, which makes the system slow
Vehicle vibration signal processing for road surface monitoring	The system [2] can detect and classify the abnormal events such as pothole and hump from the collected data at any vehicle driving speed. It can also estimate the severity of the identified event when the test-driving speed falls in the range of 15–20 km/h	The system is unable to detect the irregularities for only a particular range and is unable to estimate the event severity at any given vehicle driving speed
Evaluation of detection approaches for road anomalies based on accelerometer readings—addressing Who's Who	A smartphone has been used as a low-cost, widely available instrument to assess road quality. A collection of seven seminal heuristics [3] that have impacted the development of new anomaly detection systems have been evaluated Among the seminal efforts, the best technique is termed STDEV(Z), which surpasses other popular and well-known detectors like Pothole Patrol and Nericell. Dispersion measures, particularly standard deviation, are among the most effective markers for detecting disturbances in accelerometer measurements	Certain circumstances where STDEV(Z) and SVM(Z) showed their lowest performance

(continued)

Positioning System module for finding the latitude and the longitude have been used as sensors.

Table 1 (continued)

Title	Advantages	Gaps
Road pavement condition diagnostics using smartphone-based data crowdsourcing in smart cities	The paper [4] uses the road condition tool (RCT) to analyze data (linear accelerations, speed, and vehicle location) from a large number of RCT-enabled smartphones. The combined data can give an accurate idea about the road conditions of a pavement An accuracy of over 90% with a precision of 80% was obtained	While Accuracy and Precision are very impressive in terms of machine learning algorithms, these numbers are very hard to work with in the real world. A 10% error would mean thousands of "false-positive" detections, which would lead to a range of problems
Scalable cloud–sensor architecture for the Internet of Things	The paper uses Cloud-Edge-Beneath (CEB) [5], an event-based programming framework for IoT application development, as well as a design for large-scale, extendable cloud–sensor systems. They conducted experiments to validate CEB's scalability and capability of adapting to dynamic load on the cloud–sensor system	Even though CEB is an architecture designed with a built-in optimization platform, this paper does not propose or report on any optimizations to enable further scalability and energy efficiency of the cloud–sensor system

5 Proposed Architecture

The data collected from the sensors of the phone are sent to the Web server via a Socket Connection. The socket connection enables the data to be sent much quicker as compared to the traditional HTTP Protocol. The data sent is then fetched, to be analyzed. The analysis is done using the Z-Thresh algorithm, which helps determine the location of the pothole. The location of the potholes is further sent to the authorities as illustrated in Fig. 1.

Z-Thresh Algorithm

Z-Thresh is the simplest event detection algorithm. The Z-Thresh algorithm uses the minimum value of the z-axis accelerometer as a threshold to detect potholes. In the proposed model, a threshold of 0.4*g has been used for classification. The value of the received data is compared to the threshold value by the algorithm. A pothole is identified when the value's amplitude surpasses the threshold. The Z-Thresh algorithm is shown in Fig. 2, when the number of occurrences exceeds the threshold value. A pothole will be detected if the magnitude of the z-axis value deflects first in a positive direction, then in a little negative direction.

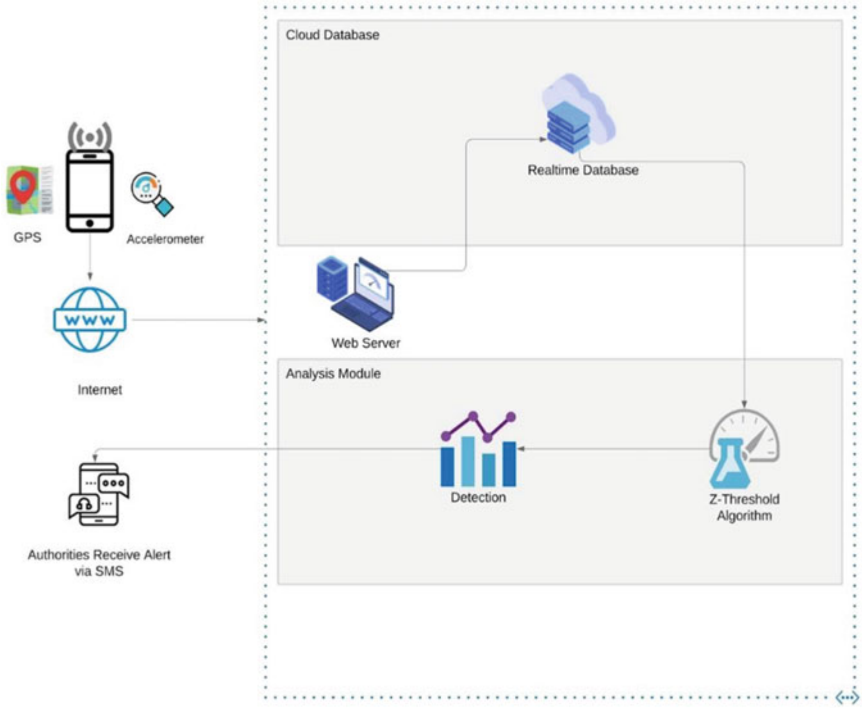
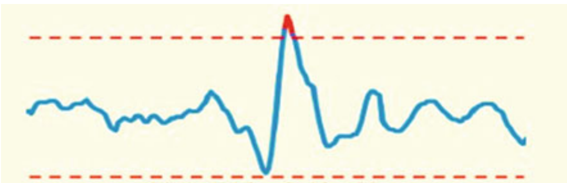


Fig. 1 Proposed system model

Fig. 2 Z-Thresh algorithm [6]



The pothole will be indicated with the change in the value of the z-axis. In this scenario, if a pothole or potential bump is recognized, an alert will be sent to Firebase. In the proposed model, Google's Cloud Platform has been used to store the data, which is collected from the Mobile App. The Data is later fetched from cloud, and analyzed further. WebSocket enables the transmission of message-based data in a manner similar to UDP but with the security of TCP. WebSocket employs HTTP as the initial transport protocol, but it maintains the TCP connection open after the HTTP reply is received, allowing messages to be sent back and forth between client and server. WebSocket allows users to build "real-time" applications without the use of long-polling. WebSocket begins life as a standard HTTP request and response. Within that request–response chain, the client asks to open a WebSocket connection, and the server responds (if it is able to). If the initial handshake works well, the client and server have agreed to use the current TCP/IP connection as a WebSocket connection for the HTTP request. Data can now flow across this connection using a rudimentary framed message protocol. The TCP connection is terminated after all parties agree that the WebSocket connection should be terminated.

6 Implementation

The in-built GPS of a smartphone is used to get the accurate location of the user in real time. This paired with cellular mobile data helps to pinpoint the exact location on a map using services built by Google. Accelerometer data is used to know the acceleration of the vehicle in all the axes. In the ideal scenario, it would be ideal to orient the axes of the mobile and align it with the axes of the car for accurate readings. Using the readings of the Accelerometer, the presence or absence of a pothole on a particular road can be detected, while GPS helps pinpoint the coordinates of the pothole and cellular mobile data helps store the location of the pothole. The readings of the GPS coordinates and Accelerometer readings are stored in a cloud server. Google Cloud has been used for the purpose of storing and analyzing data, due to its compatibility with Android Studio and its ability to perform analytics on the cloud itself. The use of mobile devices for getting accurate location and accelerometer readings is ideal, as it allows multiple people to collect sample data by installing a simple app. Furthermore, the size of the sample dataset can be expanded with ease. The accelerometer provides the acceleration of all three coordinates, excluding the effects of gravity. In the ideal scenario, the mobile phone shall always remain aligned to the axes of the car. However, the testing carried out shows that the detecting of a pothole is accurate with minor deviations in the angle of both the axes of the car and mobile as well. Some sample accelerometer readings and GPS readings have been shown in Fig. 3.

The three components of an acceleration that it measures can be understood with the following example.

- Pushing the device toward the right side makes the X component of acceleration positive.
- Pushing the device to the bottom makes the Y component of the acceleration positive.
- Pushing the device toward the sky with an acceleration of A m/s^2 makes the value of acceleration as (A-9.8) m/s^2 for the Z component.

The Z component of the acceleration is the relevant acceleration for finding out the irregularities of the road. Thus, the algorithm used in the further explanation works with the Z component of acceleration.

The accelerometer data is normalized and is adopted in the pothole detection algorithm to obtain the pothole information. The analysis reveals if a pothole is

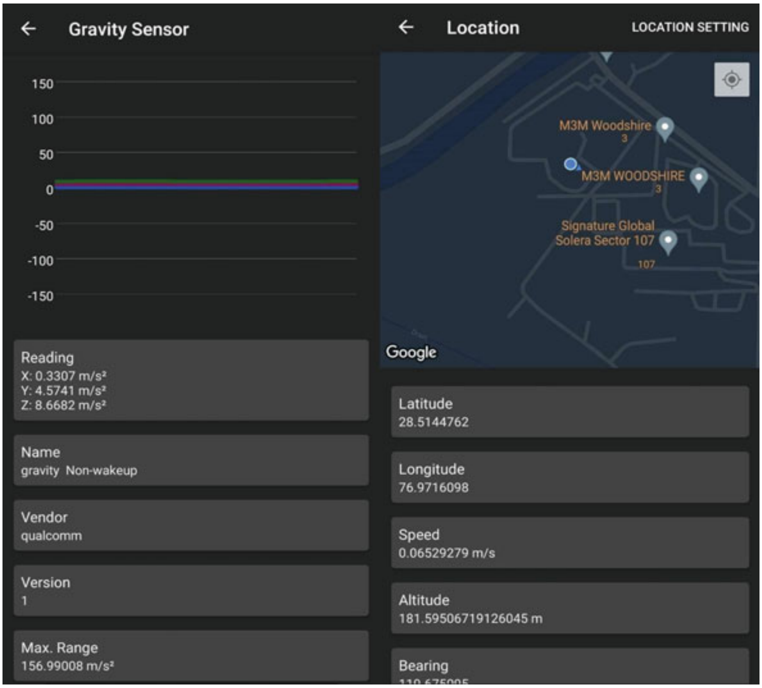


Fig. 3 Sample accelerometer and GPS readings

present at that particular location. The proposed real-time pothole detection method based on mobile sensing includes three main steps:

- accelerometer data normalization,
- pothole detection algorithms, and
- pothole location determination.

Using sensors to recognize the vibration patterns of the vehicle generated by any deformity or obstruction on the road has been the most prevalent strategy utilized in prior research for monitoring road conditions. The suggested "virtual sensor"-based real-time pothole identification system has three primary steps: accelerometer data gathering and normalization, pothole detection approaches with signal processing algorithms, and pothole position determination (GPS data). It is necessary to link up the raw accelerometer signals with the GPS data regularly received by a database in order to construct a real-time algorithm: in this instance, information about the location of the holes may be provided. The raw accelerometer data is sent into a processing system that detects the pothole using a Z-Thresholding technique.

6.1 What Form of Data Analytics Can be Applied to Collected Data?

The first step in performing data analytics is data collection. Here, the most essential step is the flow of data and tracking of this data. For that, it is of absolute significance that a suitable time parameter is specified in order for the efficient monitoring of the data. For every nth millisecond, the accelerometer readings and GPS coordinates are stored and analyzed. Firebase stores the values of the observations along with their latitude, longitude, x, y, and z coordinates of the Android phone. The data available in Firebase is downloaded initially through a simple JavaScript code, which is then converted into json format.

Once the file is available in json format, it is converted into csv format using a script. Then the csv file is loaded for analysis. The next step is to filter the data which is the value of z with respect to indices. A certain threshold for z (numerically equal to 0.4*g) is set to find out the latitude, longitude, and indices along with the z value of the indices that cross this threshold. Consider a situation that happens when there is an immediate jerk or a sudden turn. Such a situation will act as an outlier to this because the period is really short. For every observation, there can be a comparison between the previous and the next observation. If a cluster of data points has an acceleration value greater than that of the threshold and the neighboring data points have an acceleration value lesser than that of the cluster, then we can infer that the location can potentially have a pothole. In other cases, the data observation is treated as an outlier and not treated as a pothole. Finally, we store the location of the pothole in terms of latitude and longitude. If multiple cars detect a pothole at that particular location, then a notification can be sent to the local authorities informing them that the road needs to get repaired.

7 Results and Discussions

The previous section discusses the working of the entire Pothole Detection system and also compares and contrasts it against some of the different approaches, involving concepts of machine learning. The results section would show the outcome of implementing the methodology proposed in the previous sections.

Z-Threshold algorithm predicts a pothole based on the following conditions:

- The value of z-axis acceleration should be greater than 0.4*g.
- The value of the previous and the next observation should be lesser than the acceleration of the point where the pothole is present.

The algorithm detects whether both of the conditions have been satisfied. The algorithm also groups observations, which indicate the same pothole, i.e., observations which are right next to each other.

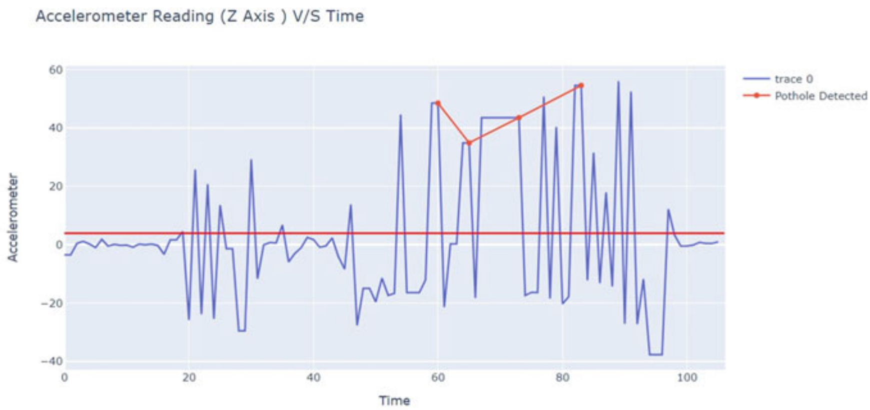


Fig. 4 Indicating the points where potholes have been detected according to the Z-Thresh algorithm

7.1 Graphical Analysis

As soon as the indices of potholes are determined using the Z-Threshold algorithm, as shown above, an SMS alert is sent to the authorities. A graph is plotted of the values of acceleration of z-axis; the points where the Z-Threshold algorithm detects a pothole are also plotted and the points are connected in the form of a straight line. The graph as shown in Fig. 4 depicts the z-axis acceleration with respect to time. It is evident from the above graph that the Z-Threshold algorithm accurately detects potholes, except in the case of one observation. The observation at time ~50 shows an observation which satisfies all the conditions of the Z-Threshold algorithm. However, this observation should not be considered a pothole. This is due to the fact that points were suspected.

7.2 Comparative Analysis

Feature	Existing methodology	Proposed System
Memory and speed	HP laptop with Intel®Core™i7-3632QM CPU @ 2.20 GHz × 8 and 8 GB memory was utilized	Any device capable of accessing the Internet can be used as the analysis is done on a cloud-based platform
Driving speed range	Systems are able to detect the irregularities for only a particular range	Ensures detection of irregularities at all driving speed ranges

(continued)

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Feature	Existing methodology	Proposed System
Cloud-Edge-Beneath (CEB) architecture	CEB ensures that the optimal algorithm is being used at the individual node level. Certainty of the performance of algorithms is not guaranteed at a larger scale	Data from every single node is analyzed on a cloud-based platform which ensures scalability

8 Conclusion

The first step in this research was building an application on Android Studio to detect potholes with the help of the mobile's position which would detect potholes if there is a jerk. The values for x, y, and z were computed along with the latitudes and longitudes. These data values were stored in Firebase from Android. From Firebase, a json file was generated, which was converted to csv using Python script. If the values of the z crossed a certain threshold that is 3.92 (9.8*0.4), then there would be a pothole. To assure the pothole, it was checked whether the index values were consecutive and if they were then the values of z were updated along with their latitude and longitude, and these values were demarcated and shown that at these positions there lies a pothole. The Z-Threshold algorithm was used for this.

Once the pothole is detected, then SMS is triggered using Twilio alerting the authorities that there is a pothole. These alerts are useful for people commuting on a certain route and they should be careful when they go about a particular route having a pothole. Also, these alerts make road authorities aware of the fact that they need to repair them well in advance and make it comfortable for people to commute. Therefore, this implementation would be able to save people from road accidents and also the wear and tear of the tires that frequently occur on the road.

This system would be useful in rainy areas as well as areas of low visibility due to smog and fog thereby helping people commute to places they wish to. The concept of detection of potholes can be extended to the following applications in the domain of the smart city.

- Google Maps Integration: A simple API call can help millions of users across the globe to know about the Potholes around their area.
- Peer-to-Peer Smart Car Network: In the future, cars would communicate with the nearby smart cars using peer-to-peer networks, which helps ensure faster communication.

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Pose Driven Deep Appearance Feature Learning for Action Classification

Rejeti Hima Sameer, S. Rambabu, P. V. V. Kishore, D. Anil Kumar, and M. Suneetha

Abstract In this work, we propose to learn the fusion process between the dominant skeletal features and the RGB features. This is in contrast to the previous fusion methods that simply fused these multimodal features, without learning the fusion process to exploit the semantic relationship between them. Here, we propose a gated feature fusion (GFF) of multimodal feature data which provides attention to the appearance stream of RGB data using the temporal skeletal data. Initially, the features from RGB and skeletal frames are extracted using CNN models. Subsequently, the gated fusion network fuses the features from pose and appearance domains using temporal convolutions which are further combined into a latent subspace. Finally, the latent subspace features are classified using fully connected layers with the combined loss embeddings. The proposed architecture has performed better than the state-of-the-art models on RGB-D action datasets.

Keywords Human action recognition · Feature fusion · Appearance and pose models · Temporal convolutional network

R. H. Sameer · S. Rambabu · P. V. V. Kishore
Department of ECE, Koneru Lakshmaiah Education Foundation, Guntur (DT), Andhra Pradesh, India
e-mail: pvvkishore@kluniversity.in

D. A. Kumar (✉)
Department of ECE, PACE Institute of Technology and Sciences, Ongole, Andhra Pradesh, India
e-mail: danilmurali@ieee.org

M. Suneetha
Department of ECE, Gokaraju Rangaraju Institute of Engineering and Technology, Kukatpall, India

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1 Introduction

Human Action is the most versatile physical motion in the world. The dynamics of human body are extremely agile and diversified to the individual, making it uniquely distributed across similar classes. This diversification within class actions poses a challenge for the classification of human actions in the digital domain. Human Action Recognition (HAR) [1] is defined as a set of algorithms that classify data from sensors in multiple domains that capture human actions. The actions that are originating from the human body are destined to express feelings and performing a task in this world. Interestingly, HAR finds prominent applications in the form of smart surveillance [2], person re-identification [3], gait analysis [4], sports action investigation [5], fall detection [6], crowed sensing [7], and many more.

Singularly, all these applications need video data in either RGB (Red, Green, Blue) color or depth or skeletal formats. The most widely generated data is a color video in RGB format. Though RGB is easily available and less expensive to generate, it is the most difficult to process due to multiple challenges such as background variations, blurring, lighting, and inter-object occlusion. Consequently, the availability of low cost multimodal sensor has enhanced the possibilities of HAR. This sensor is Microsoft Kinect [8]. The output of Kinect consists of RGB, depth, and skeletal data, which has indeed uplifted the recognition accuracies of action recognition algorithms.

The challenging task in most of the real-time action recognition models has a non-contributing background information for action recognition. Most of the previous works have handled this challenge through self-attention models [8], depth attention [9], and skeletal attention [10]. The missing point in these works is the semantic relationship between the multimodal data. In the past, spatial matching of data from two sources has been necessary to generate attention between multimodal data. There are many methods to align the multimodal data into a single space to generate attention [11]. The above challenges are addressed in this work through the application of gated feature fusion (GFF) without focusing on the alignment problems between the RGB and skeletal frames. To extract spatial features from RGB and skeletal frames, we apply CNN deep model with six convolutional and three maximum pooling layers. The fusion of RGB appearance and skeletal pose features is computed traditionally by point-wise multiplication in spatial domain [12–14]. However, it is evident that it is very difficult to align spatial features due to recreating exact positional references between skeletal and RGB data. Interestingly, this problem was addressed effectively through feature fusion in temporal domain [15, 16]. In this work, we propose to apply temporal convolution networks (TCN) [17] for feature fusion that will provide pose-based attention to the appearance models. The previous models apply contextual information between the two modalities, whereas these models were unable to classify out-of-context information [14].

This was addressed using a dynamic pose fused appearance model using temporal convolutional networks. The idea is to allow the pose features to decide on the importance of appearance features to participate in the classification process. The gated feature fusion (GFF) focuses on building a latent feature space by combining the appearance and pose features that are necessary for action classification. The proposed model is evaluated through experimentation on RGB-D datasets to ascertain that this model classifies better than the existing methods. The objectives of this work are threefold: 1. To extract the RGB appearance and skeletal pose features using a multi stream CNN model. 2. To develop a fusion mechanism for generating attention driven latent feature space, and 3. To validate the proposed gated fusion model against the state-of-the-art models.

The rest of the paper is organized as follows. Section 2 discusses the proposed methodology applied for action recognition. Results and discussions were presented in section 3. Finally, conclusions were drawn on the proposed method for GFF between RGB and skeletal data for recognition problems.

2 Methodology

Given a sequence of RGB action frames $A_n\ (x)\ \forall\ n = 1\ to\ N$as input our Gated Action Net (GaNet) along with the corresponding skeletal pose information $P_n\ (x)\ \forall n = 1\ to\ N$, the trained model predicts the target action class distribution probabilities. The entire framework of GaNet is shown in Fig. 1. The figure shows two streams of CNN: one for RGB video frames and the other for pose frames. The RGB stream is called appearance S_A and the skeletal is called pose stream S_P. Initially, S_A and S_P streams extract spatial features at the end of the last convolutional layers. Subsequently, these features are passed through the temporal convolution networks for temporal relationship modeling in both appearance and pose features

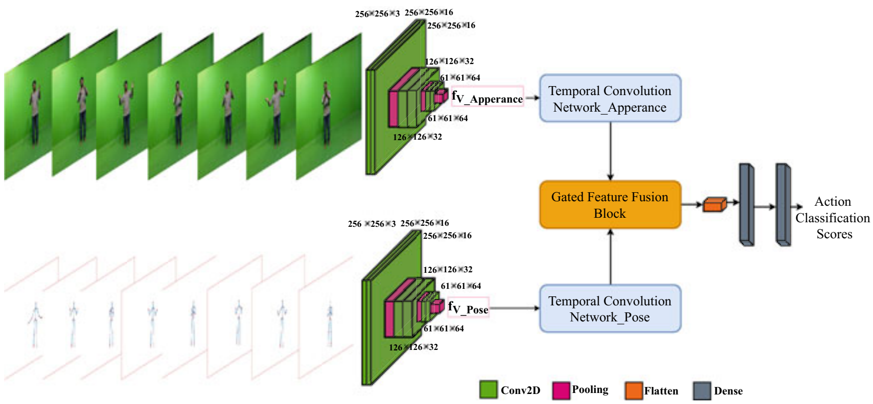

Fig. 1 Illustration of GaNet framework for action classification

separately. Next, the GFF block fuses these spatiotemporal features using gated sigmoid functions. Finally, the fused appearance—pose features are flattened and are learned by the fully connected dense layers for action classification.

2.1 RGB Appearance Stream (S_A)

The RGB video sequence $A_n\,(\times)\ \forall\, n = 1\ to\ N$ is divided into a length of N frames, the appearance sequence is a multidimensional tensor represented as $A \in R^{r\times c\times 3\times N}$. Here, (r, c) are RGB frames height and width in three color channels. Based on the GPU capacity, the frames are resized to $256 \times 256 \times 3$. This becomes input to the RGB appearance stream S_A. The S_A stream is made from six convolutional layers and three maximum pooling with rectified linear activations across all layers. There is no padding in convolutional layers. The S_A stream will extract features from A using the trainable parameters Θ_{S_A} by optimizing the loss function L_{S_A} on the entire dataset as

$$\Theta_{S_A} = \arg\min_{\Theta_{S_A}} L_{S_A}\left(\Theta_{S_A} : A\,(x)\,,\,y\right) \tag{1}$$

Here, y denotes the class labels. The S_A stream is optimized using the categorical cross-entropy loss L_{S_A}defined as

$$L_{S_A} = -\sum_{i=1}^{C} \left(y_i \times \log\left(y_i\right) + \left(1 - y_i\right) \times \log\left(1 - y_i\right)\right) \tag{2}$$

The trained model M(Θ_{S_A}) will output at the end of ith convolutional layer with jth appearance feature map by using the expression

$$F_A^{ij}\,(x, y) = f_a\left(\sum_{p}\sum_{n=0}^{r-1}\sum_{m=0}^{c-1}\left(W_{ijp}^{nm} * A_{(i-1)p}\,(x+n, y+m)\right) + b_{ij}\right) \tag{3}$$

Where A is the video frame and f_a is the activation function. W_{ijp}^{nm} are the weights at position (n, m) associated with pth feature map in the $(i - 1)$th layer of the CNN network. The parameter b_{ij} is the bias associated with each of the neurons. Equation (3) depicts the convolutional operation between the video frames and the weight matrix, which is updated sequentially during training of the network. The output RGB appearance features has the dimension $F_A \in R^{r_j\times c_j\times 3\times C\times N}$. Here, C is the channels or filter kernels applied in jth convolutional layer.

2.2 Skeletal Pose Stream (S_P)

Similar to the above, the pose stream is built on skeletal data transformed into a video sequence. However, the spatial resolution and temporal length of the skeletal video sequence differ from the appearance stream. Consequently, the fusion process is extremely difficult between the two-modal data. Hence, the proposed GFF with temporal convolutional networks is proposed in this work to fuse them together. The S_P stream will extract features from $P \in R^{r \times c \times 3 \times M}$ skeletal pose sequences using the trainable parameters Θ_{S_P} by optimizing the loss function L_{S_P} on the entire dataset to extract the pose features $F_P$by applying the above equations. The size of the pose feature tensor $F_P \in R^{r_j \times c_j \times 3 \times C \times N}$. Here, M is the number of skeletal video frames. The number of video frames is different in both modal data. The goal is to align these multimodal features across temporal dimensions dynamically to build a semantically fused features for action recognition.

2.3 Temporal Convolution Block

The previous works have used some off-the-shelf pose estimation models such as open pose [13] to extract the joint location information from appearance models. Then the extracted key points are translated into heat maps and part affinity fields, which are further combined along the channels or kernels during the training process. Contrasting to this, we simply extract the video frames and feed them to the pose stream S_P. To combine the RGB appearance features $F_A \in R^{r_j \times c_j \times 3 \times C \times N}$ with skeletal pose features $F_P S \in R^{r_j \times c_j \times 3 \times C \times M}$, we propose GFF module. The GFF module learns the pose distribution across the appearance features and selects them appropriately for action classification. The GFF module is shown in Fig. 2.

The first stage of the GFF network is to align the pose and appearance features with multiple dimensionalities. From the above, the number of frames in both the sources are different ($N \neq M$). Coupled to this, there will be spatial imbalances in

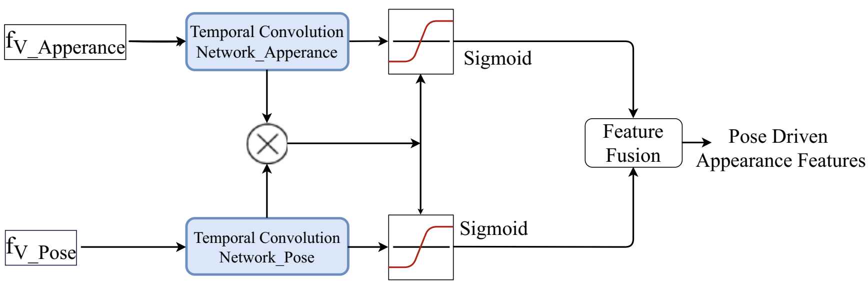

Fig. 2 The gated feature fusion module

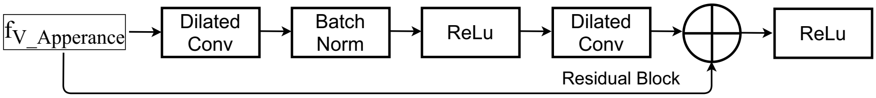

Fig. 3 Temporal convolution block

location of features between the two modalities. These unbalances can be eliminated by passing the features through temporal convolution networks (TCN). The TCN architecture is shown in Fig. 3.

The generated feature maps in both S_A and S_P streams are fed into the TCN block in Fig. 3. Since batch normalization is used in TCN, it has been avoided in the core streams. The TCN performs a convolution operation as a causal convolution operation as the present output depends on previous and past outputs only. This is performed using dilated convolutions which preserve the resolution of the features and supports exponential growth of the receptive field of the neuron. TCN can be implemented with a smaller number of computations when compared to long short-term memory networks. This process in our work will preserve spatial resolutions and align temporal features between the pose and appearance models. For example, the appearance features $F_A \in R^{r_j \times c_j \times 3 \times C \times N}$ and skeletal pose features $F_P \in R^{r_j \times c_j \times 3 \times C \times M}$ are different. During implementation, the RGB appearance clips have a constant period of N=120. However, the pose was reconstructed from the binary files, the frame periods were in the range of M = 245 to 266. Hence, to perform the temporal pooling and generating a relationship representative through training process, we apply two different TCN with dilation depths $'d'$.

The value of dilation parameter $d_A = 4$ for appearance features and it is $d_P = 8$ for pose TCN. Subsequently, the appearance features at the output of TCN are $F_{A\_comp} \in R^{r_j \times c_j \times 3 \times T \times C}$ and the pose features $F_{P\_comp} \in R^{r_j \times c_j \times 3 \times T \times C}$. In this work, d is considered as a hyperparameter depending on the number of frames across all datasets. The value of T is 15 for $N = 120$ and $M = 250$. This process is iterated across all the filter channels and the T frames are an ensemble of N and M in two streams.

2.4 *Gated Feature Fusion (GFF)*

As a result of the TCN block, the output feature vectors in both the streams form a channel representations. At this stage, the process of fusion starts between the temporally aligned features across appearance and pose channels. However, simple element-wise multiplication will highlight the features in both the modalities without considering the impacting ones. To overcome this problem, we applied gates to the selection of features with a sigmoid multiplier as shown in Fig. 3. A visual illustration of the process is shown in Fig. 4.

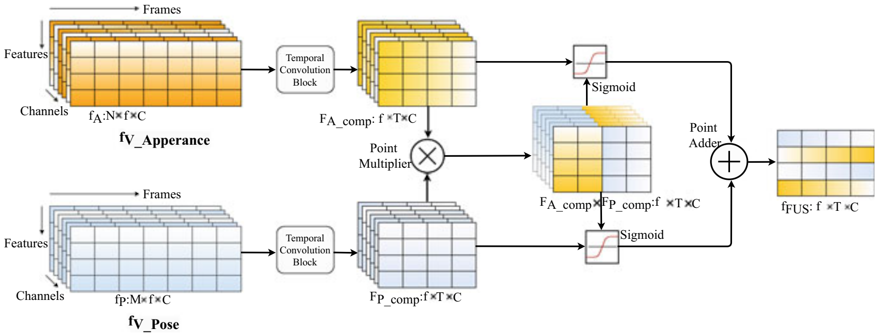

Fig. 4 Visual illustration of GFF for action recognition

The outputs of the TCN blocks in appearance and pose streams are first passed through the element wise multiplier. The output of the multiplier is

$$F_{A*P} = F_{A\_comp} \otimes F_{P\_comp} \in R^{r_j \times c_j \times 3 \times T \times C} \tag{4}$$

The output F_{A*P} generates a transformation matrix with maximum spatial features that are related temporally in the TCN block. Since these features are learned over a fixed set of multiple time frames, they form ensemble feature embeddings. Element-wise multiplication generates a gating transformation matrix G_{T_AP}. However, operating exclusively on such features has resulted in a bleeding values that have lost due to multiplication with a small feature value. To overcome the problem of bleeding features, we apply gating mechanism with the sigmoid functions. The output of sigmoid multiplier in both modalities is defined as

$$F_{A\sigma} = \frac{e^{F_{A*P}}}{e^{F_{A*P}} + 1} \times F_{A\_comp} \tag{5}$$

$$F_{P\sigma} = \frac{e^{F_{A*P}}}{e^{F_{A*P}} + 1} \times F_{A\_comp} \tag{6}$$

The features in $F_{A\sigma}$ and $F_{P\sigma}$ have the same size as their inputs. These features are highly discriminative and well characterize a defined class in both modalities that exhibit nonlinear properties. This nonlinearity is useful in generalization of class labels. Finally, we add these features to produce a highly discriminative latent feature space f_{FUS} for each class. The fused feature latent space is

$$f_{FUS} = F_{A\sigma} + F_{P\sigma} \in R^{r_j \times c_j \times T \times C} \tag{7}$$

2.5 Implementation Details of GaNet

The latent features aggregated from appearance and pose f_{FUS} are passed through the dense layers for classification. The final dense layer has a Softmax activation which gives the class probability distribution over the entire dataset. The loss in the individual streams is calculated independently using the categorical cross-entropy loss $\left(L_{S_A}, L_{S_P}\right)$. The entire loss of the GaNet is the collective loss of the two streams S_A and S_P mixed with the Softmax loss in the dense layers as

$$L = L_{S_A} + L_{S_P} + L_{Softmax} \tag{8}$$

The GaNet is trained in an end-to-end configuration model. The weights and biases are randomly initialized using the zero mean Gaussian distribution with a standard deviation of 0.01. The weights are updated using stochastic gradient descent (SGD) optimizer through a batch size of 16. The number of channels $C = 64$ across all datasets. The size of the inputs in both the streams is set as $256 \times 256 \times 3$. The initial learning rate was set to 0.0001, which was reduced by 10 at instances where the validation error became constant. However, the pose stream experienced overfitting due to high learning rates. This was controlled effectively by applying L1 weight regularization after maximum pooling layers in the pose stream. Three types of data augmentations such as translation, scaling, and flipping are applied during training in each stream. The model was trained on 8GB graphics NVDIA GTX1070i with 16GB memory. The training of each batch took 1.84 seconds. The model was designed in TensorFlow 2.5.

3 Experiments and Results

The goal here is to test the GaNet for action recognition. The first experiment is testing the trained GaNet on our 40 class BVCAction3D dataset [18] and three other benchmark RGB-D action datasets such as UT Kinect [19], and NTU RGB-D [20]. Secondly, the GaNet is validated against the baselines and state-of-the-art methods for action recognition. Thirdly, the GFF is validated against the fusion methods. Finally, an ablation study was carried out on the proposed GFF to understand its contribution to the overall performance of the GaNet.

3.1 Results on BVCAction3D and Other Benchmarks

The GaNet is tested on all the datasets and the resulting performance metrics were tabulated in Table 1. The testing is conducted in cross subject mode, means that the network is shown samples with subjects that are previously unseen by the net-

Table 1 Performance of GaNet across datasets and comparison of work with multiplicative fusion model in [11]

Dataset	GaNet with GFF				GaNet multiplicative fusion			
	Rr-1	F1	Rr-5	F1-5	Rr-1	F1	Rr-5	F1-5
BVRCAction3D	96.23	0.955	97.55	0.966	81.12	0.865	84.76	0.841
UT Kinect	94.72	0.947	95.93	0.949	77.45	0.837	78.87	0.806
NTU RGB D	93.66	0.938	94.77	0.932	81.12	0.848	81.43	0.819

work during training. The Rr-5 recognition rate achieved is around 96.23% on our BVRCAction3D dataset, which is found to be better than the most widely used multiplicative fusion. The Rr-1 and Rr-5 represent top-1 and top-5 testing accuracies, respectively. The Rr-5 values for NTU RGB-D and UT Kinect are 93.2%, and 94.9% on their respective data sizes. With the induction of GFF network, the GaNet performance improved by 10% over the fusion techniques such as multiplication [11, 12].

3.2 Validating GaNet Against Baseline Deep Models

Here, the performance of GaNet is compared with the appearance and pose—only models from literature in Rr-1. Table 2 shows the results of the comparison. Since most of the models were available on online repositories as pretrained models, we

Table 2 Top-1 accuracies for appearance, pose—only state-of-the-arts against GaNet

Method	BVRCAction3D	UT kinect	NTU RGB D
Appearance-based HAR			
[21]	80.46	79.44	74.58
[22]	80.65	78.44	73.74
[23]	82.55	81.4	76.89
[24]	85.99	85.24	84.88
Pose-based HAR			
[15]	76.32	76.52	69.98
[16]	71.77	72.85	70.85
[25]	75.19	75.9	78.11
[26]	75.18	74.53	78.26
[27]	81.89	78.33	79.48
Mixed pose and appearance			
[28]	90.96	88.7	89.69
[29]	92.15	89.49	90.42
GaNet(ours)	96.23	94.72	93.66

fine-tuned the layers with our datasets. Specifically, the hyperparameters of training were kept constant across the entire work. Results in the table were computed for top-1 Rr only. The results in the table reflect that the appearance based HAR methods perform better than the pose-based methods. This is due to the inconsistency in the capturing of skeletal poses as they are prone to missing joints and background effects. However, the combined methods have shown to outperform the two methods. The temporal convolutions and the gated fusion has elevated the features in the latent space for learning the discriminations among classes.

3.3 Comparing Fusion Models with GFF

We validate our gated feature fusion block with other feature fusion model using multiplicative, additive, and other types of gated furoin models [30–34]. The results of the comparison are evaluated for top-1 and top-5 recognition accuracies on BVCAction3D and NTU RGB D datasets only. Since most of the blocks in the reference works are available as pretrained modes, we re-trained them on our dataset with the same hyperparameters as discussed above. The results are presented in Table 3. The fusion methods used for comparison are having multiple features in the form of appearance and pose for fusion. However, there was little or no regulation on the amount of pose being fused with appearance features except in [13] that comes close to our model. Specifically, the work in [13] applied a pose regulator as a loss function in the 1D convolutional network. The work in [31] used trust gates to regulate the features from pose being fused with appearance models, which are not trainable. Hence, the recognition accuracy is good in some cases and is weak in others. The work in [34] has been applied only on skeletal data with geometric features on LSTM networks. As can be seen, LSTM networks have indeed produced an overall good Rr's when compared to CNN models. Despite their brilliant performance, LSTMs nets are deep and require heavy computational resources for large data samples.

Table 3 Comparison of GFF against state-of-the-art fusion methods

Method	BVRCAction3D		NTU RGB D	
	Top-1	Top-5	Top-1	Top-5
[15]	80.24	81.6	81.29	81.37
[30]	60.8	61.47	60.35	60.86
[31]	85.99	86.98	86.84	87.18
[32]	82.97	83.92	82	82.96
[33]	70.8	71.85	70.52	70.32
[34]	86.13	86.15	86.38	86.93
[13]	91.85	90.55	90.75	90.22
GaNet(ours)	96.23	97.55	94.72	96.66

Table 4 Standard CNN architectures versus the GaNet model with GFF block

Architecture	BVRCAction3D		UT kinect		NTU RGB D	
	Top-1	Top-5	Top-1	Top-5	Top-1	Top-5
VGG-16	74.01	75.63	75.5	76.32	74.98	76.52
AlexNet	79.43	79.05	81.51	80.46	79.58	79.44
GoogleNet	77.53	79.04	79.59	80.65	78.74	78.44
ResNet-34	83.2	85.75	79.33	82.55	81.89	81.4
Inception V3	85.65	92.16	79.1	89.99	79.88	90.24
GaNet	96.23	97.55	94.72	95.93	94.72	96.66

It has been found that the score fused models have performed meagrely when compared to feature fusion models. This is due to overfitting on the same type of data or features that are present in the background of the video frames. In the next section, the GFF block is tested on standard convolutional models.

3.4 Comparison with Standard CNN Models

This experimentation is carried out to check the integrable capabilities of GFF block with the standard CNN architectures. The training and testing process is similar to the previous models. Here, all the models were trained from scratch for only 150 epochs and the recognition accuracies are calculated. Only inception V3 from google has been the clear winner though all the networks in Table 4 has accepted the GFF block well. Specifically, the deeper networks with larger channels have been a problem for time convolutional network to learn temporal relationships. We faced the problem of vanishing gradients in all the networks except the inception v3 due to the feature expansions in the 1×1 convolutions.

4 Conclusions

This paper proposed a gated feature fusion with temporal convolution network to integrate appearance and pose features for human action recognition. The appearance features are captured from RGB data and pose is from skeletal data. The previous works applied the fusing process in a rather passive manner, without considering the temporal relationships in the video data and without any regulations on the feature ensemble. This work performed both the above operations with temporal convolutional networks and gated feature fusion to transform the features into latent subspace for learning. The proposed GaNet has shown to have robust human action recognition on RGB-D data.

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Machine Learning Approaches in Smart Cities

Priya Sachdeva and M. Dileep Kumar

Abstract With the advent of urbanization, the introduction of smart cities is taking place at a rapid rate to enable the ever-growing population in the urban cities to give them a chance of having a good lifestyle. Smart cities aim to do so by using and adopting the modern concepts of technology. The objective of this research is to understand and unleash how the smart cities that are coming up depend on technological aspects like sensors and actuators so that large volumes of data can be both stored as well as utilized to extract information that could prove to be beneficial for the growth of the city. The study followed content and document reviews with a systematic literature review to arrive at the observation made. For conducting this study, secondary data has been taken into consideration where the database of reliable sources like EBSCO, Scopus, and Web of Science have been utilized. This study has shown that how the emergence of ML (Machine Learning) tools makes use of algorithms that help in providing personalized services as well as efficient resource management in smart cities.

Keywords Smart cities · Artificial intelligence · Machine learning · Deep learning · Big data · Algorithms

1 Introduction

With the onset of globalization and modernization, more and more people are moving from rural areas to urban areas in search of better opportunities as well as lifestyles. This transition from a rural to an urban setting is causing a slew of problems, including increased congestion, pollution, and a strain on infrastructure and waste management techniques. All this has led to an enhanced need for a sustainable way of living. This is

P. Sachdeva (✉)
Amity School of Communication, Amity University, Noida, India
e-mail: sachdevapriya35@yahoo.in

M. Dileep Kumar
Faculty of Management Sciences, Nile University of Nigeria, Abuja, Nigeria
e-mail: prof.dr.dil@gmail.com

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also the area where the need for smart cities arises. Smart cities are built in such a way that they support the green environment, energy consumption, as well as the economic and living standards of their citizens. These cities also need to be developed in a way that they can adopt modern information as well as communication technology, which is an integral part of the present world. The rationale behind creating a smart city is that it could aid in managing the assets of the city effectively and at the same time collect data and information that could later be used through various applications in the appropriate situations. One of the most basic aspects of a smart city is the different types of sensors. These sensors can be divided into three categories, namely electronic, chemical, and biosensors. These sensors are created in such a way that they can efficiently take in important information. However, since the standards, as well as the mechanisms, are not fully established and developed, the user data that has been captured in these sensors and other similar devices cannot be extracted for the effective use of information. Hence, it is advised that machine learning, or ML, as it is so popularly called, be used to decipher this dat, and use technology and IoT in the best possible way in these smart cities. It is believed that this machine learning would take into consideration the best possible long-term objectives and also make decisions that are optimal for the technological advancement of these cities. Hence, this chapter aims to establish an understanding of how ML has been leveraged to make smart cities smarter and more effective. This research reveals and unleashes that in the modern day, more and more cities are moving toward becoming smarter, which is why it is essential to understand how this effectiveness of the intelligence of the cities can be enhanced. This study followed qualitative content analysis and systematic literature review [1] methods, to explore the knowledge pertaining to ML and IoT applications in smart cities, that would help brands and businesses understand the indispensability of machine learning approaches to make smart cities smarter.

2 Literature Review

2.1 COVID-19 Pandemic and Machine Learning Market

The COVID-19 epidemic continues to alter the development of numerous businesses. Nevertheless, the instant effect of the eruption varied from industry to industry. COVID-19 will have a low impact on the machine learning market. Substantiating the trend, several companies are adopting machine learning artificial intelligence platforms for their business operations, like Microsoft Corp., Alibaba Group Holding Ltd., Salesforce.com Inc., Amazon.com Inc., Hewlett Packard Enterprise Development LP, Cisco Systems Inc., SAP SE, and SAS Institute Inc (Fig. 1).

It is estimated that the machine learning market is expected to grow by USD 11.16 billion during 2020–2024, and it will provide a CAGR of more or less 39% throughout the predicted period [2].

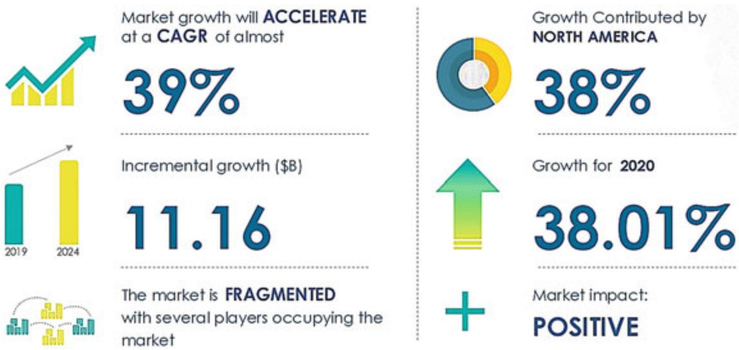

Fig. 1 Global machine learning market 2020–2024 [2]

2.2 *Concepts*

2.2.1 Machine Learning

Machine learning, or ML, is a sub-category of artificial intelligence. It is the technology that provides systems with the ability to learn through the data that they have access to [3]. One of the most frequently quoted ML definitions is: "is the study of computer algorithms that can improve automatically through experience and the use of data" [4]. This explanation places an interest in familiarizing yourself with the importance of the learning process, which would be derived from the information. The ML method includes numerous phases before it goes for data analysis. Such phases include separation of facts and figures on training and test sets, information pre-dispensation, prototypical structure preparation, structure tuning, and assessment of its procedure on the working out and exam sets through metrics. The aim of machine learning (ML) is to create computer-generated plans which can be studied in real time using facts and figures. The programs make inductive extrapolations from the data obtained, which support deductive generalizations [5]. Although ML is considered a subfield of AI, it also intersects with many other scientific disciplines such as statistics, cognitive science, and information theory.

2.2.2 Intelligent Cities

Objectively, a universal definition of the concept of "Smart City" is indistinct. Previous literature has identified its position in several areas such as IoT, ICT, social and environmental capital, sustainability, and so on. However, a pure technology-centered approach ignores the novel areas of ICT and pushes the novel areas of ICT to encourage the purposes of cities from a multifaceted perspective. The term "smart city" was first used in 2007 [6], with the ideas linked to the establishment and association of human resources, social assets, and ICT setup, with the objective of better and more sustainable economic development and a better quality of life. A particular topographical area, which makes use of ICTs in several aspects, such as transportation, energy production, and so on, that ensure advantages for residents in terms of well-being, inclusion and involvement, ecological value, and intelligent progress, which is administered by a finely described pool of subjects, enables the state to develop rules and policies for the city's government and growth and is termed "Smart City" [7]. A Smart City is one that makes use of technology-driven solutions to augment social and human capital when networking with natural and economic resources, and it alleviates issues of the community in cities to attain a better quality of life and sustainable development, through collaborations [8]. Overall, a smart city is well-defined as a city that observes and assimilates vital infrastructure and services with the support of sensor and IoT equipment [9].

3 Application of ML in Smart Cities

3.1 Use of Machine Learning in Healthcare

In the modern world, there has been an increased creation of electronic health data (EHR), owing to which the healthcare industry can come up with better and more effective practical applications with the help of which diagnosis could be improved and diseases could be predicted at an early stage. In the past few years, there have been several different devices that help in gathering data about the health of a given individual. However, this information is seen to be unstructured and cannot be leveraged in the various predictive models used by the industry [11]. Machine learning, on the other hand, is popular for handling data that is both messy as well as quite large in volume. The use of this ML in the industry eliminates the need to consider the right variables and their optimal combination (Fig. 2).

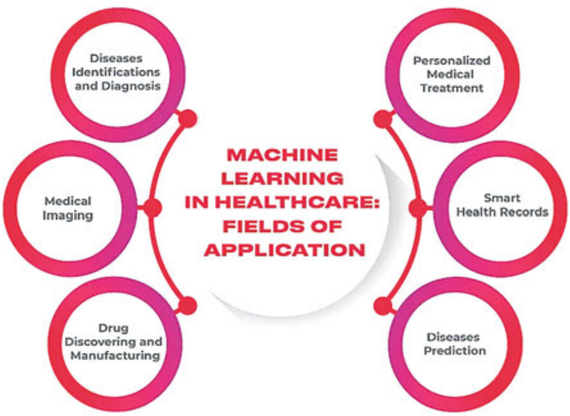

Fig. 2 Use of ML in Healthcare [10]

The neural networks used can easily learn from the key factors that have been represented along with the interaction that they have with the data. This is the reason why ML is so important in the way of creating smart healthcare [12]. Moreover, this electronic health data, which has been mined, can be used for several different purposes, such as providing effective medications and treatment to patients. It also helps in providing the probability of whether or not a patient will react adversely to the antibiotics given. ML tools can also be used to identify different patterns that come up in image data, which could help in better decision-making regarding a patient's course of treatment. In the research that has been undertaken in terms of smart healthcare, it has been found that ML has been used in glaucoma diagnosis, Alzheimer's disease, etc. [13].

Smart cities where smart healthcare systems are integrated have the integration of all ML applications to diagnosis, imaging, record management, personalized medical treatment, and disease prediction support systems. The tracking of physical activity is also an important part of the ML application. The sensory data that is thus collected from the wearable smart devices is something that can automatically infer health information to provide recommendations to patients about the behavior changes that need to be undertaken by the individual.

3.2 Machine Learning Applications in Smart Traffic and Transportation Management

Smart cities make use of ML applications to avoid traffic jams. Smart mobility refers to a concept that consists of sustainable transport systems as well as logistics so that smooth urban traffic can be ensured. This is mainly done by applying different information and communication technologies. The ML technologies that are used for smart mobility are also useful for harnessing personal information so that the right kinds of recommendations can be provided in terms of small-scale personal management of transportation [14–16]. Some of the most prominent ML techniques used by smart cities include support vector machines, or SVM, which can detect abnormalities on the surface of the roads [17]. A very popular ML tool is a combination of k-Means and DBN that aids in optimizing the traffic network configuration. Along with this, there is also a regression tree tool that aids in forecasting both the short-term as well as the long-term flow of traffic in the work zones.

3.3 Making Use of Machine Learning to Combat Pollution

Growing levels of pollution have become one of the biggest concerns of the modern world [18]. In smart cities, several machine learning techniques have been applied in the past decade to extremely complex and time-related data to provide accurate estimations about the level of pollution in the air. Before the use of ML, traditional techniques were used to measure and predict air quality. This involved the creation of a physical model which was designed by using several different mathematical differential equations [19]. However, this method was not very accurate and, at the same time, was extremely lengthy. With the advent of smart cities, analysis of air quality can be undertaken by automatic techniques using which an appropriate action plan can be created for the same. Some of the most commonly used ML tools for combating pollution in smart cities include artificial neural networks, which help in predicting the daily peak concentration of air pollutants [20]. A genetic algorithm was also used to predict the daily maximum concentration of pollutants in the air. Smart cities are using many other ML algorithms to get an understanding of the pollution situation in these cities.

3.4 Application of Machine Learning to Public Safety

Smart cities are slowly becoming vulnerable to cyberthreats like stealing and leakage of data [21]. ML tools help in identifying crime patterns that have taken place over time. By leveraging ML for enhancing the different security systems, innovators have come up with an intelligent detection system which is known as AD-IoT, which can both detect and alert on any unusual activity taking place in the IoT network. This system is based on RF classification, which helps in classifying an algorithm that effectively detects any benign or malicious data [22]. Along with this, a lot of smart cities have a crime pattern machine learning algorithm that aids the police at a station in an area where the crime pattern is the most prominent. Other ML algorithms such as ANN, SVM, and GNN have also been used to effectively apply both safety and security measures in smart cities [23].

3.5 Intelligent Flood Monitoring

One of the major issues faced by cities in general is flash flooding and proper monitoring of floods during rainy seasons. A few of the reasons that are associated with urban flooding challenges include drainage and gully blockages. Obstruction of drainage and gullies in the streets develops into challenging situations when outside substances block the normal flow of water. Setting up automated sensors to monitor the situation is difficult and not always practicable. Consequently, a substitute system is essential to screen drain and gully blockages for the adequate observation of flooding occurrences [24]. Monitoring systems should be installed in cities to have better control over these drainage and gully blockages. Modeling of natural hazards and emergencies is usually done with methods of liquid level monitoring [25] and the water level of gully pot monitoring [26]. Even with the data obtained from satellite imageries and enhanced predicting exactness, real-time observing to sustain adequate decision-making is still a task [26] (Fig. 3).

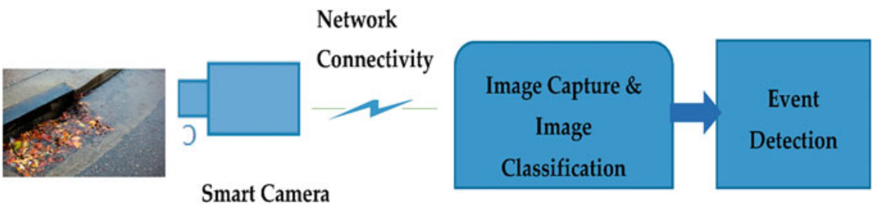

Fig. 3 Basic flow of flood monitoring, with an example image of a drain blocked by leaves [27]

The image in the above picture clearly indicates how real-time information related to drainage and gully images can be captured by cameras and, henceforth, can be properly analyzed and classified to detect possible flooding hazards. However, the efficacy of the scrutinizing is subject to the competence of the image categorization task. Consequently, an effective image categorization technique is necessary for categorizing drainage and gully images to detect blockage levels and, therefore, flooding alerts. Drainage and gullies frequently get blocked due to the gathering of items from the street and roads. Even though there are systems to access information related to rainfall data, water level reading, satellite imagery, and improved forecasting accuracy, identifying, supervising, and making effective decisions are still a task [27].

3.6 The Smart Home

A smart home is a part of the smart city concept. A home that is well connected with automated systems that ensure an ambiance of easy living is termed a "smart home" or "e-Home." The role of IoT applications is highly acknowledged in constructing smart homes. IoT applications monitor and regulate connectedness as well as control several functions at home, such as lighting and temperature, home utilities, multi-media tools, and security systems, regardless of time or location. IoT-enabled advanced automated systems, which are also termed "intelligent systems," are used for networking at home. Such automated systems ensure a better quality of living and make our homes smarter [28].

3.7 The Smart Garden

Gardens are part of city beautification. Proper irrigation in parks and gardens are necessitated daily. Smart gardening with the support of AI and IoT applications would ensure optimized use of water resources without wastage. AI systems support to minimize the use of water as well as adjust the water circulation to the gardens and parks in accordance with the requirements. In addition to that, AI systems can

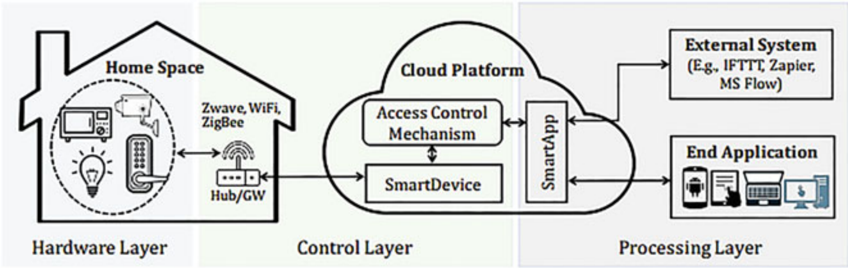

Fig. 4 Application of learning algorithms in smart home IoT system security [29]

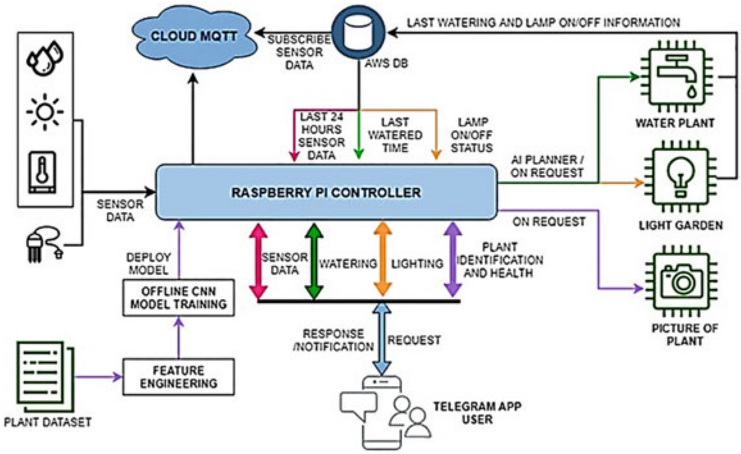

Fig. 5 Smart garden system architecture [30]

identify the groundwater quantities and assess the gardening needs to stabilize the water usage by guiding sprinkler systems [30]. The diagram above clearly shows an architecture that details the role of AI-built design made at frequent periods for irrigating the plants and gives sufficient illumination in the garden area for aesthetics. The real-time sensor status may be clearly observed and monitored by the end-users of the garden over a smartphone utilizing the Telegram application (Figs. 4 and 5).

4 Theoretical Implications

The current discussion on AI and its applications facilitates the advancement of the body of knowledge detailing the role that ML, AI, and IoT will play in Smart Cities. However, the deliberations above lead to both the pros and cons of the adoption of AI in smart cities. A few of the constraints cited on increasing adoption of smart technologies with ML and IoT include the slow pace of adoption of communication technology and decreased operational effectiveness in developing economies. Since smart city development involves a huge initial CAPEX, the adoption of smart technologies is still at a slower pace among national and local governments. Security fears over the implementation of smart applications and gadgets in cities are one of the main reasons limiting the progress of the smart cities market. Smart city application systems, like any other associated technology, rely on networks for data transmission and are, thus, vulnerable to breaching.

5 Conclusion

The current and future scope of ML and IoT is unlimited. Since its inception, both AI and ML have been providing effective solutions to organizations across various industries, such as manufacturing, healthcare, education, and hospitality. The most recent use of these two technologies has been in terms of creating smart cities. The cloud-based nature of IoT platforms used for building smart cities is based on the concept of open data, which is why it can be used effectively by small cities as well. It is because of this technology that both big and small cities can create a common urban system. Due to this common system, the solutions that would be provided to both types of cities would be controlled by a central cloud platform. Hence, every city has the potential to become a smart city if only the right kind of technology is executed in the right way and at the right time.

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Blockchain in IoT Networks for Precision Agriculture

Rashi Tanwar, Yogesh Chhabra, Punam Rattan, and Sita Rani

Abstract With the increase in research and development in communication technology, it is predicted that more and more number of sensing devices will be added in various sectors by application of IoT. Therefore, there is an immediate need of replacing the traditional methods of storing, sorting and sharing of data that has been collected from various sensing devices (Chiang and Zhang in IEEE Internet Things J 3:854–864, 2016), (Lee et al. in Comput Electron Agric 74:2–33, 2010). This will help in making data more transparent, reliable, decentralised and immutable. This has led to the integration of blockchain into IoT systems. The upcoming section gives a vivid picture about the basic concept and feature of blockchain technology and thereby detecting various advantages of integration of blockchain into IoT.

Keywords Internet of Things · Blockchain · Ledger · Precision agriculture · Smart contract

1 Introduction

Blockchain theory was invented by Satoshi Nakamoto in the year 2008 in context to Bitcoin transactions for making these transactions independently auditable, verifiable and transparent [3]. Blockchain is defined as a "decentralised distributed Ledger for sorting timestamp transactions between many computers in a peer-to-peer network". The designing of blockchain basically can be summarised as stacking of records which are formally known as blocks (Fig. 1).

R. Tanwar · Y. Chhabra
CT University, Ludhiana, Punjab, India
e-mail: Dryogeshchhabra3012@ctuniversity.in

P. Rattan (✉)
School of Computer Applications, Lovely Professional University, Phagwara, India
e-mail: punamrattan@gmail.com

S. Rani
Department of Comuter Science and Engineering, Gulzar Group of Institutions, Khanna, Punjab, India

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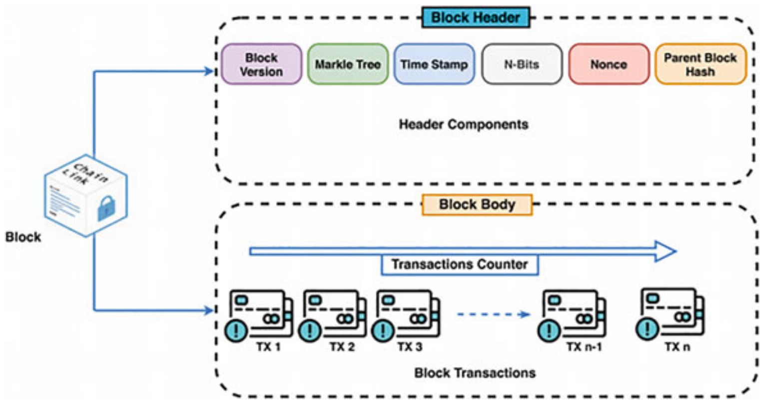

Fig. 1 A typical block design

The blocks contain a peculiars hash value which is the unique identification of the block and the first block in the chain is known as Genesis Block [4]. The blocks are connected to each other through cryptographic methods. Furthermore specifically, each block must contain a set of confirm transactions, a timestamp and a hash code of the last block. A single block unit consists of block header and block body. A P2P network and a public time stamping server autonomously controls this blockchain ledger making the entire block steam system transparent and decentralised for tracing and securing transaction workflows [5].

1.1 Features of Blockchain

The four main feature of blockchain system is summarised below.

1.1.1 Decentralisation

The use of ledger based on P2P network makes the system transparent and decentralised [6]. It makes additions and verification of block transactions in such a way that all nodes function altogether in a peer-to-peer fashion in the blockchain-based communication process.

1.1.2 Anonymity

Participants willing to communicate through a blockchain communication system need not reveal their real identity as they can communicate with a virtual identity code [7]. However, this feature of blockchain is one of the major security and privacy concerns related to blockchain transactions.

1.1.3 Persistency

The decentralisation of transaction through blockchain also adds to its persistent nature [4]. Persistency refers to the fact that in a blockchain system any identified transaction which is added to the block once cannot be rolled back. It also features the identification of invalid transactions immediately.

1.1.4 Auditability

The tracking of transactions that makes the blockchain system persistence also adds to the auditability feature [8]. The secure linking of one block to the previous block makes the blockchain system easy to be verified and tracked.

2 Review of Literature

2.1 Integration of Blockchain and IoT

Integration of IoT with blockchain is a revolutionary change that is expected to happen in various domains. The application of the distributed ledger-based P2P system across various heterogeneous IoT networks have attracted many researches to focus on this aspect [9]. It is estimated that the integration of blockchain into IoT-based environments will enhance the economic value of IoT by 176 billion dollars in 2025 which is further expected to raise up to 23 trillion dollar in 2030 [10]. The integration of blockchain distributed ledger in the IoT devices will play a major role in determining how the IoT devices will be linked together for further ease of collecting sorting and storing data [11]. It will also facilitate cost reduction, trust building and accelerating transactions. This has therefore led to identification of various design patterns by the researchers for integration of blockchain in IoT. Thereof the majorly identified design patterns in this context are discussed below

i. **IoT to IoT design pattern:** In this design pattern, the major communication process occurs outside the blockchain as the blockchain only helps in storing data in the IoT devices [12].
ii. **IoT to blockchain design pattern:** This design pattern has blockchain in a bit more integrated manner. The block chin here functions for storing of data along with monitoring and managing transactions [13]. Therefore, this design pattern allows IoT transactions to go through blockchain making it highly appreciated because of the guaranteed traceability empowered by blockchain in the IoT

network. Furthermore, it also is extremely helpful in establishing successful transactions between a variety of IoT devices in varying domains.

iii. **Hybrid design approach:** This design approach is amalgamation of mission of IoT with high throughput data analysis techniques such as artificial intelligence, fog computing along with blockchain [14]. In this approach transmission of data to the cloud is not required as data manipulation occurs in the IoT device itself. Artificial intelligence helps in critical decision-making by the IoT devices [1] and the blockchain provides secure links for the edge computing approach [15]. However, the use of only artificial intelligence and blockchain in the IoT network requires a huge volume of data transmission in a secure and reliable manner. This limitation could be sorted by the use of fog computing as it helps in reduction of the bandwidth amount and thereby hastening the blockchain mining operation [16].

2.2 Blockchain Mediated IoT Networks in Precision Agriculture

As stated in the above sections, it is quite evident that the integration of blockchain in the IoT network enhances the overall efficacy of the agricultural IoT networks [17]. The same has been witnessed in case of IoT-based precision agriculture. Blockchain has introduced many new opportunities in the IoT-based smart precision agriculture systems. Therefore, the current times have seen a boom in literature that has defined many applications of blockchain mediated IoT networks for precision agriculture. This integration provides the following advantages in agricultural sector.

i. The distributed ledger system helps in building a secure and smart connection between various IoT devices thus enhancing IoT network security [18].
ii. Blockchain is able to extend the address space for the IoT networks thereby enhancing the scalability of IoT networks for agricultural usage [19].
iii. Blockchain helps in keeping a track on the end-to-end process by generating unique identities and managing access to agricultural IoT devices. This also helps in building data transparency [20].
iv. Blockchain can enhance performance of IoT devices by defining communication rules between sensors that are embedded in the agricultural IoT devices such as humidity sensors or sensors for different soil parameters [21].
v. As the devices are registered with a unique code in the blockchain system, the integration of blockchain into IoT helps in making the IoT transactions more authentic by developing authorization of IoT systems [22].
vi. Integration of blockchain to the IoT networks helps in making the communication process a bit more precise by decreasing the network complexity due to the decentralised network system provided by blockchain [23].
vii. Blockchain also helps in enhancing the data storage ability of IoT devices as large volume of agricultural data could be stored in blockchain-based storage

systems that will also help in analysis and manipulation of data in the real time in a secure manner [9].

The aforementioned advantages of integration of blockchain in IoT have also received research attention. However, bibliometric analysis of literature in this domain depicts a neonatal stage of research contribution in the SCOPUS database starting from 2016 (Fig. 2).

The major research work that could be traced from the literature in terms of smart agriculture through integration of both the communication technology could be categorised into four sub-applications namely food safety, farm overseeing, land registration, supply chain. The bibliometric trend in research depicts the following contribution of research under each of the above-mentioned subdomain Fig. 3.

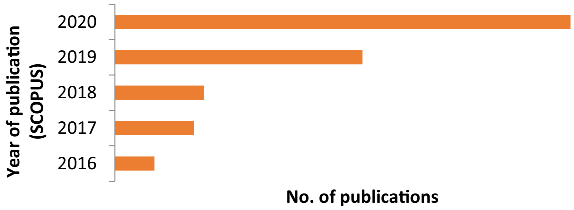

Fig. 2 Bibliometric trend of literature published in SCOPUS under applications of blockchain-based IoT in agriculture

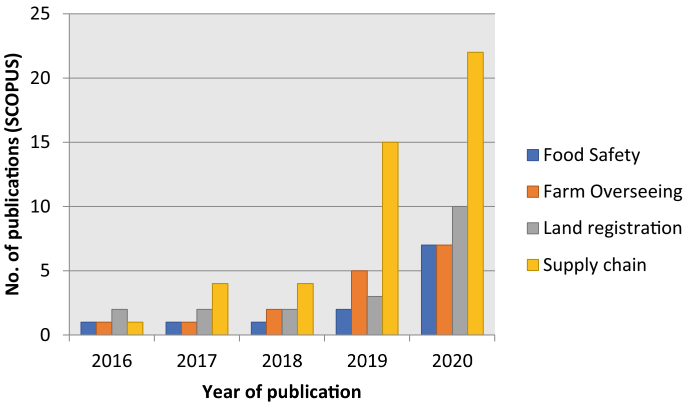

Fig. 3 Research contribution in various subdomains of blockchain-based IoT applications in agriculture

Table 1 Some Prominent studies on the proposed application of the blockchain-based IoT system on food safety

Authors	Proposed application of the blockchain-based IoT system by researchers
Iqbal and Batt (2020)	Ensuring safe farming by deploying sensors to detect and repel animal attack in fields by producing human-safe ultrasonic sound waves [24]
Lin et a. (2019)	Blockchain system for preventing food data tampering [25]
Lin et al. (2018)	Food tracking technique based on IOT and blockchain [26]
Tse et al. (2017)	Blockchain use cases in securing food supply chain process [27]
Tian (2016)	Tracking system for an agri-food supply chain in China [28]

Table 2 Some Prominent studies on the proposed application of the blockchain-based IoT system on farm overseeing

Authors	Proposed application of the blockchain-based IoT system
Pincheira et al. (2021)	Improving IoT sensor-based irrigation system [30]
De Clercq et al. (2018)	Future farming tech. in agriculture 4.0 [31]
Lin et al. (2017)	Monitoring system for water distributions [32]
Patil et al. (2017)	Tracing system for securing sensor communications in the farms [33]

2.3 *Proposed Application of the Blockchain-Based IoT System by Researchers*

The following are the applications proposed by various researchers in the field of Food Safety (Table 1).

2.4 *Blockchain and Farm Overseeing*

This application includes fabricating blockchain mediated IoT devices with sensors like humidity, temperature, crop maturity sensors, light, etc. in order to help farmer record and utilise data for better farming opportunities [29] (Table 2).

2.5 *Blockchain and Land Registration*

“It can be defined as the process of determining, recording and sharing transactional information about rights, value, and use of land pieces” [34] (Table 3).

Table 3 Some Prominent studies on the proposed application of the blockchain-based IoT system on land registration

Authors	Proposed application of the blockchain-based IoT system
Barbieri and Gassen (2017)	A Blockchain model for managing digital land registry [35]
Vos et al. (2017)	Analysis model for applying blockchain in Land Administration [36]
Anand et al. (2016)	Blockchain system for managing land admiration activities [34]
Chavez-Dreyfuss (2016)	"Proof of concept": a blockchain in the Swedish land registry [37]

2.6 Block chain and Supply Chain

This application aims at monitoring food at every point in the supply chain thus enhancing the transparency of the supply chain processes [38] (Table 4).

Table 4 Some Prominent studies on the proposed application of the blockchain-based IoT system on supply chain

Authors	Proposed application of the blockchain-based IT system
Nihit Choudhary (2020)	Contract Farming Through Blockchain Technology Using Smart Contracts [39]
Ronaghi (2020)	Improving supply chain transparency with less human intervention [40]
Dujak and Sajter (2019)	Blockchain application in supply chain and logistics [41]
Lin et al. (2018)	Enhancing the traceability of food in various stages of supply chain by reducing human intervention in verification of food in each step of supply chain [26]
Caro et al. (2018)	AgriBlockIoT mechanism for managing Agri-Food supply chain [42]
Li and Wang (2018)	Monitor system for agricultural products [15]
Platform with duplicated and shared bookkeeping (2018)	Provenance system for supply chain trust [43]
Leng et al. (2018)	Double Blockchain chain system for securing public transactions [44]
Toyoda et al. (2017)	Blockchain system for the Post Supply Chain [45]
Chen et al. (2017)	Supply Chain system for Quality Management [46]
Lu and Xu (2017)	Monitoring system the product origins in supply chains [47]
Xie et al. (2017)	Secure blockchain system for tracking products [48]

3 Research Gaps and Future Scope

3.1 Research Gaps

i. IoT network used for various applications in smart agriculture has many lacunas such as security and privacy threats, lack of authentication and authorisation, lack of interoperability, lack of scalability and reliability, quality of service, etc. [49].
ii. Numerous IoT devices are connected in the IoT-based smart agriculture networks; therefore, a huge volume of data with high level of throughput is required for proper functioning of the IoT networks in a harmonised manner which is another challenging issue [39].
iii. IoT sensors which are installed in various agricultural devices and machines like tractors, greenhouses emit a lot of data which is a cause of data loss at times. This also marks for another challenge for adaptation of IoT in smart agriculture [18].
iv. To implement smart contract with right condition in agriculture is a big challenge in blockchain technology [49].
v. Lack of unifying requirements is another big issue. Current systems do not support rapid and reliable response to trace data in case of food chain and analysis of data can be difficult in case of decision-making [50].

3.2 Future Scope

i. To overcome the lacunas of IoT network such as security and privacy threats, lack of authentication and authorisation, lack of interoperability, lack of scalability and reliability, quality of service, etc. blockchain technology will be integrated with IoT [49].
ii. Practical implementation of Smart Contract in Agriculture field using these two technologies has not been developed yet. So, a new model can be developed for smart contract using blockchain and IoT [40].
iii. As consumer preference shifting rapidly, they demand relevant and reliable information according to their need. So in case to provide data on time there is a need of secure network which is possible by IoT and blockchain [9].
iv. Smart Contract can also be used as an automated warning code for a system, in case of finding problems and process them in time by law-executors [35].

4 Conclusion

As a conclusion it is observed that Integration of blockchain and IoT helps in building an ecological, trusted, open and self-organised smart agriculture system.

The proposed methods discussed above tried to use IoT devices instead of manual recording and verification, which reduces the human intervention to the system effectively. Some of the prominent studies related to different applications of blockchain and IoT are described and at last future scope of IoT and blockchain is discussed in the paper.

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Role of IoT in Healthcare: A Comprehensive Review

Nandini Nayar, Neha Kishore, Shivani Gautam, and Alok Kumar Agrawal

Abstract Internet of Things (IoT) has been continuously bringing vast technological advancements in our daily lives, thereby serving to simplify our life and making it more comfortable through its innumerable applications. IoT offers numerous benefits in the field of healthcare by reducing the cost of services and by offering care to patients that require intensive care or remote assistance. This provides numerous opportunities to enhance the quality of healthcare and reduce the cost of healthcare services. Lack of medical services assets and rising clinical costs make IoT-based innovations necessarily be customized to address the difficulties in medical services. IoT provides unprecedented advancements in the field of healthcare. This paper examines the various roles of IoT that are revolutionizing the healthcare domain by imparting extensive benefits to mankind by providing practical and affordable medical assistance. This paper presents IoT in healthcare, literature review of work carried out in this area, various challenges faced, and future scope.

Keywords IoT · Smart devices · Healthcare · Smart hospital

N. Nayar (✉) · N. Kishore · A. K. Agrawal
Department of Computer Science and Engineering, Chitkara University Institute of Engineering and Technology, Chitkara University, Himachal Pradesh, India
e-mail: nandini.nayar@chitkarauniversity.edu.in

N. Kishore
e-mail: neha.kishore@chitkarauniversity.edu.in

A. K. Agrawal
e-mail: alok.agrawal@chitkarauniversity.edu.in

S. Gautam
Department of Computer Science and Applications, Chitkara University School of Computer Applications, Chitkara University, Himachal Pradesh, India
e-mail: shivani.gautam@chitkarauniversity.edu.in

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1 Introduction

The term “IoT” alludes to a wide vision, where “things” including the everyday articles, environments, and places can be inter-connected with each other by means of the Internet. IoT refers to an “intelligent” network that connects all the things with the internet, for communicating and exchanging the information according to specified protocols. This enables the system to track, monitor, identify, locate, and manage things with great efficacy, thereby developing a new information society.

The rapid evolution of IoT is due to numerous benefits offered by IoT including reduced cost, more accuracy, and growth in digital economy. IoT has brought numerous benefits to the mankind and many organizations by providing services in real time. For the domains that need the data to be continuously controlled or monitored, IoT-based systems are becoming immensely beneficial. Internet of Things (IoT) is extensively adopted in numerous applications and its significance is increasing in our daily life. IoT-based systems are prevalent for home-automation systems, fitness tracking system, smart cities, smart education, environment protection, health monitoring, and smart agriculture. IoT is creating a connected community by enhancing human interaction with the intelligent things.

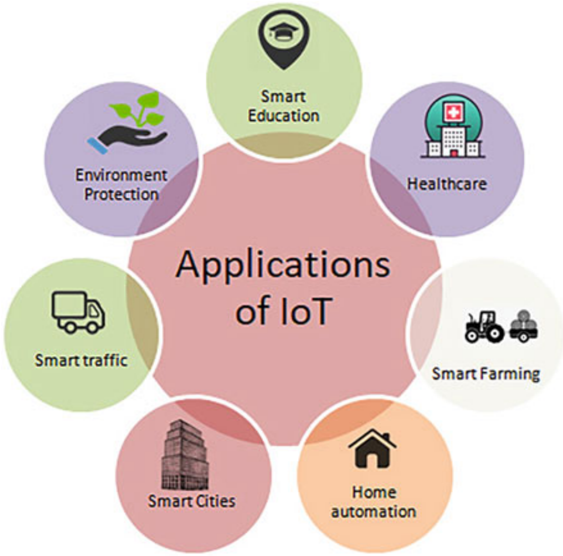
IoT in the field of education provides communication among a variety of sensors, controllers, and objects. IoT-based systems enable efficient and comfortable learning by using intelligent devices, learning analytics, wearable gadgets that are used in Smart classrooms, thereby providing a Smart learning environment. IoT is also successfully implemented in environmental applications for real-time analysis of air/water pollution, temperature, monitoring harmful radiations. Smart cities are using IoT for efficient management of water resources, waste materials, energy conservation, and smart buildings. Real-time information can assist in parking facility, traffic management, and smart assistance in case of road accidents. Some applications of IoT are summarized in Fig. 1.

2 IoT in Healthcare

IoT has a far-reaching impact on monitoring patient’s health and for providing essential services to patients. IoT has brought “Smart” healthcare system in the medical domain, comprising sensors having smart capabilities, remote server, and network. The system is intended to impart numerous features, suggestions for basic treatment, and continuous monitoring of patient’s health. Numerous devices like ventilators, infusion pumps, MRI machines, etc., are connected via hospital network, thereby having the ability to improve efficacy and quality of analyzing and providing medical data.

The usage of wearable computing devices and various kinds of sensors is also increasing. Various devices are commercially available that are beneficial for tracking

Fig. 1 Applications of IoT

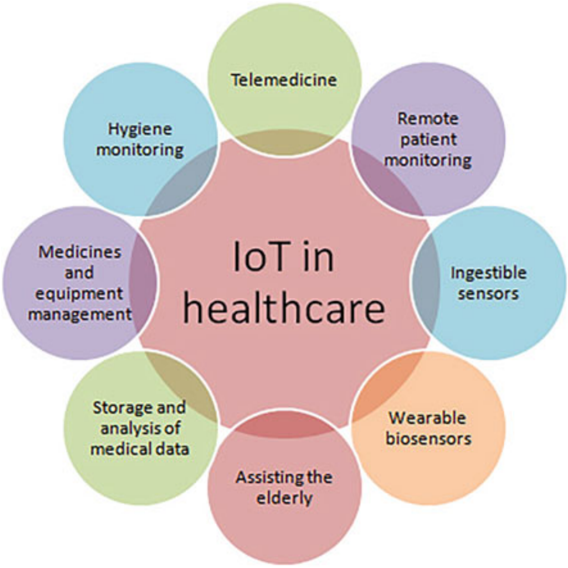


physical activity, biometric measurements, personal healthcare and to adjust environmental control. Moreover, predicting chronic disorders in initial phase is exceptionally crucial. The "Smart" devices are even able to sense and store these biometric measurements over the time, thus enabling the analysis of results. This provides enormous opportunities to the medical professionals for diagnosing and treating distant patients suffering from chronic diseases or multimorbidity. With help of remote monitoring, their visits to hospital and hospital re-admission can also be reduced.

Smart hospital can be referred to as an ecosystem comprising of people, servers, equipments, sensors, actuators that are inter-connected and managed in a unified manner for efficient utilization of resources [1]. Body area sensors, wearable gadgets, and smartphones play a vital role in the IoT m-health ecosystem [2] (Fig. 2).

Various devices like sensors, cameras, actuators are inter-connected to collect patient's data. For further processing, the data is converted to digital form and stored on the cloud. Then the data is analyzed for efficient decision-making by the experts. Wearable devices like fitness bands, glucometers, heart-rate monitoring system help the healthcare professionals to proactively monitor patients' conditions. Continuous monitoring of data is also helpful in prognosis of diseases at initial stage and providing proactive treatment. IoT sensors are beneficial to elderly persons also, as their health can be monitored by healthcare professionals. Moreover, numerous equipments including oxygen pumps, wheelchairs, etc., are tagged with sensors for managing and tracking their real-time location. As the devices are inter-connected, therefore they can be managed with efficacy. Ingestible sensors are also emerging as useful technology for detecting gastrointestinal problems. Many IoT-based hygiene monitoring equipments are used in hospitals for maintaining health and safety of patients. WBAN (Wireless Body Area Network) comprises numerous wearable

Fig. 2 IoT in healthcare



sensors that are capable of measuring physiological parameters like blood pressure and body temperature. This information is transmitted to gateway server using Bluetooth connection. Then this data is stored on cloud-based remote server to enable it for retrieval later on. With help of content service application, medical staff is able to access the stored data.

RFID (Radio Frequency Identification) technology uses radio waves for transferring data using electronic tag that is attached to the objects, thereby being able to find and track objects within the infrastructure. It is also beneficial for retrieving patient information from database on the basis of unique ID that is generated by RFID technology [3]. In the recent times, many smart devices are available that are able to monitor patients' health parameters, e.g., pulse rate, blood pressure, level of sugar in blood, body temperature, etc. IoT-based systems connect the available resources as a network for performing various activities such as diagnosing, monitoring, and obtaining valuable real-time data, by reducing direct contact of patients with doctors.

Advancement in the field of IoT has led to expansion of portable, affordable, and user-friendly devices. These devices have sensors to gather patient's information. Some of the common IoT healthcare devices are listed in Table 1, that are commercially available to gather patient's information for prognosis of diseases, real-time monitoring of patient's health and alert the patients and medical professionals in case of any medical emergency situation.

Table 1 Common IoT healthcare devices

IoT device	Application
Glucose level sensing	IoT-based wearable gadgets for collecting the data of glucose level in blood are being used that enable the medical staff to access real-time data of patients. These devices can also alert patients if the glucose level is too high or too low
Blood pressure monitoring system	IoT-based gadgets that are wearable and cuffless are used to measure diastolic and systolic pressure, save the information for real-time monitoring
Heart-rate monitoring system	Small IoT-based devices are offered for continuous heart-rate monitoring for real-time diagnosis of heart abnormalities
Body temperature monitoring	Light-weight wearable sensors are being used for real-time monitoring of body temperature for adults as well as infants
Oxygen saturation monitoring	IoT-based devices provide non-invasive methods for real-time monitoring of pulse and blood oxygen levels that can transmit the information and also alert the patients and doctors if a critical value is obtained
Depression/mood monitoring	These devices can gather the information about patient’s mental well-being by analyzing patient’s heart beat and blood pressure
Ingestible sensors	These are small IoT-based devices that can be swallowed with ease and gather information about patient’s digestive and other systems
Smart wheelchairs	For patients with restricted mobility, Smart wheelchairs provide easy gestures for controlling the wheelchair, also possessing feature of obstacle detection. Caregivers can also navigate and track the movement of smart wheelchairs
Activity tracking	Using IoT-based wristband sensors or smartwatches, patient’s activity level and diet intake can be monitored

3 Literature Review

The developing countries have high death rate, as there is lack of timely available treatment. However, majority of deaths can be prevented by providing adequate healthcare facilities to patients by real-time monitoring and tracking patient’s health. In this section, the literature review is presented, how IoT contributes to the field of healthcare. For chronic diseases, smart system for monitoring patient’s health is designed that obtain sensor data. Using the body sensor network and the wireless body area network, health status can be analyzed using Bluetooth technology and ZigBee. Moreover, during emergency situations, the system is capable of sending emergency alert to monitoring authority, family relative, and specialist doctor [4].

A wearable and flexible real-time ECG monitoring system is proposed that is integrated on a T-shirt. The system is by a rechargeable battery of 240 mAh, also equipped with a flexible solar energy harvester. For collecting the patient's ECG data, a biopotential analog frontline chip is used [5].

A system is designed for cancer prediction using IoT, which extracts details of blood results and tests whether it is "normal" or "abnormal". In case of patients suffering from cancer, the blood test results are encrypted and for quick reference, these are stored on the cloud. AES algorithm is used to provide security and authentication for handling the patients suffering from cancer [6]. A machine learning-based system is proposed for early-stage detection of breast cancer for efficiently classifying benign and malignant people in the environment of IoT. For testing the proposed method, Wisconsin Diagnostic Breast Cancer dataset is used. The proposed system is reliable for IoT in healthcare [7]. A model is proposed for prognosis of COVID-19 patients in smart hospitals. The model is based on IoT and Machine Learning that can be used for clinical decision support [8]. An IoT-based predictive model is proposed [9] using fuzzy cluster-based augmentation and classification that predicts lung cancer by continuous monitoring, that improves healthcare through medical instructions. To extract the transition region from lung cancer images, Otsu thresholding method is used. For cancer patient's rehabilitation scheme, a user-friendly intelligent system [10] is designed. The system is beneficial for doctors for selecting personalized rehabilitation and nutrition programs, that are apt for patients in rehabilitation treatment's later stage. For this purpose, BAS and CNN algorithms are used under IoT framework. For hospitals and nursing institutes, an IoT aware smart architecture is proposed [11] that is able to automatically monitor, track patients and biomedical devices. The system relies on WSN, RFID, and smart mobiles that inter-operate with each other with help of Constrained Application protocol.

A healthcare system based on IoT and fog is proposed [12] that is able to identify and control the outbreak of CHV (Chickungunya Virus). To diagnose possibly infected people, generate diagnostic or emergency alerts from fog layer, Fuzzy-C Means is used. For representing state of outbreak of CHV, Social Network Analysis is used. For risk-prone (infected regions), warning alerts are issued to healthcare agencies and government. A scheme is proposed [13] for dynamically selecting radio protocols for wearable IoT-based healthcare system that is energy-constrained. Patient's physiological parameters are transmitted using multiple radio protocols to the server using LPU (Local Processing Unit). For patient's continuous monitoring, an algorithm is developed [14] for real-time wearable device for analyzing ECG that uses Discrete Wavelet Transform and Support Vector Machine classifier that yields accuracy of 98.9%. A prototype for mobile real-time heart monitoring system is described [15] to access the patient's status (preventive or detective control) who had been prognoses for heart diseases. This system comprises mobile wearable devices which are capable of sensing cardiac rhythm. These devices are also able to access patient's geographical location.

Researchers proposed design and implementation for IoT-based healthcare system using personal health device- ISO/IEEE11073PHD and Constrained Application protocol standards which reduces data-loss and also enhances inter-operability [16]. A smart fitness mirror [17] provides a platform to users for monitoring health and fitness status every day. Body Mass Index (BMI) is monitored and the amount of body-fat in user's body can also be monitored with help of sensors. The system also comprises ultrasonic sensor for measuring user's height and load sensors to measure user's weight. Total body water, lean body mass, and percentage of body fat can also be measured with help of electrode plates. A fog-driven IoT-based healthcare system is investigated, that focuses on key agreement and authentication. From the bilinear pairings, a three-party authenticated agreement protocol is proposed. The proposed protocol performs superior to Hamid et al.'s protocol [18]. Another secure key agreement scheme is proposed whose security is illustrated by ProVerif (for security simulation), BAN logic and also informal security analysis that demonstrate that the proposed scheme can attain the well-known security requirements [19]. For efficient treatment, prognosis, patient monitoring, and maintaining records, a smart and secure framework is presented [20] which can assist in smart design of hospitals using Artificial Intelligence and IoT. Moreover, a multifaceted system uses IoT for integrating various network elements, sensors, actuators as well as various other healthcare equipments. A user-friendly system is demonstrated on the basis of miniaturized polymerase chain-reaction equipment that can serve as an essential tool for medical professionals for dealing with infectious diseases that can be identified either with help of ribonucleic acid or through DNA. The researchers have tested its capability for dengue fever virus. Results show that this device can be used as efficient tool for early prognosis of diseases or even pandemic outbreak [21].

A new IoT-based architecture is presented for healthcare applications that primarily focuses on principles of weak coupling and relies on message-oriented middleware that is improved using semantic representation of exchanged data. For validation of the proposed architecture, a prototype is designed for bedsore risk detection [22].

A secure system is proposed for medical IoT devices that use LMDS (Lamport Merkle Digital Signature), which authenticates IoT devices by constructing a "tree", wherein the leaves represent patient's medical data hash functions. Furthermore, the centralized health controller determines the root with help of Lamport Merkle Digital signature verification. The experimental results demonstrate the proposed technique to be more secure and are able to identify malicious activities with low Computational Time and overhead [23]. A messaging system is presented [24] for an IoT healthcare service that uses Constraint Application Protocol and Message-Queuing Telemetry Transport (MQTT)-based system. This system is interoperable and based on international standards. In terms of round-trip time and transaction packets analysis, the system shows superior performance.

Assessing sleep quality is another vital research area in IoT, wherein detection and analysis of sleeping patterns is performed using Commercial off-the Shelf sensors and performs result prediction by using Random Forest model. The results demonstrate that this technique yields 95% accuracy to measure patients' sleeping patterns [25]. IoT-based user-friendly wheelchairs are proposed for providing self-supporting lifestyle for patients with impairments [26–28]. To monitor human activities and to interact with living environment, a home mobile healthcare IoT-based system is proposed [29] for patients using wheelchairs. The research focuses on architecture and design of WBSN (Wireless Body Sensor Networks).

The system can perform remote monitoring; the family members and wheelchair users can operate and perceive the intelligent equipments. For prognosis of Parkinson's disease, IoT-based systems have been proposed by researchers for monitoring and diagnosis of the disease [30–33]. A secure framework is proposed [34] using blockchain technology for healthcare multimedia data that helps to provide transparency and privacy among the intermediates as well as patients. This also ensures tracing of illegal activities during any phase of communication process.

To improve the performance of healthcare systems during pandemic, IoT Enabled healthcare systems solve medical challenges like price, speed, and complexity. The system can be customized to monitor calorie intake and treatment of diseases like diabetes, asthma, and arthritis [35]. The article[36] explores how IoT can support healthcare for enhancing healthcare services in better way. The paper [37] presents the detailed review on the application of machine learning techniques used for analysis of big data in the healthcare domain. This study provides an overview for doctors to keep themselves updated and well-informed with the latest trends in ML-based big data analytics for smart healthcare. Another important aspect in Healthcare and remote health monitoring is a systematic approach for security and privacy measures that should be used while monitoring the devices, and during communication, data storage and handling. The paper [38] studies the current situation of security and privacy of IoT-based healthcare systems and the challenges that are faced during implementation of security frameworks. The article [39] implements the Digital Twin (DT) framework for intelligent context-aware healthcare system. The results demonstrate that integration of DT with the medical field can improvise various healthcare processes and can provide an ecosystem that is scalable, comprehensive, and intelligent. The paper [40] proposes an IoMT-based health monitoring system that is able to monitor patient's real-time vital statistics, i.e., oxygen level, heart rate, pulse rate, body temperature, and communicates the live date to the doctors. Compared to existing health monitoring systems, this system achieved more than 90% accuracy. Moreover, it provides significant improvements in terms of accuracy, portability, and response time. Table 2 summarizes the various frameworks and approaches used with IoT in the domain of healthcare.

Thus, we can conclude that researchers are providing superior ways for monitoring and analyzing patient's health, thereby leading to global development of healthcare services. The growth of IoT in healthcare sector is tremendously evolving by connecting. Intelligent objects together and thereby allowing numerous applications to actively support the process of decision making for healthcare services. Although, there are some challenges that are associated with healthcare services that are presented in next section.

Table 2 Summary of various frameworks/approaches used in IoT-based healthcare systems

Author	Proposed work	Outcome
Wu et al. [5]	ECG monitoring system integrated on T-shirt	Low power ECG monitoring system with battery that can operate continuously for more than 110 h
Anuradha et al. [6]	Cancer prediction system	Secure system that encrypts patients' result to be stored on cloud that can be assessed by medical practitioners
Memom et al. [7]	Breast-cancer diagnosis system	99% classification accuracy for Wisconsin Breast Cancer
Abdulkareem et al. [8]	Model for diagnosing patients with COVID-19	Proposed model with SVM scored 95% accuracy
Palani er al. [9]	IoT-based predictive model for lung cancer	Provides a prediction model for effectual image segmentation
Han et al. [10]	Cancer rehabilitation scheme—Recommendation system	Able to extend patients' post-operative recurrence time by more than 95%
Catarinucci et al. [11]	Smart Healthcare—IoT aware architecture	For interoperation among various technologies, complex network infrastructure implemented
Sood et al. [12]	IoT-based healthcare system that identifies Chikungunya virus	Able to determine health severity, outbreak state with minimum delay in real-time notification generation
Misra et al. [13]	DROPS	Proposed scheme selects apt radio protocol that enhances data rate by 78% and throughput by 7%
Azaria et al. [14]	ECG analysis and classification algorithm	Yields accuracy of 98.9% using Discrete Wavelet Transform and Support Vector Machine classifier
Narvaez et al. [15]	Real-time mobile heart-rate monitoring system	Wearable devices which are capable of sensing cardiac rhythm
Ge et al. [16]	Design, implementation of IoT healthcare system comprising of Constrained Application Protocol and Personal Healthcare Device	Reduced data loss among devices and enhanced inter-operability

(continued)

Table 2 (continued)

Author	Proposed work	Outcome
Muneer et al. [17]	Smart Fitness Mirror	For measuring body temperature, the system yields 95.3% accuracy. For measuring body fat percentage, the system the system yields 93.7% accuracy and for body mass index, it yields 92.5% accuracy
Jia et al. [18]	Fog-driven IoT-based healthcare system	Provides security against common attacks
Wu et al. [19]	Authenticated Key agreement scheme	Secure key agreement scheme
Valanarasu et al. [20]	IOT and AI integration framework	Secure integration for Smart Hospital using AI and IoT
Zu et al. [21]	IoT PCR for pandemic disease detection	Vital tool to tackle outbreaks of infectious diseases identified by ribonucleic acid or DNA
Zgheib et al. [22]	New IoT-based architecture for healthcare applications	Prototype for bedsore risk detection based on Braden calculation
Alzubi et al. [23]	Blockchain-based authentication tool using Lamport Merkle Digital Signature	Provides authentication security with minimum Computational Time and overhead
Saleem et al. [25]	Sleep Quality Monitoring system	System projects patients' sleep into various classes with 95% accuracy
DSouza, Akash, Reddy et al. [26–29]	Smart Wheelchair	Provides movement controls, detects abnormalities
Romero, Alzubi, Anter et al. [30–33]	Parkinson disease	Model for detection and monitoring patients with the disease
Rathee et al. [34]	Multimedia data processing framework—IoT Healthcare using blockchain	86% accuracy
Nayyar et al. [40]	Working prototype-BioSenHealth 1.0	90% accuracy in comparison to existing health monitoring systems

4 Challenges and Future Directions in IoT-Based Healthcare

- Owing to the use of various sensors, central servers, and communication networks, IoT-based healthcare systems face many challenges. IoT-based wearable devices are able to carry patients' sensitive and critical data. Thus, a significant issue in the IoT is security as these devices are vulnerable to attacks [41]. Another challenge is that data is received from millions of devices that require transmitting, storing, and monitoring in real-time and also requires high-speed computations and processing. As the data is received from multiple domains and different locations, data integration is also a challenge, especially for connecting it with existing medical systems [42].

- For elderly people, there exist concerns regarding usage of Smart devices that may require adequate training. Moreover, some wearable devices are uncomfortable for elder patients' body. Thus, more efforts must be laid in designing the devices that are more comfortable for patients, especially for elderly people.
- Moreover, there are much more areas in Machine Learning that can still be explored for developing IoT-based applications in healthcare for Disaster Management.
- The manufacturing of cost-effective Smart Healthcare Kits must be promoted that can be useful in epidemic or pandemic situations.

5 Conclusions

Growth in population imposes many challenges for the healthcare service providers and may lead to insufficiency of medical resources. These challenges must be carefully addressed, thereby providing efficient solutions based on available resources. To maintain an individual's well-being, proactive monitoring is imperative. There is an immense impact of IoT in the healthcare industry. IoT-based systems are able to provide intellectual and personalized healthcare benefits for better user experience. The key objective of this research paper is to investigate and explore various application areas and research activities that are involved in IoT-based medical systems This paper offers a methodical literature review of IoT applications in healthcare. Additionally, this paper presents the areas where IoT-based technologies can be explored.

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Privacy Preserving on Delay-Tolerant Networks

D. Meli, F. L. M. Milotta, C. Santoro, F. F. Santoro, and S. Riccobene

Abstract Common arguments related to Delay-Tolerant Networks often focus on routing performances, energy consumption or quality of service. Despite the fact that privacy-related issues are generally considered critical, they do not arouse the same interest as the other reported aspects. For instance, when the carried information contains sensitive data, it should be protected from malicious intent. Nevertheless, most of the protocols used seem to ignore this, assuming others should take charge of the task. The aim of this document is to propose an innovative routing protocol, able to provide privacy preservation with a delivery performance comparable to the current most widely used protocols by taking inspiration from a feature borrowed from human nature, the vocal timbre.

1 Introduction

Delay-Tolerant Networks are characterised by long transmission delays without any assurance to find a complete end-to-end routing path for most of the time. Movements and meetings among nodes are *opportunities* to find new partial paths towards destination. The "store, carry and forward" paradigm represents the main way to implements routing protocols on DTN.

D. Meli (✉) · F. L. M. Milotta · C. Santoro · F. F. Santoro · S. Riccobene
Department of Mathematics and Computer Science, University of Catania, Catania, Italy
e-mail: danilo.meli@unict.it

F. L. M. Milotta
e-mail: milotta@dmi.unict.it

C. Santoro
e-mail: santoro@dmi.unict.its

F. F. Santoro
e-mail: federico.santoro@unict.it

S. Riccobene
e-mail: riccobene@unict.it

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In [6], authors present a taxonomy on routing protocols for DTN, distinguishing between pure opportunistic approaches and social-based ones.

A simple approach to DTN routing problem is presented in [9]. The routing protocol, called *Epidemic*, uses a modified flooding approach to deal with the path discovery. As the name suggests, a message is replicated in every newly met node, so that every possible route is tested. *Spray and Wait* [10] is a modified version of epidemic routing protocol that tries to reduce communication overhead addressing messages only towards the supposed destination area. These two examples do not violate the node privacy, as they do not use sensitive information. The flooding approach, used by both protocols, is essentially zero-knowledge, but wastes a lot of resources, as node memory and network messages.

Other more efficient DTN routing protocols base their decisions on the past history. In real life, the node movements are not random but follow a social behaviour. In these cases, there is a non trivial probability that two specific nodes, that met each other in the past, will meet themselves again in the future.

PRoPHET [4] bases its routing protocol on the knowing of these behaviours. When a node encounters another one, it calculates the probability that the second one could reach directly or indirectly the final destination. To implement this approach, every node has to maintain a vector, contained the so-called *Delivery Predictability*, to keep trace of previous meeting, in order to calculate future meeting probability.

The exchange of this information among nodes represents an obvious weakness in terms of *Privacy Preserving*. Malicious intruders can collect them to easily rebuild the graph of node contacts and movements, violating their privacy.

The main aim of this work is to design a routing protocol for opportunistic DTN, where sensitive information is preserved by means pseudo-anonymisation.

2 Related Works

Nowadays, *Privacy Preserving* is assuming a role even more important inside digital communications because a lot of data, often related to our daily life, are conveyed into network infrastructures. In [5], authors suggest a cryptographic method based on the network-zero-knowledge routing algorithm to predict which neighbour can be more suitable for message forwarding. Another approach is the *Opportunistic Mix network* proposed in [2] to provide anonymous communications in OppNets (Opportunistic Networks). The focus of this work is essentially to maintain the anonymity for the sender and the receiver. However, both the above solutions require a high computational capacity, in order to perform the cryptographic operations. In [3], authors propose to assure the Privacy Preserving on DTN by the adoption of an optimised protocol for trust and reputation-based routing.

In [11], the authors describe an approach based on multiple paths for each destination to prevent traffic analysis. The proposed architecture uses layered encryption scheme based on a PKI (Public Key Infrastructure). A message is split in parts using erasure code and each part follows a different path.

Another approach to the Privacy Preserving problem in DTN routing is grounded on the use of Homomorphic Encryption (HE) schemes [1, 7]. In [8], authors present a routing protocol based on the concept of Habitat, defined as the main zone where a node stays in. To decide which node can be the best carrier towards the destination, the protocol calculates which node, between the two candidates, can provide a habitat closer to the destination one. This is done with the exchange of encrypted coordinates, representing a simplified version of the habitat zone. However, the protocol presents two main weaknesses: first, the communication involves only one intermediate carrier: a chain of carrier is hard to find; second, the concept of habitat works well in case of long permanence of a node in a given limited zone.

3 Innovation From Natural Context: Privacy Preserving Delay-Tolerant Network (PPDTN)

When somebody learns to speak a language, he is influenced by the country where he is and by the people which live there. Changing place and/or meeting different people, he will also change his way of talking, in terms of tone, accent or syntax. In fact, when we listen someone speaking around, we can guess where he comes from, with a good accuracy.

Contextualizing this example into the network domain, we have DTN and nodes instead of countries and people, respectively. A node can address a message using some peculiar characteristics of destination. These features are specific not only of the wanted node, but also of the zone and the context where destination node currently is.

As in human context, we speak about vocal tone or timbre, whereas in a DTN environment, we will use a peculiar track for every node: each track shape will be molded by meeting history.

Routing will be based on the similarity of the node tracks.

Track shapes aren't permanent. A track will evolve continuously in time, trying to resemble to the ones of the met nodes. If the tracks of two or more nodes are similar, it means they approximately go around to the same area and they know the same neighbours. However, note that this fact does not constitute a proof that they met each other in the past.

4 Protocol Description

Let us introduce some features related to the new proposal:

- *Starting phase*: when a node joins a network, it needs an initial track. This will be generated pseudo-randomly.

- *Meeting phase*: when a node meets another one, their tracks must be accordingly modified in order to resemble each other. We need an *evolution function* that starting from the two tracks, produces a modified one (different for each node).
- *Routing phase*: to address correctly a message, a node must decide how much the encountered node can be considered a good choice to reach a specific destination. To implement this, we need a *matching function* that, receiving two tracks as input, returns an index of similarity, normalised between 0 and 1.
- *other*: if a node changes for a long time its locations, it must forget past influences. Other new encounters will help this behaviour, but we need a faster method. The protocol provides an *ageing function* that modifies a track towards its initial shape. This represents a sort of forgetfulness procedure.

From a mathematical point of view, a track is a continuous function $T(x) : \mathbb{R} \to \mathbb{R}$ with some peculiar characteristics. To easily maintain and handle it, we introduce the following characteristics:

- the function is defined in [0, n] with $n \in \mathbb{N}$
- $T(x) \in [-m, m]$ with $m \in \mathbb{N}$
- the function must have a strong variability in $[0, n]$

The function becomes $T(x) : [0, n] \to [-m, m]$. The firsts two characteristics allow a simple comparison between two shapes. The last—the high variability —is essential to strongly characterise the node and the context.

Starting Phase When a node joins the network, its track must be randomly generated. The high variability constrain can be obtained leveraging in the frequency domain. The desired function can be obtained by means the inverse Fourier transform. Store and handle this kind of function can be very hard; so we sample the track in the interval of definition, choosing $n + 1$ equispaced values for the abscissa

$$s_i = T(x_i) \qquad x_i = 0..n \tag{1}$$

obtaining $n + 1$ different points: $\{(0, s_0), (2, s_2), ..., (n, s_n)\}$. All the s_i values are then normalised and quantized into the amplitude $[-m, m]$. In the following, we will indicate them with y_i. In this way, a track can be easily stored as a vector of $n + 1$ values. The set with all the points (x_i, y_i) identifies, with a high degree of accuracy, the original function.

Evolution Function. The track exchange during node encounters is a mandatory step to implement evolution and matching functions. To reinforce the Privacy Preserving property, it is useful to hide the exact function shape, sending instead a blurred representation. To implement this, the protocol implies the following steps. Let us consider two numbers k and p, such that

$$k, p < n \qquad n - 1 \le p * k \le n \qquad k, p \in \mathbb{N}$$

We extrapolate a subset of k values from the original set

$$x'_0 = x_0 \ldots x'_j = x_{j*p} \ldots x'_k = x_{k*p} \quad j \in [0, k]$$

From these values, we can derive the correspondent points on the function

$$(x'_j, T(x'_j)) \quad j \in [0, k]$$

Note that the set $\{(x'_j, T(x'_j))\}$ represents an under-sampling of the track. After this step, the track is approximated with a cubic spline interpolation function. The blurred representation is what we call the public track of a node. Figure 1a shows, in a zoomed view, the set of points of the public track, the correspondent cubic spline interpolation and the original track. Note that, in some parts, the approximation well fits the original track, but in other parts some peculiar characteristics are strongly blurred. The precision of the interpolation directly depends by the ratio k/n.

To implement the mutual influence between nodes in case of an encounter, we need an evolution function, that, given a remote public track, modifies the real track of the node. Let T_A the real track of the node A and $T_{B_{public}}$ the public (blurred) track of B. We define

$$f^{evol}(A, B, x) \stackrel{def}{=} \beta \cdot T_A(x) + (1 - \beta) \cdot T_{B_{public}}(x) \tag{2}$$

where $\beta \in]0.5, 1[$ is a coefficient that determines the impact of influence of remote tracks on track evolution. Node B communicates its track with a set of points

$$T_{B_{public}}(x_j) \quad j \in [0, k]$$

Using these points, we derive the cubic spline that interpolates this set. Call it $S_B(x)$. Applying the evolution function to node A track, we will have

$$T_A(x_i)_{new} = \beta \cdot T_A(x_i)_{old} + (1 - \beta) \cdot S_B(x_i) \quad i \in [0 \ldots n] \tag{3}$$

where $T_A(x)_{new}$ represents the evolved track. It has been empirically observed that massive execution of the evolution function (3) tends to flatten the tracks, minimising

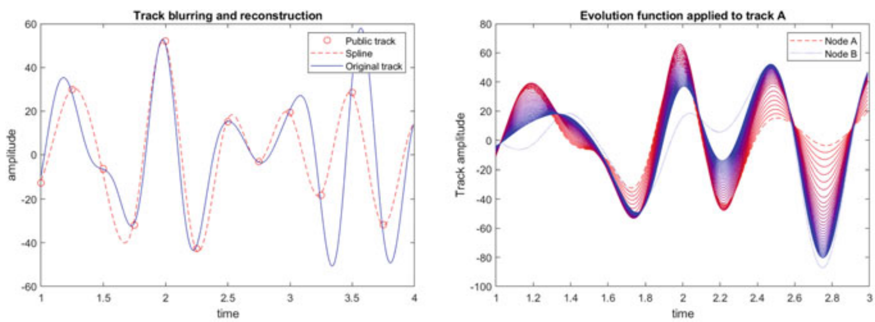

Fig. 1 **a** Track examples. **b** Repeated applications of the evolution function

more and more the characteristics. To avoid this behaviour, we apply the normalisation procedure after the generation phase.

Figure 1b shows an example of the evolution for a track, applying 30 times the formula (3), keeping unmodified the other track. The figure is a zoomed part of the entire shape. As we can see, when the two tracks present peaks in the same direction, at time 1.8, the result accentuates the behaviour. Instead, when they are in opposition, the result tends to a mean value (see time 1.2). Further, the effect of the normalisation procedure is visible in the movements of the peaks towards the ones of the track B (see, for example, the interval between 1.0 and 1.6).

Ageing Function
As explained in Sect. 3, we need an ageing function that represents a sort of forgetfulness method of past encounters. This function modifies the track towards the original one. It can be implemented in a similar way of the evolution function and will be applied at constant time intervals.

$$f^{age}(A, x) \stackrel{def}{=} \gamma \cdot T_A(x) + (1 - \gamma) \cdot T_{A_{orig}}(x) \tag{4}$$

where $T_{A_{orig}}(x)$ is the track generated in the starting phase, and $\gamma \in]0, 1[$.

Matching Function
The matching function provides a simple information on the ability of the encountered node to carry data towards the correct destination. Starting from the profile of the destination and the public track of the met node, the function returns a value in the range [0, 1], where 1 means a perfect match.

Let $T_1(x)$ and $T_2(x)$ the two functions associated with the destination and the encountered node. We define

$$f^{match}(T_1, T_2) \stackrel{def}{=} 1 - \frac{\sum_{i=0}^{n} |T_1(i) - T_2(i)|}{2mn} \tag{5}$$

Every encountered node that determines a matching function result higher than a predetermined threshold can be considered a good carrier. Moreover, for a given destination if the matching function provides a set of results with very high values, we can assume the destination as very close or really reached. So in this case the obtained set can be used to determine when to stop the next carrier search, considering the message as delivered, and so delete it.

5 Experimental Results

The proposed solution has been evaluated by means of a simulator in a scenario of 20x20 km with 100 nodes. The wireless communication range for the mobile nodes is about 250 m. The scenario has been divided into 16 zones; every node can travel along a limited number of contiguous zones, so there is a non trivial possibility that

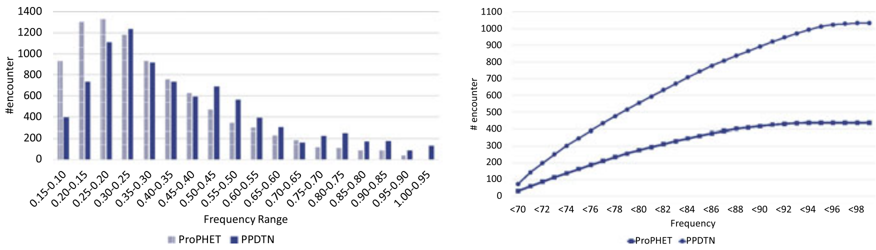

Fig. 2 **a** Comparison between PRoPHET versus PPDTN in terms of encounters that can reach a given target. **b** Performances of PRoPHET versus PPDTN in the range of working value

two given nodes cannot encounter each other during the simulation. Also, we defined a set of meeting points: they represent the locations where the nodes move towards and stop for a certain time (600s in average). The speed of the movements is variable between 3 and 30 m/s, similarly to human beings.

Every node follows a route that, with some probability, drives it towards a point chosen from the prefixed set of meeting points.

Let $L_i = \{w_1, w_2...w_{z_i}\}$ be the circular list of points chosen for node i and $z_i = |L_i|$. When the node reaches the position w_j, we randomly select a value $k < z_i$ and a set of probability $p(x) : x \in [1, k] \mid \sum p(x) = 1$. Every $p(x)$ value corresponds to a point in the list L_i that follows the point w_j. During the simulations, we monitored about 10000 encounters.

To validate our protocol, we compared its performance with the PRoPHET one. Figure 2a shows the distribution of the encounter probability obtained for all the occurrence of the encounters. For PRoPHET, every bar represents the value that the encountered node communicates in order to reach the destination. For PPDTN, instead, it represents the results of the matching function. We compare these values with each other because they are used to choose the encountered node as carrier. As we can see, both distributions present a very similar shapes. In particular, the number of encounters with low value ($P < 0.70$) is high for both protocols, representing, respectively, the 94% and the 88% of the total.

To evaluate the actual working phase, we must extrapolate only the portion in the range $0.70 - -1.0$, because lower values are discarded by both protocols (i.e. the encountered node is judged as a useless carrier). In Fig. 2b, the focus is placed in this range, considering only the encounters that provide a useful possibility for the delivery. Every point indicates the number of useful encounters with a given probability. For example, we have about 480 encounters for PPDTN and 220 for PRoPHET with probability in the range $0.70 - -0.78$. As we can see, PRoPHET shows a limited increment over the value 0.86, forcing to choose a general threshold lower than 0.80, in order to increment the number of nodes classified as “good choice”. Instead, PPDTN shows a constant increasing trend from 0.70 to 0.94, allowing a more punctual evaluation of the correct threshold. This last consideration can be used to improve the routing when the message is closer to the destination.

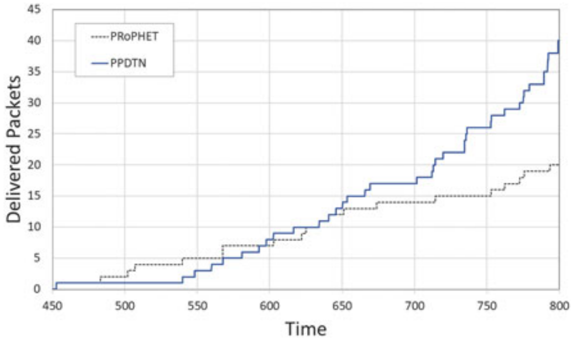

Fig. 3 Performances comparison between PRoPHET versus PPDTN related to packets delivered

Within the simulation, we also tested the message delivery performance obtained applying the rules defined for both protocols. After an initial running phase to reach the steady state, the simulator generates a message every 100 s on average, with random source and destination. The messages are not duplicated: when a node transfers a message to another one, the old copy will be deleted. Figure 3 diagrams the number of messages delivered for PRoPHET and PPDTN.

As we can see, only a small portion of the generated messages reaches its destination. This is in accord with the chosen scenario, with a large dimension (400 km^2) and a limited number of node (100). This was done to stress the protocols, highlighting flaws in the routing decisions.

The results show that PPDTN performance tends to double the PRoPHET one.

6 Conclusions

Routing protocols for DTNs are often based on the sharing of sensitive information like movements and past encounters. This can lead to a non collaborative behaviour from some nodes that see a lack of privacy in these protocols. In this paper, we presented a new approach to the routing protocol that enforces the privacy preserving by means of sharing the generic and blurred information. The simulations carried out show good performance in reaching the correct destination.

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Distributed Consensus Mechanism with Novelty Classification Using Proof of Immune Algorithm

S. Adarsh, V. S. Anoop, and S. Asharaf

Abstract Peer-to-peer lending is an emerging financial domain enabling people to receive instant credit facilities without much complicated procedures and intermediaries. Many financial institutions are focusing on setting up peer-to-peer lending platforms to enable hassle-free credit facilities with transparency between lenders and borrowers. The trust and transparency for hassle-free settlement and addressing novelties is a major concern in this domain which is hindering the mainstream adoption of such lending platforms. The objective of this paper is to propose a trusted and transparent distributed ledger approach using blockchain technology for setting up peer-to-peer lending platforms. The proposed approach creates cryptographically secured transactions stored over a publicly verifiable immutable ledger, which ensures credibility and auditability to investors and borrowers on every aspect of security. Proof of Immune Algorithm was proposed by leveraging the potential dendritic cell algorithm mimicking human immune system to provide consensus among peers involved in the lending process to enable trust.

1 Introduction

Financial institutions across the world focus on multiple lending approaches specific to wide range to customer portfolios to ensure seamless services and better business. Building the trust on every transactions is of high priority to every institution to maintain the customer loyalty and credibility in the market [1]. Classifying the known

S. Adarsh (✉) · V. S. Anoop
Indian Institute of Information Technology and Management, Kerala (IIITM-K), Thiruvananthapuram, India
e-mail: adarsh.res16@iiitmk.ac.in

V. S. Anoop
e-mail: anoop.vs@iiitmk.ac.in

S. Asharaf
Kerala University of Digital Sciences, Innovation and Technology, Thiruvananthapuram, India
e-mail: asharaf.s@duk.ac.in

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and unknown participants in financial transaction is crucial for privacy and security concerns and demands and appropriate novelty detection strategy. This enforces the financial institutions to follow strict mandates for approval and issuance of customer request causing delay and lower processing rates. Even with the advent of digital banking, the concerns over privacy of users and security of transactions are a major challenge for many banking solutions. This paper suggests a P2P lending system using blockchain-based distributed ledger technology for financial institutions to ensure faster and transparent lending with highly secure transactions. Blockchain is a distributed ledger technology proposed as backbone of the most celebrated cryptocurrency Bitcoin.

2 Related Works

Peer-to-peer (P2P) lending is gaining attraction among many banking and financial solution providers to enable better returns to lenders and ensure quicker availability of money to borrowers. According to financial experts, P2P lending in the U.S. is predicted to grab about 45 percent of global market share by 2020. The total amount of money lent through P2P platforms grew more than 80 percent per quarter from 2007 through 2014, according to the Federal Reserve Bank of Cleveland. PWC predicts the US market will reach 150 billion US dollars by 2025. Right from the inception of human civilization, P2P lending is not a new financial model of lending, rather a traditional approach of informal lending from person to person without any third parties or intermediaries.

The trust between borrower and lender was the key factor which drive P2P lending where regulations and mandates were mostly informal and depend on the interpersonal relationship between the peers. These informal lending caused many disputes among people and with the growth of civilization, people started using formal methods of lending through banks. With the advent of digital banking and online financial systems, people started building platforms for online P2P lending platforms [2]. But this is still a very niche domain possessing many security concerns among the general public.

2.1 Online Peer-to-Peer Lending

Earlier P2P lending systems mainly worked on the trust and belief between borrower and lender. The trustworthiness of the borrower is measured by the lender terms of credit rates considering repaying potential and probability of default, while borrower will be primarily focusing on ease of obtaining money and interest rates. With the advent of online banking solutions, many providers started building online P2P lending platforms connecting lenders and borrowers. In 2005, the first online P2P lending platform named Zopa was launched in United Kingdom which led way for similar platforms in different countries. Most of the online P2P lending platforms are country based as the banking regulations are specific to individual nations [1]. According to p2p-banking.com, there are over 30 online P2P lending platforms and total volume for the reported marketplaces adds up to 634 million Euro as of August 2019.

Some of the prominent online platform for P2P lending includes SALT (Secure Automated Lending Technology) and Dharma Protocol are online lending platform only for crytpocurrency trading. Faircent is the first RBI registered Indian platform offering P2P lending to customers. Most of the existing platforms follow the traditional methods and that is where a blockchain-based platform with improved consensus finds huge potential in the current scenario.

3 Proposed System

3.1 Trust Model in Existing Systems

Trust is the important element of any P2P lending platform. Even though the original idea of P2P lending avoids intermediaries, peers involved will rely on trusted intermediaries to reduce risk of transactions and easier settlement. This creates the need of trusted online P2P lending platforms supported by financial institutions ensuring credit rating of peers leading to assured returns and timely repayment. Existing systems follow many credit ranking mechanisms to calculate the risk involved for lenders and rate of interest for the borrowers are fixed accordingly. The online platform acts as a trusted intermediary between the lender who is investing money to get maximum profit with minimum risk and the borrowers looking for cash inputs with minimal interest rates through quick process. Certain platforms follow auctioning system for lending, where lenders can place bid for the amount and borrowers will place limits on the applicable rate of interest. Dealing with unknown entities is still a major challenge in the financial ecosystem where clients always demand a clear distinction between known and unknown entities to ensure security. Novelty Detection is a one-class classification mechanism which helps to classify the known and unknown classes [11]. In order to ensure trust, different platforms follow different processes. Certain platforms directly connect lender and borrower while others do the process through bank accounts satisfying all the regulatory policies and KYC (Know Your Customer) norms. With all the existing platforms, for low risk and better security, the process will be more complicated. This keeps away most of the customers away from online lending platform.

3.2 Blockchain Platform

Blockchain technology refers to the distributed data storage technology which was initially proposed for the famous cryptocurrency Bitcoin by its illusive creator Satoshi Nakamoto in 2008 [3]. Inside blockchain, the chronologically ordered data points are grouped into individual storage units called blocks. These blocks are connected sequentially using cryptographic hashing techniques and stored in a decentralized fashion across all the nodes in the peer-to-peer network to form a blockchain. This distributed ledger offers an important advantage of immutable and tamper-proof data storage mechanism which found prominent applications in many banking and financial applications. For making the data immutable, a hash value is computed locally with the content of block and hash value of immediate predecessor. The successful hash value is propagated to all the peer and the most accepted hash value and corresponding block is added to the blockchain. Hashing is a one-way function designed such as the output is very complex to compute but easy to verify. Hash functions always generate fixed size output, no matter the size of input and never allow to recreate the input back from output. To add any transaction to this public ledger, a consensus (agreement) mechanism is followed by all the participating peers which validates the transactions [5].

The consensus mechanism ensures credibility of transactions as only those transactions which are approved by the majority of peer in the network gets written into the blockchain and it then becomes immutable in the network. This creates a trusted and transparent ledger for performing transactions between anonymous peers without much security concerns as any transactions to be written into the ledger follow the consensus mechanism.

In comparison with the existing centralized platforms for financial applications, the trusted decentralized platform offered by blockchain seems to be more suitable for online lending platforms. Lending platforms always deals with a wide variety of service requests from lenders with varying risk factors which needs real-time and dynamic approval techniques for faster and efficient processing. Conventional stringent guidelines will keep investors away and an unstructured approach will increase the risk. This demands a completely novel way building self-resilient platforms where network itself can build the trust and allows transactions based on the common belief of the involved peers which will the subjective to many factors including geographies, economy, cash availability, credibility, etc. Moreover, the inherent property of avoiding double-spending problem makes blockchain a desirable solution for the payment platforms.

3.2.1 Existing Consensus Approaches

Consensus is a way making an agreement in a decentralized ecosystem of unknown peers without any intermediaries. Consensus algorithms are the core of any blockchain networks for making the network live and functional. The is no single method of consensus, that could be termed good or bad, whereas the selection of consensus depends on the business domain and the stakeholders involved. Proof of Work (PoW) consensus algorithm commonly termed as mining algorithm is the most celebrated consensus algorithm which is being used by Bitcoin and many other cryptocurrencies. PoW generally represents a cryptographic puzzle satisfying certain mandatory conditions which could be solved by spending good amount of computational power so that the output is hard to produce and easy to verify. These puzzles cannot be solved manually and probability of winning the puzzle depends on the number of hashes produced per second. There are no shortcuts here and hence minimal chances of attacks as work done by each peer are valued in PoW algorithm [6]. The major drawback of this algorithm is the need for expensive hardware requirement like GPU servers and other dedicated mining hardware and high-power consumption involved in running these machines and associated cooling systems.

Besides PoW, other consensus algorithms are also developed for blockchain networks like Proof of Stake (PoS) which depends on a voting protocol, Proof of Elapsed Time (PoET) which utilizies the concept of Trusted Execution Environments (TEE), Proof of Authority (PoA) which is a modified PoA mechanism utilizing the identity of validators and so on. Majority of consensus mechanisms are either computationally expensive or domain specific serving to the specific environment which may not be suitable for a peer-to-peer lending platform. This research focuses on developing a new consensus strategy for lending platforms giving due prominence to the approaches followed by humans in building trust and belief by minimizing risk among the stakeholders involved in lending. The risk factor and interaction between borrowers and lenders can be modelled similarly to the human immune system where antigens (foreign bodies) and antibodies play a vital role in controlling the risk of an attack on human body. A bio-inspired consensus mechanism built with principles of human immune system will be crucial for building a trusted online peer-to-peer lending platform using blockchain technology.

3.3 Building Trust with Bio-Inspired Computing

The acceptance or inhibition between borrowers and lenders in a peer-to-peer system find many similarities with the human immune systems. The biological immune system is a highly complex system which helps human body to identify and eliminate infections caused by foreign bodies. The choice of immune-based solution for the lending platform comes up with its capabilities such as fault tolerance, diversity, adaptability, self-learning, dynamic and memorization which could build the much needed self-resilience for the lending platform. The immune system is primarily a one-class classifier which classifies between self (components of human body) and non-self (foreign bodies). The non-self-components commonly referred to as antigens include micro-organisms (pathogens) or other unwanted elements which trigger human body to generate protein component called antibodies for counter-attack. White blood cells (WBC) produce specific antibody for each antigen which binds the antigens, engulf it and neutralize pathogens and thereby protecting human body from diseases.

The immune mechanism in human body can be mainly classified into two: innate immunity and acquired immunity. Innate immunity is the inherent immunity possessed by any individual by birth itself. Acquired or adaptive immunity is gained through a constant learning process by the immune system by exposure to various categories of pathogens. The memory B-cells produced by the lymphocytes (or WBCs) help in memorizing the antigens and corresponding antibodies which makes the subsequent responses to the known antigens quicker and efficient. An important component acting as messenger between the innate immunity and adaptive immunity is the dendritic cells which are the antigen presenting cells found throughout the body including skin, inner lining of nose, stomach,lungs, etc. This research primarily focuses on the activity of dendritic cell and to model the same to build a self-resilient system similar to biological immune systems for the online lending platforms [8].

3.3.1 Dendritic Cell Algorithm

The dendritic cells are sensitive to the presence of three categories of signals, namely, Danger, Safe and PAMP (Pathogenic Associated Molecular Patterns). Danger signals denote a specific antigen, while PAMPs represent molecules generated by pathogens (micro-organisms) and provide a fairly definitive indicator of attack. Safe signals are the opposite of danger signals, and are released as a result of controlled, planned cell death [7].

Dendritic cells have the ability to collect antigen from external environment and combine it with the signal information to provide ’context’ for the classification of antigen. If the antigen is collected in an environment of mainly danger and PAMP signals, the context of the cell is ’anomalous’ and all antigen collected by the cell are deemed as potential intruders. Most of the existing Artificial Immune System (AIS) algorithms which mimicked the biological immune system including the famous Negative Selection Algorithm and Clonal Selection Algorithm focuses on self/non-self-classification that primarily distinguished known and unknown entities in a given context. Polly Matzinger proposed Danger Theory in 1994 which suggested that the role of immune systems is beyond a one-class classification of self/non-self, and will react against the potential danger/threats to the body [9]. The Dendritic Cell Algorithm (Greensmith) was proposed as a subsidiary research under the whole project of Danger theory focusing on the relevance of dendritic cells in identifying the potential dangers and acting against them. This algorithm classifies the dendritic cells into different stages based on the exposure levels to different categories of signals. Initially every cell will be immature, upon exposure to more of PAMP or danger signals, it will become mature dendritic cell which indicates the harmful behaviour [10]. If the immature dendritic cell is exposed to more of safe signals, it will become semi-mature cell which is acceptable by the system.

Algorithm 1: Context assessment for a single DC

input : semi-mature and mature cumulative output signals;
output: collected antigen and cell context;
if *semi-mature output* > *mature output* **then**
  cell context is assigned as 0 ;
else
  cell context is assigned as 1;
end

After the Dendritic cells have been created they must be exposed to the environment in order to store data which will enable them (upon migration to the lymph node) to decide on whether they sensed danger or not. Information collected by the various dendritic cells are evaluated based on the "Mature Context Antigen Value" (MCAV) which determines the anomaly coefficient for a given antigen type. The MCAV value is calculated by Eq. (1), where the MCAV of a given antigen type is given by the average of Dentritic cells that registered that antigen type as associated with a mature context.

$$MCAV = mature - count/antigen - count \tag{1}$$

The closer the value of MCAV is to 1, the highest the probability of that antigen type being associated with the danger signals, and therefore, representing danger itself.

3.4 Proof of Immune Algorithm

As we have seen with most of the blockchain based consensus algorithms, the P2P lending platforms also need an efficient consensus mechanism to handle with the risk involved in transactions and to create the artificial consciousness between lenders and borrowers for every transaction being made. This research proposes a new consensus algorithm named Proof of Immune (PoI) which focus on building a conscious consensus algorithm mimicking the human immune response system for P2P lending platforms. As already discussed, for any request made by borrower, lender always use human consciousness checking multiple parameters including credit rating, repayment potential, risk of default etc. before making the deal. Different lenders have different perception regarding different borrowers and decisions will be more on a personal basis in the unstructured platform. Certain borrowers and their allowable risk may be acceptable for certain lenders while not for others. There is no single standard and risk calculation will be different for different borrowers, just like how certain antigens may be disease causing in certain human while not that harmful in others.

Trust refers to a firm belief over someone. It gives a measure of predictability of a person at a particular scenario. At the start, in the blockchain network, every node will be anonymous and the network may not be clear about the intentions and activities of the nodes. For measuring trust, PoI algorithm propose to leverage the notions of danger theory and the dendritic cell algorithm. This algorithm models a term Danger Quotient (DQ) which builds the trust value in a one-to-one relation between lender and borrower.

$$Trust = 1 - DQ \tag{2}$$

Higher the value of DQ, lower the trust and more will be risk involved. The value for DQ is computed from 2 parameters namely Self-Danger Score (SDS) and Neighbourhood-Danger Score (NDS) The concept of Self-Danger Score (SDS) is to evaluate a single peer based on its participation at various levels of transaction validations (with good credit history and timely repayment) and thus its influence on committed transactions over the network. SDS provides an indication about the node relating to its 'Karma' in the network. Better the validations (like timely payment and low default) made by the peer in the network. This could be done by calculating the ratio of failure (default) contexts to the total number of validations. This gives a computation similar to occurrence of false negatives made by the peer in the given context. For a new peer, SDS will be zero, and the score will be updated for every transactions. Based on the business model, lending platforms can also set an initial value for SDS by completing a KYC or credit score (like CIBIL) to on-board trusted clients. The value of SDS lies in the range of 0 and 1, where 0 means the borrower is trustworthy with no defaults in the transaction history

$$SDS = failure - contexts/total - validations \tag{3}$$

Neighbourhood-Danger Score (NDS) represents the parameter for danger set by the neighbourhood of lenders for a borrowers. NDS mainly serves two purposes: it helps lenders of similar category to select potential borrowers and helps borrowers to maintain a healthy relation with lenders for future engagements. NDS will be computed automatically by smart contracts (self-executing code) running on blockchain network. NDS is the ratio of sum of acceptance per lending request made by the borrower to the total number of lending requests made. High value of NDS means better acceptance for the borrower among the lender community and more neighbourhood peers will be willing to lend to this borrower.

$$NDS = \sum acceptance_i/total - requests \tag{4}$$

For ease of computation, the NDS value can be normalized to a value between 0 and 1. The Danger Quotient defined in Eq. (2) can be computed as the ratio between SDS and NDS value.

$$DQ = SDS/NDS \tag{5}$$

Borrowers maintaining lower SDS value will have good reputation among the lenders and eventually they can improve on the NDS score thereby keeping DQ in an optimal manner. The general equation of Trust for Proof of Immune consensus mechanism is represented in Eq. (2) for anonymous peers interacting over a common blockchain platform. Based on the business case, PoI algorithm can be modified to satisfy more needs of the platform. This research work is mainly focusing on building a trust value for borrowers and make them acceptable among lenders. A similar scoring mechanism can be developed for the lenders also to keep the borrowers informed about the best choices on offer for receiving the amount. This depends more on the business positioning of the lending platform.

4 Experimental Results

The PoI consensus mechanism is tested using smart contracts deployed on Ethereum public blockchain network by creating a blockchain based sample mobile wallet application which can on-board anonymous peers who could be borrowers or lenders. Ranking of borrowers were made on the basis of trust score from PoI algorithm and made available to lenders. The test results showed that even in complete anonymous scenario, the trust score and transactions written in immutable transparent ledger build value to clients and peers finding it easier to perform lending operation. As the agenda of experimentation was to test the practicality and acceptance of a new consensus method,it was done with the ERC-20 token standards on Ethereum Blockchain and not fiat currency or payment gateway integration was made for experimentation. The test was conducted on Ethereum Test Network comparing the PoW, PoS and PoA consensus mechanism with the score from PoI for 60 transactions.The primary aim was to showcase on the trust of the node based on the peer-to-peer network monitored o incoming transactions to the respective node. The test results showed promising results and if blockchain based wallet application can be synchronized with the existing services offered by banks to open a new business domain with greater returns for the stakeholders (Fig. 1).

5 Conclusions

The P2P lending platforms leveraging blockchain technology opens a new business avenue for the financial institutions. Individuals can become micro-investors (lenders) by lending even the small monthly balance from their saving account and yield better interest rates. Banks could yield a percentage of profit by acting as a facilitator for better utilization of idle money in the accounts (saving) and can attract more customers with the higher returns.This could even help in faster and efficient loan processing as loans to a certain extend can be funded through these P2P platforms. Distributed ledger eliminates the current process of duplicate reconciliation, which

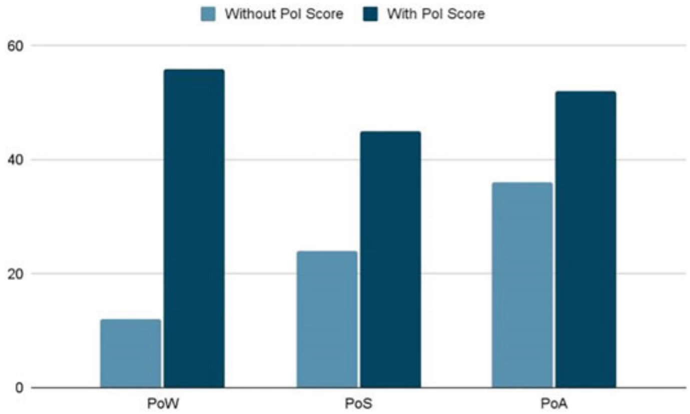

Fig. 1 Performance of PoI with standard consensus approaches

is costly and time-consuming and ensures an easier audit mechanism. This research is an effort to correlate the potential of bio-inspired consensus mechanism to address the challenges of novelties in P2P lending platform and found immense potential to explore deep into various avenues of this upcoming business domain. In future more research could be carried out in various aspects of immune response systems for building futuristic lending models on top of blockchain networks. Moreover, Proof of Immune Algorithm can be utilized in domains beyond banking to build conscious consensus mechanism for anonymous peers with cost-effective computing.

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Ensemble Deep Learning Models for Vehicle Classification in Motorized Traffic Analysis

U. Asmitha, S. Roshan Tushar, V. Sowmya, and K. P. Soman

Abstract Automation of vehicle classification is essential in the establishment of effective Intelligent Transportation Systems (ITS). Based on the MIOvision Traffic Camera Dataset (MIO-TCD), this paper categorizes the types of vehicles as car, bus, van, light truck, motorcycle and multi-axle truck. The classification of surveillance images is achieved using an ensemble of Deep Networks. Three networks are trained separately to make up the deep learning ensemble model with ConvNet, LeNet and EfficientNet achieving 89%, 68% and 87% classification accuracy, respectively. Results of experiments unveil that the ensemble of networks outperforms the individual networks. The ensemble of networks achieves 92.77%, which is high when compared to the performance based on genetic method in the recent literature.

Keywords Vehicle image classification · Ensemble method · Deep learning · Intelligent transport systems

1 Introduction

Vehicle classification is a challenging task in deep learning due to its application such as intelligent parking systems, self-driving vehicles, driver assistance systems, traffic monitoring systems including speed and count of the vehicle [1]. The vehicle features will be difficult to discern from low-resolution surveillance footage. The vehicle images are always textureless due to the limited size and poor quality of traffic images. The problem is further worsened by various road conditions, lighting circumstances and can be influenced by neighbouring objects. Furthermore, surveillance cameras can have diverse perspectives, making it much harder to discriminate between vehicle

U. Asmitha · S. Roshan Tushar · V. Sowmya (✉) · K. P. Soman
Center for Computational Engineering and Networking (CEN), Amrita School of Engineering, Amrita Vishwa Vidyapeetham, Coimbatore, India
e-mail: v_sowmya@cb.amrita.edu

K. P. Soman
e-mail: kp_soman@amrita.edu

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kinds. There is a significant variation within classes as vehicles might differ in colour, dimension. These are the difficulties of vehicle type classification.

In this paper, vehicle classification is performed by developing an ensemble method of deep learning algorithms utilizing the MIOvision Traffic Camera Dataset (MIO-TCD) captured from surveillance cameras. The major aim of this paper is to demonstrate that by utilizing the same size dataset as [2], we may achieve better outcomes. Ensembles of deep neural networks have proven to be highly effective in many image classification [3] and localization applications due to their excellent prediction ability. Several models with different architectures are incorporated into ensembles for better predictability and stability. Accordingly, it is difficult to anticipate which algorithm would achieve the best accuracy for a given prediction task and dataset. As certain deep learning methods may have a poor overall prediction but might be good at classifying specific subclasses, ensembles can effectively utilize the combined strengths of the various deep learning algorithms. Merging strategies for the ensemble model including majority voting are employed in this paper. Conversely, algorithms that are less accurate and have weak precision are susceptible to this method. In this paper, we present an ensemble model that consists of three individual models, namely, ConvNet [4], LeNet and EfficientNet for vehicle-type classification in surveillance frames.

The rest of this paper is organized as follows. A brief discussion of prior work on deep learning-based classification networks is presented in Sect. 2. In Sect. 3, we describe our classification methodology in detail. We describe the MIO-TCD classification challenge dataset in Sect. 4 and present experimental results for networks as an ensemble. As a final section, Sect. 5 concludes the paper.

2 Related Works

Cho et al. [5] fused laser and radar systems together with a Kalman filter to detect and classify objects using computer vision, which has been largely used with handmade features and sensors in the past. In 2017, Thakoor and Bhanu [6] measured the variation in structural signatures among vehicles of different sorts as they travelled ahead and classified vehicles using rear view images. The classification was performed with support vector machines (SVM). In the years following the contribution of Krizhevsky et al. [7] to the ImageNet LSVRC contest (ILSVRC)-2010 using deep convolutional neural networks (DCNNs), significant deep learning research has been conducted to address classification issues [8]. Among the several CNN models for vehicle classification employed in [9], the Inception-ResnetV2 has been found to have the greatest performance. The ensemble of two individual networks for training, combined with three individual networks for testing, to get a final prediction based on the weighted average of the results of the individual networks, is demonstrated by Rajkumar in [10]. For the vehicle-type classification issue, a super-learner ensemble is presented in [11]. ResNet50, DenseNet and Xception are densely linked single-split super learners that harness the strengths of each base learner and mitigate its weaknesses. A new fine-tuned algorithm for classifying vehicles based on convolution neural network was proposed by Tanveer et al. [12]. The genetic algorithm was used by [2] for vehicle classification using convolutional neural network architectures for image classification.

3 Proposed Method

In this paper, the ensemble approach is performed to classify images from three models (ConvNet, LeNet, EfficientNet) using the max voting method. The ultimate aim of ensemble is to analyze the limitations of models, resulting in enhanced classification results. The majority vote ensemble learning of three neural networks that are proposed for vehicle-type classification is inspired by one of Ludmila I. Kuncheva's ensemble methods [13]. Preprocessing and data augmentation are performed on the data before it is sent on to the models for classification. The proposed methodology for the classification of the MIO-TCD dataset is depicted in Fig. 1.

The objective of preprocessing is to improve image data by eliminating extraneous distortions or enhancing the features of the images for particular visual properties that are important for subsequent analysis. To compare the results obtained, the size parameters used in [2] are chosen as the base size.

The next step of preprocessing is normalization, which maps the RGB channel values ranging from 0 to 255 to the range between 0 and 1 because this is not optimal for the neural network.

Overfitting can be avoided by data augmentation which is a technique for creating new training data from existing examples by applying random transformations (shifts, flips, zooms, etc.) to them, resulting in plausible pictures. This allows the model to be exposed to more features of the data and generalize more effectively.

ConvNet, LeNet-5 and EfficientNet are three deep convolutional neural network structures that have been used. In our framework, all of the three models take 64×64 RGB input images, and the last fully connected layer has six outputs to predict six classes. To deal with the imbalanced nature of the dataset, class weights are set to each class. In order to determine the weight for each class, the number of training

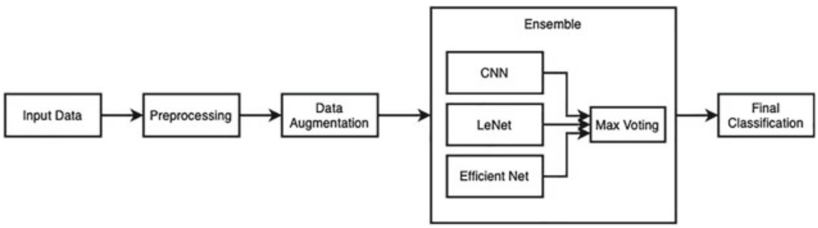

Fig. 1 Framework of the proposed method for vehicle classification

images is divided by the number of classes and the total number of images in the corresponding class. These weights are applied to the model during training.

The ConvNet architecture employed in this paper consists of a sequential network of four convolution layers with a maximum number of 128 filters and an input layer with an input size of $64 \times 64 \times 3$. We utilized the Adam optimizer with a learning rate of 0.001 as described in [14]. With the loss function sparse categorical cross-entropy, the built model is trained over 32 epochs. The best score is determined by the highest test accuracy among all epochs.

To classify the vehicle images in the MIO TCD dataset, LeNet-5 [15], an 8-layer Convolutional Neural Network is deployed. Excluding the input layer, the model has eight layers. The input size is the same as the ConvNet input size. For all convolutional layers with activation relu, a kernel size of 5×5 was applied. To prevent overfitting, a dropout layer of the rate of 0.2 is employed. The model is run for 32 epochs, with the outputs passing through the sigmoid activation function with the categorical cross-entropy loss function.

EfficientNet is one of the most efficient models that achieve cutting-edge accuracy on both imagenet and image classification transfer learning tasks, as initially described by Tan and Le in 2019 [16]. The pre-trained ImageNet weights of EfficientNet B1 is used to initialize the model and then fine-tune it on our dataset.

The initial stage in transfer learning is to freeze all layers and just train the top layers. For this step, a reasonably high learning rate (0.01) using the Adam optimizer and loss function categorical cross-entropy can be employed. The next step is to unfreeze a few layers and fit the model with a lower learning rate. For the first 50 epochs, the model is trained only using the top layers. The next 20 epochs are run after unfreezing all the layers.

4 Results and Discussion

4.1 Dataset Description

For training and testing images, a subset of the MIO-TCD dataset is used. The dataset contains images captured at different hours of the day with different traffic densities with varying orientations which includes low-resolution images taken in severe weather conditions. The low resolution of the images is due to the motion of the vehicle. There are 648,959 low-resolution images that are split into 11 groups in the classification dataset. The subset used for training and testing in this paper is taken from [2] and the number of classes is narrowed down to 6 as taken in [2] to compare the performance. The dataset contains 7200 images for training and 1800 for testing. There are six folders corresponding to six classes (motorcycle, light truck, van, bus, car, multi-axle truck) for both test and train. More details of the image category are shown in Table 1.

Table 1 Size of each category in the dataset

Class	Training	Testing
Car	6341	1565
Van	214	58
Motorcycle	39	17
Bus	239	60
Light truck	131	30
Muti-axle truck	236	70
Total	7200	1800

The number of images of cars is significantly larger than those of other vehicle images since the MIO-TCD dataset is recorded from real-world traffic surveillance environments.

4.2 Results and discussion

A subset of the MIO-TCD classification challenge dataset which is highly skewed is employed to show the usefulness of our proposed methodology.

The model is comprised of three separate models, each trained with 32 epochs using the Adam optimiser and a 0.2 dropout rate for the dropout layer.

ConvNet obtained a classification accuracy of 0.89. LeNet obtained a classification accuracy of 0.68. EfficientNet obtained a classification accuracy of 0.87. With regard to our proposed max voting ensemble, we got 0.92 classification accuracy on test data. The accuracy for individual models and proposed ensemble model is shown in Table 2. When compared to individual models, the ensemble model achieved higher precision, recall and f1-score for each class which is shown in Table 3.

The confusion matrix indicates that the proposed vehicle classification technique is capable of effectively classifying classes such as multi-axle trucks and motorcycles which is shown in Fig. 2. Car and Bus have easily categorized accurately due to their high dominance in training data. The prediction is decent since the light truck and van have fewer images. The precision of each class acquired in this paper transcends

Table 2 Accuracy for individual models and proposed ensemble model

Classifiers/metrics	Accuracy
ConvNet	0.89
LeNet	0.68
EfficientNet	0.87
Ensemble	**0.92**

Table 3 Precision, recall, f1-score for each classes for the proposed method

Metrics/class	Multi-axle truck	Bus	Car	Motorcycle	Light truck	Van
Precision	0.76	0.80	0.96	0.92	0.61	0.46
Recall	0.73	0.80	0.97	0.65	0.57	0.50
f1-Score	0.74	0.80	0.97	0.76	0.59	0.48

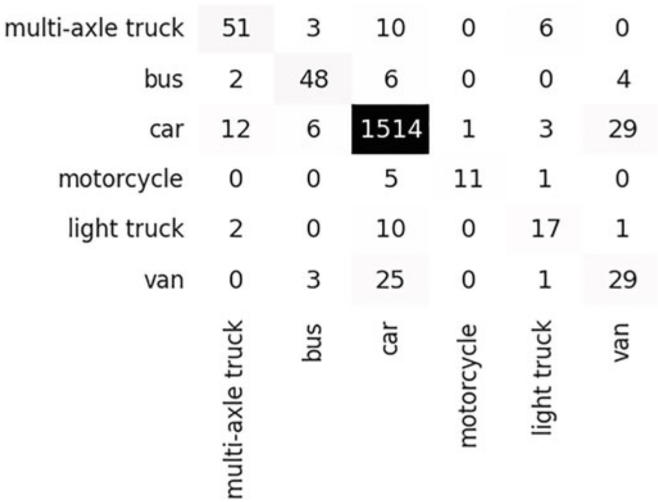

Fig. 2 Confusion Matrix for the vehicle classification

Table 4 Comparison of results of our proposed ensemble model and genetic algorithm

	Genetic algorithm [2]	Ensemble (Proposed method)
Accuracy	0.78	**0.92**

the precision of classes obtained in any previous paper that trained with a very small subset of images.

The overall accuracy was low because the model struggled to recognize multi-axle trucks owing to the angle of the testing images. Because the images in the MIO-TCD dataset are blurry, and some vehicle images have the same properties as other vehicle types, the model's accuracy is modest. Additionally, many of the images in the dataset do not depict the entire vehicle.

The classification accuracy provided in our model is 92.77% with precision for each class mentioned in Table 3, which is significantly higher than the classification accuracy(78.53%) obtained by Cero [2] using genetic algorithm shown in Table 4.

5 Conclusion

In this paper, an actual traffic surveillance dataset (MIO-TCD) is used to build an ensemble model comprised of three deep neural networks for the categorization of vehicle images. The ensemble model that was trained on the MIO-TCD dataset's 9000 pictures performed commendably, with an overall accuracy of 92.77%. There is a limitation to the proposed ensemble model which can classify only six vehicle types, and the accuracy for vans and light trucks is poor because of the distortion in the images, which affects its overall accuracy. For future work, the proposed ensemble of deep neural networks can be used to perform localization on the MIO-TCD localization challenge datasets and aim to improve the overall accuracy of our vehicle classification problem.

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Smart Attendance Monitoring System for Online Classes Using Facial Recognition

Suraj Goud, R. Abhiram, Padmalaya Nayak, and Priyanka Kaushal

Abstract One of the most important activities in a classroom is the process of marking attendance. It is a universally accepted process to measure the punctuality of a student. However, there are certain drawbacks to the existing system where a teacher has to physically mark, whether a student is present or not. The main drawbacks of taking physical attendance are time-consuming while marking the attendance and there is a possibility of proxy attendance. The existing systems like fingerprint scanning and RFID are not completely proof worthy and can be easily tampered with. Keeping this view in mind, we implement a face recognition algorithm to mark the attendance of a student. The main aim of the proposed system is to make the process efficient and save time. The proposed system recognizes the student's face from the images stored in the database and updates it in the attendance sheet automatically. To implement the online attendance system, we use popular algorithms like Haar-Cascade and HOG algorithm which is provided by the face_recognition library. As most of the face recognition algorithms work on 2D frames, they are unable to overcome the problem of spoofing, where the person's face gets recognized from a photo. This problem of spoofing is dealt with the help of the eye-blinking detection CNN model and trained using Keras. The proposed system uses OpenCV and Machine Learning techniques to perform the complete process.

Keywords OpenCV · Histogram of gradients · Face-recognition · Haar cascade classifier · Convolutional neural network

S. Goud (✉) · R. Abhiram · P. Nayak
Gokaraju Lailavathi Womens Engineering College, Hyderabad, India
e-mail: surajgoud36@gmail.com

P. Kaushal
Chandigah Group of Engineering College, Sahibzada Ajit Singh Nagar, Punjab, India

S. Goud · R. Abhiram
Gokaraju Rangaraju Institute of Engineering and Technology, Hyderabad, India

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1 Introduction

The classical approach of taking attendance is a tedious task as it involves manually calling out the name of the student with his/her roll no and then marking against the name in the sheet. In such a scenario, when the number of students is large, there will always be a probability of proxy attendance. Apart from this, it's not easy to maintain tangible records for attendance as there will be a lot of work involved for its maintenance and storage, and there will be a risk of damage and tampering. Such an approach is neither reliable nor efficient. To overcome this problem and make the process of taking attendance more simpler and reliable, we make use of the Smart Attendance System which uses machine learning-based facial recognition techniques for automated attendance without manual intervention, thus saving a lot of time and effort. The existing attendance systems are manual, radio frequency identification (RFID) based [1]. There are several lapses present in these methods especially conventional methods like marking on an attendance sheet [2]. The manual attendance system also consumes a lot of time and resources; it can also be manipulated by the usage of proxy attendance. The problem with RFID is that anyone with the ID card of an individual can scan and mark their attendance, the individual need not be physically present for this, their ID card is enough to get attendance. This is a major drawback of using RFID-based systems. Hence, the need for an intelligent attendance system arises. The proposed system incorporates facial recognition techniques to automate the attendance system. Humans are capable of recognizing faces automatically and instantly, and they are so good at that, they end up seeing faces in everyday objects. Whereas computers are not capable of performing such generalization so we need to make them learn the process of facial recognition step by step by chaining several machine learning algorithms. The important libraries and algorithms which are used in this project for face detection and recognition are as follows:

- **Haar Cascade Classifiers** which are pre-trained classifiers used to detect faces, eyes, and other important facial features, proposed by Paul Viola and Michael Jones in their paper, "Rapid Object Detection using a Boosted Cascade of Simple Features" in 2001.
- **Face Recognition Library** provides functions that enable us to recognize faces. They do that internally using the Histogram of oriented gradients method and a Convolutional Neural Network to encode an image into a 128 feature vector.

After the facial recognition of a particular student, the attendance is marked in the CSV file. This process is followed for all other students and finally, after the attendance marking phase is over, the absentees will be appended to the attendance file and it will be sent to the mail id of the respective faculty.

The rest of the paper is structured as follows. Section 2 presents the related work. Section 3 presents the conceptual model. Experimental results are given in Sect. 4. Section 5 concludes the paper with future insights.

2 Related Work

Recent advances in automated face analysis, machine learning techniques, and pattern recognition have made it possible to develop automatic face recognition systems to address these applications. There are several boundaries for face recognition. The authors in [1] have stated an approach to implement a face recognition system that collects a database that contains students' faces using the Haar Cascade classifier. It finds faces when a webcam is activated and photos are captured, stored in a folder along with the student's details like roll number and name. In the next step, the webcam is switched on inside the class and the students' faces are detected and recognized by using the HOG method. The detected faces (encodings) are then compared with the existing dataset. The faces are recognized, then stored in a CSV file with the corresponding date and time. The system gave good results under ideal conditions like good lighting and head position but some results were unclear due to bad lighting, occlusion, etc. In paper [2], the authors have proposed a system that comprises two subprocesses, viz., Facial Recognition System (FRS) and Attendance Marking System (AMS). In the Facial Recognition System, the tasks like detection, extraction, storage, processing, matching, and recognition of faces are performed. There are two input parameters in this step—the first one is where students' faces are added to the database and the model is trained on those images, in the second one, the classroom image is provided for detecting and recognizing faces. In both cases, the output is the same, i.e., the faces which were recognized in the database. The proposed system is also interfaced with an attendance portal for easy access to attendance details. The research in [3] implemented facial recognition using deep belief networks known as DBN. This is an implementation of deep neural networks where a neural network is created layer by layer, starting from the input layer and ending at the output layer. The proposed system has proved to be very effective in recognizing faces. In [4], the authors have proposed a system that uses the histogram approach for face recognition. In this method, the system is first initialized by training a set of faces. After this, when a face is detected, the face region is divided into smaller regions from which Local Binary Patterns, histograms are extracted and combined into a single feature vector. Then, the feature vector of the detected face is compared with the existing dataset and the face is recognized. The system has provided good results. The authors in [5] have discussed various approaches to solve the problem of spoofing. The main task here is to extract features from the image or video. It was found that using feature fusion when extracting features and using a deep learning model which comprises Convolutional Neural Network (CNN) and SoftMax classifier gave good results. The authors of [6] performed a literature survey on various existing methods involved in face liveness detection. The major problem in liveness detection is the condition in which face is to be detected, in some situations there may be less lighting, a high amount of noise, etc. It was found that PCA (Principal Component Analysis) and LDA (Linear Discriminant Analysis) methods were useful to project the original face into lower dimensions and LBP for texture analysis.

In [7], the authors have emphasized the benefits of an automated attendance system, especially for college students and employees. The authors in [8] have projected the prevalent techniques and methodologies for detecting and recognizing faces like PCA-LDA, etc., have failed to overcome the issues like scaling, pose, illumination, variations, relations, and occlusions. To overcome such problems the author proposed advanced LBP for face recognition and Viola-Jones algorithm which includes Haar features, Adaboost, and Cascading components for face detection. The proposed system has achieved an overall accuracy of 83.2%. The research in [9] discusses an integrated GUI-based attendance system, where the front end is based on Electron JS serving as a client and the backend side comprising the face recognition logic. The system is capable of calculating the attendance of each student subject-wise. They have used a Histogram of gradients for face detection and deep learning techniques to calculate and compare 128-d facial features for face recognition. The authors have used a face landmark estimation algorithm for better positioning of faces using the 68 important face landmarks without distorting the original image. This approach has yielded good results. In [10], the proposed attendance system makes use of cascade classifier for face detection and a Local Binary Pattern histogram algorithm for face recognition. In the proposed system, the camera module captures the image of a student who enters the class then using the haar cascade classifier the ROI of the face is extracted and then it is preprocessed to improve the quality of the image. The LBP algorithm generates a new histogram for the unrecognized image. This generated histogram will be compared against the precomputed histograms in the database for face recognition. If there is a match, then attendance will be marked in the excel sheet.

3 Proposed Model

Our proposed model follows the following flow of operation. The conceptual model is shown in Fig. 1.

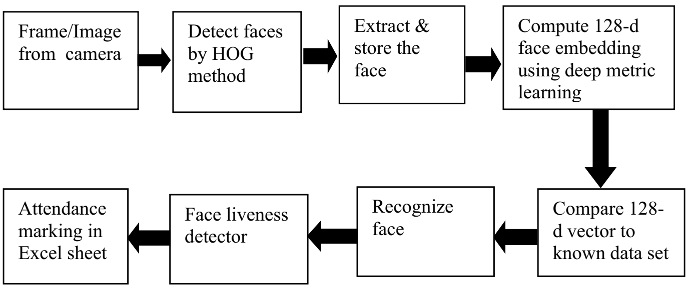


Fig. 1 Proposed model

- **Step 1: Camera Installation**—The camera has to be installed in the classroom where it has to capture each student entering the classroom.
- **Step 2**: **Image Captured**—After the image has been captured, it will be sent to the system as an input.
- **Step 3: HOG Image**—If the image is dark or with disturbance, the system will perform enhancements and would convert the image to black and white for Histogram of Oriented Gradients (HOG) conversion. The system converts the image into a HOG image. HOG methods convert each picture into black and white and then break up the image into small squares of 16 × 16 pixels each. In each square each pixel with its neighbors and replace it with an arrow pointing in the direction where the image is getting darker and continue this process for each pixel in the image. The arrows are called gradients and collection of the all the gradients will provide us with the important features of that particular image. To find faces in this converted HOG image, we have to extract that portion of the image that looks similar to know HOG pattern that was extracted from a bunch of other training faces.
- **Step 4: Haar Cascade Classifier**—The system extracts and stores the face region of the student if it has been called for registration, using Haar Cascade Classifier. Haar Cascade Classifier is constructed using the Viola-Jones face detection algorithm which is used for real-time object detection. Haar Cascade Classifier is trained for detecting the faces using the following techniques:

    1. Haar features from an integral image—Initially, the algorithm requires a lot of positive images and negative images to kick start the training of the classifier. Then we proceed to extract features from it. We use the following Haar features that are edge features, line features, etc., where each feature is a single value obtained by subtracting the sum of all white pixels from the sum of all the black ones.
    2. Adaboost algorithm—This algorithm enables us to identify those features which are truly relevant for face detection and discards the other features.
    3. Cascading Classifiers—This algorithm enables us to identify those features which are truly relevant for face detection and discards the unwanted features. This algorithm initially applies all the features on all training images and for each feature, it checks how well it can classify the faces as positive or negative. There will be certain errors and wrong calculations but we select the features with less error rate and increase the weights of incorrectly classified images. This process is repeated again and again until we get the required accuracy.

- **Step 5: Face Encoding**—For face Recognition, the system computes its 128 face encodings and compares them with known face encodings in the database. To find the face encodings, the face_encodings function of the face recognition library is used. The face_recognition library enables us to use a pre-trained deep neural network to get the encodings of a face, by encodings it means 128 measurements of the face obtained from its HOG image. So this algorithm is the pre-trained neural network that takes an image as input and gives 128 measurements of the face.

The measurements are almost the same for a similar image. Thereby comparing the face encodings of known faces with the unknown faces, one can make the computer recognize images or faces.

- **Step 6: Attendance Update**—If there is a match and the eye blink detecter detects that the eyes are closed and opened, then attendance for that particular student will be marked. After detecting the face and recognizing it, the data associated with the given image is stored in a.csv (comma-separated value) file, this file contains the time at which the face was recorded and also the ID of that respective image (face). This file is linked to a spreadsheet and the spreadsheet contains the details recorded similar to the attendance register. The spreadsheet is stored locally in the system, an email containing the details of the attendance is sent to the admin.

4 Experimental Results and Discussions

The experiment has been done using the python programming language on PyCharm IDE, with the following system configuration:

- Processor: Intel i5-3450, 3.10 Ghz
- Ram: 8 GB
- GPU: 4 GB
- Windows 10 Operating System.

Using the approach discussed in Sect. 3, we have considered 6 test cases as presented in Table 1 which cover all the functionalities of the proposed system. Our experimental results are shown in Fig. 2, 3, 4, 5, 6, 7, 8 and 9.

For **TC-1**, the Face is detected using the HaarCascasde Classifier as shown in Fig. 2. For **TC-2**, we have extracted the ROI using the locations provided by the classifier and stored it in the database along with student details in the class data file as shown in Figs. 3 and 4.

For **TC-3**, face encodings of the stored faces are precomputed using the FaceEncodings function and each face encoding value is associated with the name of the student it represents. During the attendance marking phase, face locations functions of the face recognition library are used to return the face locations of all the faces

Table 1 Test case descriptions

Test case ID	Description
TC-1	Face detection
TC-2	Storing face in database along with student details
TC-3	Recognizing faces registered in database
TC-4	Marking attendance with timestamp
TC-5	Emailing the file with the list of absentees
TC-6	Detecting photo attack

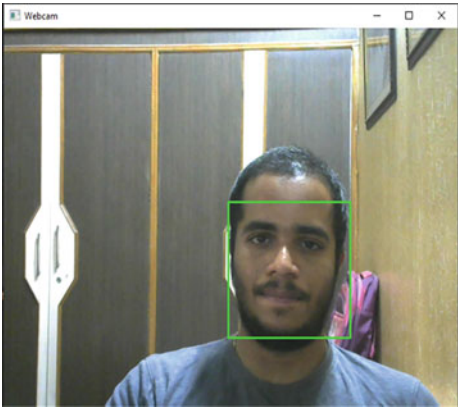


Fig. 2 Face detection

Fig. 3 Storing faces in a database

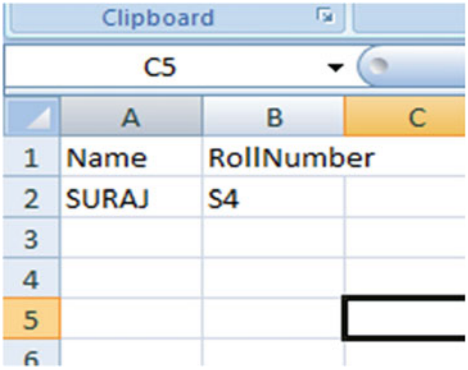


Fig. 4 Details updated in class file

Fig. 5 Face recognition

Fig. 6 Face liveness detection

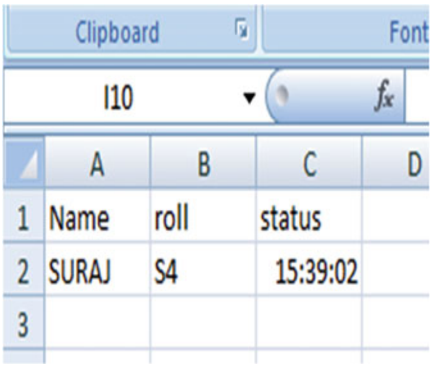


Fig. 7 Marking the attendance

present in the frame using the HOG method and CNN. For each face, its encoding value is computed as discussed earlier and it is compared with all known face encodings using the compare faces function provided by the face recognition library that determines whether there is a match or not. If a match is found then we check for face liveness (as shown in **TC-6**) using the eyeBlink CNN model, which detects

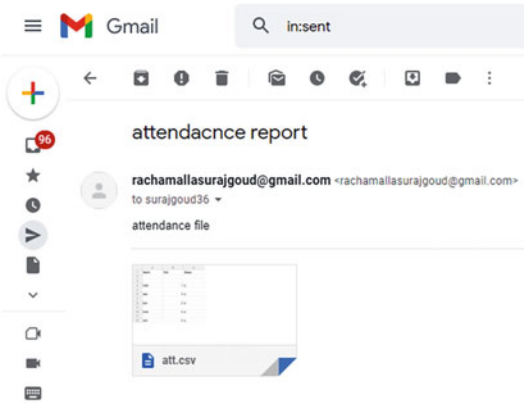
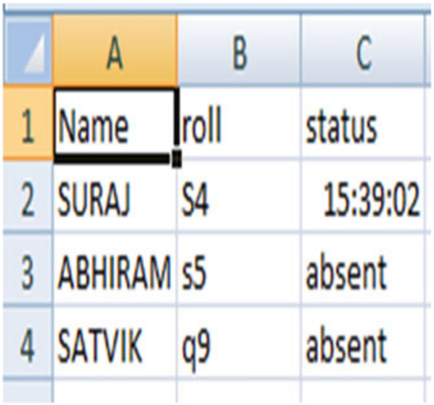


Fig. 8 Mailed attendance file



	A	B	C
1	Name	roll	status
2	SURAJ	S4	15:39:02
3	ABHIRAM	s5	absent
4	SATVIK	q9	absent

Fig. 9 Attendance file with absentees

whether eyes have blinked or not. For a spoofed image we display it as fake. For a live face, the name is displayed beneath the face and it is appended to the attendance sheet along with the current time (**TC-4**) (see Figs. 5, 6, and 7). **TC-5** is implemented using the yagmail library which uses a Gmail/SMTP client we send the mail to the respective user. The attendance file will be appended with absentees using the class file and then the mail will be sent as shown in Figs. 8 and 9. All the functionalities of the proposed system have been achieved, and their results are as follows.

4.1 Performance Parameters

The performance of the proposed model is evaluated by testing the accuracy of the model through encoding and recognizing people's faces which are stored in the database. About 100 predictions were made using the proposed model and the

Table 2 Confusion matrix

N = 100 (total predictions)	Actual: No	Actual: Yes
Predicted: No	24	8
Predicted: Yes	3	65

results are shown with the help of confusion matrix (see Table 2) and face detection success rate/accuracy is evaluated and compared with the Local Binary Pattern Histogram (LBPH) method discussed in [11]. The experimental result shows that our proposed model provides 89% accuracy, whereas the LBPH method provides only 80% accuracy.

5 Conclusion and Future Scope

This research paper aims at implementing a Smart Attendance System using facial recognition in keeping a view of avoiding the proxy system. The existing systems such as RFID have been failed to be effective in proxy cases since the ID card of an individual can be scanned by anyone and attendance is marked present in such a case. This pitfall is covered by the system, which records attendance only if the individual is present physically. The proposed model is developed using simple equipment like a laptop and webcam and provides 89% accuracy defeating the LBPH method. It does not need heavy investment in resources, so it is highly cost-effective. It solves various problems with manual attendance marking, dependency on human resources due to the smart environment, which helps to reduce burden. It also saves time while taking attendance. The following features may be integrated into the future to carry out further research.

- A mobile-based application can be implemented to monitor real-time attendance. A mobile-based application is remote and can be used for various functions both by the student and the admin. A student can easily access and get to know his/her attendance and the admin can keep a track of the attendance from time to time. Keeping in view that some students just log in and keep away from their systems in online classes, the system can be custom made to suit the needs for taking attendance in online classes without the intervention of an in-charge. A randomized attendance system may be developed regarding the same.

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E-Rupi—Recent Advancement in Digital Payment System

Deepika Dhamija, Ankit Dhamija, Ravi Ranjan, Shiv Swaroop Jha, and Renu

Abstract In the era of demonetization, the banking sector has seen an exponential increase in the usage of digital payments. There has been a slew of digital payment networks proposed by both corporate and public entities. These platforms are being used by users to make payments, pay bills, and send money. The cost of Internet plans, the availability of low-cost mobile handsets, and technological savvy are just a few of the factors driving this digital revolution. Although private companies' platforms are preferred by the bulk of people using digital platforms, public players are continually bringing novel ideas to the table, such as UPI. Another new payment platform named e-Rupi has been created and released for users by the Indian government in a similar endeavor. This platform attempts to use a voucher-based system to deliver social programs, health benefits, and a variety of other services. Hence, this paper investigates the detailed functionality of the e-Rupi platform and performs an empirical evaluation and comparative analysis of e-Rupi with other digital payment platforms.

Keywords e-Rupi · Digital payments · UPI · NPCI · COVID-19

D. Dhamija (✉)
Directorate of Online Education, Manipal University Jaipur, Jaipur, India
e-mail: deepika.dhamija@jaipur.manipal.edu

A. Dhamija
University of the People, Pasadena, USA
e-mail: ankit.dhamija@uopeople.edu

R. Ranjan · S. S. Jha
Amity College of Commerce, Amity University Haryana, Gurgaon, Haryana, India
e-mail: rranjan@ggn.amity.edu

S. S. Jha
e-mail: ssjha@ggn.amity.edu

Renu
Department of Commerce and Business Studies, Central University of South Bihar, Gaya, India
e-mail: rai.renu97@gmail.com

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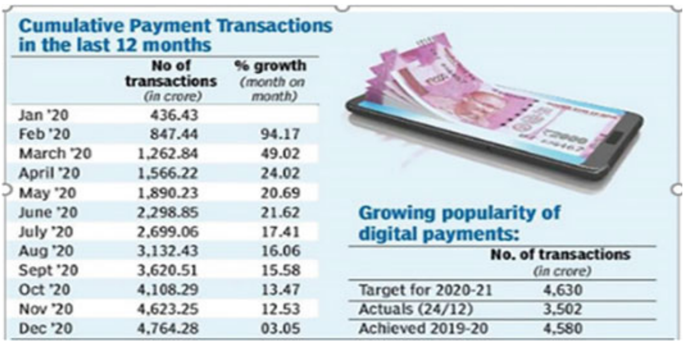
1 Introduction

The COVID-19 pandemic has thrown our lives into disarray and altered the way we conduct our daily activities. According to the WHO, transmission can also occur when a buyer and seller exchange coins or paper money. Contactless, seamless payments are the most desirable payment mechanism to utilize after a pandemic due to the risk of contaminated surfaces. M-payments, which were once considered a convenience, are now becoming a requirement in the face of the pandemic. Coronavirus is expected to change the way some business models are executed in the future, and many firms will be forced to embrace them. Payment methods have evolved throughout time, moving from cash to checks, credit cards and debit cards, online banking, mobile wallets and UPI following demonetization, and now contactless digital payments.

Digital payments and fintech were one area [1] that saw record highs in 2020, as a large number of people wanted to stay at home and maintain social distance. From the Unified Payments Interface to the Aadhar-enabled Payment System, digital payments will hit a new peak in 2020 (AePS). UPI transactions hit a new record in November, with 221 crore transactions worth Rs. 3.9 lakh crore, after breaking beyond the 200-crore barrier in October. According to industry players, the Center has set a target for digital payments of 4630 crores for 2020–21, which is expected to be exceeded (Fig. 1).

The launch of e-Rupi, a voucher-based cashless and contactless payment system by our Prime Minister Narendra Modi on August 2, 2021, was a recent achievement in this area due to COVID. It is a QR code or SMS string-based e-voucher that will be issued to mobile users and can be redeemed without the use of a digital payment app, Internet banking, or a card. To establish this digital payment, NPCI (National Payments Corporation of India) partnered with the Department of Financial Services, the Ministry of Health and Family Welfare, and the National Health Authority. e-Rupi's most important features are as follows [2]:



Cumulative Payment Transactions in the last 12 months

	No of transactions (in crore)	% growth (month on month)
Jan '20	436.43	
Feb '20	847.44	94.17
March '20	1,262.84	49.02
April '20	1,566.22	24.02
May '20	1,890.23	20.69
June '20	2,298.85	21.62
July '20	2,699.06	17.41
Aug '20	3,132.43	16.06
Sept '20	3,620.51	15.58
Oct '20	4,108.29	13.47
Nov '20	4,623.25	12.53
Dec '20	4,764.28	03.05

Growing popularity of digital payments:

	No. of transactions (in crore)
Target for 2020-21	4,630
Actuals (24/12)	3,502
Achieved 2019-20	4,580

Fig. 1 Digital payment transactions in 2020

- Payments are made by QR code and SMS string-based e-voucher that is delivered to the user's mobile phone. This voucher can be redeemed without the need for an app, a card, or online banking.
- In conjunction with the Department of Financial Services, the Ministry of Health and Family Welfare, and the National Health Authority, NPCI created this system on its UPI platform. Through this initiative, the sponsor of the services will be connected with the beneficiaries and service providers, and payment to the service provider will be made after the completion of the transaction.
- This payment mechanism is utilized in healthcare to provide pharmaceuticals and nutritional support, fertilizers, and subsidy programs, among other things.

The following is a breakdown of the paper's structure: The following section highlights relevant work that demonstrates current breakthroughs in digital payments. The objectives are set, and the research methods used to achieve the stated goals are given in the next section. Then a working model of e-Rupi's is displayed. The benefits, uses, limits, and comparative analysis of e-Rupi with other payment mechanisms are discussed in the next section, which is followed by a conclusion.

2 Related Work

The study revealed how digital currencies are processed, how they work, and what factors influence their use. The study identified a number of concerns associated with digital currency, including a lack of transparency, cyber fraud, public perception, inefficiency, and so on [3]. From PPIs to UPIs, Indian Mobile Payments are Changing: The researcher examines the newest trends in mobile banking platforms in India, including their evolution from PPIs (Prepaid Payment Instruments) to the latest UPIs (Unified Payments Interface). He also goes over the major participants in the UPI-based mobile banking platforms, their market shares, and recent changes [4]. The authors stressed the concept of digital currency, demonstrating how the shape of money has evolved over time. The concept of digital money has been shaped by the digitalization process. The use of digital currency has a worldwide impact. The future of digital currency looks bright in the aftermath of COVID-19 [5]. The literature on the subject ranges from UPI as a digital innovation to how it plays a vital role in resolving challenges related to payment service digitalization to the societal impact of digitalization on financial services. The literature on the topic, on the other hand, is piecemeal and does not give a holistic and cause-and-effect relationship between UPI and ED, as the current study demonstrates. The goal of this literature review is to show that the study of UPI for economic development has never gone beyond theoretical discussion and has always been limited to descriptive research. The goal of this literature review is to look into the relationship between UPI and other variables, which will be empirically tested. UPI has been studied conceptually and operationally. Theoretical research on UPI looks into the possibility of UPI having a wider impact [6–9]. A Review of the Unified Payments Interface [UPI]: The writers of this scientific work discuss the distinctions between UPI and other mobile banking approaches such as NEFT and IMPS. They also provide a visual depiction of the UPI's workflow [10]. Operational research on UPI focuses on its operational strength in order for it to be acknowledged as a futuristic tool for digitization with broad appeal. However, the authors point out that none of the studies empirically explore the influence of UPI on impoverished people's economic progress. Accessibility, convenience, cost, and the removal of financial exclusion obstacles are all factors that drive UPI [11].

3 Objectives and Research Methodology

The following objectives have been formulated:

- To determine which digital platform is expanding the fastest following COVID-19.
- To understand the working of e-Rupi and identify its benefits to different parties for successful implementation of e-Rupi.
- To compare e-Rupi with other payment mechanisms.

4 Methodology

The authors plan to use descriptive research to attain the above-described objectives. This is because the subject matter that authors consider is relatively fresh and the best method of comprehension and analysis is to conduct an extensive examination of the literature from existing papers, printed and electronic journal reports, and so on. At the completion of the analysis, the data collected and analyzed by the authors shall be given.

5 Discussion

5.1 Digital Payments Trend in India

Over the last decade, a huge part of the population has seen an exponential increase in digital payments. This section analyzes an overview of various growth of Indian digital payments in order to achieve Goal 1. The data is collected from reports published by RBI and NPCI and evaluated for a decade.

RBI has created several operators of payment systems (PSOs) such as NPCI, CCIL, and ATM networks in India. Thus, NPCI's IMPS, RuPay card system, and UPI are different payment modalities (Fig. 2).

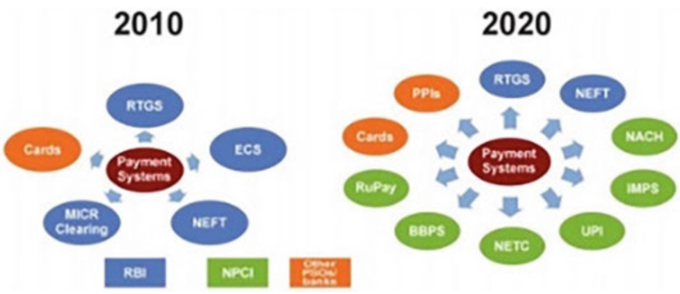


Fig. 2 Different modes of payments launched by PSO [12]

This graphic shows a comparison of several ways of payment launched in 2010 and 2020 by RBI, NPCI, and others [12].

The choice for payment from paper clearing to digital payments has drastically changed during the previous ten years. Figure 3 reported by RBI shows that digital payments have increased from Rs. 3435 crores for 2019–20 from a total of 498 crores with a value of 96 lakh crores in 2010–11 to 1623 crores.

As the sorts of mobile payments from 2010 to 2020 are changing dramatically. The two quick payment systems which exist in India include IMPS and UPI. Figure 4 shows this and analyzes it. The UPI [13], on the other hand, is a mobile quick payment system where bank credentials are not required to be given by the trader. According

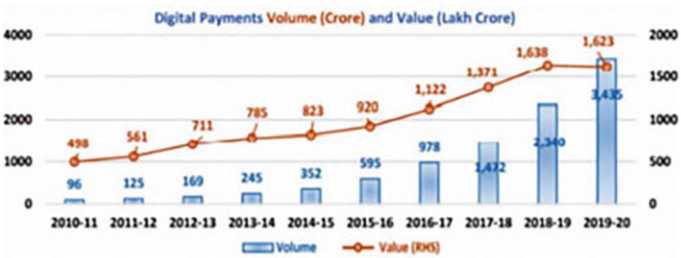


Fig. 3 Digital payments growth in India [3]

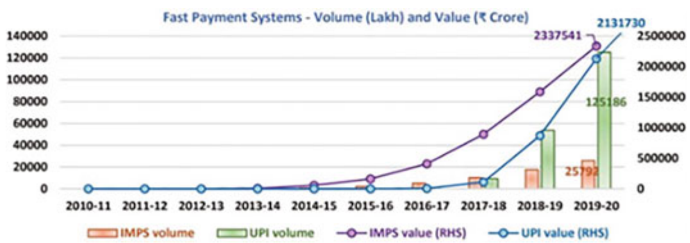


Fig. 4 Growth of fast payments [3]

to the RBI statistics, IMPS and UPI in Dec2020 performed 8.35 crores transactions. The acceptance in recent years of two rapid payments and also of the preferred way of payment for a majority of individuals has expanded exponentially.

5.2 Working Model of e-Rupi

The NPCI has introduced the e-Rupi, a new method of donating money to a certain cause. It's a UPI-based voucher-based payment mechanism [14] in which a voucher is granted to a person and sent to them as an SMS string or QR code. The receiver can use this code as a one-time payment, and retailers can accept and use this digital payment voucher. Payments are cleared into the merchant account without the use of a bank account.

The actors in the e-Rupi working model are as follows:

Issuer (Govt. Agent): The issuing agency that offers or issues a voucher to the person is known as the issuer. It might be any bank or government agency that issues/sends an e-voucher to a specific user in the form of an SMS or QR code on their mobile phone.

Customer: A customer is a person who receives an e-voucher that he can use for the specified reason for which it was provided. For instance, healthcare services, vaccinations, or any other purpose.

Merchant/Voucher Selling Point: The area where a client can use his e-voucher to pay for certain services is known as the merchant or voucher selling point. They are the most important participants in the payment process.

Service Provider: The service provider is a mobile network service that assists merchants and customers in sending and receiving SMS and QR codes on their mobile phones.

Merchant's Bank: A merchant's bank is a financial entity that accepts payment amounts from government entities on behalf of customers (Fig. 5).

Below is a step by step working of e-Rupi [15]:

1. The issuer (for example, the government) issues the person an e-voucher that is good for 6 months. The money is held in a government account at a bank or the Reserve Bank of India. The e-Rupi voucher is sent to the recipient as an SMS or a QR code.
2. The e-Rupi coupon can now be redeemed at any merchant or through any platform that accepts it.
3. The merchant now scans the QR code/SMS with his app, and the merchant's service provider gives the customer an OTP for verification.
4. The user to whom a coupon is granted will receive an OTP, which will be validated by the merchant and the consumer. The amount now transfers from the Government account to the merchant account.

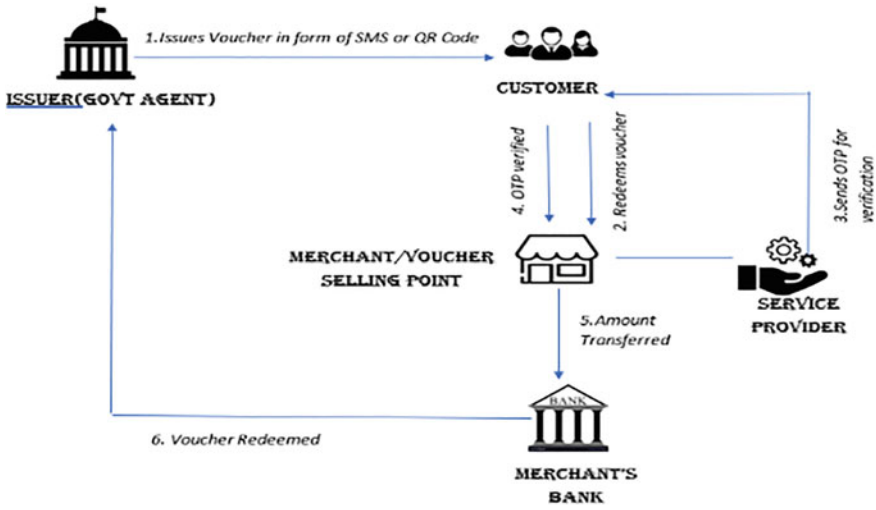


Fig. 5 Working model of e-Rupi

5. The voucher is redeemed, and the merchant's bank sends a confirmation message to the issuing agency. If the sum is not entirely utilized, the remainder remains with the government, and if the voucher is not redeemed within six months, it expires, and the funds are released from the government's account.

5.3 Uses of e-Rupi

- To provide [2] drugs and nutritional support like mother and child welfare schemes,
- Tuberculosis eradication program, Child welfare schemes,
- Fertilizer subsidies, and welfare services.

5.4 Benefits of e-Rupi

There are multiple benefits of e-Rupi to different parties [16] like corporates, hospitals, and end users involved. The benefits are listed as follows:

- e-Rupi has a number of advantages for the various parties involved, including corporations, hospitals, and end consumers. The following are the advantages:
- e-Rupi is a cost-effective solution because it is an end-to-end digital transaction that does not require physical issuance (card/voucher).
- The issuing authority can simply track voucher redemption.

- The voucher is authorized using a verification code provided by the beneficiary, making it safe and secure. Because the voucher can be used for a specified purpose and for specific people to whom it is given, it also aids the impoverished.

5.5 *Comparative Analysis of Various Payment Mechanisms*

Table 2 represents the list of all banks that are live with E- Rupi [2] and active with their mobile apps for smartphone users.

Table 1 Comparative analysis of payment mechanism

Basis	RTGS	IMPS	NEFT	UPI	e-Rupi
Introduced by	RBI	NPCI	RBI	NPCI	NPCI
Charges on money transfer	Yes	No	Yes	Very less	No
Transferring amount on Saturday and public holidays	No	Yes	No	Yes	Yes
Transaction limit	2–5 lakhs	Up to 5 lakhs	Up to 5 lakhs	No limit	No limit
Transaction input	IFSC code, account no.	IFSC code, account no.	IFSC code, account no.	Virtual Private Address/Adhar card, etc.	Amount from any of the existing payment mode
Time limit for transfer	Instant	Instant	Up to 12 h	Instant	Instant
No. of accounts linked	Only one	One	One	N no. of accounts	N no. of accounts
Beneficiary	Anyone having bank account	Anyone having bank account	Anyone having bank account	Anyone having bank account	person whose phone no is shared
Used for	Money transfer for businesses and specific people	Money transfer for businesses and specific people	Money transfer for businesses and specific people	Money transfer for businesses and specific people	Welfare schemes
Bank account required	Yes	Yes	Yes	Yes	No

Table 2 List of banks that are live with e-Rupi

Name of bank	Issuer	Acquirer	Acquiring app
Union Bank of India	Yes	No	NA
State Bank of India	Yes	Yes	YONO SBI Merchant
Punjab National Bank	Yes	Yes	PNB Merchant Pay
Kotak Bank	Yes	No	NA
Indian Bank	Yes	No	NA
IndusInd Bank	Yes	No	NA
ICICI bank	Yes	Yes	Bharat pe and PineLabs
HDFC bank	Yes	Yes	HDFC Business App
Canara bank	Yes	No	NA
Bank of Baroda	Yes	Yes	BHIM Baroda Merchant Pay
Axis Bank	Yes	Yes	Bharat Pe

5.6 Limitations of e-Rupi

The economically deprived segment of India, which lacks access to mobile phones, is a major target for the e-Rupi. However, because the service is only available through mobile phones and does not require registration or a bank account, the government has no way of knowing if the user actually exists, which might be exploited by impersonators or scammers. Like other payment gateways, it has server issues, which may cause users inconvenience because the voucher expires in a set amount of time.

6 Conclusion

According to many studies, the government is already working on building a central bank digital currency, and the launch of e-Rupi will close the gaps in digital payment infrastructure, which is a prerequisite for future digital currency success. e-Rupi is an Indian-based digital payment system that, like cryptocurrencies, provides and fulfills all of the basic security and privacy standards.

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Security Issues in the Routing Protocols of Flying Ad Hoc Networks

Santosh Kumar, Amol Vasudeva, and Manu Sood

Abstract Flying ad hoc networks (FANETs) empowered with unmanned aerial vehicles (UAVs) are a subset of mobile ad hoc networks (MANET). In a FANET, a swarm of mini-UAVs is deployed as per application scenarios to communicate critical data to ground control stations (GCSs). Owing to their distinct characteristics and unique features, FANETs pose numerous challenges making secure communication a cumbersome task. Security issues in FANETs may exist either from intrinsic design flaws or due to any extrinsic attacks performed by an attacker. Before designing the secure routing protocols, all existing security issues related to FANETs must be explored in detail. This paper explores security attacks feasible on FANETs' routing protocols that may occur either due to network design flaws or perpetrated by a malicious attacker to gain unauthorized access to the network. The potential countermeasures against the possible routing attacks are also highlighted.

Keywords FANET · Security attacks · Routing protocols · Flooding · Sybil attack

1 Introduction

The use of multi-UAVs is growing as they accomplish several tasks in multiple application domains such as military, civilian, border surveillance, parcel delivery, target detection, traffic monitoring, managing wildfire, and many more other applications. Communication using ad hoc networks based on multi-UAVs is becoming more popular and widespread [37]. FANET [28] is a type of ad hoc network designed solely by highly mobile UAVs, most prevalent in many UAV-based communication

S. Kumar (✉) · M. Sood
Department of Computer Science, Himachal Pradesh University, Shimla, India
e-mail: santosh4103@gmail.com

A. Vasudeva
Department of Computer Science and Engineering, Jaypee University of Information Technology, Waknaghat, Himachal Pradesh, India
e-mail: amol.vasudeva@juit.ac.in

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networks. Though FANET is very efficient in providing a prompt solution to emergency scenarios, still there are many design and security issues. The FANETs' unique characteristics like node movement autonomy, power scarcity, limited memory, dynamic topology, high node mobility, and network sparsity are consequential in multiple security issues [19].

To effectively use UAV-based networks for collaboration and communication, several security issues related to communication need to be addressed [29]. Authors [37] provide a comprehensive overview of FANET and crucial aspects related to it, including classification, architecture, kinds of potential communication, limitations, features, design, and routing issues. Authors [43] studied the effect of constrained resources on the security of swarm UAVs and proposed the lightweight block chain-assisted approach to maintain the efficiency of the network. Authors [13] identified various security attacks on UAV swarm-based communication and designed a simulation platform for the location perception of the UAV swarm. Furthermore, the study suggested design improvements to counter GPS spoofing attacks. In [3], the authors investigated that the autopilot-based drones employed for communication have only a collision avoidance mechanism to counter the security issues. As a result, various hacking attacks and signal spoofing attacks are possible over the network. In [39], the authors reviewed recent advancements in drone security testbeds and analyzed the performance of testbeds, particularly for multi-UAV and single UAV-based networks against jamming and distributed denial of service (DDoS) attacks. In [26], the authors mainly focused on the characteristics of UAV-based ad hoc networks and highlighted various security issues and countermeasures for routing protocols. In [33], the authors investigated possible security vulnerabilities with UAV-based networks' radio communication systems. Authors [23] analyzed multiple independent levels of security for UAV-based system design requirements for communication security. In [34], the authors classified the security attacks in UAV-based communication networks as wireless attacks, hardware attacks, and sensor attacks. They proposed a mechanism with a monitoring component supervisor to detect and eliminate malicious activities.

Although researchers have covered many design and security concerns in the communication architecture of ad hoc networks for FANETs, still the existing studies fail to reveal all security issues because of its unique requirements and resource restrictions. So, this paper focuses on various security flaws in FANETs' routing protocols. Additionally, the factors alleviating the need for secure communication and various types of cyber-attacks targeting different phases of FANETs' routing process along with available countermeasures have been discussed thoroughly. A phase-wise vulnerability of the routing schemes and categorization of routing attacks have been studied for the first time.

In the remainder of the paper, Sect. 2 presents various factors responsible for security flaws in communication using FANET; Sect. 3 describes an overview of different types of possible attacks over the FANET routing protocols. Section 4 discusses some of the possible countermeasures. Finally, Sect. 5 concludes the article along with the future work.

2 Security Flaws in Communication Using FANETs

In a FANET, several challenges and limitations hinder secure and efficient communication. These need to be considered to achieve optimal communication. The security issues in FANETs may arise due to various network design-related flaws, nodes' unique characteristics, or network communication protocols operating at different layers. Some of the challenges are discussed below.

2.1 Resource Constraints

In FANETs' application scenarios, miniature drones, which are generally capable of flying at high altitudes and very high speeds, are favored. Owing to their size, UAVs are resource-constrained making them vulnerable to many security attacks. Furthermore, it is not feasible to mount complex hardware onboard. Thus, lack of security makes UAVs easy to be hijacked by attackers [8].

2.2 High Mobility and Network Scalability

FANETs are generally sparsely deployed as compared to other ad hoc networks. Additionally, the number of nodes in a FANET keeps on changing due to high mobility [5]. Furthermore, designing a secure and efficient routing protocol to adapt the network scalability and load management is a challenging task. Consequently, an attacker can easily target the routing protocols [25].

2.3 Limited Network Energy

The battery-powered UAVs have a shorter life span requiring efficient usage of the residual energy [21, 37]. Because the bulk of their energy is used in flying and hovering, adding more hardware is not viable, resulting in a hijack attack.

2.4 Missing Inherent Security

By default, UAVs do not possess any internal security mechanisms like the ability to detect and counter potential threats, making them vulnerable to malicious attacks [9]. Before their deployment, an external security mechanism must be appended to the network.

2.5 *Missing Centralized Control*

Due to their unique characteristics, FANETs frequently operate without any central or base station control [46]. Nevertheless, most of the existing security systems are implemented with the help of base stations. So, these networks are vulnerable to many security attacks.

3 Possible Network Attacks on FANET's Routing Protocols

The routing mechanisms in a FANET are vulnerable to multiple attacks that can be launched from inside or outside of the network [27]. These attacks can be classified into three categories based on the phases of the routing, i.e., route discovery, route maintenance, and data forwarding (as presented in Table 1).

3.1 *Route Discovery Phase Attacks*

Route discovery is the initial step where prior to forwarding the data packets, the source node finds a path to the destination or intermediate node by broadcasting a route request (RREQ) and waits for the route response (RREP) from the receiver node [20]. The malicious node may manipulate these RREQ and RREP control messages or impersonate itself as a destination node to gain unauthorized access to the network. Numerous attacks that are possible during route discovery are as follows.

3.1.1 Black Hole and Gray Hole Attacks

The black hole attack may advertise itself as a new route toward the destination node by creating a forged RREP. In this case, when the sender node selects a path using this forged RREP, the malicious node becomes the intermediate node in the network. So, during the communication, this malicious node may entirely drop the data packets and thereby launches a black hole attack. Moreover, to deceive the detection of its neighbors, the malicious attacker can use selective forwarding, also known as the gray hole attack [38].

3.1.2 Byzantine Attack

In a byzantine attack, the attacker first captures multiple victim nodes in the network. Thereafter, it uses these nodes to work in collusion for disrupting the routing process

Table 1 Attacks on FANET's routing protocols; security breaches and countermeasures

Routing phase	Attack	Security breaches					Proposed countermeasure
		Availability	Confidentiality	Integrity	Timeliness	Non-repudiation	
Route discovery	Black hole attack	No	Yes	Yes	No	No	Use of cryptographic solutions like digital signature and hash chains [18]
	Byzantine attack	No	No	No	Yes	No	Trust-based algorithms [1]
	Colluding attack	Yes	No	Yes	No	No	Increasing the transmission power and node density [17]
	Delay addition	No	No	Yes	Yes	No	Using time delay and geo-location as routing metrics [26]
	DoS attack	Yes	No	No	Yes	No	Anomaly-based IDS [45], Secure routing algorithm using cryptography, and Increasing node density [14]
	Eavesdropping attack	No	No	Yes	No	Yes	Use of directional antenna and free-space optical communication [24]
	Flooding attack	Yes	No	No	Yes	No	Trust-based algorithms [5]
	Channel jamming attack	Yes	No	No	Yes	No	Use of directional antenna [24]

(continued)

Table 1 (continued)

Routing phase	Attack	Security breaches					Proposed countermeasure
		Availability	Confidentiality	Integrity	Timeliness	Non-repudiation	
	Link-spoofing attack	Yes	Yes	Yes	Yes	Yes	An intrusion detection system (IDS) [45], Cryptography with GPS or Increasing node density, and Use of directional antenna [24]
	Rushing attack	No	No	No	Yes	No	Hash Chain Authentication [15], Increasing node density [1]
	Route cache poisoning attack	No	No	Yes	No	No	Use of cryptographic solutions like digital signature and hash chains [24]
	Routing table overflow	Yes	Yes	Yes	No	No	Trust-based algorithms [5]
	Replay attack	No	Yes	Yes	No	Yes	Authenticated routing protocols with timestamp [4]
	Sleep deprivation attack	Yes	No	No	Yes	No	Secure routing algorithm using cryptography, and Increasing node density [14]

(continued)

Table 1 (continued)

Routing phase	Attack	Security breaches					Proposed countermeasure
		Availability	Confidentiality	Integrity	Timeliness	Non-repudiation	
	Sybil attack	Yes	Yes	Yes	No	Yes	Use of cryptographic solutions like digital signature and hash chains [1]
	Wormhole attack	No	Yes	Yes	No	Yes	Using time delay and geo-location as routing metrics [14]
Route maintenance	RERR dropping attack	No	Yes	Yes	Yes	No	Increasing node density Secure routing protocols [26]
	Route forging attack	No	Yes	Yes	No	Yes	Use of cryptographic solutions like digital signature and hash chains [1]
Data forwarding	Route cache poisoning attack	No	Yes	Yes	No	No	Rule-based IDS, Increasing node density [45]
	Traffic addition attack	No	Yes	Yes	No	Yes	Rule-based IDS, using time delay and geo-location as routing metrics [45]

using various attacks like selective packet drop and routing loops and using non-optimal routes for data forwarding [1].

3.1.3 Colluding Attack

To perform a colluding attack, the intruder may reduce path length by using a private link between valid nodes. Furthermore, this attack also provides a platform for the wormhole attack [4].

3.1.4 Delay Addition Attack

The attacker node can delay the data packet delivery by promoting a non-optimal path or using a forged data packet header. This attack is known as a delay addition attack [22].

3.1.5 Eavesdropping Attack

In FANETs, the use of insecure wireless routes is the primary reason for its exposure to eavesdropping attacks. During communication, a malicious node can easily overhear the link [7].

3.1.6 Flooding Attack

The main objective of this attack is to drain the network resources rapidly, resulting in severely degraded network performance. In a short time, the malicious intruder broadcasts multiple RREQ control packets to the target node. The RREQ is generated for a non-existent node. Due to the non-availability of the route, the whole network is flooded with RREQ packets [41].

3.1.7 Channel Jamming Attack

In this attack, during the route set phase, the intruder interrupts the network by blocking the path between source and destination. The shared wireless link is jammed by the attacker, resulting in degraded network performance [32].

3.1.8 Link-Spoofing Attack

This attack can be performed in two ways. In the first method, the intruder willingly declines the route requirement for a specific UAV. Hence, the victim UAV is isolated from the network. In the second method, an attacker broadcast forged routes through itself. After receiving RREP for the manipulated link, the victim node may select the intruder node as its multi-point relay (MPR) [36].

3.1.9 Replay Attack

Owing to the FANETs dynamic topology, the nodes continuously keep on changing their locations. The attacker tries to capture genuine control messages and retransmit them later when it is beneficial to manipulate the network. Additionally, an intruder can update the routing tables with stale entries to disrupt the entire routing process [41].

3.1.10 Route Cache Poisoning Attack

To perform a route cache poisoning assault, the promiscuous mode of routing is exploited, which enables the intruder to see all traffic including control messages. The attacker overhears the communication and inserts false routing information into the route caches of genuine nodes, even though that node is not on the route [26, 44].

3.1.11 Routing Table Overflow Attack

In proactive routing, the malicious attacker tries to fill the rooting table with bogus route information congaing false routes toward non-existent nodes. Hence, new genuine paths are prevented from being created due to the routing table overflow [11].

3.1.12 Rushing Attack

In the case of ad hoc on-demand routing, an intruder can increase or decrease the time delay before the rebroadcasting of a received RREQ. Furthermore, the attacker can prioritize routes through itself by rejecting other authentic RREQ packets thereby increasing the chances of selection of these malicious routes for communication [5].

3.1.13 Sleep Deprivation Attack

In this attack, the attacker selects a victim node inside the network (such as a node with the minimum residual energy). The objective is to exclude the victim node from the network. To achieve this, an attacker overwhelms the victim node with continuously generated data packets. During the route setup phase, the malicious node generates an RREQ message to a non-existent node. Since the demanded destination does not exist, every node keeps on rebroadcasting. During this process, the residual energy of the victim node exhausts completely and thus making it inactive [26].

3.1.14 Sybil Attack

In the case of FANETs, there is no central controller to check whether each node is assigned a valid IP address. Exploiting this fact, during the route setup phase, a malicious attacker can broadcast multiple control packets using different ghost identities. This attack is known as the Sybil attack [30].

3.1.15 Wormhole Attack

To perform a wormhole attack, the malicious attacker needs to capture two nodes in the network. Then, the attacker captures the data packets at one place and replays them to another counterpart via a high-speed private link. After gaining the trust of nodes, in the neighborhood, additional attacks like flooding, rushing, and black hole can be performed to hamper the network communication [2].

3.2 Route Maintenance Phase Attacks

The route maintenance phase consists of updating the routing information after topology changes due to node mobility are observed, or in a case when a better path as compared to the existing one is available. This phase tries to stabilize the network by reducing the computation and processing time. The malicious attackers can target this phase to degrade the network performance by intentionally rejecting control packets or adding bogus and redundant traffic, resulting in increased routing load and processing delay.

3.2.1 Route Forging Attack

The intruder can perform a route forging attack by injecting forged information in HELLO packets and declaring non-existent nodes as its neighbors. Hence, the chances of its selection as an MPR node in networks using proactive routing algorithms have increased [6].

3.2.2 Route Error Reporting (RERR) Packet Dropping Attack

This attack can target a reactive routing protocol where an attacker can systematically block all RERR packets to make an invalid route a valid route [35].

3.3 Data Forwarding Phase Attacks

During this phase, the malicious attacker targets the payload traffic by injecting bogus data packets, to severely affect the overall data communication.

3.3.1 Route Cache Poisoning Attack

The attacker can use a route cache poisoning attack by providing absurd routing information into the route caches of genuine nodes [12].

3.3.2 Traffic Addition Attack

The malicious node adds redundant data packets during data transmission to enhance routing load, thus, decreasing network performance [16].

4 Potential Countermeasures

The FANETs' routing protocols with security countermeasures can improve the reliability of data communication and network resiliency against numerous security threats. Various potential countermeasures to guard the FANETs against security assaults are given below.

4.1 Increasing Node Density

In sparsely deployed UAV applications, the workload on the nodes is increased. Additionally, a sensor node has to cover longer distances before forwarding data to the MPR node. Consequently, these nodes can be easily compromised resulting in network partitioning and data loss. This security issue can be solved by adding new nodes in the network to increase the network density. With increased node density, the number of active routes also increases, hence under colluding, DoS, rushing, RERR drooping, or route cache poisoning attacks, chances of selecting falsified links are minimal. Additionally, these nodes can be used in place of nodes with low residual energy [40]. Furthermore, the higher node density is beneficial while evaluating the trust value in the network. By discarding the traffic from the non-trusted nodes, a swarm-based network can be protected against byzantine, flooding, and routing table overflow attacks.

4.2 Use of Flying Base Station

Security mechanisms like node and message authentication are generally implemented using the GCS. So, a flying base station [10] can be employed to implement security mechanisms and to carry out complex computations. By using a flying base as a central controller, the Sybil attack can be countered by detecting the presence of the Sybil identities.

4.3 Use of Directional Antenna

A FANET communication generally operates wirelessly making it vulnerable to eavesdropping attacks. The attacker's range for eavesdropping can be confined by using a directional antenna instead of an omnidirectional antenna [42]. Chances of channel jamming and eavesdropping attacks are less since communication is limited to the desired direction. Additionally, the system can achieve longer transmission ranges and protection against wormhole attacks.

4.4 Free-Space Optical Communication

The use of free-space optical communication technologies in FANET is the most promising solution to ensure secure and high-speed communication [31]. Short-range directional narrow optical beams are employed for communication. Hence, the chances of eavesdropping and colluding attack are minimized.

4.5 Using Cryptographic Solutions

Modern cryptography techniques provide a variety of security approaches including privacy, authentication, integrity, non-repudiation, and secret sharing. The active attacks, such as modification of routing messages, can also be prevented through source authentication and message integrity mechanism. Techniques such as digital signature, message authentication code (MAC), hashed MAC (HMAC), and one-way HMAC key chain may be used for this purpose [4]. Attacks like a black hole attack, the Sybil attack, link spoofing, and route cache posing can be countered using hybrid routing protocols with embedded cryptographic solutions.

4.6 Intrusion Detection System (IDS)

A rule-based IDS provides secure communication between a flying node and a GCS by inspecting the signal strength. To protect against route cache poisoning, link spoofing, and traffic addition attacks, a signature-based IDS utilizes the signature and location of the drone. Whereas, an anomaly-based IDS uses a learning algorithm based on anomaly to guard against DoS attacks [45].

4.7 Secure Routing Protocols

The first layer of defense is the use of secure routing protocols. The existing routing protocols may be augmented with a security mechanism like trust value, blockchain, and IDS, to guard against rushing and replay attacks [1].

5 Conclusion and Future Work

The routing process in FANETs is severely affected by various kinds of attacks. An attacker can target the route discovery process by manipulating the RREQ and RREP control messages. Once the attacker succeeds in advertising itself as a legitimate node and gaining trust in the neighborhood, it can start discarding data packets or can replay them at later stages. To secure the routing protocols in FANETs, the solutions like cryptographic techniques, rule-based IDS, and trust-based mechanisms can be applied. The objective of this paper was to have a better understanding of the challenges presented by the security attackers on FANETs routing schemes. In the future, we will extend the work on efficient and secure routing for FANETs with specific consideration to the security of control messages in the route discovery phase. The effectiveness and trustworthiness of the proposed countermeasures will be evaluated through simulations.

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A Novel Access Control Mechanism Using Trustworthiness of Nodes in a Cross-Domain Cloud Environment

Kaustav Roy, Debdutta Pal, and Ayan Kumar Das

Abstract The phenomenal growth of cloud computing over the last few years resulted in the need of developing new mechanisms to make the system more secure in every possible manner. When it comes to establishing access control mechanisms in a cross-domain virtual organization-based cloud environment, the situation becomes more cumbersome due to the lack of proper standardized solutions. In this paper, an approach is being defined which combines role-based access control policy with the establishment of trust among the various nodes of different domains which are a part of the cloud environment. Several parameters are considered to calculate the trust values of different entities based on the concept of a collection of feedback from neighbor nodes. A statistical mechanism is also introduced to prevent any biased feedback. If the total trust value exceeds some pre-defined threshold, then only it is considered for the transaction; otherwise, it is not considered. The resource provider as well as the initiator can gather the feedback, and the trust is calculated from both ends in this model. We assess the trust of both user as well as the resource provider so that a proper access control mechanism can be established.

Keywords Cloud computing · Virtual organization · RBAC · Trust · Reputation

K. Roy (✉) · D. Pal
Department of CSE, Brainware University, Kolkata, India
e-mail: kr.cs@brainwareuniversity.ac.in

D. Pal
e-mail: ddp.cs@brainwareuniversity.ac.in

A. K. Das
Department of CSE, Birla Institute of Technology, Ranchi, India
e-mail: das.ayan@bitmesra.ac.in

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1 Introduction

The ever-changing, multi-institutional nature of cloud computing technology produces a considerable amount of risks and threats to the users of the environment. In a virtual organization-based cloud computing environment, the situation becomes much more complicated due to the existence of multiple autonomous domains which are scattered in various places. Lots of research has been carried out to enforce some sort of standardized authorization mechanisms in place, but unfortunately we are yet to reach that level till now. In such a context, the evolution of role-based access control and its further implementation in securing the cloud environment has been a natural choice.

In a virtual organization-based cloud environment, several different autonomous management domains exist on the network, so access control should be managed using global management and local autonomy. Cloud access control policies may allocate different permissions to different global users at the various local domains. Users will be given role rankings based on their jobs or functions. The user's needs to be restricted by proper authorization mechanisms while accessing cloud services. A general diagram of cloud computing components is depicted in Fig. 1.

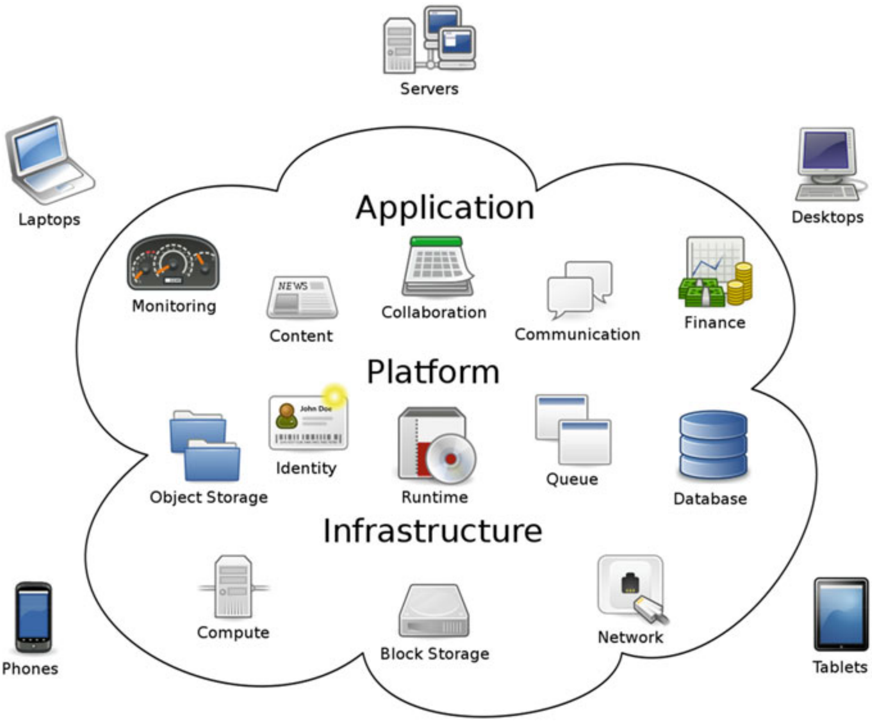

Fig. 1 Basic cloud architecture

No standard solutions exist for cross-domain authorization in VO-based multi-institutional cloud environments [1]. The request may originate in one domain and may span several domains for completion. As such, the local role of user's needs to be converted into a global role which is acceptable to all and a proper authorization policy is to be implemented for granting or denying user's request [2]. In this paper, in the following sections such a model is being described which may come in handy if put into practice.

To the best of our knowledge, as far as current research is concerned, several gaps exist in implementing proper cross-domain access control mechanisms in VO-based cloud environments and the computational overheads in such an architecture also needs to be reduced as far as possible to speed up the processing activities. The deficiencies of the current research are found to be as follows:

- Usage of the certificate authority and complex cryptographic techniques in the distributed cloud computing domain are a huge roadblock in the current research.
- Calculation of dynamic trust values of different nodes which changes from time to time in a dynamic environment such as cloud computing.

The main contributions of this paper can be summarized as follows:

- Proposing a new hierarchical access control mechanism for a virtual organization-based cross-domain cloud environment combined with trust mechanisms.
- A two-way trust model is being defined which takes into consideration the reputation of both the service provider and the client.
- A robust trust calculation mechanism devoid of any biasness.

The rest of the paper is organized as follows. Section 2 describes some related studies. Section 3 describes the cross-domain architecture model and mechanism. Section 4 illustrates the two-way trust model. Section 5 shows the performance analysis. Section 6 discusses the managerial and social implications, and Sect. 7 concludes the paper.

2 Literature Review

In Mahmood et al. [1], the authors have proposed a secure cloud computing system by combining encryption techniques along with role-based access control model. The authors have suggested an enhanced RSA algorithm to encrypt the data before sending it to the cloud. For further access control purposes, they introduced a combination of the RBAC model with extensive access control markup language (XACML) to limit user access and protect the system. XACML is a standard access control policy language to specify the RBAC policies which establish a proper reference for implementing an authorization principle consisting of policy enforcement point (PEP), policy decision point (PDP), and policy administration point (PAP).

In Uikey and Bhilare [3], a role-based access control architecture for a multi-domain cloud environment is proposed, which consists of multiple interrelated cloud domains which communicate or interact with each other using the domain policy administration component or DPAC. DPAC are used to establish communication policy relationships. Along with DPAC, they are also using policy decision point (PDP), policy enforcement point (PEP), and a context handler for each domain.

In George Amalarethinam and Edel Josephine Rajakumari [4], the authors have highlighted possible cloud environment attacks and mentioned some ways to overcome all those problems to make the system more secure. Several security issues are being highlighted such as availability, confidentiality, data breach, IP spoofing, and DDoS which can be prevented by some counter-measures such as redundancy, data encryption, end-to-end encryption, scanning for malicious activities, etc.

In Meghanathan [5], the authors have highlighted privacy protection and data security in cloud computing, based on the concepts of access control, encryption, trust, and reputation. They have opined that it is necessary to integrate all these issues to have a secure cloud system which can be fully trusted by the end-users or clients.

In Sohal and Kaur [6], the authors have outlined several advanced access control mechanisms such as team-based access control, temporal role-based access control, location-based access control, etc. Team-based access control originated to provide team-wise access control in a cooperative environment. A unique team will have a unique role to perform and thus will be having a unique set of permissions. The binding of role permissions will be done at run time. Temporal role-based access control introduces the concept of role enabling and disabling based on temporal constraints. In location-based access control, access to resources is given to subjects after checking their locations. LBAC supports role hierarchy but does not support the separation of duty.

3 Cross-Domain Access Mechanism

Cross-domain authorization is a crucial factor where multiple domains are involved. Complexity may arise while formulating access control policies. Different domains may be employing their own customized rules and regulations for granting resource access [7]. The role of a node may also vary extensively across domains. A genuine need exists for establishing some sort of equality among the roles. Here the approach which has been highlighted is a trust-based solution.

Role-based access control has gained much importance of late for implementing authorization and for providing RBAC, amalgamation of rules is to be done for the cloud computing environment with the corresponding virtual organizations [8]. In this paper, a novel architecture and cross-domain policy mechanism for authorization is proposed which focuses on RBAC, combined with the calculation of trust values of the user and the provide.

The cross-domain architecture consists of the following components:

- Domains A and B have been taken comprising user and resource entities.
- User authorization server 1 for cloud entities from domain A and a resource authorization server 1 for resource nodes from domain A exists.
- The user authorization server 2 and resource authorization server 2 do the same for the entities of domain B.
- Rating servers 1 and 2 for two domains A and B store the necessary information of all the entities in the corresponding domains.
- For routing purposes, a global rating server is there (Fig. 2).

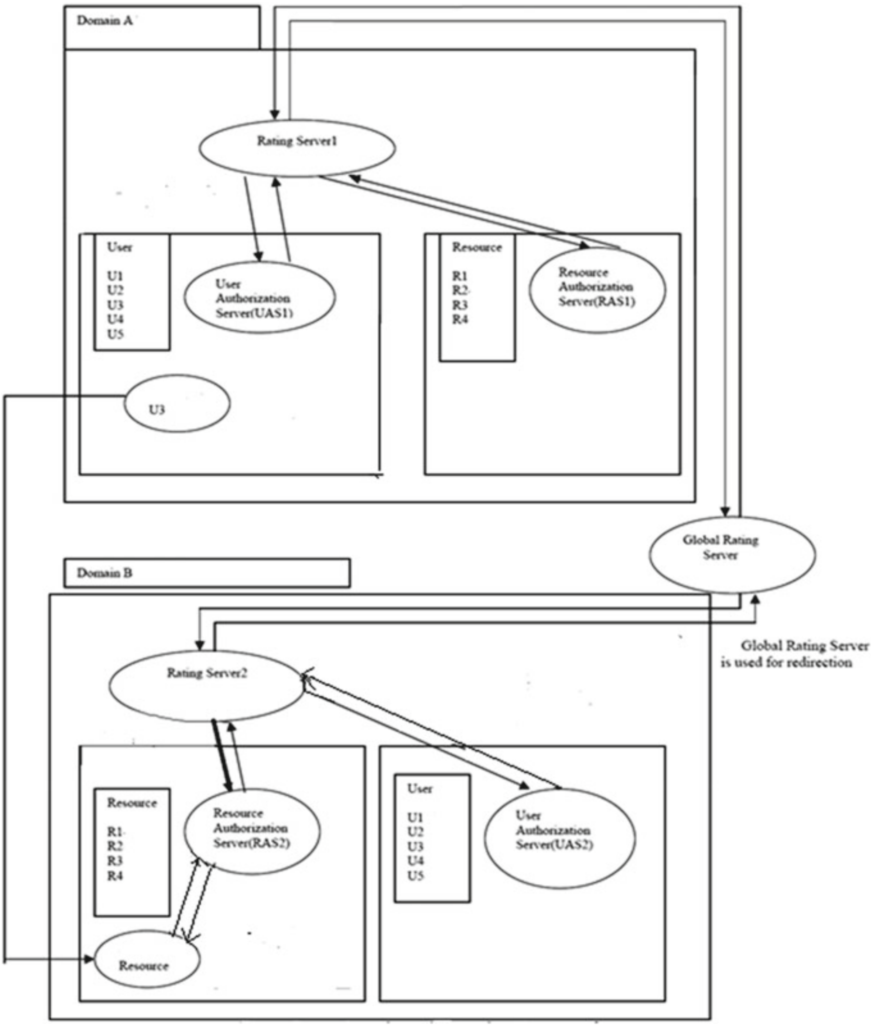

Fig. 2 Cross-domain architecture

U1, U2, ….Un: User entities

R1, R2, …..Rn: Resource entities

UAS1: User Authorization Server of user nodes at domain A

UAS2: User Authorization Server of user nodes at domain B

RAS1: Resource Authorization Server of resource nodes at domain A

RAS2: Resource Authorization Server of resource nodes at domain B.

3.1 Working Principle

- Initially computational complexity of each node in a domain is calculated as the summation of the total turnaround time of all the jobs by the total number of jobs in the job set which is being defined as under:

$$C_t(N) = \frac{\sum_{i=1}^{m} TAT(J_i)}{m} \tag{1}$$

  where N denotes a node and m = total number of jobs at time instant t, and J = (J1, J2….Jm) in a unit interval of time.
- Storage complexity of each node is calculated as:

  In unit interval time, if ‘f’ no of file request comes for storage, then a file set can be described as F = (f1, f2, ….fm).

  Storage complexity can be described as

$$S_t(N) = \frac{\sum_{i=1}^{m} (\alpha \mathrm{i} + (\text{mode of operation}) * \text{no of instances affected})}{m} \tag{2}$$

  at time instant t, where the mode of operation can be addition (= 1), deletion (= −1), or modification (= 0), and α is the file size.
- Also data transfer complexity of a node is calculated as the ratio of a number of successful data transfer operations by total number of data transfer operations.

$$Dt(N) = \frac{\text{No of successful data transfer opeartions}}{\text{Total no of data transfer operations}} \tag{3}$$

- Based upon these formulations and applying fuzzy logic principle nodes are being classified as computation specific, storage-specific, or data—transfer specific i.e. based on their roles which they can perform with greater precision they are being classified.
- Appropriate queues are to be maintained for separate types of activities.

- As a service request may span several domains, the credentials of the entities need to be evaluated which are passed through tokens.
- We now propose a two-way trust model which is to be implemented for final access purposes.

4 Two-Way Trust Model

Cloud computing and its associated technologies will certainly gain more popularity in the coming days. The only constraint is to gain the user's trust [9]. The system should be absolutely scalable, robust, and reliable. Reliable transactions do play a vital role in clouds. Reliability can be increased only if we introduce multiple checking constraints or parameters. The consumer should be satisfied with the provider and vice-versa. A two-way trust model can be implemented in such a scenario where the reputation of a single node may be estimated by taking into consideration the collective opinion of the other nodes [10].

In the proposed mechanism, the reputation of nodes is calculated. Feedback are taken, and rank correlation methods are used to remove biased feedback [11]. Two types of trust—direct trust and indirect trust are calculated. Direct trust is of greater significance [12]. Direct trust is calculated based on transactions which originates from the initiator or requestor. Indirect trust is measured based on feedback values obtained from neighbor entities of the same domain or other domain. Some specific parameters in the form of similarity, activity, specificity, and idleness are put to practice to determine the trustworthiness of the recommender's opinion. The transaction is granted only when the requestor's trust score is greater than a pre-defined threshold value, and the same is applicable to the provider as well.

4.1 Trust Calculation

Considering A to be the user and B to be the provider, the following mechanism is to be adopted here.

First A will be making the decision whether to accept services from B or not. The total trust is estimated here by combining the following expressions:

$$\text{Direct Trust} = \frac{\text{Total no of successful transactions within a time period T}}{\text{No of submitted jobs within the time period T}} \tag{4}$$

$$\text{Indirect Trust} = \frac{(1 - \text{CR}) * \text{average feedback received from the same domain}}{\text{Credit factor}} \tag{5}$$

where Credit factor $= 0.50$ and CR is the value of the credibility.

Direct trust is the value which is assumed to be of more significance and is obtained by the user's own performance. Indirect trust is calculated by taking the recommenders' feedback. Spearman rank-order correlation method with some modifications is implemented here to ascertain the similarity of the feedback values for a certain node obtained from its neighbors. If the correlation is greater than zero then only feedback is taken, thus avoiding any sort of biasness. The credibility of the recommender's feedback is more fine-tuned by introducing the rank correlation method. The same procedure is to be repeated for provider B as well i.e. B will be making the decision whether to provide services to A or not.

The following formulations are also to be calculated in implementing the proposed mechanism:

$$\text{similarity} = 1 - \frac{6\sum d_i^2}{n\left(n^2 - 1\right)} \tag{6}$$

where d is the difference in ranks and n is the total number of entities.

$$\text{activity} = \frac{\text{Number of interactions by recommendor}}{\text{Total number of interactions by all recommendors}} \tag{7}$$

$$\text{specificity} = \frac{\text{Number of interactions with initator}}{\text{Total number of interactions with all other hosts}} \tag{8}$$

$$\text{idleness} = 1 - \frac{\text{Total number of successful transactions within time period T}}{\text{Number of submitted jobs within time period T}} \tag{9}$$

$$\text{Credibility} = m * \text{similarity} + n * \text{activity} + o * \text{specificity} + p * \text{idleness} \tag{10}$$

where m > n > o > p and m + n + o + p = 1.

The recommendations from the neighbor nodes are collected, rank correlation is being done, and a decision is taken on whether to accept the feedback or not. If the rank correlation is positive, then only feedback is to be taken seriously; otherwise, it is rejected. Then total trust is measured. If the value of the total trust is greater than the minimum permissible threshold value, the provider is chosen; otherwise, searching continues for another trustworthy node.

4.2 Flow Diagram

The flow diagram of the proposed model is illustrated above. User A may opt for services from entity B. The user or initiator then goes for the calculation of the trust value of the provider by collecting feedback about its services from the neighbors. The credibility of those feedback values is examined by rank correlation methods.

Then the total trust values are calculated and if it is more than some pre-defined threshold value, the resource provider is being requested to provide services. Then it is the turn of the provider to go through all the steps as illustrated in the model from its end to ascertain the trustworthiness of the user or requestor. If both the user and the provider are satisfied with the trust values of each other, then the transaction may start (Fig. 3).

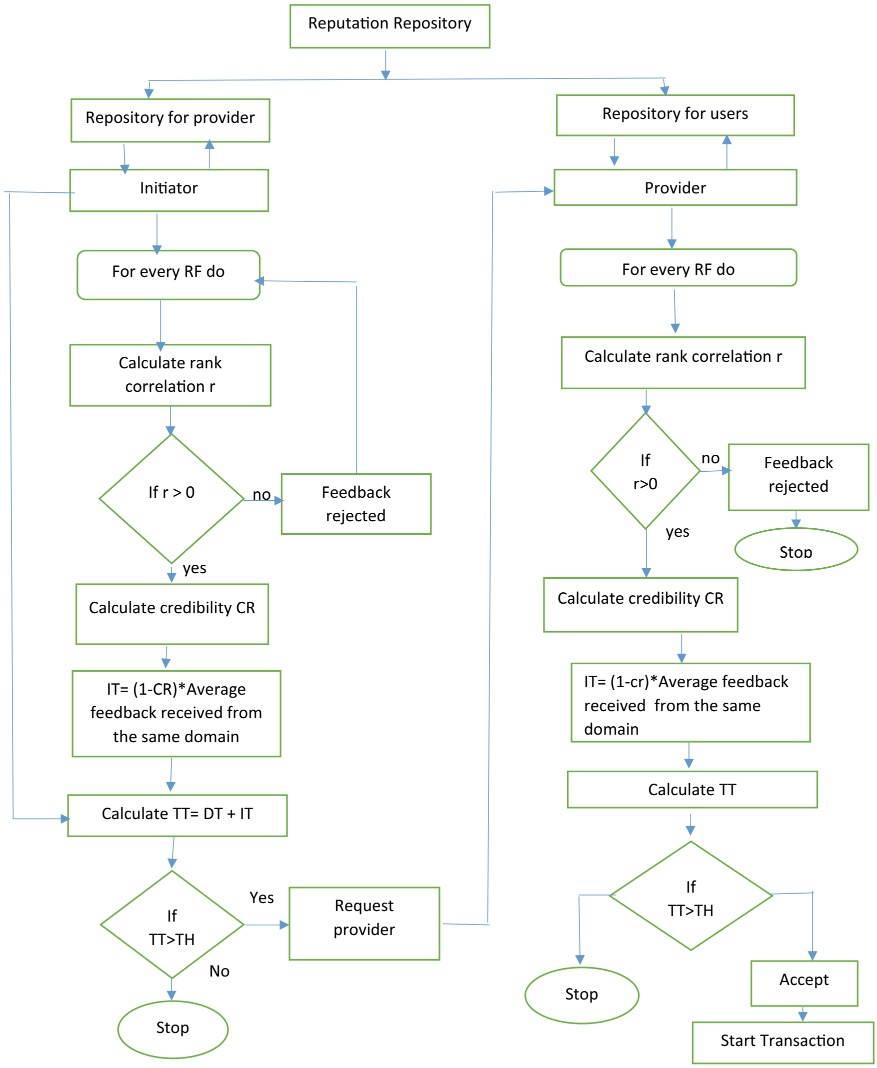

Fig. 3 Flow diagram

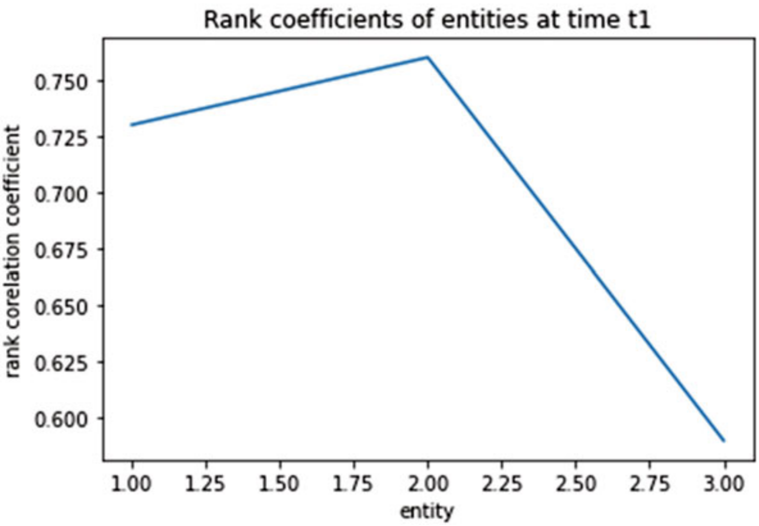

Fig. 4 Depiction of rank coefficients at a particular time instant

5 Performance Analysis

For analysis purposes, we have taken a representational set of three no. of requestors and ten number of recommenders and the results that we have got after plotting the rank co-relations clearly suggests that if the variance of feedback about a particular entity is high, then there is a considerable chance of rank co-efficient value being rejected and in that case the corresponding feedback will not be considered to be fit for further progression in the said model (Fig. 4).

In the above figure, the rank co-efficients are being plotted at a particular time instant t1. The closer the value of co-relation is to 0, the weaker is the association and it is likely to be discarded. The closer is the value to 1, the more is the trustworthiness of the node. As per the above graph, the second entity is enjoying the greatest reputation among the three entities and serves as the best one to ask for any services (Fig. 5).

In the above figure, the rank coefficients are plotted with reference to two different time instances t1 and t2. The rank coefficients may vary over time and if there are considerable differences among the recommender's feedback about a particular node, then it will be certainly having less amount of trustworthiness.

6 Managerial and Social Implications

Security is of prime importance in a distributed environment such as in cloud computing. Unless the system is secure, clients will not be interested to participate in it. Our proposed model not only tries to implement a robust and secure

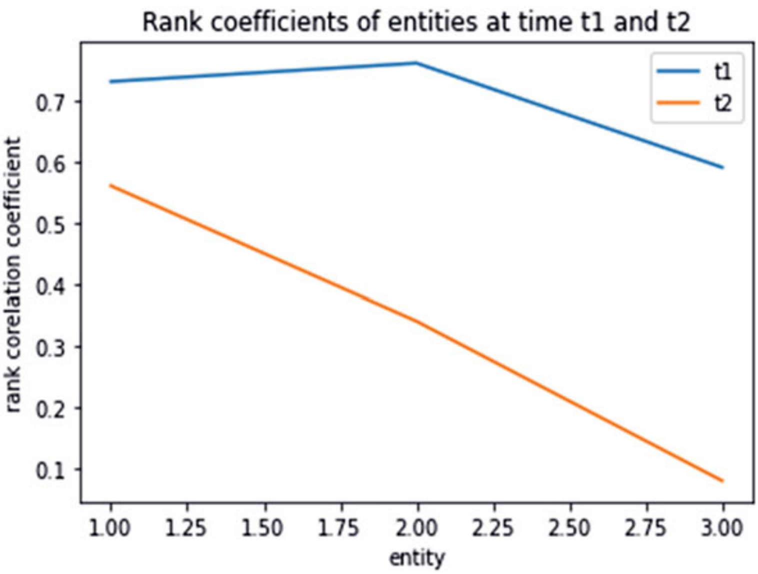

Fig. 5 Variance of rank co-efficients at different time instants

environment but also aims at providing an ethical model which will be devoid of any unethical practices. Any sort of ambiguity will be strictly dealt with by the implementation of the modified version of Spearman's rank-order correlation method. The entities which are having a considerable reputation in the system will be playing major roles, thereby improving the overall performance of the system. As an end result, the consumers will be getting an almost error-free secure system to work with. Management of such a system also can be done much more smoothly.

7 Conclusion

The proposed model has presented a new dimension for establishing authorization combined with a two-way trust model. Trust is being measured not only from the provider's end but from the user's end as well. Only upon exceeding a pre-defined threshold value, the transaction is executed. Reputation calculation is also not solely dependent on the feedback values but credibility is also being calculated to prevent biased feedback. Some malicious nodes may exist in the system, and they may produce biased results but that can be prevented by the measurement of the rank correlation method. The existence of malicious nodes may hamper the smooth operation of the system and their ill effects should be neutralized. Rank correlation performs that role in the proposed model. By the removal of the biased feedback, the system may perform efficiently, thereby aiding in the development of a stable and secure cloud environment.

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OCR Based Number Plate Recognition Using LabVIEW

Davuluri Jahnavi, Dasetty Lavanya, and M. Sujatha

Abstract Number Plate Detection System is a surveillance system which captures vehicle images and recognizes their license number. This system helps to minimize the traffic violations. For tracking, identifying stolen vehicles and unauthorized use of vehicles, this number plate recognition technique is very helpful. A number plate detection system is used to develop a real-time application to monitor the violation of traffic rules. The first objective of the paper is to develop a system which detects vehicle's number plate, to detect the characters on the number plate, and to show the details of the vehicle owner. To detect the number plate and recognize the characters of the number plate we used the Optical Character Recognition (OCR) technique in LabVIEW Software.

Keywords LabVIEW · Optical Character Recognition (OCR) · Number Plate Recognition (NPR) · Vision and motion · Image processing · Vision assistant

1 Introduction

In every country it is a difficult task to control the traffic and to identify the vehicle's owner. When a vehicle violates traffic rules it becomes difficult to find the owner of the vehicle. Therefore, to avoid this difficulty, the Number Plate Detection system is one of the solutions to this problem. There are many types of number plate detection systems with many types of methodologies and algorithms. To build this Number Plate Recognition system, we used Optical Character Recognition to deal with image

D. Jahnavi (✉) · D. Lavanya · M. Sujatha
Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation, Green Fields, Vaddeswaram, Andhra Pradesh 522502, India
e-mail: jahnavi.jak@gmail.com

D. Lavanya
e-mail: dasettylavanya999@gmail.com

M. Sujatha
e-mail: sujakarthik77@kluniversity.in

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processing. This Optical Character Recognition helps us to acquire the image and to process the image in our required forms. This system helps to minimize the traffic violations on the road. For tracking, identifying stolen vehicles, and unauthorized use of vehicles, this number plate recognition technique is very helpful.

Number plate recognition is proposed in this paper to develop a real-time application to monitor the violation of traffic rules. Using this technique, it is easy to detect the number plate of a vehicle so that we can track the vehicle quickly. We used NI LabVIEW software to develop this system which is developed by National Instruments. In this software to perform image processing techniques we need to install a toolkit named Vision and motion. This is a module which helps us to easily work with images.

The contribution of the paper is

- To develop a system which detects vehicle's number plate
- To detect the characters on the number plate
- To show the details of the vehicle owner.
- To detect the number plate and recognize the characters of the number plate we used Optical Character Recognition (OCR) technique in LabVIEW Software.

When the number that is detected by the system matches in the dataset it will check the details and give the output as the details of the owner as followed by the vehicle number, owner name, phone number, district, and state.

1.1 Introduction to NI LabVIEW

LabVIEW means Laboratory Virtual Instrument Engineering Workbench. LabVIEW is a software developed by National Instruments (NI). LabVIEW is a graphical programming language known as G language. LabVIEW is used to work on real-time applications. LabVIEW has two VI's: one is called Front panel, and the other is called Block Diagram. Front Panel is a user interface where controls and indicators are available. The code of the application can be done in the block diagram. It is efficient to use as we need to just drag the functions from the functions palette and drop those functions in the block diagram.

1.2 Introduction to Vision Module

Vision and motion are a toolkit used to work on image processing techniques. It is a module in NI LabVIEW software used for prototyping and also testing the applications of image processing. For this module we mainly used the vision assistant function which is a feature to train the image and to process the image in the required forms. Using this module, it is easy to train the machine for image-related applications.

1.3 Introduction to OCR

Optical Character Recognition (OCR) technology is an efficient solution to extract the data automatically from written text or printed text from scanned documents or from an image file and converting the text into the machine-readable form used to process data like searching or editing.

1.4 Introduction to Vision Assistant

The system is trained by using the Vision Assistant function. Vision Assistant is an Express VI in the Vision and Motion palette of this LabVIEW software. When this Express VI is placed on a block diagram, NI Vision Assistant launches. Using the vision assistant processing functions it can create an algorithm. After creating the algorithm, we can select the controls and indicators that we want to programmatically set in LabVIEW. To edit the algorithm we just need to double-click the Vision Assistant Express VI. Using this Vision Assistant function we can train our system easily and quickly. Figure 1 is the structure of Vision Assistant function in LabVIEW.

2 Related Techniques

In Anand and Indu [1], Anand proposed a vehicle number plate detection system with voting classification. The system itself converts the normal image into a binary form using some filtering techniques and morphological operations. By using KNN, Support Vector Machine (SVM) algorithm, and Random Forest algorithm the system can identify the characters present on a vehicle's number plate. For voting classification the system compares the accuracy between KNN and SVM (Support Vector Machine) algorithms. This system is efficient with the voting classification method.

In Ap et al. [2], Vigneshwaran proposed an automatic system for number plate detection. This system is developed using matlab software. By using a faster R-CNN algorithm the system can detect the number plate automatically. The system is developed using CNN (Convolution Neural Network), YOLO (You Only Look

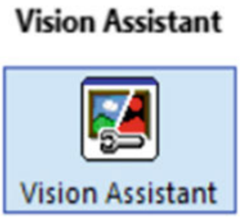

Fig. 1 Structure of vision assistant

Once), R-CNN, and faster R-CNN methods. YOLO is a real-time system which can detect objects. Using CNN (Convolution Neural Networks) the system takes the input image and processes using Yolo and R-CNN methods. Faster R-CNN improves the system's capability to detect the number plate automatically. The system efficiency is more than 90%.

In Das and Kumari [3], Das proposed a system which can train itself from online and can detect the number plate's characters from vehicle images. The system first captures the vehicles and separates the picture into frames so that it is easy for the system and can recognize the image quickly. They also used the image acquisition functions to extract the vehicle's features which helps to recognize the vehicle. They convert the RGB image to binary form, so the system can understand the binary form of the image and can train easily. This is a real-time system which also uses vision assistant function from image processing functions.

In Huang [4], Fuhai Huang proposed an accurate license plate identification system. This includes three processes named number plate localization, segmentation of characters, and character recognition. According to the background and the character's color they have done the localization and extraction of the number plate image from the vehicle image. They have done the character segmentation by converting the extracted number plate image to a binary image and using optical character recognition they have done the character recognition.

In Menon and Omman [5], License plate recognition is done using Support Vector Machine (SVM) and Artificial Neural Networks (ANN) algorithms and they also use infrared cameras to capture the image of the vehicle. They have done the character segmentation by converting the extracted number plate image to a binary image. They have done this in C++ by applying a sober filter and multi-layer perceptron for the ANN algorithm. The sober filter is to find the edges and use threshold values to identify the edges.

In Shariff et al. [6], Mohammed Shariff proposed a system which can detect the vehicle's number plate. This system is developed using Python and OpenCV. Using the image processing technique the system can convert the rgb image into a grayscale image. Preprocessing of the image can be done by using morphological operations and by compressing the image. They implemented bilateral filtering and canny edge detection techniques to detect the characters on the vehicle's number plate. The system gives the final output as the vehicle's number plate image.

In Prasad [7], Srinivas proposed an accurate Automatic vehicle recognition system. They used image processing techniques for vehicle feature extraction, feature segmentation, and vehicle feature filtering. They also used the image acquisition functions to extract the vehicle's features which helps to recognize the vehicle. In this they have used the SMTP (Simple Mail Transfer Protocol) protocol which helps to transfer mail to differently located devices.

In Pustokhina et al. [8], Pustokhina proposed a system which can automatically recognize the vehicle number plate. The system is developed by using the Optimal K-Means algorithm with Convolution Neural Network (CNN). They have acquired an image, preprocessed an image by image processing, and then by using image processing they have done the license plate's localization and license plate segmentation. For license plate localization and recognition they used K means clustering with KH algorithm. To recognize the characters on the license plate they have done the character recognition process using the Convolution Neural Network (CNN) algorithm.

In Sathiyabhama et al. [9], Lakshmi proposed a system which can trace the location of the vehicle and can also detect the vehicle's number plate. The system is developed by using neural networks and deep learning algorithms. They have done some morphological operations to remove the other connected objects with the number plate of the vehicle. To detect the number plate YOLO (You Only Look Once) is used with the help of the dark flow toolkit. YOLO is very fast and can detect many objects at a time.

In Kumar et al. [10], Nitish Kumar proposed an accurate number plate detection system. They have converted the RGB image to grayscale. They introduce Otsu's binarization technique to calculate the pixel values of the image to recognize characters as per ROI (Region of Interest). Then they used the OCR (optical character recognition) technique in LabVIEW software.

3 Methodology

Detecting the number plate of a vehicle is performed by taking the Region of Interest. OCR (Optical Character Recognition) session is performed on the specified Region of interest in the captured image. Optical Character Recognition (OCR) technology is an efficient solution to extract the data automatically from written text or printed text from scanned documents or from an image file and convert the text into a machine-readable form used to process data like searching or editing. From the detected number plate the character classification can be done by using OCR (Optical Character Recognition) and Image Processing techniques after which the number plate separation is done followed by the character classification. The output of the character classification is the character on the detected number plate (Fig. 2).

The processed information is then sent to an excel sheet which classifies the cars based on the state and district. The characters in the number plate are compared with a dataset which contains different vehicle information. When there is a matched vehicle number it will check for the information of the vehicle's owner. This gives the owner details of that vehicle separately. Using the dataset it shows the details.

After recognizing the characters on the number plate the machine compares the detected number with the dataset given in the csv format. After comparing if there is a match with the same number in the data set then it shows the owner details of the vehicle having the same number as which was detected. This process is easy to implement in LabVIEW software using the OCR (Optical Character Recognition) technique.

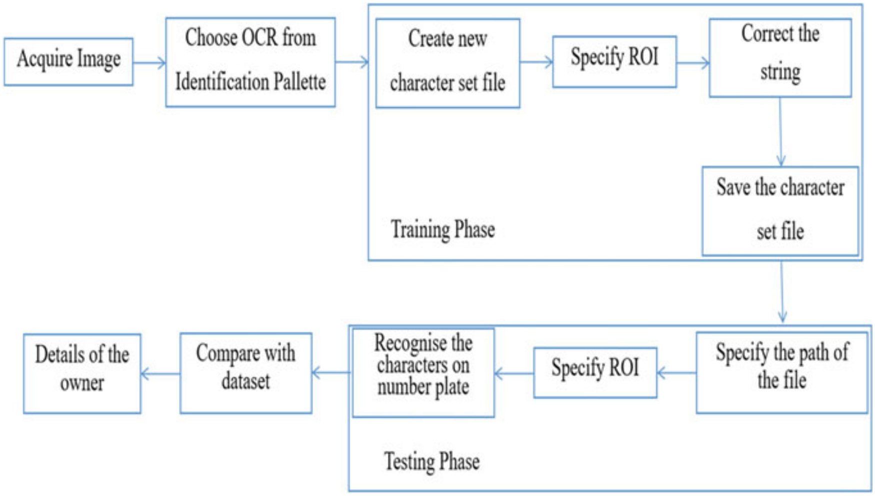

Fig. 2 Block diagram for OCR based number plate recognition system

- Firstly, we have to import an image in vision acquisition to train the machine to detect the number plate of the vehicle.
- After that we need to save trained data into a .abc file as it is needed while using the optical character recognition technique for detection.
- Then by using the .abc file as input to the ocr read function, the machine detects the character as per the training data in the .abc file.
- After detecting the characters, the machine will compare the detected characters with our dataset containing different vehicle numbers.
- When the number that is detected by the system matches in the dataset it will check the details and give the output as the details of the owner as followed by the vehicle number, owner name, phone number, district, and state.

3.1 *Training the System*

The system is trained by using the Vision Assistant function. Vision Assistant is an Express VI in the Vision and Motion palette of this LabVIEW software. When this Express VI is placed on a block diagram, NI Vision Assistant launches. Using the vision assistant processing functions it can create an algorithm. After creating the algorithm, we can select the controls and indicators that we want to programmatically set in LabVIEW. To edit the algorithm we just need to double-click the Vision Assistant Express VI. Using this Vision Assistant function we can train our system easily and quickly. Figure 3 is the overview of the Vision Assistant function in LabVIEW.

The training phase of our system is shown below (Fig. 4).

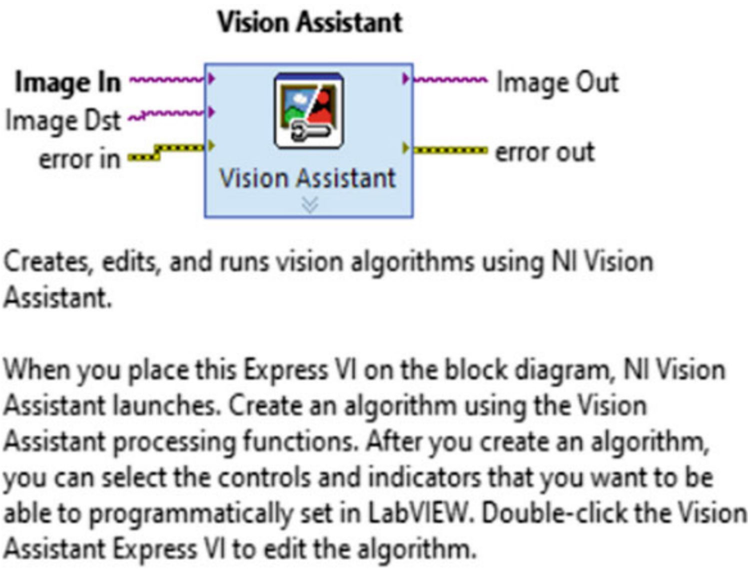

Fig. 3 Overview of vision assistant in LabVIEW

Fig. 4 Training the system

3.2 *Testing the System*

Firstly, we must import an image in vision acquisition to train the machine to detect the number plate of the vehicle. After that we must save the trained data into a .abc file as it is used while we are implementing this optical character recognition for detection. Then by using the .abc file as input to the ocr read function the machine can detect the character as per the training data in the .abc file. After detecting the characters, the machine will compare the detected characters with our dataset containing different vehicle numbers. When the number that is detected by the system matches in the dataset it will check the details and give the output as the owner details as followed by the vehicle number, owner name, phone number, district, and state.

Figure 5 is the input image given to the system.

Number Plate Extraction and Character Recognition Using ROI:

ROI means Region of Interest. This has to be specified for separating the number plate image from the whole vehicle image. ROI can be specified using the below pixel calculations. The vehicle's number plate is extracted from the image of the vehicle using ROI (Region of Interest).Below are the pixel calculations for ROI (Region of Interest). Figure 6 is the pixel calculations for the Region of Interest.

Fig. 5 Input Image to the system

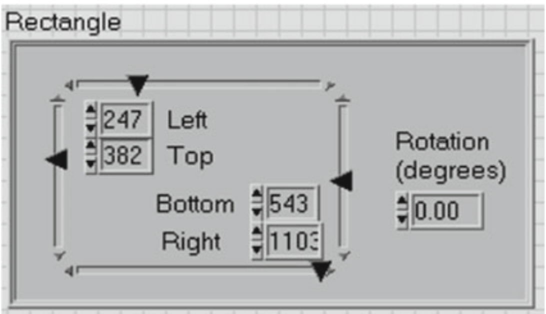

Fig. 6 Pixel calculations for Region of Interest

Fig. 7 Character recognition

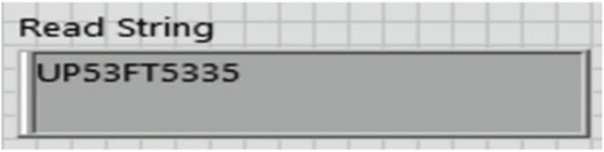

Fig. 8 Output as characters from the system

The characters on the vehicle's number plate are recognized by the system. Figure 7 shows us how the system is recognizing the characters on the vehicle's number plate.

Output String:

The characters recognized by the system are in the read string as output. This read-string will give the output as the characters that are recognized by the system. Figure 8 is the output given by the system as the characters on the number plate.

Details:

The system compares the resulting string with a dataset and gives details of the vehicle's owner. Figure 9 shows us the details of the vehicle's owner according to the dataset.

4 Experimental Results

Vision assistant is an application, created using OCR functions, it segments each object from an image and compares those characters with the character set file, created during the training procedure. In a number plate the characters are recognized in the testing phase of OCR. The implementation of this OCR (Optical Character Recognition) Based Number Plate Detection System is done using LabVIEW Software. In the front panel, the Image is used to separate the number plate image from the whole vehicle image. The Rectangle is used for the pixel calculations for Region of Interest (ROI). Region of Interest is used to separate the number plate image from the vehicle image.

Fig. 9 Details of vehicle's owner given by the system

The error in (no error) and error out will show us if there is any error in our program. These errors in and errors out have three modules in it. They are status, code, and source. Status is a Boolean value either True or False. It shows a green color tick mark if no error is present in our program or else it will show a red color cross mark if there is an error in our program. Code is an integer value. It will show the error code if there is an error in our program. The source is a string. It will show us where the error is present in our program. Read string will show us the characters recognized by the system. Characters from the read string are then compared with the dataset and give the owner details according to the dataset. Details of the owner will be shown in the details.

Figure 10 shows the output of the system when the input image is UP53FT5335 numbered car image. The system correctly recognized the characters in the input image.

Figure 11 shows the output of the system when the input image is HR26DK8337 numbered car image. The system correctly recognised the characters in the input image and gives the details according to the dataset.

Figure 12 shows the output of the system when the input image is KA01GS0369 numbered car image. The system correctly recognised the characters in the input image and compares the characters with the dataset and gives the details of the vehicle's owner according to the dataset.

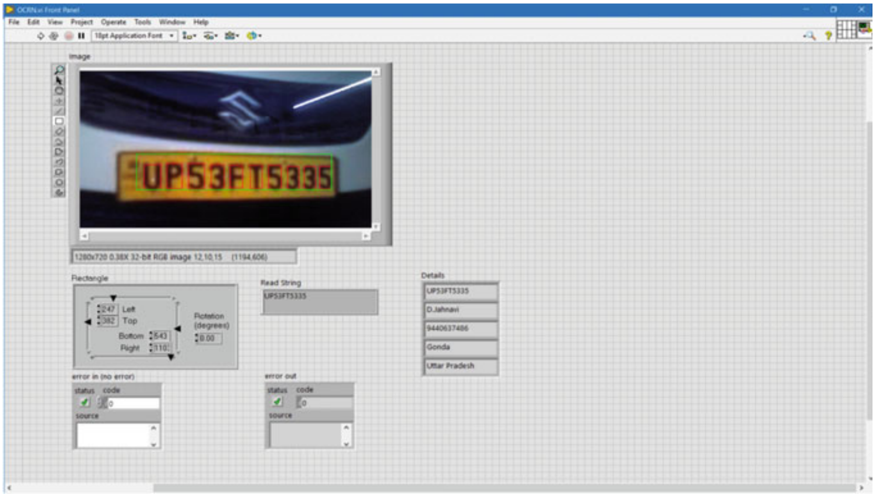

Fig. 10 Result from the system for UP53FT5335 numbered car image

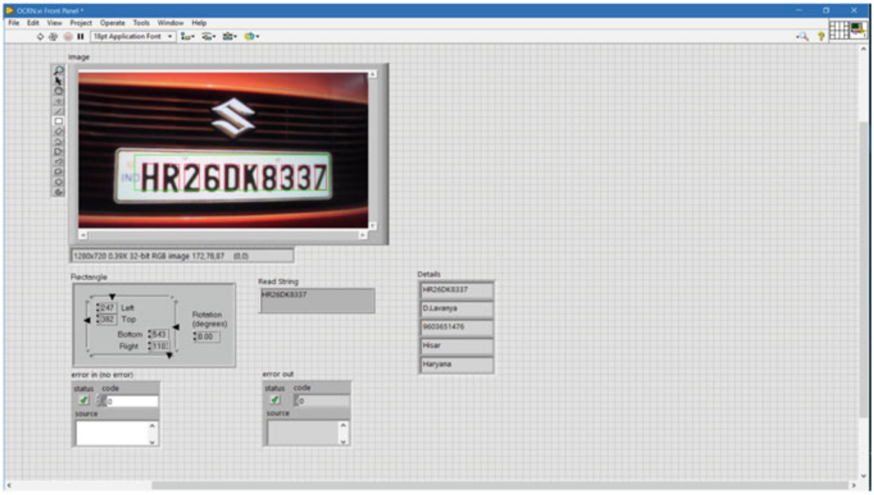

Fig. 11 Result from the system for HR26DK8337 numbered car image

5 Future Scope

Number Plate Recognition can be further extended for the identification of vehicle owners by using a video camera where the number plate recognition can be done in a frame in which the number plate is located that allows on-the-go recognition by the system to use in mobile units. It can also increase the security for women to travel as they can easily detect the number plate before using a cab or other services.

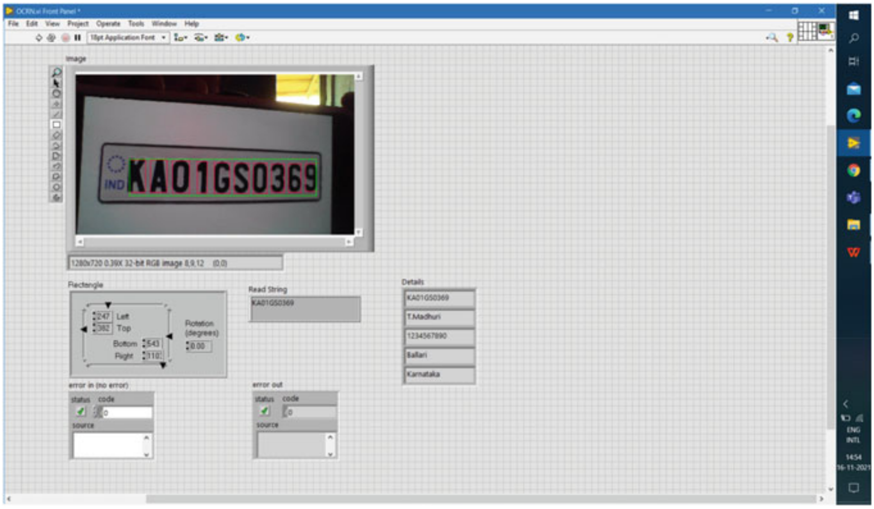

Fig. 12 Result from the system for KA01GS0369 numbered car image

6 Conclusion

Number plate extraction is performed using OCR (Optical Character Recognition). Using the Vision and Motion Toolkit it is easy to train the system and also to test the system to recognize the characters on the vehicle's number plate. The system can identify a vehicle's location by comparing the characters on a vehicle's number plate with a dataset. Got details of the owner as followed by the vehicle number, owner name, phone number, district, and state. So, we can easily identify that a person violates the traffic rules. By using this system it is an easy task to identify the person who violates traffic rules and can punish the vehicle's owner. So the controlling of traffic makes it easy without delay.

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Siamese Bi-Directional Gated Recurrent Units Network for Generating Reciprocal Recommendations in Online Job Recommendation

Tulika Kumari, Ravish Sharma, and Punam Bedi

Abstract Unlike conventional Recommender Systems (RS) techniques where items are recommended to users, in Reciprocal Recommender Systems users become the items that are recommended to other users. Hence the generated recommendations should be accepted by both the service user (receiver of the recommendation) and the recommended user. In this paper, we propose SBiGRU: Siamese Bidirectional Gated Recurrent Units-based model to generate reciprocal recommendations in the online Job Recommendation by computing the semantic similarity between service users and recommended users. It can recommend reciprocal recommendations to any recruiter and job seeker even in the absence of interaction data that may not be available due to data privacy being exercised by concerned parties. The performance of SBiGRU is compared with existing state-of-the-art approaches and two Recurrent Neural Network variations viz. Bidirectional LSTM (SBiLSTM) and unidirectional LSTM (SLSTM).

Keywords Reciprocal recommender system · Deep neural network · Siamese Neural Network · Online job recommendation

T. Kumari (✉)
Shaheed Rajguru College of Applied Sciences for Women, University of Delhi, Delhi 110096, India
e-mail: tulika.singh@rajguru.du.ac.in

R. Sharma
P.G.D.A.V. College, University of Delhi, Delhi 110065, India
e-mail: ravish.sharma@pgdav.du.ac.in

P. Bedi
Department of Computer Science, University of Delhi, Delhi 110007, India
e-mail: pbedi@cs.du.ac.in

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1 Introduction

Reciprocal Recommender System (RRS) [1, 2] is a subtype of recommender system that is important for tasks where people are recommended to each other such as job recommendation, mentor–mentee matching, and online dating. To date, proposed approaches in traditional RS may not be very successful in RRS due to the following reasons (a) reciprocity is not considered (b) there is only one service user whose interests or needs are to be satisfied. With the recent advances in word embeddings and the success of deep neural networks for automatically extracting deep-level discriminative features, we are motivated to propose a deep learning-based model, Siamese Bidirectional Gated Recurrent Unit (SBiGRU) to generate reciprocal recommendations by computing the semantic similarity score between service users and recommended users. Our proposed model is applied in online job recommendation where reciprocity plays an important role. The level of reciprocity or mutual compatibility between service users and recommended users is determined as follows: candidate c is a successful reciprocal recommendation for a job j if the candidate c is in $TopN$ recommendations of the job j and job j is also in $TopN$ recommendations of the candidate c where $TopN$ is set of N most relevant matches for a job or candidate.

$$RR(j) = \{c : c \in TopN(j) \wedge j \in TopN(c)\} \tag{1}$$

Similarly, job j is a successful reciprocal recommendation for candidate c provided:

$$RR(c) = \{j : j \in TopN(c) \wedge c \in TopN(j)\} \tag{2}$$

Here, $TopN(c)$ is the $topN$ recommendations for candidate c and $TopN(j)$ is the $TopN$ recommendations for job j.

Proposed model SBiGRU successfully contributes to the following three dimensions:

- Extracts deep-level discriminative features using Siamese Neural Network.
- Limited access to data often makes existing RRS approaches infeasible as they are majorly based on interaction data that may be in the form of messages exchanged between the users or previous interactions of the user. These interaction data may usually not be available due to data privacy being exercised by concerned parties. However, our model generates $TopN$ successful reciprocal recommendations for a candidate/recruiter on the basis of semantic similarity between the job descriptions and candidate profiles.

- In traditional RS, users feel reluctant to provide detailed information. However, in RRS, service users have evident motivation to provide their detailed information and preferences because a successful match is not solely dependent on service users and thus, they may not want to face rejections by the recommended users by providing incomplete or insufficient information. Hence cold start problem will not arise using our model as it requires only the job descriptions and candidate profiles. A pair of job descriptions and candidate profiles is sufficient to start a new system.

The rest of our paper is organized as follows. Section 2 covers related work with a focus on reciprocal recommender systems and online job recommender systems. Section 3 presents the proposed SBiGRU model. Experiments and results are presented in Sect. 4. Section 5 concludes the paper followed by references.

2 Related Work

Malinowski et al. [3] proposed a bilateral approach for a person-job recommender system. A probabilistic model was used for a CV recommender and a job recommender separately and results were integrated. Li et al. [4] proposed MEET, a generalized framework for reciprocal recommender systems in which a bipartite graph based on the relevance between users of different sets was constructed. Akehurst et al. [1] proposed CCR: content collaborative reciprocal recommender approach by combining the predictive capabilities of content-based and collaborative strategy in online dating websites. A generalized explanation method was used in [5] for providing recommendations with reciprocal explanations.

Roy et al. [6] used a Linear Support Vector classifier to classify candidates' resumes and recommend relevant resumes to the recruiter. Qin et al. [7] proposed a neural network-based approach for matching resumes with job postings. Maheshwary et al. [8] used Siamese adaptation of Convolutional Neural Network for recommending jobs to a candidate only. Yu et al. [9] used users' interaction history to find their online recruitment preferences. Wenxing et al. [10] used tf-idf for converting features to corresponding vectors and cosine similarity for assessing similarity between job seeker and recruiter in a mobile reciprocal job recommender system.

Many of the approaches presented by researchers to generate reciprocal recommendations in online recruitment were based on historical information of users' preferences, ratings/feedback/ranking provided by the employer to the job seeker, or vice-versa. In some other works, information such as which candidate applied to which job postings, search history profile, interaction data reflecting the actions of the companies on the candidate's Curriculum Vitae were used to generate recommendations. However, such interaction or historical information is mostly not provided by the companies or job seekers. Most of the job seekers are reluctant to share their interactions reflecting the action of recruiters, companies also do not specify candidates they hired or rejected. Job seekers are actively involved only when looking for a job, not consistently active in the system, which makes it difficult to have historical or rating information used in prior works.

Different from previous works, our model generates *TopN* successful reciprocal recommendations for a candidate/recruiter only based on job descriptions posted by recruiters and candidate profiles. Based on semantic similarity between job descriptions and candidate profiles, our proposed deep neural network-based model can capture bi-directional preferences. When a new job description is given, it can be matched with the corresponding candidate profiles and when a new candidate searches for a job, his profile can be matched with the corresponding job descriptions. At least one job description and one candidate profile are required to start a new system.

3 The Proposed SBiGRU Model

The proposed SBiGRU model uses Siamese adaptation of bi-directional Gated Recurrent Units (GRUs) for computing semantic similarity of job descriptions and candidate profiles to generate *TopN* reciprocal recommendations. The key steps involved in the model are depicted in Fig. 1 and are as follows: (1) pre-processing of job descriptions and candidate profiles, (2) generating word embeddings, (3) computing semantic similarity score of candidate profiles/job descriptions with existing ones, (4) generating reciprocal recommendations for candidates/jobs.

After performing pre-processing on job descriptions and candidate profiles, an embedding matrix with word indices and respective vectors from word vectors is computed. Embedding matrix is then fed to an embedding layer, which acts as a look-up layer for selecting a fixed size vector representation of a word. This layer is initialized with pre-trained word vectors. Next, each sequence of word vectors representing a job description or candidate profile is passed through a recurrent neural network with bi-directional GRU cell units. Both the input sequences u and v from a paired data point (u, v) are processed by Siamese Neural Network comprising individual bi-directional GRU layer with shared weights and parameters. Representations obtained from both the bi-directional GRU are concatenated into a single vector and

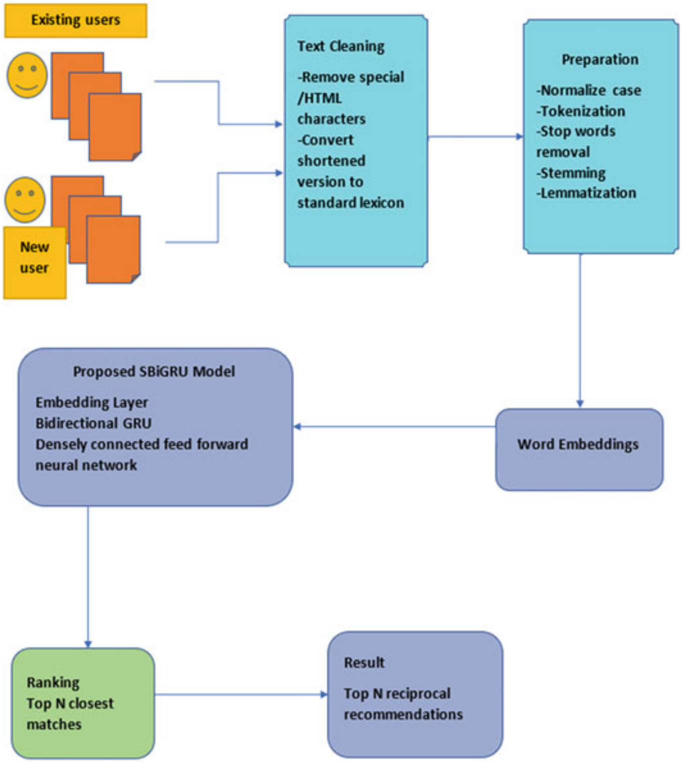


Fig. 1 Workflow of the proposed model, SBiGRU

passed through a densely connected feed-forward neural network with dropout and batch normalization. Sigmoid activation function used at the output layer gives a probability score representing the semantic similarity value between u and v and on the basis of this probability score *TopN* reciprocal recommendations are generated for the service user. The training process of SBiGRU is illustrated in algorithm 1. Algorithm 2 illustrates steps performed for generating reciprocal recommendations for a candidate and job in the system.

Algorithm 1 : Computing semantic similarity of job description, J_{su} and candidate profile C_{su} with existing ones to generate $TopN$ matches for J_{su} and C_{su}.

Input: The set of candidate profiles $C\ (C_1, C_2, \ldots C_m)$ and job descriptions $J\ (J_1, J_2, \ldots J_n), J_{su}$ and C_{su}.

Output: $TopN$ recommendations for job J_{su} and candidate C_{su}.

Begin

1. For each C_i and $J_k \forall i \in [1, m]$ and $\forall k \in [1, n]$ do:
   i. Tokenize C_i and J_k.
   ii. Remove stop words, perform stemming and lemmatization.

   end for
2. Let φ(C$_i$) and φ(J$_k$) be the vector representations of C_i and $J_k \forall i \in [1, m]$ and $\forall k \in [1, n]$.
3. While stopping criterion is not met:
   i. Obtain embedded sequences (e_i, e_j) for both the word-vector representations φ(C$_i$) and φ(J$_k$).
   ii. Feed (e_i, e_j) to two identical bi-directional GRU.
   iii. Concatenate e_i and e_j.
   iv. Sigmoid activation in the output layer to compute probability score p_i.
   v. Update the parameters with Nadam optimizer.
4. For candidate profile, C_{su} and job description, J_{su} do:
   i. For $i \rightarrow 1$ to m $(su! = i)$ do:

      $M_{n,i} \leftarrow p_i\ (C_{su}, C_i)$ //or $M_{n,i} \leftarrow p_i\ (J_{su}, C_j)$

      //or $M_{n,i} \leftarrow p_i\ (C_{su}, J_i) \forall i \in [1, n] \wedge su! = i$

      //or $M_{n,i} \leftarrow p_i\ (J_{su}, J_i) \forall i \in [1, n] \wedge su! = i$

      end for
5. Sort $M_{n,i}$ and retrieve Top N most similar matches
6. Return TopN

Algorithm 2: Generating reciprocal recommendations for a job J_{su} and candidate C_{su}.

Input: $TopN$ matches computed by Algorithm 1 for J_{su} and C_{su}.

Output: Reciprocal recommendations for J_{su} and C_{su}.

Begin

1. Let $TopNJ_{su}$ and $TopNC_{su}$ are the $TopN$ matches computed by Algorithm 1 for J_{su} and C_{su}.
2. For each element, R_i of $TopNJ_{su}$ do:

   Compute $TopNR_i$ from Algorithm 1.
3. $TopN$ reciprocal recommendations for J_{su}:

   $RR(J_{su}) = \{C_i : J_{su} \in TopNR_i \wedge C_i \in TopNJ_{su}\}$
4. For each element, S_i of $TopNC_{su}$ do:

   Compute $TopNS_i$ from Algorithm 1.
5. $TopN$ reciprocal recommendations for C_{su}:

   $RR(C_{su}) = \{J_i : C_{su} \in TopNS_i \wedge J_i \in TopNC_{su}\}$
6. Return $RR(J_{su})$ and $RR(C_{su})$.

Figure 2 illustrates SBiGRU architecture that computes probability score representing semantic similarity between job descriptions and candidate profiles. Figure 3 summarizes the reciprocal recommendations generation process by SBiGRU.

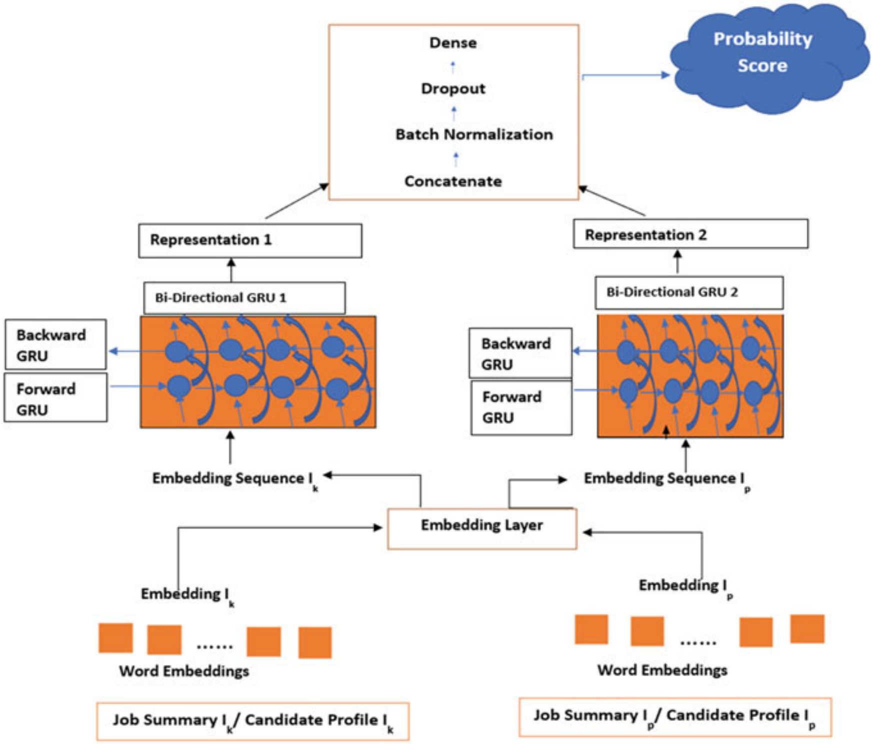


Fig. 2 Probability score computation by the proposed SBiGRU model

4 Experimental Study

SBiGRU is implemented in Python with opensource library, Tensorflow. Model is trained using Nadam algorithm with 0.01 learning rate. The task of assessing whether two data points $\{(u, v) : u \in Joru \in C; v \in Jorv \in C\}$ are semantically similar or not can be seen as a binary classification problem. Model is trained for {50, 100, 200} epochs and batch size are tuned to 64. With Early stopping call-back function, we stopped training when there was no improvement in the validation loss values for fifteen consecutive epochs. Batch normalization is used to normalize the activations and a dropout of 0.2 is used after GRU layer and at the last layer inputs.

4.1 Dataset Used

Candidate profiles were collected from a popular knowledge market website, “Stack Overflow” widely used by software developers and learners. It consists of attributes of 88,863 candidates. Job profiles were collected from a popular job site “Indeed.com”,

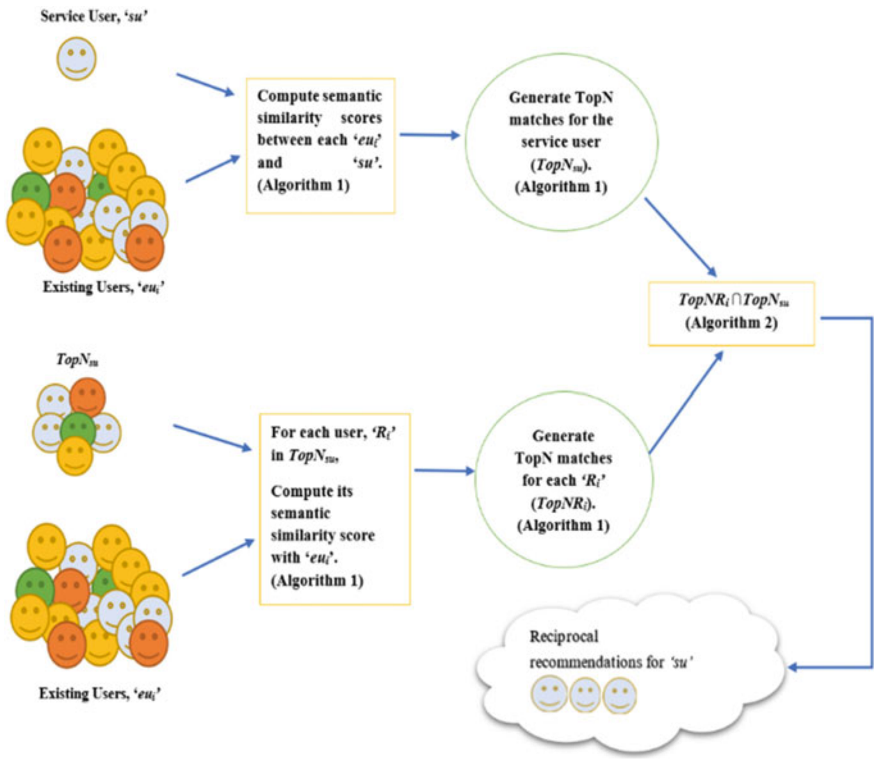


Fig. 3 Reciprocal recommendations generation process with SBiGRU

which consists of 10,000 job profiles from different companies. All the data used in our experiments are publicly available.

4.2 Evaluation Metrics

To evaluate the performance of the proposed model SBiGRU, accuracy, binary cross-entropy loss, precision@K, recall@K, and F1-measure were used. For binary classification, accuracy in terms of positives and negatives is computed as

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \tag{3}$$

where True Positive (TP) is the number of similar job descriptions/candidate profiles correctly predicted as similar. True Negative (TN) is the number of dissimilar job descriptions/candidate profiles correctly predicted as dissimilar. Dissimilar job descriptions/candidate profiles predicted as similar are referred to as False Positive (FP). Similar job descriptions/candidate profiles predicted as dissimilar is False Negative (FN). The binary cross-entropy loss function calculates the loss of an example by computing the following average:

$$Loss = \frac{-1}{N}\sum_{i=1}^{N} y_i.\log(p(y_i)) + (1 - y_i).\log(1 - p(y_i)) \tag{4}$$

where y_i is the true label and $p(y_i)$ is the predicted probability.

Precision@ K is defined as the proportion of top-K job descriptions and candidate profiles that are actually similar (relevant). Recall@ K is defined as the proportion of actually similar job descriptions and candidate profiles (relevant) that are in top-K. F1-score is defined as the harmonic mean of precision and recall.

$$\text{Precision@K} = \frac{|relevant \cap top - K|}{|\text{top} - \text{K}|} \tag{5}$$

$$\text{Recall@K} = \frac{|relevant \cap top - K|}{|\text{relevant}|} \tag{6}$$

$$F1 - score(F1) = \frac{2 * Precision * Recall}{\text{Precision} + \text{Recall}} \tag{7}$$

4.3 Experimental Results

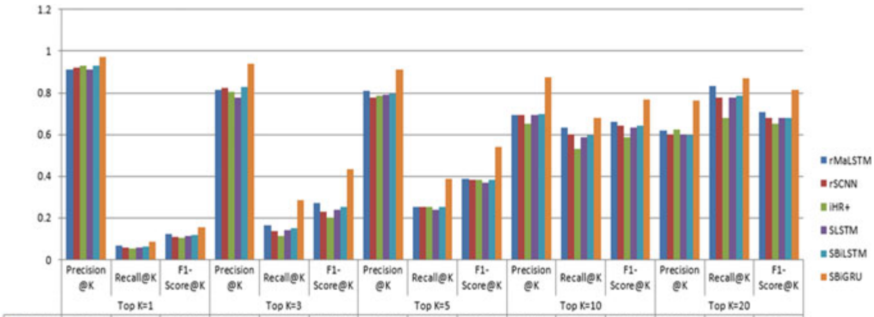
Muller et al. [11] used Siamese recurrent neural network architecture with LSTM for learning sentence similarity with Manhattan distance metric. Since our model also finds semantic similarity between a pair of job descriptions or candidate profiles, we implemented their model MaLSTM. We also implemented Siamese adaptation of convolutional neural network for recommending jobs to job seekers proposed by Maheshwary et al. [8] and a reciprocal job recommender system application iHR + [10] for comparing our results. In addition to our proposed SBiGRU model, we experimented with two RNN variations, viz., Bidirectional LSTM (SBiLSTM) and unidirectional LSTM (SLSTM). MaLSTM was computing semantic similarity between sentences; we applied their model for computing semantic similarity score of job descriptions and candidate profiles. Using the semantic similarity scores returned by MaLSTM, we generated reciprocal TopK recommendations for a job description or a candidate profile and call this model as rMaLSTM. Approach proposed by Maheshwary et al. [8] recommended jobs to job seekers only. We implemented their version to generate recommendations for both jobs as well as job seekers and selected TopK reciprocal recommendations for comparing the results and call it

Table 1 Comparison of (1) rMaLSTM (2) rSCNN (3) iHR+ (4) unidirectional LSTM (SLSTM) (5) Bidirectional LSTM (SBiLSTM) (6) Proposed model, SBiGRU

Model	Accuracy	Binary cross-entropy loss
rMaLSTM (Muller et al. [11])	0.7056	0.5758
rSCNN (Maheshwary et al. [8])	0.8218	0.3876
iHR+ (Wenxing et al. [10])	0.8426	0.3367
SLSTM (variant 1)	0.8611	0.3538
SBiLSTM (variant 2)	0.8944	0.2302
SBiGRU (**variant 3: proposed model**)	**0.9622**	**0.2183**

as rSCNN. Table 1 illustrates the performance comparison of rMaLSTM, rSCNN, iHR+, SLSTM, SBiLSTM, and SBiGRU.

We also computed precision@K, recall@K and F1@K with threshold value of 0.7 (TopN most similar matches having similarity score $> = 0.7$) for K = 1, 3, 5, and 10. We lowered the threshold value to 0.6 for obtaining TopK (K = 20) recommendation results. From Fig. 4, it is evident that our proposed model SBiGRU outperforms in terms of precision, recall, and F1-score.



	Top K=1			Top K=3			Top K=5			Top K=10			Top K=20		
	Precision @K	Recall@K	F1-Score@K	Precision @K	Recall@K	F1-Score@K	Precision @K	Recall@K	F1-Score@K	Precision @K	Recall@K	F1-Score@K	Precision @K	Recall@K	F1-Score@K
rMaLSTM	0.91	0.06549	0.12219	0.8133	0.16365	0.27247	0.808	0.25337	0.38577	0.691	0.63272	0.66058	0.6175	0.8324	0.70902
rSCNN	0.92	0.05889	0.11069	0.8233	0.13471	0.23154	0.776	0.25295	0.38153	0.694	0.59836	0.64264	0.601	0.77535	0.67713
iHR+	0.93	0.0546	0.1031	0.8045	0.1141	0.1999	0.7843	0.2535	0.3832	0.6521	0.5312	0.5855	0.6235	0.6782	0.6497
SLSTM	0.91	0.05952	0.11173	0.77667	0.14096	0.23861	0.79	0.23962	0.36771	0.694	0.58442	0.63452	0.6025	0.77743	0.67888
SBiLSTM	0.93	0.0629	0.11783	0.82667	0.14865	0.25199	0.794	0.25128	0.38175	0.698	0.59734	0.64376	0.5975	0.7841	0.6782
SBiGRU	0.97	0.08433	0.15516	0.94	0.28623	0.43459	0.91	0.38561	0.54168	0.875	0.68064	0.76568	0.7625	0.86824	0.81194

Fig. 4 Precision@K, Recall@K, and F1-score@K obtained with rMaLSTM, rSCNN, iHR+ , SLSTM, SBiLSTM, and SBiGRU for varying K (K = 1, 3, 5, 10, and 20)

4.4 *Discussion and Analysis*

In this section, we discuss the interpretability of predicted recommendations generated by the proposed model SBiGRU for different cases in addition to reciprocal recommendations.

4.4.1 When a Recruiter Enters His Job Requirements

Case I: *Predict TopN suitable candidates for a recruiter*

For a job requirement J_{su} posted by a recruiter, given the set of candidate profiles $C\ \{C_1, C_2 \ldots, C_m\}$, Algorithm 1 can compute the probability score $M_{n,i}$ denoting semantic similarity of J_{su} with each candidate C_i, $i \in [1, m]$. After that, *TopN* suitable candidates can be retrieved and recommended to the recruiter using Algorithm 2. This will help the recruiter identify relevant talent pools of suitable candidates. Recruiter can identify candidates whose qualification and other prerequisite skills match with their advertised job positions and avoid the expensive retention problems that could occur by hiring partially fit or mostly fit candidates.

Case II: *Predict TopN similar jobs to the job posted by a recruiter*

For a job requirement J_{su} posted by a recruiter, given the set of job descriptions $\{J_1, J_2 \ldots, J_n\}$, Algorithm 1 can compute the probability score $M_{n,i}$ denoting semantic similarity of J_{su} with each job J_i, $i \in [1, n]$. With Algorithm 2, *TopN* similar jobs can be presented to the recruiter which can help him identify the state-of-the-art and recent trends in the industry. This can assist the recruiter by keeping him informed about the technologies, platforms, programming languages, and other tools used by similar recruiters. In addition to inciting new strategies for the recruiter, when the recruiter is not sure about the skill set to look for, intents and preferences of similar recruiters can help him recognize the type of candidates they are looking for.

4.4.2 When a Candidate Enters His Profile

Case III: *Predict TopN suitable jobs for a candidate*

Job seekers strive to find jobs that successfully match with their preferences. For a candidate, our proposed approach can recommend a list of appropriate job postings for the job seeker by suggesting him *TopN* most suitable jobs on the basis of semantic similarity between the candidate profile and existing job descriptions computed by SBiGRU.

Case IV: *Predict TopN similar candidates for a candidate*

A job seeker can be presented with *TopN* most similar existing candidate profiles by our proposed approach. This can help him recognize gaps between his skills and expertise with other candidates. This information can be utilized by the candidate to improve his skillset and increase the chances of his acceptance in a desired job position.

5 Conclusion

Reciprocal recommender systems attempt to generate recommendations by taking into account the preferences of both the service user and the recommended user. We proposed a SBiGRU model, based on Siamese adaptation of Bidirectional GRU variant of RNN. We predicted semantic similarity of a job description and candidate profile posted by a recruiter and job seeker with former job positions and candidate profiles and selected *topN* most similar matches. The presented approach can recommend reciprocal recommendations to any recruiter and candidate in the absence of interaction data which may not be available due to data privacy being exercised by concerned parties. Hence cold start problem will not arise using the presented model as it requires only the job descriptions and candidate profiles. A pair of job descriptions and candidate profile is sufficient to start a new system. It was found that the performance of SBiGRU is better when compared with existing state-of-the-art approaches and two RNN variations, viz., Bidirectional LSTM (SBiLSTM) and unidirectional LSTM (SLSTM).

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Comparative Analysis of Image Denoising Using Different Filters

Kavya Duvvuri, Jaswanth Kunisetty, Chethana Savarala, Shruti P., and Sarada Jayan

Abstract The quality of images is often hampered due to the presence of noise. There are different image denoising techniques that can be used. One such technique is the use of filters. Filters are used for enhancing the appearance of images by eliminating unwanted information. We provide a detailed comparative analysis of different filters that can be used in denoising images containing various noises, in this paper. Four different noises, Speckle, Salt and Pepper, Gaussian, and Poisson, have been considered and different filters like Bilateral, Wiener, Mean, and Median have been applied to images containing each of them. The different filtered output images have been compared with the original image using their structural similarity index. Through observation and experimentation, new combinations of filters like Multiple Mean and Median-Mean have been introduced. The processing time has been calculated to decide upon the performance of different filters. A conclusion has been drawn as to which filter has to be used for denoising images containing different noises.

Keywords Filter · Bilateral · Wiener · Mean · Median · Noise · Speckle · Salt and Pepper · Gaussian · Poisson

1 Introduction

We often find images with various noises like Salt and Pepper, Speckle, Gaussian, and Poisson. Various filtering methods are required to denoise images containing each of these different noises. In this paper, we show a comparative study of different types

D. Kavya (✉) · K. Jaswanth · S. Chethana · P. Shruti
Department of Computer Science Engineering, Amrita School of Engineering, Amrita Vishwa Vidyapeetham, Bengaluru, India
e-mail: krishnakavya.duvvuri@gmail.com

J. Sarada
Department of Mathematics, Amrita School of Engineering, Amrita Vishwa Vidyapeetham, Bengaluru, India
e-mail: j_sarada@blr.amrita.edu

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of filters and compare their performances using them to denoise images containing different types of noises. Section 1 of this paper gives an introduction to the paper and elucidates the different references that have been taken. Section 2 describes the different types of noises while Sect. 3 describes the different types of filters that have been used. Section 4 gives an insight into the experimentation and results obtained while Sect. 5 discusses the observations. Finally, Sect. 6 gives a conclusion by mapping different noises to the filters that can be used in denoising images containing them.

Any grayscale image of $m \times n$ dimension can be represented in the form of a matrix of dimension $m \times n$ such that each element of the matrix contains the grayscale intensity of each pixel of the image. The grayscale intensity values range from 0 to 255, where 0 represents black and 255 represents white. The pixel values closer to 0 have a darker shade while the pixel values closer to 255 have a lighter shade.

In Ref. [1], an overview of different types of noises like Gaussian, Salt and Pepper, and the Speckle has been given. Various Linear and Non-linear filtering techniques are explained.

The application of the Wiener filter for digital image restoration in 2D has been shown in Ref. [2]. The Wiener filter and its use as a linear filter have been demonstrated. Reference [3] provides an optimal parameter selection for a Bilateral filter and an extension to the Bilateral filter, namely the Multiresolution Bilateral filter.

Reference [4] proposes a new weighted mean filtering method specifically for the Salt and Pepper noise. In Ref. [5], a new Median filtering method, which stands superior to the Standard Median filter, the Center-Weighted Median Filter, and the Tri-State Median filter, has been put forth. The use of the Total Variance Denoising method in detecting the R-peaks in ECG signals has been illustrated in [6]. Reference [7] discusses the application of l 1 trend filter as an image denoising technique for 3D color images. In Ref. [8], ECG signals have been denoised using Wiener filter as well as Kalman Filter.

In Ref. [9], a comparison between Least Square-based denoising and Total Variation denoising has been done while in Ref. [10] Weighted Regularized Least Square denoising method has been introduced. Reference [11] illustrates the use of Partial Differential Equations, like Heat Equation and Perona-Malik Equation, in image restoration. Reference [12] gives a vivid account of the use of the Weighted Regularization Least Square method in aerial and satellite image denoising. Reference [13] illustrates the denoising of medical images using a bilateral filter and their classification using CNN.

2 Different Types of Noises

2.1 Gaussian Noise

Gaussian noise is a type of statistical noise. It is a noise that is uniformly distributed throughout the image signal. Gaussian noise gets its name as the noise probability distribution function follows the Gaussian distribution. An image with Gaussian noise is obtained by replacing the pixels of the original image with the sum of their original pixel intensities and the noise value.

2.2 Poisson's Noise

The Poisson noise is also a type of statistical noise. It is also known as quantum noise. It is often present in photon images. The Poisson noise is dependent on image signals and is also known as additive noise because it is added to images through the addition of the noise signal with the original image signal.

2.3 Salt and Pepper Noise

Salt and pepper noise is also known as impulse noise. It adds white and black pixels to images at random positions thereby making them noisy. Salt and Pepper noise often occurs due to some disturbances that may occur in image signals when it is being shared. This noise gets its name because it randomly adds white pixels which resemble salt and black pixels which resemble pepper to the image. Salt and Pepper noise is added by changing the intensity of random pixels of an image to either 0 or 255.

2.4 Speckle Noise

Speckle noise is also known as granular or grain noise. It adds pixels with random grayscale intensities ranging from 0 to 255 to images. Speckle noise is also referred to as multiplicative noise as it is added to images by multiplying the original image signal with the noise signal. Speckle noise is often detected in medical ultrasound and Synthetic Aperture Radar (SAR) images. This is due to the phenomenon of constructive and destructive interference that results in bright and dark spots on images.

3 Different Types of Filters

3.1 Mean Filter

The mean filter is a type of filter which is also known as an average filter. There is a sliding matrix, and the center value of the sliding matrix is replaced with the average of all the pixel intensity values in the sliding matrix. The preferred order of the sliding matrix is of odd order. In this project, we have considered a sliding matrix of order 3×3. This method was developed from the fact that every pixel in an image should have a grayscale intensity value similar to that of its neighbors. This filter achieves that by reducing the difference between grayscale intensities of neighboring pixels. This filter results in the smoothening of images.

3.2 Multiple Mean Filter

Multiple Mean Filter is the name given to the filter which contains iterative Mean filters. The output image of the first Mean filter is given as the input to the second Mean filter and the pattern moves on. In this project, we have considered repeating the use mean filter five times.

3.3 Median Filter

The median filter is a type of filter which is similar to the mean filter. The only difference between the median filter and the mean filter is that the center value of the sliding matrix is replaced with the median of all the pixel intensity values in the sliding matrix. The preferred order of the sliding matrix is of odd order. In this project, we have considered a sliding matrix of order 3×3. The Median filter is better than the Mean filter as the mean filter is more sensitive to outliers than the median filter.

3.4 Median-Mean Filter

As the name suggests, the Median-Mean filter is a combination of both the Median filter and the Mean filter. The noisy image is first filtered using the Median filter, and the output image obtained from the Median filter is given as input to a Mean filter. The output of the Mean filter is the final output image. A point to be noted is that the sequence of these filters is not to be changed.

3.5 Wiener Filter

The Wiener filter is an extension of the Inverse filter. The inverse filter works by minimizing the mean square of the noise as the noise value has to be negligible for the Inverse filter to work. The Wiener filter also minimizes the noise mean square error like the Inverse filter. However, the Wiener filter can be used to filter images containing noise in them by smoothening the noise.

3.6 Bilateral Filter

The Bilateral filter is an extension of the Gaussian filter. The Gaussian filter utilizes the spatial distances of the pixels to multiply the weights. The Bilateral filter makes use of the photometric distance of the pixels to obtain the weights. A matrix with the weights of each pixel in the surrounding region is considered and is multiplied with parts of the image matrix and the average of the obtained sum replaces the value of the pixel.

4 Experiments, Results, and Analysis

In this paper, we have considered an image of a bird to observe the changes over it by adding different noises and in turn filtering the noisy images using various types of filters. Figure 1 shows the color image of the bird that we considered in this paper while Fig. 2 shows the image after conversion into grayscale. All the work that has been carried out in this paper is with the grayscale image in Fig. 2.

We considered different noise values for each type of noise and added noise to the images. These noisy images are filtered using the various types of filters mentioned

Fig. 1 Image that has been considered

Fig. 2 Grayscale image of the bird

Table 1 Noise intensity values considered

Noise	Noise value 1	Noise value 2	Noise value 3
Salt and pepper	0.02	0.2	0.5
Gaussian (Mean, Variance)	0, 0.004	0, 0.04	0, 0.1
Speckle	0.02	0.2	0.5

above. The structural similarity index is used to compare the filtered image with the original image.

Table 1 gives the noise values that have been considered for Salt and Pepper, Speckle, and Gaussian noise.

Figure 3 gives a flowchart describing the process that we followed for adding noise and denoising the input bird image.

When we use the Mean filter to filter images containing different types of noises, it is observed that the Mean filter is best in filtering images containing Speckle noise. As the noise value increases, the structural similarity index of the filtered output image of the original grayscale image decreases. Images with Poisson's noise filtered using a mean filter also show good results, but this is not the best application as the Poisson noise value is very less by default.

Figure 4 represents the image after adding Salt and Pepper noise of value 0.2 and the filtered output image obtained using the Mean filter alongside the original image.

Figure 5 represents the image after adding Gaussian noise of value 0.2 and the filtered output image obtained using the Mean filter alongside the original image.

Figure 6 represents the image after adding Speckle noise of value 0.2 and the filtered output image obtained using the Mean filter alongside the original image.

Surprisingly when we repeatedly use Mean filters, we get better results than those observed using Mean filters. We observe that as the number of Mean filters applied

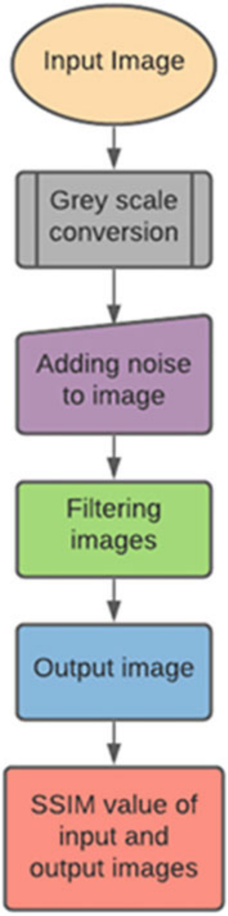

Fig. 3 Flowchart for image denoising

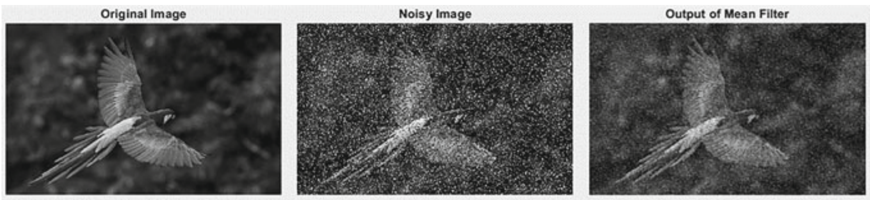

Fig. 4 Mean filter output for salt and pepper noise (0.2)

Fig. 5 Mean filter output for Gaussian noise (0, 0.04)

Fig. 6 Mean filter output for Speckle noise (0.2)

increases, the structural similarity index of the filtered output image and the original grayscale image increases. In this paper, we have considered only five iterative mean filters as it was observed that even when the number of iterations is more than five, the structural similarity index of the filtered output image and the original grayscale image remains constant. But there is one exception when Poisson's noise is considered. In the case of images with Poisson's noise, the structural similarity index of the filtered output image and the original grayscale image increases only until two iterations and then decreases from two iterations. And it is also observed that the Multiple Mean filter is best in filtering images containing both Speckle and Gaussian noises.

The time taken for the execution of the first Mean filter is 1.800386 seconds while the simulation time for the execution for all the five Mean filter loops is 8.867266 seconds. The simulation for the calculation of elapsed time has been done on MATLAB in a system with 16 GB RAM.

When we use the Median filter to filter images containing different types of noises, it is observed that the Median filter is best in filtering images containing Salt and Pepper noise and least suitable for filtering images containing Gaussian noise.

Figure 7 represents the image after adding Salt and Pepper noise of value 0.2 and the filtered output image obtained using the Median filter alongside the original image.

Figure 8 represents the original image, the image after adding Gaussian noise of value 0.04, and the filtered output image obtained using the Median filter.

Figure 9 represents the image after adding Speckle noise of value 0.2 and the filtered output image obtained using the Median filter on the original image.

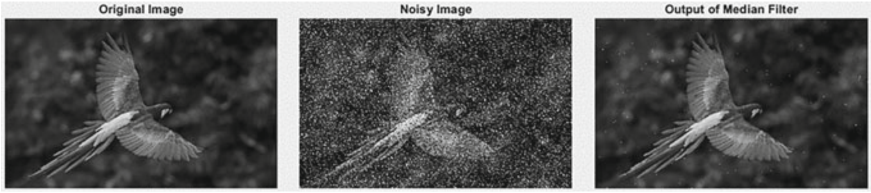

Fig. 7 Median filter output for salt and pepper noise (0.2)

Fig. 8 Median filter output for Gaussian noise (0, 0.04)

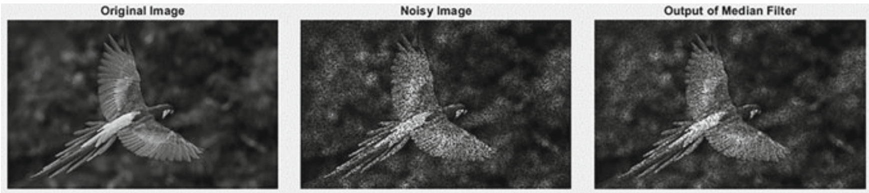

Fig. 9 Median filter output for Speckle noise (0.2)

Interestingly, it has been observed that the Median-Mean filter gives the best results compared to the above-mentioned filters. It is more suitable for filtering images containing Salt and Pepper and Speckle noises. It is observed that the Median-Mean filter gives a better structural similarity index when compared with the Median filter only when the noise is above a certain minimum value. The value is approximately 0.00324 in the case of Speckle noise and 0.17027895 for Salt and Pepper noise.

Figure 10 represents the image with a Salt and Pepper noise value of 0.2 and the filtered output image obtained using the Median as well as Median-Mean filter.

Fig. 10 Median filter and Median-Mean filter output for salt and pepper noise (0.2)

Figure 11 shows the image after adding Gaussian noise of value 0.04 and the filtered output image obtained using the Median as well as Median-Mean filter.

Figure 12 shows the image after adding Speckle noise of value 0.2 and the filtered output image obtained using the Median as well as Median-Mean filter.

The Wiener filter is best in filtering images containing Speckle and Gaussian noises. The Wiener filter is least suitable for filtering images containing Salt and Pepper noise as the structural similarity indices are the least.

Figure 13 represents the image after adding Salt and Pepper noise of value 0.2 and the filtered output image obtained using the Wiener filter alongside the original image.

Figure 14 represents the image after adding Gaussian noise of value 0.04 and the filtered output image obtained using the Wiener filter alongside the original image.

Fig. 11 Median filter and Median-Mean filter output for Gaussian noise (0, 0.04)

Fig. 12 Median filter and Median-Mean filter output for Speckle noise (0.2)

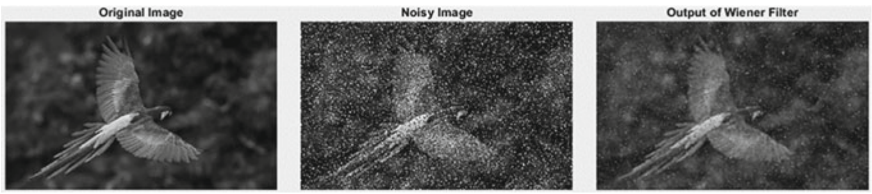

Fig. 13 Wiener filter output for Salt and Pepper noise (0.2)

Fig. 14 Wiener filter output for Gaussian noise (0, 0.04)

Fig. 15 Wiener filter output for Speckle noise (0.2)

Figure 15 represents the image after adding Speckle noise of value 0.2 and the filtered output image obtained using the Wiener filter alongside the original image.

The Bilateral filter is suitable for filtering images containing Speckle noise. It is not suitable for filtering images containing Salt and Pepper and Gaussian noises. In general, the structural similarity indices are the least for the Bilateral filter.

Figure 16 represents the image after adding Salt and Pepper noise of value 0.2 and the filtered output image obtained using the Bilateral filter alongside the original image.

Figure 17 represents the image after adding Gaussian noise of value 0.04 and the filtered output image obtained using the Bilateral filter alongside the original image.

Figure 18 represents the image after adding Speckle noise of value 0.2 and the filtered output image obtained using the Bilateral filter along with the original image.

Table 2 gives us structural similarity indices of the filtered output image and original grayscale image for images containing Speckle, Gaussian, and Salt and Pepper noises, with different noise values, using various filters.

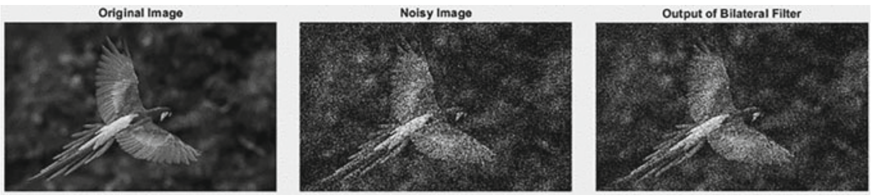

Fig. 16 Bilateral filter output for Salt and Pepper noise (0.2)

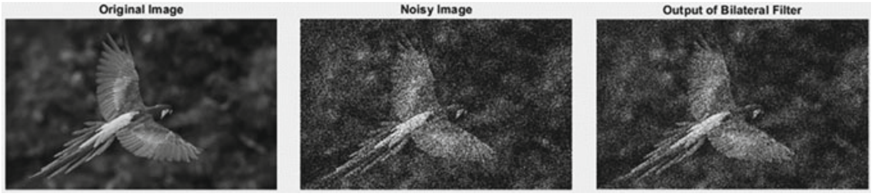

Fig. 17 Bilateral filter output for Gaussian noise (0, 0.04)

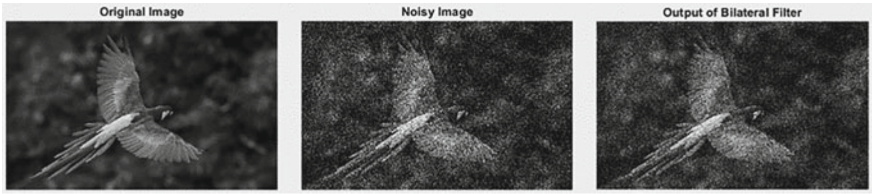

Fig. 18 Bilateral filter output for Speckle noise (0.2)

Table 2 Noise value and SSIM value observation table

Salt and pepper noise			Gaussian noise			Speckle noise		
Filter	Noise	SSIM	Filter	Noise	SSIM	Filter	Noise	SSIM
Mean	0.02 0.2 0.5	0.7467 0.2116 0.0868	**Mean**	0, 0.004 0, 0.04 0, 0.1	0.7572 0.3429 0.2056	**Mean**	0.02 0.2 0.5	0.9012 0.6380 0.4732
Multiple Mean	0.2	0.5795	**Multiple Mean**	0, 0.04	0.7205	**Multiple Mean**	0.2	0.8608
Median	0.02 0.2 0.5	0.9680 0.9154 0.2125	**Median**	0, 0.004 0, 0.04 0, 0.1	0.6849 0.2399 0.1310	**Median**	0.02 0.2 0.5	0.8399 0.4686 0.3044
Median-Mean	0.02 0.2 0.5	0.9505 0.9246 0.3667	**Median-Mean**	0, 0.004 0, 0.04 0, 0.1	0.8267 0.4409 0.2755	**Median-Mean**	0.02 0.2 0.5	0.9009 0.6621 0.4950
Wiener	0.02 0.2 0.5	0.6900 0.4140 0.2785	**Wiener**	0, 0.004 0, 0.04 0, 0.1	0.9015 0.6211 0.4603	**Wiener**	0.02 0.2 0.5	0.9356 0.7736 0.6797
Bilateral	0.02 0.2 0.5	0.5026 0.0281 0.0077	**Bilateral**	0, 0.004 0, 0.04 0, 0.1	0.6482 0.641 0.0256	**Bilateral**	0.02 0.2 0.5	0.8279 0.3934 0.2040

5 Discussions

The highest structural similarity value for the images with Salt and Pepper noise is 0.9680 which is obtained using the Median filter on the given input image. Images containing Gaussian noise show the highest structural similarity index, 0.9015, for images filtered using the Wiener filter. Similarly, images filtered using the Wiener filter give the highest structural similarity index, 0.9356, in the case of images containing Speckle noise.

6 Conclusions

From the observations made, we can conclude that the structural similarity index of the original grayscale image and filtered output image decreases as the noise value increases. From the structural similarity indices, it is understood that the Median filter is better than the Mean filter in the case of Salt and Pepper noise, and the Mean filter is better than the Median filter when we consider images containing Gaussian and Speckle noise. The Median-Mean filter is far better than the Median filter in the case of all the different types of noises. We observe that the Median-Mean filter is best for filtering images that contain Salt and Pepper noise. Images containing Speckle noise and Gaussian noise can be filtered using the Wiener filter. Poisson's noise is very less in quantity as it is assigned a default value. Hence, images with this noise can easily be filtered using the Multiple Mean filter. In the case of the Multiple Mean filter, it is observed that the time complexity of execution increases at a relatively lesser rate as the number of Mean filters applied increases. As it gives a higher structural similarity index and takes a moderate amount of time when compared to the Mean filter, the Multiple Mean filter stands better in denoising images containing Poisson's noise.

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The Proposed Context Matching Algorithm and Its Application for User Preferences of Tourism in COVID-19 Pandemic

Van Hai Pham, Quoc Hung Nguyen, Viet Phuong Truong, and Le Phuc Thinh Tran

Abstract Currently, many applications of information search tourism are limited in the COVID-19 pandemic using a search engine. However, most application service online has not supported directly, matching end users with their preferences to find suitable tourist places. This paper has presented a proposed model using the Context Matching algorithm mostly based on the Smartphones; matching with user's preferences and behaviors allows users to find tourism packages and regions. The experimental results show that the proposed model achieves significant improvements in matching user preferences for the domain under dynamic uncertainty. We posit that our novel approach holds the prospect of improvements in user preferences for tourism and weather in the COVID-19 Pandemic.

Keywords Service context · Context matching algorithm · The weather forecast · The help system

1 Introduction

Currently, information technology has become an important industry, associated with all necessities in the lives of humans, and with the creation and ongoing development, applications developed on the platform mobile are increasingly diverse and focused on serving the practical benefits of the users.

V. H. Pham
Hanoi University of Science and Technology, Hanoi, Vietnam
e-mail: haipv@soict.hust.edu.vn

Q. H. Nguyen (✉) · V. P. Truong · L. P. T. Tran
University of Economics Ho Chi Minh City (UEH), Ho Chi Minh City, Vietnam
e-mail: hungngq@ueh.edu.vn

V. P. Truong
e-mail: truong@ueh.edu.vn

L. P. T. Tran
e-mail: thinhtlp@ueh.edu.vn

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Weather forecast information has always been extremely important to the people, from pupils, students, workers and employees to make a career but who like driving characteristics, fishermen ... etc. Updated weather information regularly will help reduce many difficulties and dangers for people to start a day of learning, and working. Expand further, based on the purpose of the work to identify the areas with suitable weather conditions will increase dynamism and help work to achieve the best performance.

Our contributions focus on (1) proposed research model lookup information to help forecast the weather on Smartphones. Techniques used in this model use the Context Matching algorithm to quantify the attribute information based on personalized service users on the weather API; (2) Model proposed offering features advantages for finding information in the approach personalized and for adapting the user for service access to personalized applications seeking forecast weather on Smartphones.

2 Literature Review

Tourism is considered the industry hardest hit by the COVID-19 pandemic. The spread of the disease and complicated developments on a global scale has caused many countries to implement distance and blockade measures, causing travel to be narrowed. Smart tourism (ST) can become a tourism recovery solution where technology will be useful tools for tourism services such as vaccine screening, smart guides, and tourist flow monitoring. To enhance in order to improve the quality of the guest experience at the destination, new technology plays an essential role in controlling and managing the COVID-19 pandemic. There have been many studies on smart tourism adapted to the current COVID-19 epidemic situation, and the applications focus on using automation technology as a tool to guide the recovery of the tourism industry. Among these technologies, the most researched use of robotics, artificial intelligence, and IoT focuses on Smart Tourism Development. The following are some of the studies that have been developed such as: In [1], the authors analyze new trends in tourism approach including new technologies such as virtual reality (VR), augmented reality (AR), and 3D online sightseeing via Zoom. In [2], virtual tourism is proposed using a model of using drones in providing online virtual tours to tourist attractions that are blocked because of the COVID-19 epidemic. Petrovic et al. [3] showed that for smart tourism, different technologies are applied such as: (1) augmented reality (AR)—virtual tour, (2) deep learning—predicting visitor numbers access, and (3) IoT/blockchain vaccination records. Digital ticket using NFC near communication technology is proposed for use on smartphone platform to help control visitors in [4]. Buhalis and colleagues [5] demonstrated that smart tourism emerged as a result of the growth of e-tourism and the web, providing the information infrastructure to create innovative value propositions for all related parties. The author also indicates the next steps of this development will be Ambient Smart Tourism (AMI), where individual and collective interests will be aligned to promote collaborative performance optimization and competitiveness. This new phase of AMI Tourism is based on new disruptive technologies adopted by brands to increase co-creation and exploration of the "current" effects mentioned in [6].

3 The Proposed Context Matching Algorithm for User Preferences of Tourism in COVID-19 Pandemic

3.1 The Proposed System Architecture

In this paper, we have developed the proposed model of algorithms. Context Matching for weather forecast information is described as shown in Fig. 1.

The system architecture model is described as follows: The inputs of the model problem are the Context Input; output is Output Context.

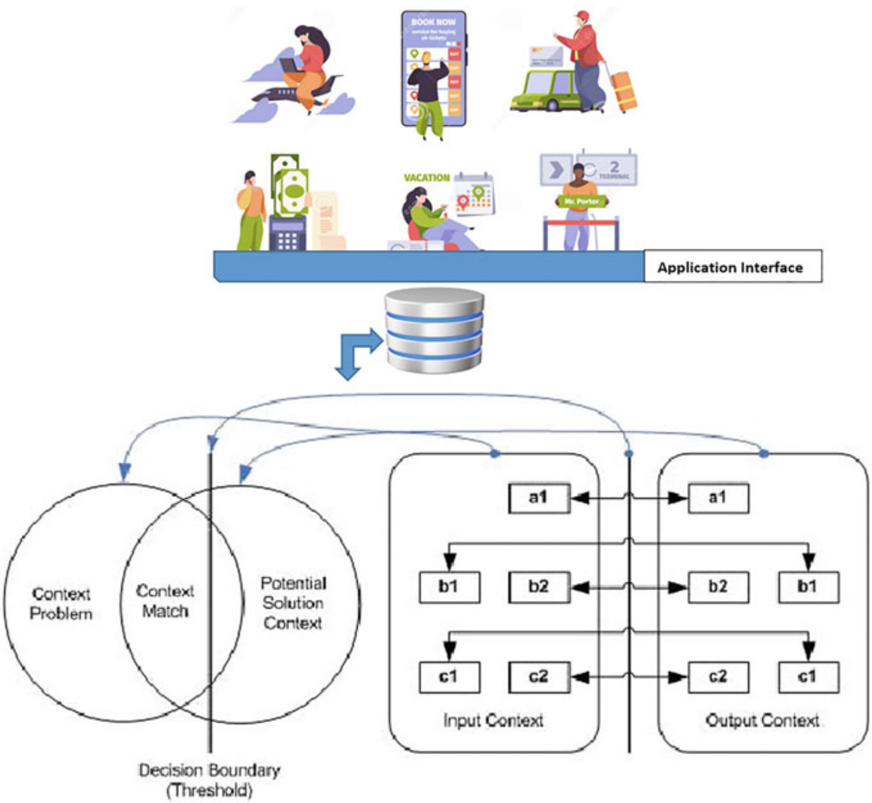


Fig. 1 The proposed model

- **Input Context** is a set of attributes of the context (an expert system to help users select the properties of the input context so that the result is optimal). Also, Input Context attributes in fellowship weather include status, temperature, humidity, rainfall, wind speed, etc.
- **Output Context is** a set of attributes of the context that is removed from the database and do not interact with the user, to be put into Context Matching algorithm for comparison with Input Context. In addition, Output context attributes among suitable locations for the weather are Places and Region.

The output of the algorithm after performing Context Matching Between Input Context and Output Context is a set of attribute values of Context Match [8, 9] (i.e., the set of values Output Context of the location matching Input Context) from the set Output context this can be inferred is that sites contain Input and display context for the user.

Weather information: state of the weather, temperature, humidity, wind speed, sunrise time, time wore sunset, suitable venue, etc.

- **Input Context**: Bad weather, temperature, humidity, level wind, etc.
- **Output Context**: Location Name, according to the model algorithm above-described process of Context Matching algorithm to search for entities based on research domain properties for weather information.

3.2 The Algorithm Context Matching and Steps

The main steps of this algorithm are described as follows:

- **Main idea**: the algorithm is based on algorithms Context Matching Algorithm using Rule bases. Input and output contexts in the context-matching algorithm are to check whether the output of tourism packages is matched for inputs of user preferences. In the period of introducing the model used in the proposed approach (Context- Matching) [7]. The terms and their definition are as follows:
  - ω_i^S : {0.1 ... 1.0} is a weight of each context property of human preferences.
  - e_j^s : {0, 1} is the Boolean value for each context property match true = [1] or false = [0].
  - $av_i^S = \omega_i^S * e_j^s$ is the Actual Value for each context property in the range {0.1 ... 1.0}.
  - $sav_j^S = \sum_{i=1}^{m} as_i^S$ is the sum of the actual values av_i^S.
  - $mpv_j^S = \text{argmax}(sav_j^S)$ is the maximum potential value that represents context property matches. The mpv_j^S assumes that a perfect context match has been identified.
  - $rv_j^S = \left(sav_j^S / mpv_j^S\right)$ – the resultant value in the range {0.1 ... 1.0}.
  - $\boldsymbol{t}$: the value for the decision boundary (threshold) in the range {0.1 ... 1.0}.

- **Describe the steps of the proposed algorithm in a rule-based approach** [7] **to the problem of searching for tourism are as follows:**
  - ***Step 1***: input human preferences for each individual context property: ***Kansei*** words as adjective pairs (Synonym—Antonym, Synonym—Not Synonym). ***Kansei*** words in X^S are used to evaluate an alternative with respect to criteria in domain *S*. Let $W_m^S = \{W_m^-, W_m^+\}$ be opposite pairs of Kansei words with respect to alternative W_m^S.
  - ***Step 2***: evaluate the context match for each context property ***Kansei*** word by using a posset of a Hedge algebra.
  - ***Step 3***: assign values of the linguistic variable Truth, such as True, VeryTrue, ProbablyFalse, and VeryProbablyFalse, which represents a set of generators (primary terms). $G = \{False, True\}$ using hedges from a set $H = \{Very, More, Probably, ..\}$ as unary operations.
  - ***Step 4***: evaluate the context match $\{1, 0\}$ for each individual context property, for example, $IF\left(X_i^S(input)\right).equalTo\left(X_j^S(output)\right)THENe_j^S = 1ElseIF\left((X_i^S(input)\right).notEqualTo\left(X_j^S(output)\right)THENe_j^S = 0$
  - ***Step 5***: Calculate resultant value (rv) for testing against the threshold value $(t) : rv_j^S = \left(sav_j^S \frac{}{mpv_j^S}\right)$.

Set threshold value $(\boldsymbol{t})$ for decision making if the output (Potential solution) context definition is matched with the input contexts. $\boldsymbol{IF(rv)} > decisionboundary(\boldsymbol{t})$ **THEN** context match = **true** [1] or **IF** (**rv**) is less than **(t) THEN** context match = **false** [0].

4 Experimental Results

In this paper, the experimental results have successfully built a search system based on weather Matching Context algorithms. The program has a full description of the functions and particularly the successful installation of context matching algorithms for location search function as follows: *(i) The tourism weather information lookups are completed correctly; (ii) Matching algorithm based on context may find the locations that fit user requirements rather than simply searching by place name or location coordinates; (iii) Compared to the application lookup weather information other than to merely predicted, the app also finds the right locations tha suit user requirements.*

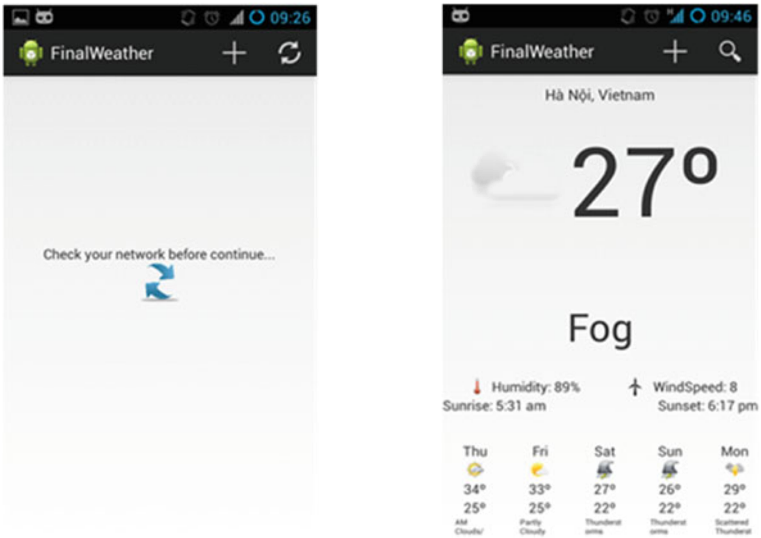
- **Describe the steps taken by the user as follows**:
  - ***Step 1***: The user enters the tourism weather information, such as weather conditions (tourism, sun, rain, cloudy, etc.), the highest temperature, lowest temperature, humidity, and wind speed.

– ***Step 2***: Based on the values entered by the user, the proposed model will execute the value of a location in the database and calculates the value f and w weighted values.
– ***Step 3***: The calculation formula represents threshold value ($\boldsymbol{t}$), compared to the value of the sample to give results TRUE or FALSE; if FALSE, then proceed to the value of the location next to calculate.

The comportments of the proposed model are as follows:

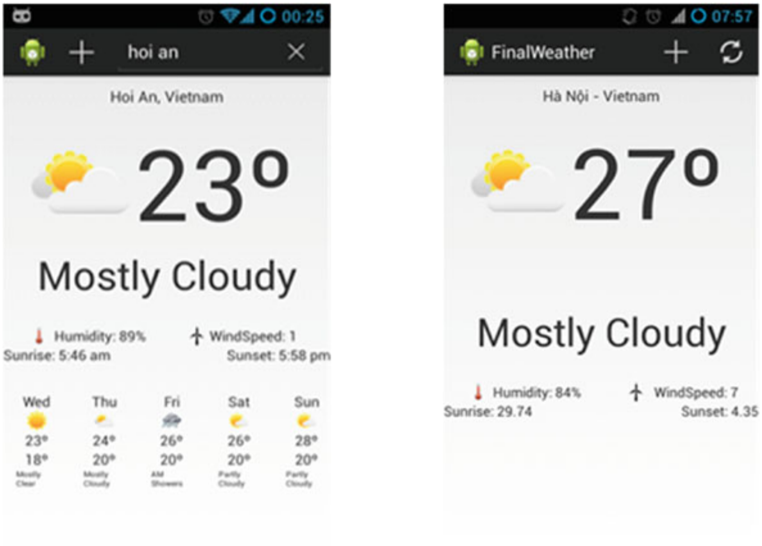
- **Interface devices**: The main interface is the first display when you switch programs or users to view the weather information and can search for information under the name of the place or switch interface information entered in search location. Lookup function weather information and display information:

  – When newly installed applications are running for the first time, when there is no data in the database, and no Internet connection, screen will display the interface manual for users in Fig. 5a.
  – When running the app for the first time and having no internet connection, the device relies on the GPS available to identify the coordinates of longitude, and latitude at the current location of the device to bring up the server, perform lookups weather information at the location coordinates with the coordinates properly received then send information to the device through the RSS link, the device will display the information on the main screen as shown in Fig. 2b.



(a) **(b)**

Fig. 2 The interface first app launch and displays tourism weather information at the current location of the device



(a) (b)

Fig. 3 The interface main screen and app home screen to run after no Internet

Besides, in addition to the automatic search locations by coordinates, the application can also lookup weather information by entering the name of your desired location as shown in Fig. 3a. Once you launch the app, but the next time, if it cannot connect to the Internet, the main screen will be based on the information stored in the database to display information from searches for the nearest previously shown in Fig. 3b.

- **Search interface**: at this interface, the user enters the information that you want, then finds a suitable site. Location search function matching the user's requirements:

After clicking on the icon "+" in the toolbar of the device, users will be switched to another screen to enter information about the weather such as the weather conditions, temperature, and humidity and users want to come up with a suitable site with a user's request. After receiving information entered by the user, the user clicks on the icon on the toolbar to run the search algorithm to give Context Matching place name matching attribute information weather described as in Fig. 4.

- **Interface information**: display information on the location, the scenic and beautiful images. Function display location information:

After clicking on the icon "+" in the toolbar of the device, users will be switched to another screen to enter information about the weather such as the weather conditions, temperature, and humidity and users want to come up with a suitable site with a user's

Fig. 4 The interface screen to enter information from the user

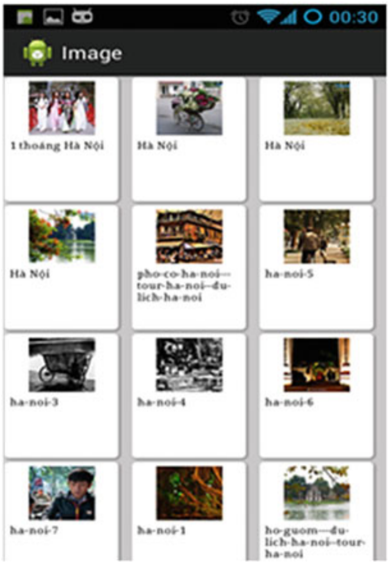


Fig. 5 Interface screen tourism location information

request. After receiving information entered by the user, the user clicks on the icon on the toolbar to run the search algorithm to give Context Matching place name matching attribute information weather described as in Fig. 5.

5 Conclusions

The experimental results show that the proposed model achieves improvements in matching user preferences. The proposed model has been applied using user preferences of tourism and weather during the COVID-19 Pandemic. Research results have shown features the advantage of finding the information sought under the approach personalized, contributed adapted user for current application service weather forecast on Smart Phone. Further development of an application will integrate smartphones with Web-based applications, improving the expert knowledge. With this development, the application on the Smartphone development towards a global approach ONE SERVICE an application can access and update the database on the Web-based applications.

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Analysis of Different Interference Mitigation Techniques Based on Bit Error Rate (BER) in 5G

Mithila Bihari Sah, Abhay Bindle, and Tarun Gulati

Abstract 5G technology is a revolutionized technology of wireless communication system, and it changes the way of communication as used before. It makes it easier for the user to communicate with any devices linked to the 5G network. 5G can provide a bigger data rate, low latency, low power consumption, higher energy efficiency, enhanced quality of experience (QoE), higher throughput, etc. One of the important technologies is the massive MIMO system, which is used in the 5G network to provide an effective and high-quality signal to each and every individual user. 5G is a highly efficient network and it increases the network capacity and spectral efficiency at an extreme level. The 5G network can connect a huge number of user equipment or appliances, which transmit different signals that cause high interference in the network. So Interference becomes a major issue in this network. There are various types of interferences in this network like inter-cell and intra-cell interference, inter-symbol interference, co-channel interference, interference from various connected machines, and interference from other connected devices. For resolving this issue, different linear and non-linear equalizers are used. In this work, the performance analysis of a network with massive MIMO system is done by using zero forcing, minimum mean square error (MMSE), and maximum likelihood (ML) equalizer algorithm, where zero forcing and MMSE are linear equalizers while ML being a non-linear equalizer. The BER analysis is accomplished under the Rayleigh channel using 4-QAM modulation. The present work has been analyzed and implemented using MATLAB R2020b. The simulation results show that the BER value is lesser for higher SNR value, and the ML equalizer gives the lesser BER among these three.

M. B. Sah (✉) · A. Bindle · T. Gulati
Maharishi Markandeshwar Deemed to be University, Mullana, Ambala, Haryana, India
e-mail: mithila.cts@gmail.com

A. Bindle
e-mail: abhaybindal@gmail.com

T. Gulati
e-mail: gulati_tarun@mmumullana.org

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Keywords 5G · Massive MIMO · Zero forcing-SIC · MMSE-SIC · Maximum likelihood · BER

1 Introduction

The next-generation mobile network technology is a heterogeneous network, which is also known as fifth-generation (5G) technology consisting of different small cells and nodes and it can be able to connect millions of devices to the networks. 5G technology has revolutionized the way people use mobile phones in the high-bandwidth environment. The user has never encountered such a high-value technology before. Cell phone (mobile) consumers nowadays are well-versed in technology [1]. 5G technology has a wide range of innovative features, making it the most powerful and in high demand in the near future. Under the new mobile operating system, 5G technology has exceptional data features, including the ability to connect unlimited call volumes and limitless data broadcast [2]. Since it can accommodate the most advanced devices and provide consumers with priceless handsets, 5G technology has a promising future. Perhaps in the coming days, 5G technology will take over the global market [3]. Future 5G cell networks would need to accommodate cell edge throughput in the range of tens of megabits per second (Mbps) and cellular bandwidth of several gigabits per second (Gbps). The usable bandwidth constrains current cellular spectrums below 6 GHz. Millimeter-wave (mm-Wave) bands (Ranging from 30–300 GHz) provide an alternative; because of that, they have a large amount of usable bandwidth. Because of the short wavelengths, lower order massive MIMO antenna arrays can be used on both the user equipment (UE) and the base station. Due to the usage of massive MIMO antenna arrays, significant beam-forming gains could assist in overcoming the high propagation losses across the mm-Wave frequency, and spatial reuse could help to reduce the interference observed with intra-cell and inter-cells [4]. Massive MIMO antenna array systems are a key component of 5G and it is operating in the mm-Wave band and are perfect for high-capacity transmission [5].

In 5G networks, there will be millions of connecting devices that may be mobile phones, wearable devices, smart devices, home appliances, and many more. Due to the huge amount of connection within the 5G network, interferences occur which may be inter-cell and intra-cell interference, co-channel interference, inter-symbol interference, interference from other devices, and interference from various machines connected in the 5G network. When a receiver receives signals from unintended transmitters, interference occurs, and the system's output suffers. As a result, the interference issue must be addressed to maintain high device efficiency and high Quality of Service [6]. For the elimination of the interference from the 5G networks, Equalization is performed at the receiver end. There are different equalizers, which are used for the detection of signals in the 5G network. In this paper, ML, Zero forcing-SIC, and MMSE-SIC equalizers are used for the elimination of interference in terms of the BER calculation of the massive MIMO system used in the 5G network.

In this work, the BER is calculated under the Rayleigh channel using 4-QAM modulation, and this work has been done by MATLAB R2020b. The BER values for these equalizers are evaluated and compared with each other. The results declare that the ML equalizer gives better BER values than that of zero forcing and MMSE equalizer.

The simulation of 4×4, 5×5, 6×6, 7×7, and 8×8 massive MIMO system and comparison of BER for various SNR values are involved in this study but it can be used for higher order massive MIMO system. The main objective of the paper is to identify better equalization techniques for mitigation of interference in terms of BER performance for 5G networks.

1.1 Massive Multiple Input Multiple output (mMIMO)

The next-generation wireless network is heterogeneous. Single transmitting and receiving antennas are unable to support next generation of wireless communication. For supporting reliable communication in the 5G network, the massive MIMO antenna system is used in the wireless communication network. The massive MIMO system is an extension of MIMO systems [7].

MIMO system contains an array of multiple antennas at the transmitting and receiving end of a communication system. To minimize the impact of multipath and to increase transmission efficiency without raising transmitted power or bandwidth, fading diversity techniques are extensively utilized in wireless communication systems. The diversity plan is a strategy for improving message signal strength in which several communication channels are used, each with its own set of characteristics. Since the individual channel has a different amount of interference, MIMO is one of the most effective techniques used to minimize Co-channel interference and multipath fading of the signal [8]. MIMO is a prospective new wireless communication technique that utilizes antenna arrays at both the source and destination to improve performance over traditional systems [9]. The key concept behind MIMO is that the transmitter and receiver antennas are paired and merged to boost the BER value or data rate for each user [10, 11]. In high-speed wireless networks, various purposes are served by a multiple antenna system. It improves connection reliability by increasing the instantaneous signal-to-noise ratio by reducing the ergodic error probability using techniques such as Beam-forming [11]. MIMO has distinct advantages, such as improved data speed and connection range without requiring additional capacity or transmission power. This is among the most common types of smart antenna technology. MIMO is a key component of current cellular networking standards like 4G, IEEE 802.11n (Wi-Fi), WiMAX, and 3GPP Long-Term Evolution because of these features [12, 13].

Massive MIMO technology has recently gained popularity due to its promise of truly broadband wireless networks [14]. Massive MIMO systems employ base station antenna arrays that consist of hundreds of elements to serve tens of thousands of active terminals (users) at the same time and frequency [15]. Due to a large number of antennas at both ends, Massive MIMO results in wireless channel diversity to offer more reliable maximum speed connections, multi-user spatial multiplexing, and large-scale application of high-gain adaptive beam-forming [16, 17]. Massive MIMO is also called by different names such as very large MIMO, multi-user MIMO, large-scale antenna system, full-dimension MIMO, and hyper MIMO [18–20]. Massive MIMO makes a significant change from current practice, which employs a bunch of service antennas (hundreds or thousands) that are completely coherent and adaptively controlled [19]. A huge range of antenna arrays will be a device requirement for 5G higher frequency band communication systems, such as millimeter waves (mmWaves), to combat the weak propagation characteristics within these bands [20].

Massive MIMO in dense deployment scenarios provides high data rates (10 s of Gbps) to a huge number of users; higher throughput; low latency, capacity, and link reliability; high spectral and energy efficiency; high degree of freedom, security enhancement, and robustness improvement; reduced network interference; and cost-efficient and simple signal processing [19–21]. To reduce harmful interference, Base Stations can easily divert transmission in unwanted directions, which results in low latency. Furthermore, massive MIMO makes effective use of beam-forming techniques to minimize fading and improve the BER, SNR, and latency [19].

1.2 Massive MIMO System Model

During Massive MIMO communication in a transmitter or receiver with several antenna elements, by using the high-dimensional wireless channel space characteristic, the data stream is divided into independent data streams, which have allocated the same time–frequency resources to the antenna port in parallel transfer, and then sent to the receiver for estimation of the channel transmission [22]. Let M and N be the transmitting and receiving antennas of massive MIMO systems as shown in Fig. 1. Consider **x** to be the transmitting signals, **r** to be the receiving signals, and n to be the AWGN (Additive white Gaussian noise), which is the generally used numerical simulation channel model.

The received signal is described by this model as the union of the transmitted signal and an additive white Gaussian noise [23]. The expression for received signal in jth Antenna is given by

$$\mathrm{r_j} = \sum_{\mathrm{k=1}}^{\mathrm{N}} \mathrm{h_{jk} X_k} + \mathrm{n_j} \tag{1}$$

where $\mathrm{j} = 1, 2, 3 \ldots \mathrm{N}$, $\mathrm{n_j}$ is the noise associated with receiver antenna j, $\mathrm{h_{jk}}$ is the fading associated with the passage from sending antenna k to receiving antenna j. The vector representation of the parameters is represented as follows.

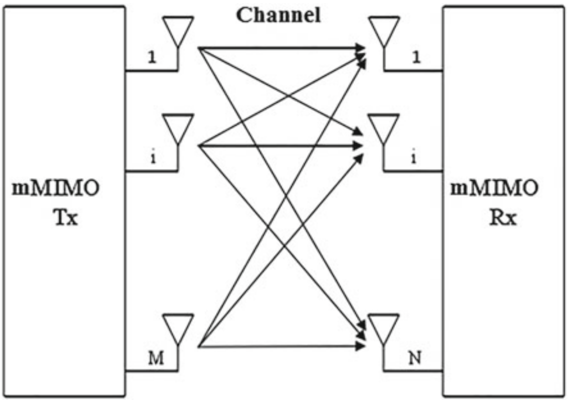


Fig. 1 Massive multiple input multiple output (mMIMO) system model

$$r = \begin{bmatrix} r_1 \\ r_2 \\ \vdots \\ \vdots \\ r_N \end{bmatrix} \tag{2}$$

$$x = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ \vdots \\ x_M \end{bmatrix} \tag{3}$$

$$n = \begin{bmatrix} n_1 \\ n_2 \\ \vdots \\ \vdots \\ n_M \end{bmatrix} \tag{4}$$

$$H = \begin{bmatrix} h_{11} & h_{12} & \cdots\cdots & h_{1M} \\ h_{21} & h_{22} & \cdots\cdots & h_{2M} \\ \vdots & \vdots & \cdots\cdots & \vdots \\ \vdots & \vdots & \cdots\cdots & \vdots \\ h_{N1} & h_{N2} & \cdots\cdots & h_{NM} \end{bmatrix} \tag{5}$$

The equivalent equation for the massive MIMO system is represented as follows:

$$\mathrm{r} = \mathrm{Hx} + \mathrm{n} \tag{6}$$

where
r = Matrix of Received Symbol,
H = Matrix of Channels,
x = Matrix of Transmitted Symbols,
n = Matrix of Noise.

2 Literature Review

In [8], the MIMO system model is described by the authors and explored channels and the different equalizers, which are used to improve the performance of the system by means of BER. In [8], the maximum ratio combining techniques, which is a linear equalizer, and ML, which is a non-linear equalizer, are used for calculating BER values. The authors concluded that for MIMO systems with the Rayleigh fading channels, BER analysis is performed by using BPSK modulation. The system BER performance with the ML equalizer is improved, and it increased the 2 × 2 MIMO system's performance.

In [9], the authors describe the salient feature of traditional MIMO and massive MIMO and investigated the BER performance under AGWN. The effect of perfect and imperfect channel state information is also invested through the Rayleigh fading communication channels.

The impact of linear and non-linear channel equalization on single-cell MIMO systems with equal antenna size at the receiver and transmitter is demonstrated in [10]. The achievable rates and energy efficiency performances of four-channel equalization algorithms, including zero forcing, MMSE, ZF-SIC, and MMSE-SIC, are investigated by the authors. The non-linear MMSE-SIC and ZF-SIC equalization methods improve the linear ones by 24–29% in terms of user attainable rates and energy efficiency. The authors justified the fact that linear channel equalization schemes do not fully suppress user interference for improved data transmission, whereas non-linear schemes use extra signal processing techniques such as SIC to provide improved user information transmission, resulting in higher receiver performance gains.

In [24], the authors describe the performance of massive MIMO and estimated spectral efficiency. The spectral efficiency was calculated by using different linear detection algorithms like maximum ratio combining (MRC), zero forcing receiver (ZF), and minimum mean square error receiver (MMSE) for an increased number of base station antennas.

In [25], the authors described the MIMO system and the noise channel like AWGN. The author considered a 2 × 2 MIMO system for analyzing the BER performance. This paper provided detailed information on the MMSE Equalizers and Zero Forcing that are used to calculate BER values. The authors compared 2 × 2 MIMO system BER performance by using zero forcing and MMSE through BPSK modulation.

In [26], the authors analyzed the performance of 2 × 2 and 4 × 4 MIMO systems by using zero forcing and MMSE techniques. The BER performance of MMSE is better than zero forcing because zero forcing only eliminates the interference while MMSE eliminates the noise also. This characteristic of MMSE makes it optimal for a wireless network. The authors concluded that the MMSE equalizer-based receiver gives better performance than the zero forcing equalizer-based receiver.

In [27], different equalizing techniques are implemented and their performances are compared. The author investigated the performance values of the MMSE-SIC and ZF-SIC equalization approaches. MMSE and LSE algorithms are used in training symbol-based channel estimation. As evidenced by earlier work in the wireless networking field, training symbols usually perform well. The author concluded that MMSE-SIC supplies a low BER value than the existing 4G that's why MMSE-SIC is used in next-generation 5G technology. 5G utilizes MIMO and OFDM because OFDM eliminates the ISI whereas MIMO can transfer multiple data at the same time through multiple channels from transmitters to receivers.

The researchers analyzed different equalization techniques for 4G or lower generation. The author of [8] used MRC and ML algorithm with BPSK modulation for 2 × 2 MIMO system, and the BER performance of MIMO and massive MIMO was estimated in [9]. Similarly, the author of [10] used zero forcing and MMSE for MIMO. The author of [25] also compares the BER performance for 2 × 2 MIMO system by using zero forcing and MMSE under BPSK modulation and the author of [26] compared the BER performance of 2 × 2 and 4 × 4 MIMO system using zero forcing and MMSE techniques. In the present work, zero forcing, MMSE, and ML equalizers are used for the next generation of wireless communication like 5G. The BER performance of 4 × 4, 5 × 5, 6 × 6, 7 × 7, and 8 × 8 massive MIMO systems are analyzed and compared for various SNR values by utilizing these equalizers.

3 Methodologies

Figure 2 shows the block diagram of the whole process, which describes how the signal is recovered at the receiver end of the system. The input bitstream is fed to the modulation, and here 4-QAM modulation is used. The modulated signal is fed to the channel encoder and the Rayleigh channel is used for transmission where AWGN noise is added to the signal. At the receiver end, the signal is detected and sent to the decoder. The decoded signal is fed to Equalizers, and here, Zero forcing, MMSE, and ML equalizers are used. After that, the signal is demodulated using 4-QAM and then the estimated signal is recovered.

The equalization technique is used to overcome ISI interference when more than one sample or pulse are superimposed on one another, creating channel noise, primarily due to overlapping periods or the propagation of multipath and frequency variations in the channel [10]. Equalizing methods can be classified into two groups

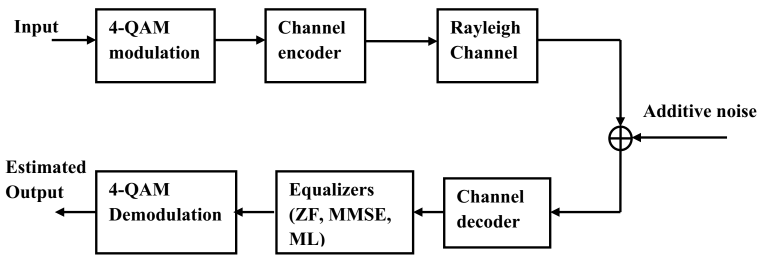


Fig. 2 Block diagram of massive MIMO System model

such as linear and non-linear equalization. These groups are defined by the use of the output of an adaptive equalizer used to control the equalizer subsequently [8]. The Equalization techniques are applied at the receiver end as depicted in Fig. 2. The receiver is supposed to have perfect channel status information. In addition, weights are dynamically computed for the equalizing filters [10]. In this paper, Linear equalizers such as Zero Forcing and MMSE equalizers with Successive interference cancelation and non-linear equalizer ssuch as ML equalizers are used but it is complex [28]. These equalization techniques are described briefly in the next section.

3.1 ZF-SIC Equalizer

ZF-SIC Stands for Zero forcing-Successive interference cancelation, which is the extension of the Zero forcing algorithm. Zero forcing equalizer is a type of linear equalizer used to reverse the frequency response of the channel in communication systems and was first proposed by Robert Lucky [10]. ZF equalizer operates the reverse of the signal distortion channel if no noise exists and the inter-symbol descends before the channel [10, 24]. C(f) is the Zero Forcing Equalizer, which is expressed by $\mathrm{C(f)} = 1/\mathrm{F(f)}$ where f denotes the channel frequency response [25]. The equalizer and channel combination provides a flat frequency response and linear phase $\mathrm{F(f)C(f)} = 1$ [26].

Zero Forcing equalizer prevents pilot contamination interference. Since ZF Equalizer can successively retrieve Inter-Symbol Interference (ISI) in massive MIMOs, the distributed form of the SNR is suffering from greater accuracy to increase the probability of symbolic errors (SEP). In multipath environments, the ZF equalizer can apply to cancel the ISI [29]. Indeed, to optimize the detection of retrieval signals, the application of a ZF equalizer must increase the number of antennas [21]. The Zero forcing technique is based on the $\mathrm{r} = \mathrm{Hx} + \mathrm{n}$. For solving x, we have to find the W matrix that satisfies $\mathrm{WH} = \mathrm{I}$, [30] and the equation of W for Zero forcing is expressed as follows.

$$\mathrm{W} = \mathrm{P}_{\mathrm{inv.}}(\mathrm{H}) = \left(\mathrm{H}^{\mathrm{H}}\mathrm{H}\right)^{-1}\mathrm{H}^{\mathrm{H}} \quad (7)$$

where

W = Weight Matrix or Matrix of Equalization and

H = Matrix of Channel.

The Equalization matrix W is also called the pseudo inverse matrix of H.

By using the zero forcing equalizer in massive MIMO, the Bit error rate (BER) can also be calculated. The expression for BER is given by the following equation.

$$P_b = \frac{1}{2}\left(1 - \sqrt{\frac{\left(\frac{E_b}{N_o}\right)}{\left(\frac{E_b}{N_o}\right) + 1}}\right) \tag{8}$$

where

P_b = BER (Bit Error Rate) and

E_b/N_o = SNR (signal-to-noise ratio).

Zero forcing-SIC works in three steps as follows:

1. Requesting—To apply for a decision of the stream transmitted with the least differences in blunder.
2. Impedance Nulling—An estimation by nulling any flimsier flag of the most grounded transmitted flag.
3. Scratch-off impedance—Demodify the bits of information, deduct their commitment from the flag vector, and return to the required step [27].

3.2 MMSE-SIC Equalizer

MMSE-SIC represents minimum mean square error-successive interference cancelation and it is utilized to minimize a mean square error that represents a normal percentage of estimator quality [27]. The ZF equalizer is used to remove all linear distortions, but noise is greatly increased when the channel response is small in size. The MMSE Equalizer is a better equalizer to accommodate the total noise channel power and partly eliminate ISI distortion [10]. The reduction of mean square error is the main idea of the minimum mean square error detection algorithm [31]. Improving post-recognition signals-to-interference plus noise (SINR) by expanding the obtained signal with the weight matrix of MMSE would decrease the interference [11]. Let us consider x and y to be unknown and known variables, respectively. An x^y estimator is a measurable function of y and its mean square error (MSE) is expressed as follows:

$$\mathrm{MSE} = \mathrm{E}\left(X^{X^2}\right) \tag{9}$$

where both x and y are taken into consideration.

We obtain an overall estimator MMSE and are known as the linear MMSE estimator by following the term AY + b. A and b are matrices and vectors, respectively, if the Y measurement is a random vector [26]. MMSE technique is based on the r = Hx + n. For solving x, W matrix can be calculated that satisfies WH = I, and the equation of W for MMSE is expressed as follows:

$$W = P_{inv.}(H) = \left(H^H H + N_o I\right)^{-1} H^H \tag{10}$$

Now if we compare the value of W for zero forcing and MMSE, both the equations are comparable except for the term N_oI. The MMSE equalizer functions as a zero forcing equalizer if the noise term value is zero [26].

3.3 Maximum Likelihood (ML) Equalizer

The best approach for retrieving the transmitted signal at the receiver end is to use the ML equalizer algorithm. The ML equalizer method compares incoming signals among all possible transmitted signal vectors that have been modified by channel matrix H and uses the ML theorem to predict the send symbol vector x [12]. For the case of a linear time-invariant data transmission system, the ML method gives the optimal joint detection for the symbol vector y, which is transmitted by each antenna during a symbol interval. If the transmitted information symbol vectors have identical probability, ML is equivalent to the cost function given in Eq. (11) [23]. The interference channel model is modified for the AWGN channel, that is r = Hx + n. The expression for maximum likelihood equalizer is given as follows:

$$x = \arg_{xk} \in \{x_1 x_2 x_3 \cdots x_R\} \min \|r - Hx_k\|^2 \tag{11}$$

The estimated symbol vector is denoted by x. While ML detection has the best error efficiency, it has a lot of complexity [32]. It has exponential complexity in the sense that the receiver must consider $|A|^M$ possible symbols for a M transmitter antenna device with A as the modulation constellation [12].

4 Results

The interference mitigation techniques like zero forcing-SIC, MMSE-SIC, and ML are simulated by using MATLAB R2020b software. In the simulation, the Bit Error Rate (BER) values are calculated for various values of signal-to-noise ratio (SNR) E_b/N_o. Simulation Parameters used for massive MIMO systems are described in Table 1.

The BER analysis of various orders of massive MIMO for different equalizers like ZF-SIC, MMSE-SIC, and ML is done and simulated by MATLAB R2020b, and all the simulated outcomes are represented by means of BER and SNR as shown in

Table 1 Simulation parameters

Parameters	Values
No. of transmitting antennas	4–8 arrays
No. of receiving antennas	4–8 arrays
Channel model	Rayleigh's channel
Noise model	AWGN (Additive white Gaussian noise)
Modulation technique	4-QAM

the figures. In this paper, 4–8 Arrays of massive MIMO systems are considered for BER calculation and analysis.

Figure 3 shows different BER values for various E_b/N_o values for the 4 × 4 massive MIMO system under the Rayleigh channel using ZF-SIC, MMSE-SIC, and ML equalizer. Figure 3 also compares these equalizers by calculating the BER value. Simulation results are represented in the form of a graph, that is BER versus Signal-to-noise ratio (E_b/N_o). BER scale is taken from 0 to 10^{-5} and E_b/N_o is taken from 0 to 20. The BER values are in the range of 10^{-2}–10^{-5} for increasing values of signal-to-noise ratio. The graph follows the zigzag pattern for high SNR values for MMSE-SIC.

Figure 4 also shows various BER values for various E_b/N_o values for the 5 × 5 massive MIMO system under the the Rayleigh channel using ZF-SIC, MMSE-SIC, and ML equalizer. Simulation results are represented in the form of a graph, that is BER versus Signal-to-noise ratio (E_b/N_o). The same scale is used for BER and E_b/N_o as in the previous figures. If the SNR increases, then the BER value decreases as in the range of 10^{-5}.

The BER values for several values of SNR (E_b/N_o) for the 6 × 6 massive MIMO system under the Rayleigh channel using ZF-SIC, MMSE-SIC, and ML equalizers

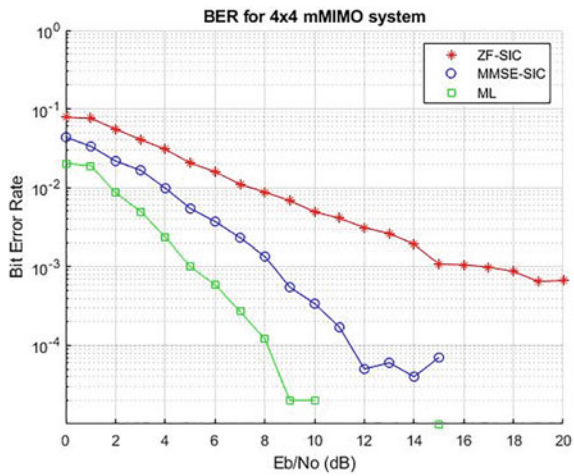
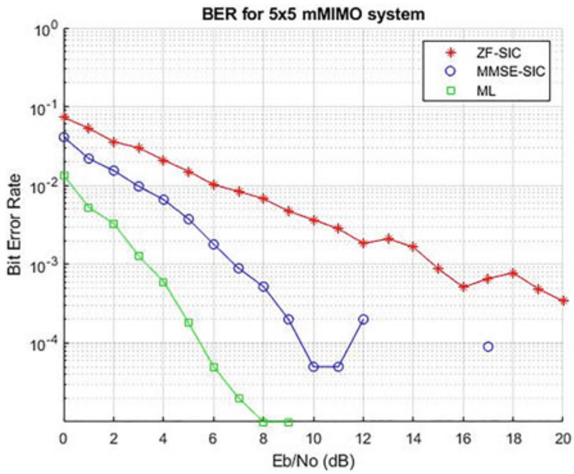


Fig. 3 BER comparison analysis for 4 × 4 massive MIMO under the Rayleigh channel

Fig. 4 BER comparison analysis for 5 × 5 massive MIMO under the Rayleigh channel

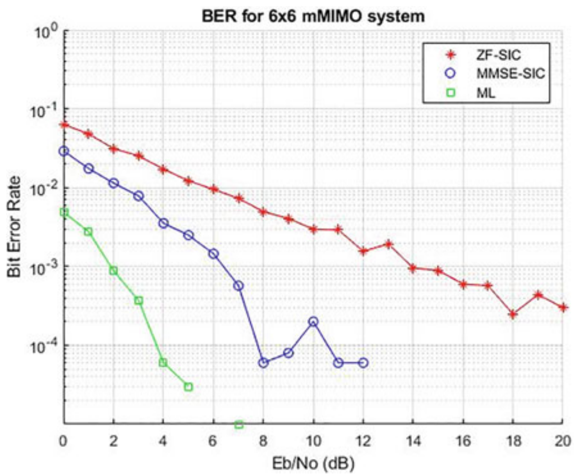


are shown in Fig. 5. The same scale is used for BER and E_b/N_o as in the previous Figures. In Fig. 5, BER values for 6 × 6 massive MIMO systems are shown, which are lesser than lower order massive MIMO systems and are in the range of 10^{-5} or less. The graph also follows the zigzag pattern for higher values of SNR.

Figure 6 compares the different equalizer that is used in this paper. The BER values are analyzed for several values of E_b/N_o by using ZF-SIC, MSE-SIC, and ML Equalizer with the 7 × 7 massive MIMO system under the Rayleigh channels. This figure also shows the BER values for the ML equalizer, which are in the range of 10^{-5} or lesser than 10^{-5}.

Figure 7 is for 8 × 8 massive MIMO system and it also compares the BER values of these three equalizers, which are used in this paper. It shows that the BER value

Fig. 5 BER comparison analysis for 6 × 6 massive MIMO under Rayleigh channel



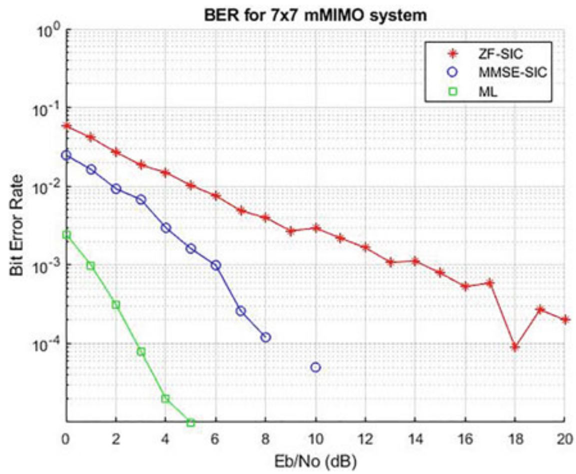


Fig. 6 BER comparison analysis for 7 × 7 massive MIMO under the Rayleigh channel

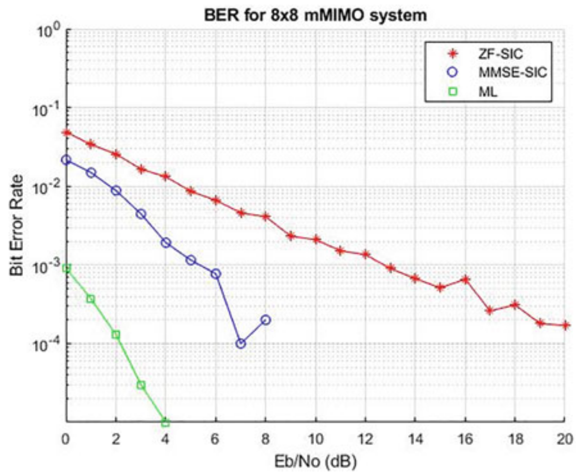


Fig. 7 BER comparison analysis for 8 × 8 massive MIMO under the Rayleigh channel

using zero forcing-SIC lies in the range of 10^{-3} while for MMSE-SIC, it is in the range of 10^{-4} but for ML, BER values are lesser than 10^{-6}. The figure also shows that for higher values of signal-to-noise ratio, the BER values are approximately zero.

5 Discussion

Table 2 shows the simulation results of various orders of the massive MIMO system using Zero Forcing-SIC, MMSE-SIC, and ML.

Table 2 BER comparison between different equalizers for a different order of massive MIMO system

Order of mMIMO	E_b/N_o (dB)	Bit error rate		
		ZF-SIC	MMSE-SIC	ML
4 × 4	3	0.040726	0.0165921	0.00496302
	4	0.0305566	0.0097893	0.00233079
	5	0.0205231	0.00540346	0.00100064
5 × 5	3	0.0300038	0.00974679	0.00127243
	4	0.02099	0.00661	0.0006
	5	0.01506	0.00374	0.00018
6 × 6	3	0.025278	0.00783937	0.00036997
	4	0.0171386	0.00352972	5.99952×10^{-5}
	5	0.012209	0.0024898	2.99976×10^{-5}
7 × 7	3	0.0185596	0.00675986	7.99984×10^{-5}
	4	0.0149097	0.00295994	1.99996×10^{-5}
	5	0.0102498	0.00160997	1×10^{-5}
8 × 8	3	0.01643	0.00445	3×10^{-5}
	4	0.01319	0.00191	1×10^{-5}
	5	0.00858	0.00115	$<1 \times 10^{-6}$

The BER values are calculated for different values of E_b/N_o. For 4 × 4 massive MIMO system at 3 decibel SNR, the BER value is 0.040726 for ZF-SIC, 0.0165921 for MMSE-SIC, and 0.00496302 for ML while for 5 × 5 massive MIMO system, the BER value is 0.0300038 for ZF-SIC, 0.00974679 for MMSE-SIC, and 0.00127243 for ML. For 6 × 6 massive MIMO system at 3 decibel SNR, the BER value is 0.025278 for ZF-SIC, 0.00783937 for MMSE-SIC, and 0.00036997 for ML while for 7 × 7 massive MIMO system at 3 decibel SNR, the BER value is 0.0185596 for ZF-SIC, 0.00675986 for MMSE-SIC, 7.99984×10^{-5} for ML. Also for an 8 × 8 massive MIMO system at 3 decibel SNR, the BER value is 0.01643 for ZF-SIC, 0.00445 for MMSE-SIC, and 3×10^{-5} for ML.

We can see from this data that at 3 decibel SNR, the BER value decreases for an increase in the order of massive MIMO for corresponding equalizers. For the Bit Error Rate values at 4 and 5 decibel, SNR is also down in the same pattern as for 3 decibels. Now for the same Massive MIMO system, the BER value for the ML equalizer is smaller than the MMSE-SIC equalizer and the MMSE-SIC BER value is smaller than the ZF-SIC BER value. This analysis shows ML equalizer is the efficient equalizer for the lowest BER value, which provides negligible interference in the network. From Table 2, it is shown that among these three equalizers, the Maximum Likelihood equalizer is better for the achievable BER value. This means for the lower BER values, the interferences are also lesser for the higher order Massive MIMO system.

6 Conclusion and Future Work

The next-generation wireless communication system is a more efficient network as compared to the previous generation networks. The massive MIMO system is the key enabling technology for the 5G network and provides high quality of service (QOS) to each user within the networks. The 5G network is highly complex because there are millions of devices connected to the network. BER is defined as the ratio of bit error number and the total number of transmitted bits. In this paper, the BER is calculated with the help of a SNR which means BER values are directly linked with the interference presented in the network. Here, some interference mitigation techniques are used to calculate the BER values. MMSE, Zero forcing, and ML equalizers are used to eliminate interference from the networks. By analyzing all the Figures from 4 × 4 to 8 × 8 massive MIMO, it is obvious that the BER values of the system calculated by using the equalizers (ZF-SIC, MMSE-SIC, and ML) declined for a higher order of the massive MIMO system. It means that a higher order massive MIMO system gives better quality of signals to the users in the network with negligible interference. That's why the massive MIMO system is enabling technology for the next-generation wireless mobile network. Now existing 4G technology generally uses the MIMO system, and the BER performance is higher than the BER performance of massive MIMO. That's why massive MIMO is proposed to use for next-generation wireless communication networks. Table 2 also compares these equalizers that are used in this paper, and it is found that the ML equalizer is the optimal equalizer that provides negligible BER values as compared to ZF-SIC and MMSE-SIC. ZF-SIC eliminates only the inter-symbol interference, but MMSE-SIC reduces noise also. Due to the computational complexity of the ML equalizer, it is difficult to implement, and after that, MMSE-SIC is the next optimal equalizer, which also provides very little BER values; therefore, MMSE-SIC is mostly used for better performance of the network.

There is a lot of scope in the sector of wireless and mobile communication systems. There are a lot of research, which are going on in this field. It is clear that an ML equalizer is better for reducing the interference from the network, but it is difficult to implement. For reducing the computational complexity of the ML equalizer, it is required to research heuristic and optimization algorithms shortly, which make it easy for calculation and implementation. This field has lots of potential for young researchers, who want to pursue their research based on the future wireless communication networks.

Conflicts of Interest The authors have no conflicts of interest to declare.

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Study and Development of Efficient Air Quality Prediction System Embedded with Machine Learning and IoT

Kaushal Kishor and Dilkeshwar Pandey

Abstract We all know that the air is essential for the existence of mankind but it is getting polluted due to the sundry activities being conducted by humans. The concept of air monitoring is old but a paramount concept for all of us. Air pollution monitoring solutions were commenced long back but were still intricate in some ways. A modern technology available today is simple, expeditious, facile to implement, and gives precise data. There are different technologies that we have utilized for presenting our conception. In the present scenario, the air quality inside the house is worse compared to the air outside due to the sundry activities which we perform customarily. This is earnest issue we require to work on. Considering this situation, air monitoring is not enough. We additionally need to add purification systems that would help to live a salubrious lifestyle. The main aim and goal of this paper is to highlight some of the advanced technologies which can be used to analyze, monitor, and purify the air, how efficacious these technologies are and to study the paramount researches in this particular area. These advanced technologies are propitious in doing the analyses of air quality and find a solution to these issues that are arising due to air pollution.

Keywords IoT (Internet of Things) · Air quality · Real-time monitoring · European commission (EC) · U.S. Environmental Protection Agency (EPA) · CWSN (Wireless Sensor Network) · WHO (World Health Organization) · MEP (Ministry of Environmental Protection) · EDP (Environmental Protection)

K. Kishor (✉)
Department of Information Technology, ABES Institute of Technology, Ghaziabad, Uttar Pradesh, India
e-mail: kaushal.kishor@abesit.in

D. Pandey
Department of Computer Science and Engineering, KIET Institute of Technology, Ghaziabad, India
e-mail: dilkeshwar.pandey@kiet.edu

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1 Introduction

Monitoring is a methodical approach to analyze and examine anything. Likewise, environmental monitoring is the process of assessing and examining the condition of the environment. For salubrious human life, we all require to inhale clean and pristine air. In modern times, industrialization is at the boom to accomplish the requisite of people. Conveyance along with the smokestack industries and homes, is the major cause for air pollution. An instrumentation in traffic leads to a more preponderant amplitude of pollutants in the air. As a consequence, in order to monitor the effects of this contamination on the atmosphere and human health, it is important to track the amount of pollution in various locations. There are a variety of contaminants in the air, with a mixture of solid and liquid dissolved substances in the air, as well as other gases such as NO_2 or CO. Today diseases like cancers, emphysema, bronchitis, and asthma have become very prevalent. Ergo, to tackle this quandary we require an air monitoring system and to purify air to a certain level we require an air purification system. The aim of air monitoring is not only to collect data, but also to provide usable knowledge to scientists and other organizations so that they can better control the atmosphere [1]. The primary goal of an environmental monitoring and purification device is to track emission levels and purify the air to a minimum standard so that citizens can breathe safely.

1.1 The Demand for Monitoring

Any human being requires clean air to survive. Today's air contamination levels have increased to the extent that it is triggering astringent diseases and losses. As a result, in order to regulate this metric, we first need an environmental measurement device so that we can learn about air emissions and emission rates, which can help us control them at the appropriate period. There are many sources of environmental contamination, including vehicle emissions, chemical discharge from factories, and so on. Gases like CO, SO_2, NO_2, and traffic-cognate pollutant emission are affecting directly on human life. As per the report of USA REPORT, pollutants in the house are so much hazardous that it could kill the person living in the house [2] This betokens, pollutants inside the buildings are higher than outside the buildings. To recuperate from this issue, we require applying astronomically immense efforts to amend the air quality of indoor and Alfresco altogether and ergo we require detecting the air quality and purifying it for a safe and salubrious environment. With an increase in computational data available for evaluation and the need for highly accurate estimates in a variety of scientific areas and domains, machine learning (ML) models have received interest, attempting to establish themselves as a solution that can replace more traditional predictive methods in time-series forecasting. ML algorithms, in particular, have been frequently used to forecast air quality [3, 4].

Due to the high nonlinear processes that comprise pollution concentrations and their imperfectly understood dynamics, developing a model capable of anticipating these types of disasters is particularly difficult. ML models are nonparametric and nonlinear models that discover the underlying relationship between variables using only historical data. When predicting time series (TS) with a high level of nonlinearity, machine learning (ML) approaches such as artificial neural networks (ANNs), [5, 6] genetic programming (GP), and support vector machines (SVMs) beat ARIMA.

1.2 Air Quality Indexing

The air pollution rate is quantified and analyzed according to the criteria predicated on in a different country in the world. Several agencies were present in the world like (EPA) U.S. Environmental Auspice Agency, WHO (World Health Organization), EC (European Commission), MEP (Ministry of Environmental Bulwark), and EDP (Environmental Aegis) which have established several number of air pollution analyses of different standards [7]. AQI is acting as an instrument that generates category-based air pollution data and provides information related to the quality of air by calculating the pollution statistics and present it in the form of a report. Different countries utilize a variant of AQI to interpret air quality. An AQI is helpful in divers' ways such as facile interpretation of air by the public [8]. Therefore, some air pollutants are defining the criteria of air pollutant. These pollutants can affect the health and harm the environment [9–11]. Some criteria pollutants are discussed in this research paper which are as follows:

(1) Carbon monoxide (CO),
(2) Lead (Pb),
(3) Nitrogen dioxide (NO_2),
(4) Ozone (O_3),
(5) Particulate matter (PM), and
(6) Sulfur dioxide (SO_2).

Air Quality Standards

For each of the criterion contaminants, the OAQPS (Office of air quality preparation and standards) is establishing a "Global Ambient Air Quality Standard" (NAAQS). NAAQS defines two types of standards: main and secondary.

(1) Primary standards: The primary goal of this norm is to guard from negative health consequences.
(2) Secondary standards: They guard against negative impacts on welfare, such as disruption to agricultural crops and trees, as well as damage to structures.

Existing AQI Indexing: Air Quality Index values help to distinguish the air pollution situation into categories [12, 13] (Table 1).

Table 1 List of all criteria pollutants and standards by NAAQS [14]

Pollutant	Primary/secondary	Averaging time	Level	Form
Carbon monoxide (CO)	Primary	8 h	9 ppm	It is not recommended to optimize more than once a year
		1 h	35 ppm	
Lead (Pb)	Primary and secondary	Rolling average of 3 month	0.15 g/m^3	It is not enough to go above and beyond
Nitrogen dioxide (NO_2)	Primary	1 h	100 ppb	Averaged over 3 years, the 98th percentile of 1-h daily gross concentrations
		1 year	53 ppb	Annual mean
Ozone (O_3)	Primary and secondary	8 h	0.07 ppm	Averaged over 3 years, the annual fourth-highest daily overall 8-h concentration

2 Literature Review

Subsisting model for air monitoring system utilizes the conventional method, which presents the result in 2D form. This method incorporates a single use of laser at center of area and these lasers rotate around in circle on the circumference of circle. This mechanism endeavors to minimize transmitted laser energy and enhance the coverage range of pollutant source [15]. Another way to track air quality is to use GPRS sensors, which have been created, deployed, and evaluated. The system consists of microcontroller and pollution server with Internet connectivity. It provides authentic-time data of pollutants at sundry locations [16]. With the development in science and engineering techniques, today, bid hardware contrivance has been superseded with the sensors nodes which are connected to the cyberworld and sundry other contrivances. These sensors are connected to the microcontroller such as Android. In this technology, the sensors nodes can be placed anywhere so that they can sense environment and transmit the data for further processing [17] (Table 2).

3 Proposed Methodology/Architecture

Considering the present scenario of air pollution, we have proposed a model for an air monitoring and purification system. This system utilizes the IoT technology which could facilely operate by the utilizer from anywhere. The system performs two major operations, i.e., monitoring and purification. All the processes are controlled by microcontroller known as Arduino. The proposed model's objective is to detect

Table 2 Color code AQI

AQI	Remarks	Color code	Possible health impact
0–50	Good	Green	Minimal consequences
51–100	Satisfactory	Light green	Sensitive people can experience minor breathing pain
101–200	Moderate	Yellow	People with lungs, asthma, and cardiac problems have trouble breathing
201–300	Poor	Dark yellow	Most people feel respiratory irritation after extended exposure
301–400	Very poor	Red	Long-term contact induces respiratory disease
401–500	Severe	Dark red	Affects good individuals as well as others who still have illnesses

the degree of air emissions and conduct the required operations. This single-board allows users to change their settings, read data from sensors, and monitor various contrivances. We used a less expensive ESP8266 Wi-Fi module with an AT command library in this project. It authorizes the Arduino to use a Wi-Fi network to link to the Internet. Furthermore, the ESP8266 chip has a complete TCP/IP protocol stack [18, 19]. To measure the air quality, we have utilized the gas sensors that are connected to the Arduino which is a microcontroller. As the gases are sensed by the sensors, data is sent to the server for calculation, and then it performs the necessary operations. If the air quality is higher than the AQI standard, then relay will switch ON and purification process will commence. In the purification, we will have utilized different filters (such as HEPA filter, pre-filter, and carbon filter) to filter the air. As anon as the air quality inside the room is mundane according to the AQI, the machine procures its ideal state. The model would be controlled by Android app which will be facile to operate [20].

The purifiers available in the market are utilizing traditional methods and require an abundance of human effort for the working. Whereas the purifier proposed by us is advanced version of the old purifiers as we are utilizing the latest technology for the better result and processing of the purifier. Our air purifier is IOT predicated and can be controlled from anywhere with the avail of mobile application. It has few kindred features as the old ones. It requires less human effort and can be accessed by just one click. The purifiers currently available in the market are comparatively costly and consequently are not facile to afford. Functioning of the purifier is intricate and requires manual effort for the processing/purification. In our purifier, the data is provided through sensor and on the substructure of that data, the Arduino compares the air quality with the air quality standards and purifier then purifies the air if needed. Data is stored on cloud and can be utilized for further researches to amend the quality of the air purifier. A smartphone application has also been built to make the system easier to use. There are two operations that could be performed by the mobile application which are turning the system ON or OFF and secondly view the status of the purifier.

Some key features of our proposed air purifier are as follows:

- Low cost for manufacturing.
- Can be controlled from anywhere.
- Facile to utilize.
- Lower power consumption.
- Data can be preserved on cloud for further research and updates.
- Utilization of IOT contrivances for better results.

3.1 Proposed Algorithm

1. Start.
2. Connect the IoT device.
3. Take input from sensors (to be taken from different types of sensors in ppm).
4. Arduino (to check the AQI for the functionality with the help of input taken by sensors).
5. Take input from sensors and save that on server (with the help of WIFI ESP8266).
6. Calculate AQI, $\mathbf{I} = \left(\left(\mathbf{I_{high}} - \mathbf{I_{low}}\right) / \left(\mathbf{C_{high}} - \mathbf{C_{low}}\right)\right) * (\mathbf{C} - \mathbf{C_{low}}) + \mathbf{I_{low}}$

where

I = air quality index (this formula is used to check the AQI with the help of inputs taken from the sensors in ppm).

C = pollution concentration (that is taken from the sensors).
C_{low} = when the index value is less than equal to C (that is, lowest value of C_{low} according to the value of C which is to be taken from the EPA table).
C_{high} = when the index value is greater than equal to C, (that is, highest value of C_{high} according to value of C which is to be taken from the EPA table).
I_{low} = when the index value is corresponding to C_{low} (that is, lowest value according to the value of C_{low} which is to be taken from the EPA table).
I_{high} = when the index value is corresponding to C_{high}, *(that* is, lowest value according to the value of C_{high} which is to be taken from the EPA table).

Table 3 Dataset

Date and time	CO2	LPG	CO
03-02-2021 Time: 12:29 pm	523	425	15
03-02-2021 Time: 12:32 pm	527	454	13
03-02-2021 Time: 12:35 pm	545	452	14
03-02-2021 Time: 12:40 pm	541	446	12
03-02-2021 Time: 12:43 pm	539	425	16
03-02-2021 Time: 12:48 pm	542	440	15
03-02-2021 Time: 12:50 pm	529	445	12

1. If(I>=α)

{
Relay will switch turn ON (the purifier will be turn on for purification)
Then Purification System work
}

1. Else

{
return to step 1(to check the AQI by following above steps again)
}

2. Mobile App (to control the device and check the AQI)

{
Control IoT device (ON/OFF)
Show the activity of device (to show the AQI and other
Gases density in ppm)
} Stop

Dataset and Analysis
See Table 3.

Genetic Algorithm—ANN Model
GA (genetic algorithm) is used to select a learning set and corresponding validation sets are generated according to each chromosome and used to construct RBF neural network and GA selected factor apply on ANN for modeling and testing. These datasets are also used for performance evaluation.GA-ANN model to efficiently predict and monitor on air quality [21, 22] (Fig. 1).

Flowchart→ The working of proposed model air monitoring and purification system flowchart is described in Fig. 2.

In this model, IoT device is connected to the network devices and with the help of sensor and Arduino Uno devices analyze the air quality if sensor value is greater than threshold value and then air purification system is switched ON (Fig. 3).

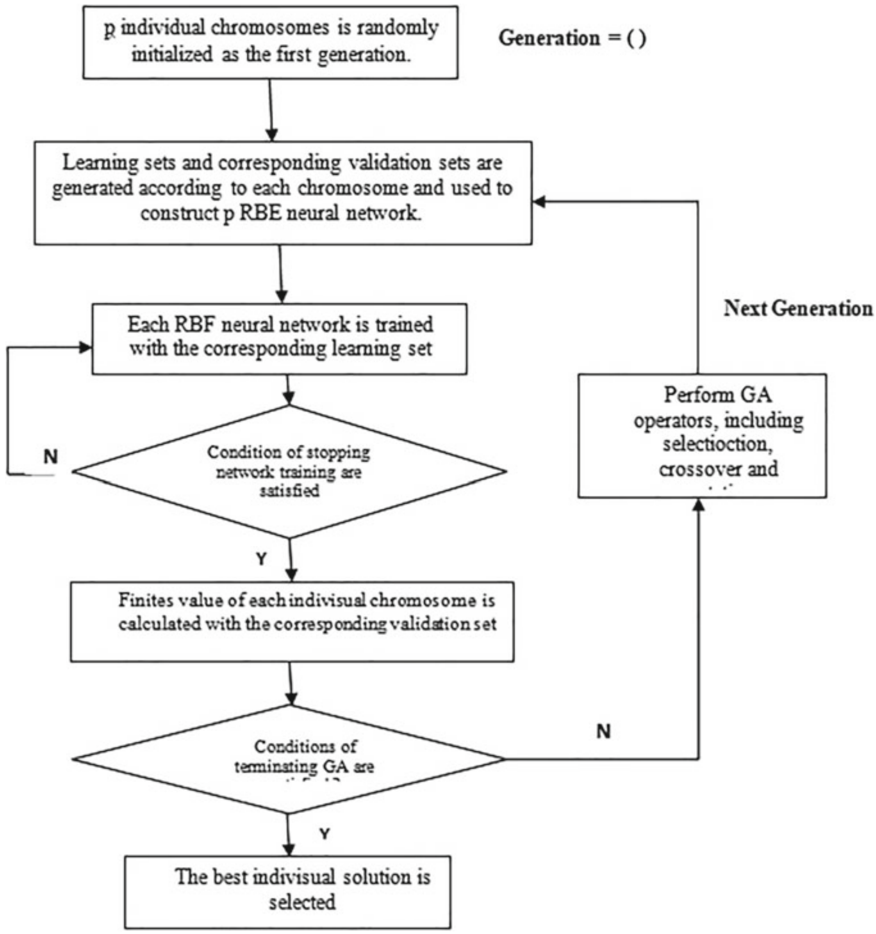

Fig. 1 Flow of genetic algorithm-based ANN

Computing the AQI

The AQI is used to measure the amount of emissions in the air (air quality index). These estimated or projected reports were transmitted to the public and publicly posted details about how toxic the environment is now or may become in the future. As a result, AQI focuses on the health consequences you can experience in a moment or for several days after consuming dirty air. The air quality index is a linear function of pollutant intensity and is directly proportional to it. A discontinuous leap of one AQI unit occurs at the boundary between AQI groups. To transform from focus to AQI, use the following equation:

$$\left(\left(\mathbf{I}_{\mathbf{high}} - \mathbf{I}_{\mathbf{low}}\right) / \left(\mathbf{C}_{\mathbf{high}} - \mathbf{C}_{\mathbf{low}}\right)\right) * \left(\mathbf{C} - \mathbf{C}_{\mathbf{low}}\right) + \mathbf{I}_{\mathbf{low}}$$

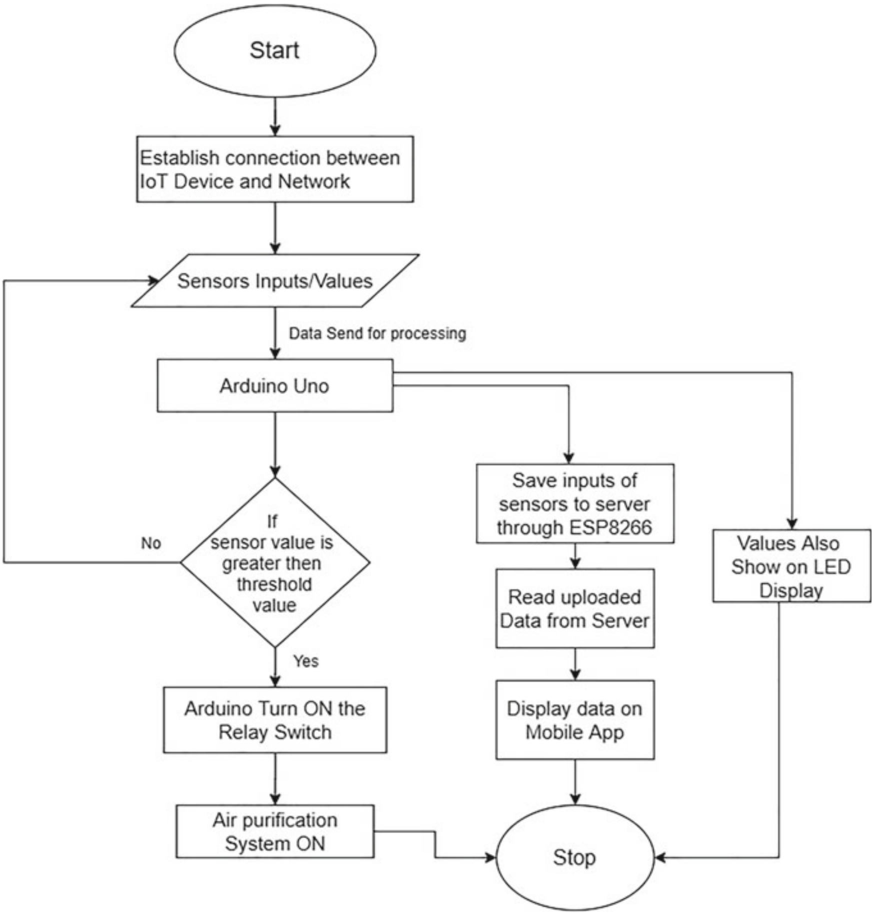

Fig. 2 Working flowchart of air monitoring and purification system

The EPA's breakpoint table is as follows: assume a 24-h average fine particle (PM2.5) concentration of 12 µg per cubic meter is measured on a camera. Calculate the AQI effect using the formula given above:

$$((\mathbf{50}-\mathbf{0})\ /\ (\mathbf{12.0}-\mathbf{0}))\ *(\mathbf{12.0}-\ \mathbf{0})\ +\ \mathbf{0}\ =\ \mathbf{50}$$

The level of air quality corresponds to a good range (Table 4).

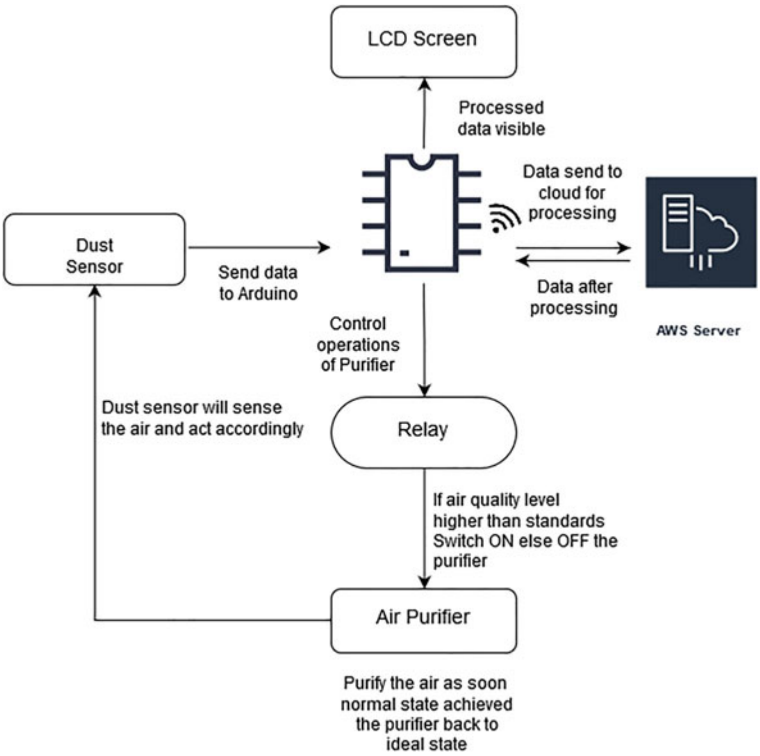

Fig. 3 Work flow of proposed model

Analysis Graphs: Figure 4a shows graph representing the change in CO2, CO, and LPG components with respect to time and in Fig. 4b the changes in LPG component are shown.

In Fig. 4c, the variation of CO_2 component is shown and Fig. 4d shows the variation of co-component.

4 Conclusion

The IoT technology in this research paper has fortified in many ways over the traditional method. Because the Internet of Things (IoT) makes use of the sensors to communicate and accumulate data, cost of project automatically abbreviates and the transition of data becomes expeditious. The sensory nodes are simple, facile to utilize, and setup which provide support to accumulate or analyze authentic-time

Table 4 Contains the range of AQI of different gases

O3 (ppb)	O3 (ppb)	PM2.5 (μg/m³)	PM10 (μg/m³)	CO (ppm)	SO2 (ppb)	NO2 (ppb)	AQI	AQI
Clow - Chigh (avg)	*Clow - Chigh (avg)*	*C - C (avg)*	*Clow - Chigh (avg)*	*Clow - Chigh (avg)*	*Clow - Chigh (avg)*	*Clow - Chigh (avg)*	*I - Ihigh*	Category
0-54 (8-hr)	-	0.0-12.0 (24-hr)	0-54 (24-hr)	0.0-4.4 (8-hr)	0-35 1-hr)	0-53 (1- hr)	0-50	Good
55-70 (8-hr)	-	12.1-35.4 (24-hr)	55-154 (24-hr)	4.5-9.4 (8-hr)	36-75 (1-hr)	54-100 (1-hr)	51-100	Moderate
71-85 (8-hr)	125-164 (1-hr)	35.5-55.4 (24-hr)	155-254 (24-hr)	9.5-12.4 (8-hr)	76-185 (1- hr)	101-360 (1-hr)	101-150	Unhealthy for Sensitive Groups
86-105 (8-hr)	165-204 (1-hr)	55.5-150.4 (24-hr)	255-354 (24-hr)	12.5-15.4 (8-hr)	186-304 (1-hr)	361-649 (1-hr)	151-200	Unhealthy
106-200 (8-hr)	205-404 (1-hr)	150.5-250.4 (24- hr)	355-424 (24-hr)	15.5-30.4 (8-hr)	305-604 (24-hr)	650-1249 (1-hr)	201-300	Very Unhealthy
-	405-504 (1-hr)	250.5-350.4 (24- hr)	425-504 (24-hr)	30.5-40.4 (8-hr)	605-804 (24-hr)	1250-1649 (1- hr)	301-400	Hazardous
-	505-604 (1-hr)	350.5-500.4 (24- hr)	505-604 (24-hr)	40.5-50.4 (8-hr)	805-1004 (24-hr)	1650-2049 (1- hr)	401-500	

data of pollutants. To monitor the pollution level inside the house, we require sundry other contrivances for felicitous management but this system can do all the activities in a better and efficient way. The system can monitor and purify the air. Benefits of this system are that it has low cost as well as energy-efficient as relay is utilized for controlling which conserves the energy. This system is planarity automatic and there is no requirement of human intervention. Along with this, system could operate and monitor the air pollution through the mobile application which provides all the information at a glance.

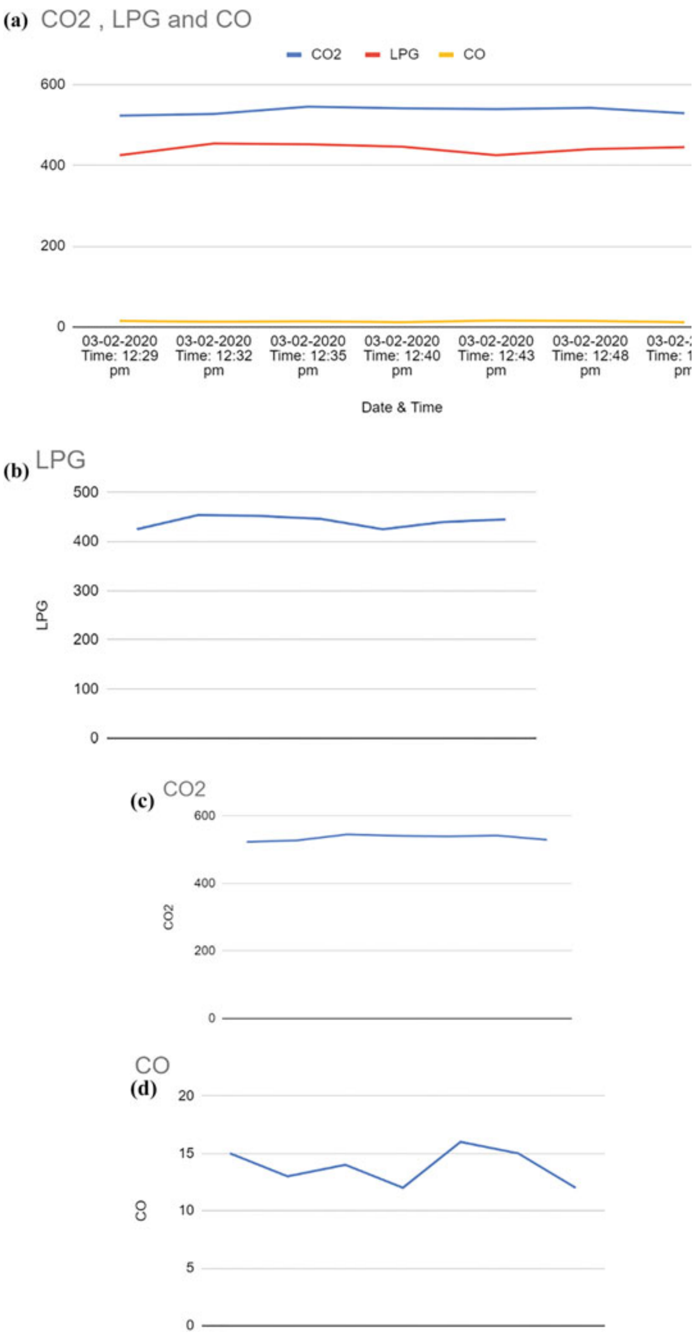

Fig. 4 **a** Changes in CO_2, CO, and LPG components vs. time **b** Graph representing the change in LPG component. **c** Graph representing the change in CO_2 component **d** Graph representing the change in CO component

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Stock Market Prediction Using Deep Learning Algorithm: An Overview

Pragati Raj, Ashu Mehta, and Baljeet Singh

Abstract A stock market, sometimes referred to as an equity market, is a gathering of buyers and sellers of stocks that represent company ownership. In this market, various investors sell and acquire shares based on stock availability. Stock trading is an important practice in the world of finance, and it is the cornerstone of many enterprises. A developing country's rapid economic development, such as India's, is dependent on its stock market. It is crucial in today's economic and social environment. The stock market's ups and downs have an impact on stakeholders' benefits. Stock market value prediction has long captivated the interest of investors and researchers because of its complexity, inherent ambiguity, and ever-changing nature. "Stock market prediction" is a method of trying to anticipate the worth of a given "stock" in the coming days. This is performed by considering historical stock values as well as price variances throughout the previous days. Due to market volatility, forecasting stock indices is definitely tough, necessitating an accurate forecast model. Recent advancement in stock market prediction technology is machine learning, which produces forecasts based on the values of current stock market indices by training on their prior values. The term "machine learning" (ML) refers to a subdivision of "artificial intelligence" (AI) in which we train machines with data and use test data to forecast the future. This study presents an overview of deep learning techniques that are currently being used to anticipate stock market movements and predictions.

Keywords Machine learning (ML) · Deep learning (DL) · Artificial neural networks (ANN) · Recurrent neural networks (RNN) · LSTM (Long Short-Term Memory) Model

P. Raj (✉) · Ashu Mehta · B. Singh
Lovely Professional University, Phagwara, Punjab, India
e-mail: pragatiraj579@gmail.com

Ashu Mehta
e-mail: ashu.23631@lpu.co.in

B. Singh
e-mail: baljeet.16938@lpu.co.in

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1 Introduction

A stock market, which is also known as an equity market, is a collection of buyers and sellers of stocks that represent company ownership. Various investors sell and buy shares in this market based on stock availability. The stock market is critical to a developing country's rapid economic development, such as India. It is extremely relevant in today's economic and social life. If the stock price grows, the economy of a country can expand rapidly. If the stock market falls, so does a country's economic growth [1]. The benefit of stakeholders is affected by the stock market's ups and downs. Stakeholders benefit from their purchased stocks if market prices rise with available stock. In the event that the market falls in line with available stock prices, stakeholders will suffer losses. Buyers purchase stocks at low rates and sell them at high prices in the hopes of making a large profit. Similarly, sellers benefit from selling their goods at high prices. To put it another way, stock market performance and national growth are intrinsically intertwined. Because of the volatile existence of the stock market, only 10% of citizens in any given country engage in stock market investing [2].

Because the stock market follows the random walk, today's value is the best indicator of tomorrow's value. Stock market prediction refers to the process of attempting and forecasting the value of a specific stock in the following days. This is accomplished by taking into account past stock values as well as the variations in those prices over the previous days. Forecasting stock indices is undeniably difficult due to market volatility, which necessitates an accurate forecast model. Many algorithms in AI play a role in predicting the future. The term ML refers to a subdivision of AI in which we use to train machines using data and with the test data to forecast the future. For prediction and forecasting, there are many algorithms. They are usually divided into two groups. The first is a linear model, while the second is a non-linear model. Auto regression moving average [ARMA], auto regression [AR], and auto regression integrated moving average [ARIMA] are examples of linear models. Because these above techniques are only suitable for a certain "time-series dataset", the algorithm that predicts well for TATA Company will not predict well for another company. Stock market forecasting is riskier than other sectors due to the stock market's ambiguous and unpredictable existence. It's one of the main reasons why stock market forecasting is so challenging. This is the area where the real-life usage of "deep learning algorithms" in "finance world prediction" [3] comes in handy. Non-linear algorithms are Neural Networks. The most common computer vision approaches are Deep Learning (DL) and Artificial Neural Networks (ANNs). Such strategies can be utilized to learn complex forms of data using supervised machine learning algorithms. When a deep learning software is built, the main motto is that it should gradually learn the process of performing intelligent and smart tasks beyond the programming boundaries—the learning is made possible by using datasets and experiences. Machines will learn differentiating trends as a result of the large amounts of data produced in stock markets, allowing them to make fairly accurate predictions.

2 Literature Review

Many studies on stock market forecasting using Neural Networks (NN) have been conducted in previous times. "Takeuchi and Lee in 2013 explored the momentum effect in an attempt to forecast that which stocks would have greater or lower monthly returns" [4]. For extracting features from the stock prices, an autoencoder with stacked RBMs is deployed, which is subsequently input into a feed-forward "neural network classifier". ANNs differ from current training or precisely programmed methods in that they incorporate specific rules that cover any possible outcome right from the start. A classification task is a process of deciding which category a piece of data belongs to; this method is commonly employed in neural network programming. For the encoder's last layer, the number of hidden components is drastically decreased, resulting in "dimensionality reduction". Also, the used dataset is partitioned in small little bunches till training. They are practiced to unroll the Restricted Boltzmann Machine (RBM) so that an encoder-decoder can be created. The performance of algorithms calculated is nearly fifty-three per cent.

On each given day, Batres and Estrada [5] anticipate which "Standard & Poor's (S&P) 500" Index stocks will beat the market. A three-layer "Deep Belief Network" with a multilayer perceptron (MLP) is used in the architecture [5]. Back-propagation is used to pre-train and fine-tune the DBN module. The Z-score is used to normalize the features for every measure span. Here, validation data's usage is to establish a number of neurons, layers, and regularization parameters. This model outperforms standard logistic regression and MLP with a precision of 53%. Fehrer and Feuerriegel in 2015 used the "deep learning" technique to train a model that can forecast German stock returns. News articles make up the input sheet. The "recursive auto encoder" [6] was deployed in conjunction with the "softmax layer" to estimate probabilities in each auto encoder. They begin the weights with Gaussian noise, and then it is updated with "back-propagation". This "recursive auto encoder" performed with fifty-six per cent of the performance rate.

"In 2015, Sharang and Rao used a DBN made up of two stacked RBMs to trade a portfolio of US Treasury note futures. Hidden characteristics are generated by the DBN and fed into three separate classifiers: regularized logistic regression, SVM, and a two-layer neural network" [7]. A contrastive divergence algorithm is used to train DBN. To be neutral to the first principal variable, the portfolio is built using PCA. In comparison to a random predictor, the final results are 5–10% more reliable.

Regular S&P 500 moves are predicted using structured data derived from headlines [8]. "The S&P 500's regular movements are forecasted using structured data gathered from headlines. Open Internet Explorer is used to extract organised event representations in the configuration of action, actor, object, and time from headlines" [8]. The short-term and long-term repercussions of events are combined using a CNN. For stock market forecasting, the outcomes of staged events generate better features than words. This method has a success rate of sixty-five per cent.

In 2016, Sirignano focused on "Limit Order Book Modelling" to estimate limit order book movements, by modelling the mutual distribution of the best bids with a "spatial neural network" and inquiring at the time of the next state shift [9]. There were four layers in every neural network. "Each secret layer in a regular neural network comprises 250 neurons, whereas there are 50 in spatial neural network". [9] The secret layer neurons' work on tan h activation mechanism. During training, the RMSProp method, which is related to "stochastic gradient descent", normalizes the gradient by taking a running average of the past gradients. The error rate of a "spatial neural network" using "non-linear features" is 10% lower than that of "logistic regression".

"For 43 commodities and Forex futures, Market-based Classification Algorithms deploy a 'deep neural network' to anticipate the sign of the price shift during the next 5 min" [10]. The input layer consists of 9896 neurons that use standard "back-propagation" with "stochastic gradient descent" to reflect lagged price differences and co-movements between contracts. For three-class grouping, the overall accuracy is 42%.

In the report on "Oscillation box theory", we can say that a stock price has a nature to fluctuate within a specific series over time. DBNs are based on the Oscillation Box Principle [11] and are used to make trade decisions. When a stock price falls out of control, it is placed in a new package. A DBM is made up of stacking RBMs with a "final back-propagation layer". Unsupervised, greedy "Block Gibbs sampling" trains every layer from lower to higher. The "back-propagation layer", which is responsible for fine-tuning the entire algorithm, was then supervised and trained.

Using news articles, "text-based classification models" anticipate bank trouble. "A neural network is used to minimize dimensionality in semantic pre-training". A classification neural network is the second neural network. "The semantic vectors are provided in a feed-forward topology by the projection layer in the centre once the link weights have been learned" [12]. 716 k bank sentences were taken from "Reuters News stories" published before and after the collapse. The classification model is determined by a custom Usefulness measure.

"The S&P 500's" regular volatility is forecasted using open, strong, low, and close prices [13]. An "Long Short-Term Memory (LSTM) block" makes up one single LSTM secret layer. The "Adam" approach is used, with 32 samples per batch and the objective loss function being mean absolute percentage error (MAPE). GARCH, Ridge, and LASSO techniques are all outperformed by the LSTM process. The term "Big Data" refers to technological advancements that allow for the storage of vast amounts of structured and unstructured data. The country's economy is based on a wide range of turnover and financial performance.

In the actual world, estimating the potential absolute worth of equities on a regular basis is challenging. The stock market has three patterns: up, down, and neutral/no change. Emerging data mining research is focusing on techniques for accurately forecasting trends. Future patterns can be forecasted to the degree depending on main indicators and also on previous habits. The stock market price variance distribution is especially essential; also, understanding how this changes over time is tough. Based on historical data, "predictive analytics" generates future state estimates. Data mining, statistics, mathematical modelling, and machine learning approaches are used to make predictions.

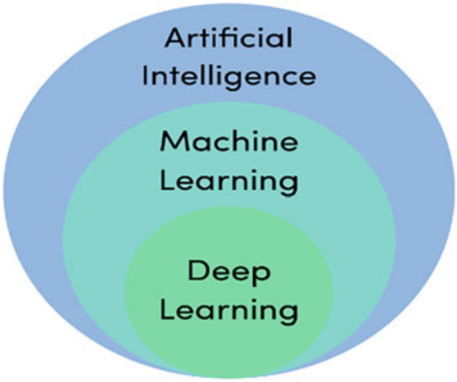

Fig. 1 Artificial intelligence subsets

3 Machine Learning

"Machine learning" is a data analysis technology that automates the process of creating models in a systematic way. The term "machine learning" (ML) refers to a subdivision of "artificial intelligence" (AI) in which we train machines with data and use test data to forecast the future. This form of learning necessitates the least amount of human interaction. P, E, and T are the three parameters that characterize machine learning: T is the task learned, E is the experience from which T is learned, and output P varies with E. The process of learning begins with the data or observations, taking examples as direct teachings, experiences, and instructions, so that we can seek patterns in the data and also make an informed decision in the future based on what we've learned so far (Fig. 1).

4 Deep Learning

"Deep learning" is a type of "machine learning" that uses several layers to extract higher level features from raw data. "Deep learning", in other terms, refers to artificial neural networks having multiple layers. It enables computational models to learn features from data at various levels in a sequential manner. "When a neural network's layers are jumbled up and give multiple edges in succeeding levels, it's termed convoluted, and when it contains at least three layers, it's considered deep. It has the capability of being incredibly deep. There have been up to 128 layers produced" [14]. It's becoming more common in Machine Learning as a result of some promising results in applications with complex target functions and massive datasets. "Deep learning" turns the given input data into a more abstract and composite representation at each learning level. Financial applications of deep learning include stock market forecasting, financial data analysis, and trade execution strategies. These "Deep Learning" models are taken into consideration to predict stock market prices based on historical prices that are available as data. The majority of IT providers are using the area of DL.

"Deep learning" is a type of computing algorithm that imitates the network of neurons of the human brain. This is a type of ML that uses "deep neural networks" and so it is referred to as "deep learning". DL algorithms are built using connected layers. The very first layer is called the input layer, the very last layer is called the output layer, and any layers which are in between are called hidden layers. A network with more than two layers of neurons is referred to as "deep". Deep learning is a type of machine learning that is gaining popularity. DL algorithms are constructed by the use of "neural networks". The inputs are sent into a "neural network", which is subsequently handled in hidden layers with weights that are changed in the time of the training process. After that, the algorithm makes a forecast. Then the weights are modified to identify trends conducive to producing improvised forecasts.

We do not need to instruct the "neural network" what pattern should be looked for; it performs this task by itself. Neurons make up each of the Hidden layers. The neurons are all connected together. The neurons process the "the input signal" received by the layer which is above it before propagating it. The intensity of the signal delivered to the neuron in the next layer is influenced by the "weight", "bias", and "activation mechanism". The inputs are then sent into a "neural network", which is then subsequently processed in hidden layers with the weights that are changed in the time of the training process. After that, this algorithm makes a forecast decision. The weights are then modified to identify trends in order to produce better forecasts. The network collects vast amounts of data and processes it across numerous levels, with each layer allowing the network to learn more complicated data properties.

Several "Deep learning models/architectures" for predicting the stock price of a certain company are already available such as Long Short-Term Memory (LSTM), Artificial Neural Networks (ANN), Recurrent Neural Networks (RNN) and Convolutional Neural Networks (CNN).

5 Artificial Neural Network

ANNs are mostly second-handed to solve complex and tough problems that regular ML techniques or simple "neural networks" are unable to solve. Artificial neural networks are linked in such a manner in which there is no such requirement to lift as much weight as the human brain, which contains roughly 86 billion neurons and is connected in a complex network. "Deep learning" is the subfield of machine learning in which "deep" learning is included. If we see in reality, machine learning aids in the creation of models that are better at the tasks they are given. If a "machine learning algorithm" generates unexpected and inaccurate results, the developers can rectify the problem. "Deep learning models" that use ANNs imitate the human brain's functioning and, as a result, assess prediction accuracy without using the human brain. "Artificial neural networks" can learn from the data they collect and apply that knowledge to generalize or generate patterns. Because the human brain does certain activities automatically, such a powerful skill is frequently taken for granted. ANNs differ from current training or "precisely programmed methods" in that they incorporate specific rules that cover any possible outcome right from the start. A "classification technique" is the process of deciding which category a piece of data belongs to; this method is commonly employed in neural network programming. Generalization is the ability to classify live trends or instances.

5.1 Training the Network

The usage of Artificial Neural Networks to teach the networks is common. This process of educating a network is referred to as "training the network". Training a network requires fitting a network to the training data collection. This method includes fitting data to a "mathematical model" or "time-series line" and is based on algebraic equations.

The training set is a set of data which is thought to be sufficiently representative of the network to learn or derive from. The model's network learning is referred to as the task. The process, which is known as ANN training, is meant to deal with the assigned tasks well based on uncertain events. Underfitting occurs when an artificial network is insufficiently trained, implying that the network has not learned the particular training set sufficiently.

Overfitting is the polar opposite of underfitting. When applied to newer data patterns, a network learns much more on the training set and becomes inefficient. By withholding some details from the training phase, we are able to find a suitable model for a specific job. It assists in the evaluation of the model both during and after preparation. The withheld knowledge can be divided into two categories: validation and preparation. The validation component is the data that our model is tested on during preparation. Even though it isn't used for training, it does provide us with a comprehensive overview of the network's success during the training phase.

5.2 Recurrent Neural Networks (RNN)

"Multi-layer Perceptron Networks (MLPNs)" and "Recurrent Neural Networks (RNNs)" are not the same thing (MLPNs). "Recurrent Neural Networks" take feedback from both present and past sources. The information acquired from various sources would be used to model the reactions of networks to "newer sets of input data". "This is feasible because of feedback loops, which allow the output of one instance to be used as an input for the next. As a result, RNN necessitates the use of memory. Every input must be stored in RNN layers because to the huge amounts of data it contains. This data or knowledge is employed in the network in a recursive manner, thus it will be swept forward to deal with newer examples" [15].

The LSTM is nothing more than a Recurrent Neural Networks prototype. Such networks are far better at detecting and learning about long-term dependencies. Schmid Huber and Hoch Reiter were the first to implement this model in 1997. These network models are frequently created to avoid the issue of longer dependence, but they are characterized by the storage of datasets or information for extended periods of time. "As compared to traditional artificial neural networks or recurrent neural networks, LSTM is special. In a traditional RNN, a simple network with feedback loops is used, while in LSTM, memory blocks or cells are used instead of a single network layer. Every cell has three gates as well as a cell state machine that controls data flow through the cell" [16].

Traditionally, recurrent neural networks have been difficult to train. Since it overcomes the challenges of training a recurrent network, the "Long Short-Term Memory, or LSTM" network is perhaps the most efficient Recurrent Neural Network. It has been used in a wide variety of applications (Fig. 2).

"Cell state" is the horizontal line segment in Fig. 3 that runs through the upper half of the image (Ct1 Ct). This works in the same way as a conveyor belt that runs across a network. It's used to move data in a consistent manner from previous cell instances to subsequent cells. The sigmoid layer is critical in determining whether or not information should be stored in the cell state. The forget gate's output is thereafter bit-wise multiplied and added to the "cell state". The "tan h" layer and the "sigmoid layer (it)" are then applied to the cell state to create the input gate. Output (ht) is generated by point-wise multiplying tan h with sigmoid gate Ot, and C contains values from the tan h layer.

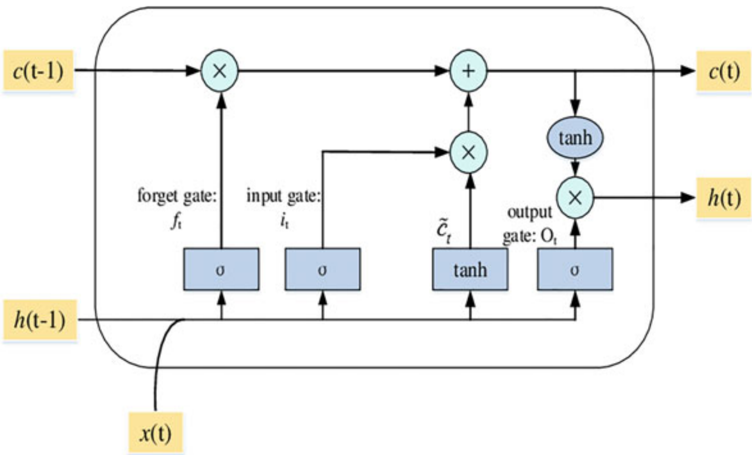

Fig. 2 LSTM architecture

6 Conclusion

The stock market is one of the places where people put their money. Proper investment may be made by forecasting fluctuations in stock prices, lowering the risk of their investment. This paper provides an overview of "deep learning algorithms" currently in use for "stock market prediction". As seen by the preceding review, these algorithms are relatively effective at identifying trends in the "stock market" arena. This demonstrates that there is an inherent dynamic that is present in all financial markets. Linear series models, like "ARIMA" and "Auto Regression", are univariate time-series-based prediction models that fail to discern underlying dynamics when multivariate time series is used. We believe that "deep learning models" outperform "Auto Regression" and "ARIMA models" based on the findings. As a consequence of the results obtained, ANN and RNN proved to be better performers than the other three networks. Since only one window is used to forecast the next case, ANN and RNN are very capable of picking up on unanticipated and unannounced changes in the method.

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An Introductory Note on the Pros and Cons of Using Artificial Intelligence for Cybersecurity

Ravinder Singh and Manu Sood

Abstract Artificial intelligence is a kind of digital representation of human intellect. Its operations are similar to those of humans in that it can make the computing machines learn, de-learn, and re-learn iteratively over and over again. The roadmap to the application of AI to Cybersecurity has been encountering a lot of issues and challenges. Digital security issues are critical in the creation of methodologies and support measures in any organization to properly prepare for countermeasures to cybersecurity threats and attacks. The role of AI in these countermeasures without a doubt is of paramount importance at present or in future. Some of the worldwide frameworks and standards being used in the context of cybersecurity across the globe may have been advocating for using AI for security. But a lot more effort is needed before the start of the process of integrating AI into these frameworks and standards and bringing the digital transformation thus caused to fruition. This paper presents an account of some of the currently used frameworks and standards for cybersecurity by various organizations around the world followed by a snapshot of using AI in cybersecurity. It also presents a discussion on the pros and cons of integrating AI into cybersecurity countermeasures.

Keywords Cybersecurity · Artificial intelligence (AI) · Machine learning · Deep learning · Neural network · Pattern recognition · Framework · Standards · HIPAA · GDPR · ANN · DNN

1 Introduction

An active application of Artificial Intelligence for finding solutions to problems related to the gray area around human beings necessitates the resolution of a variety of ethical and legal issues. It consists of machine learning algorithms that can identify and respond to threats as they occur. There are many interdisciplinary interfaces between Artificial Intelligence (AI) and Cybersecurity. Cybersecurity is a collection

R. Singh (✉) · M. Sood
Department of Computer Science, Himachal Pradesh University, Shimla, India
e-mail: aarkaybca@gmail.com

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of technologies and rules used to defend networks in the security field [1]. AI is being used in a variety of fields, including health care, agriculture, cybersecurity, space, law, and manufacturing [2]. Protection against cyber-attacks has become a critical and urgent issue in today's world, and it entails safeguarding the computer system against potential dangers [3]. Cybersecurity refers to a set of technologies and procedures for defending computers, networks, programs, and data against assaults and illegal access, modification, or destruction [4]. Machine learning is being used more often for malware analysis and network anomaly identification as a result of artificial intelligence [5]. The AI engine's key problem, however, is to demonstrate the ability to understand which observed behaviors are attack indications and which depart (substantially) from regular system behavior [6].

As Cybersecurity is concerned in this study [7], the main aim for use of AI and Machine Learning (ML) is in order to help identify anomalous behavior that could indicate previously unseen forms of attack. However, the main challenge for the AI engine is to exhibit the capacity to learn which observed behaviors exhibit signs of attack indicators, and which deviate (significantly) from a usual/normal system behavior. This paper does not cover all of the numerous approaches for detecting network anomalies, rather, it focuses solely on Artificial Intelligence techniques.

This paper explains why artificial intelligence is crucial for cybersecurity. Different AI methodologies, such as Pattern Recognition Approach, Rule-Based Approach, Machine Learning, and Deep Learning, were compared in this research. The outcomes of the various AI techniques are also shown. This study article aids in the discovery of various AI techniques as well as an understanding of how these approaches are used in the detection of cybersecurity anomalies.

Artificial Intelligence is vast and massive research of software engineering, with the goal of creating frameworks that can operate intelligently and freely, similar to the individual cerebrum's choice tools. Previously, AI was not used on a large scale for cybersecurity, but we are seeing an increase in the amount of cyber-attacks every day, making cybersecurity a serious concern. Because traditional threat detection software isn't as effective as it once was, and because attackers are increasingly employing artificial intelligence, we need to employ the most up-to-date technologies and AI methodologies to detect cyber threats effectively.

In the remainder of the paper, Sect. 2 presents various cybersecurity a approaches based on AI; Sect. 3 describes different types of cybersecurity frameworks. In Sect. 4, cybersecurity standards are discussed in detail. Section 5 summarizes the analysis of some of the significant contributions in the field of cybersecurity using AI, ML, and DL, Sect. 6 describes various pros and cons of using AI in cybersecurity, and Sect. 7 concludes the literature. Finally, in Sect. 8 we have future scope.

2 Cybersecurity Approaches Based on Artificial Intelligence

Today's Internet is a risky and unsafe environment due to the lack of reciprocal trust. In reality, the Internet's design foundation was built on the assumption that users in this type of network are mutually trusted. Currently, most of the risks, threats, and issues related to cybersecurity emanate from the free/low-cost availability of Internet connectivity, and it may further intensify in future. AI as an integral part of any modern-day cybersecurity solution is predominantly based on any of the following four approaches:

1. Rule/Knowledge-Based Approaches make use of the knowledge handling expertise of the humans for the decision-making abilities in Rule/Knowledge-based AI frameworks [8]. MYCIN was the first primitive or fundamental information-based framework created for the purpose of medical diagnostics. IBM Watson is one of the modern day systems that had relied extensively on knowledge/rule-based AI for its development.
2. The pattern recognition approach is a data-intensive approach where the data is used to generate the intelligence from the patterns and/or regularities embedded in it [9]. In an oblique fashion, these instances will determine the framework's choices. This approach has been shown to be the most effective method of generating intelligence artificially. The easiest approach to deal with pattern recognition is to use machine learning.
3. Machine learning involves various supervised, unsupervised, and reinforcement learning techniques which are among the classifications of ML algorithms [10]. Arthur Samuel was the first one to coin the phrase "machine learning" in 1959 and according to him, "it is the branch of research that allows computers to learn without being explicitly designed." ML has its deep roots based on the concepts of natural learning, which makes the machines learn from the historical datasets presented to the machines, unlike previous approaches where we were seeking to characterize a significant part of rules to decide knowledge from information. Supervised, unsupervised, and reinforcement learning are among the classifications of ML algorithms being applied to analyze the data, but the challenge is to apply the stream analytics/learning techniques for transportation data [11].
4. Deep Learning is a subset of Machine Learning (ML), which falls under the umbrella of AI. Artificial Neural Networks (ANNs), which are meant to simulate the functionality and connections of neurons in the human brain, are used in deep learning. DL and deep neural networks are defined in a variety of ways. It seeks to grasp the representation of data given as input in any scenario, whether supervised, unsupervised, or reinforced [12]. It is the collection of pseudo-code in machine learning and is used to model the high-level abstraction of the data [13]. DL is a collection of machine learning algorithms that seek to learn at several levels, each corresponding to a distinct degree of abstraction, according to a basic definition. It is also used in cybersecurity to detect vulnerabilities

or malicious activity efficiently. DL techniques allow computer programs to learn solutions from data and form their own representations to solve new problems. The advantages of DL like robustness, rapidly, accurately, and plentifully process data make it attractive for solving cybersecurity problems.

3 Cybersecurity Frameworks

A framework is a kind of an outline for the system that refers to the overall structure and boundary of that system, but the actual implementation details such as the steps, procedures, or methods to be used for making the system fully functional are not included into it. The cybersecurity framework provides recommendations, which may be optional, for enterprises for the better management and mitigation of cybersecurity risk, based on current principles and practices. A cybersecurity framework can be defined as a collection of rules, standards/measures, and best practices that an organization should adhere to when it comes to safeguarding its vital assets [14]. Various assets covered under the cybersecurity are networks, cloud, storage, applications, information/data, other critical infrastructure, operations, disaster recovery/management and business continuation strategies, education of stakeholders especially the end users, etc.

Any purposeful framework is required to be developed through a collaborative effort between industry and government, and it may consist of metrics, standards, and practices that demonstrate the safety of critical assets. The framework's systematic, adaptive, repeatable, and successful methodology assists owners and administrators of vital infrastructure in managing cybersecurity-related risks effectively and efficiently too [15].

There are three major components of a cybersecurity framework as per National Institute of Standards and Technology (NIST), USA [16] (Fig. 1).

a. **Framework core:** It provides a list of essential intuitive cybersecurity exercises as well as their outcomes in plain English. It helps organizations manage and reduce their cybersecurity risks in a way that complements their existing cybersecurity and risk management procedures.

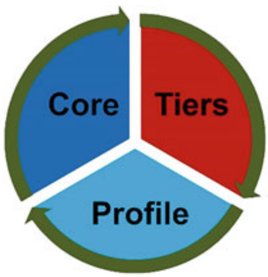

Fig. 1 Components of a cybersecurity framework [16]

b. **Implementation tiers:** There are four specific tiers (partial, risk-informed, repeatable, and adaptive) that assist organizations by defining how to approach various known and unknown cybersecurity risks and their management. The tiers assist organizations in determining the appropriate amount of detail for their cybersecurity program and are frequently used as a specialized tool to discuss risk appetite, mission need, and budget.
c. **Profiles:** These are an organization's unique arrangement of organizational requirements, goals, and assets in relation to the desired outcomes of the framework core and are mostly used to identify and categorize open avenues for improving an organization's cybersecurity.

Although there are more than twenty-five international frameworks specifically proposed for the cybersecurity by various organizations, some of the most prominent cybersecurity frameworks are enlisted below.

1. **Payment Card Industry Data Security Standards (PCI DSS)** [17]: This is a collection of security rules that must be implemented in order to ensure the security of payment accounts. It is intended to safeguard transactions involving credit cards, debit cards, and cash cards.
2. **ISO 27001/2/3/4 (International Organization for Standardization):** This series of standards from ISO consist of recommendations for information security management and program aspects based on best practices [18].
3. **CIS Critical Security Controls (Centre for Internet Security):** A set of actions for cybersecurity that provide specific and remarkable techniques for preventing today's most unavoidable and dangerous assaults [19]. The Controls have the benefit of organizing and focusing fewer actions with high outputs.
4. **Control Objectives for Information-related Technology (COBIT):** This framework is a very simple framework and is supported by a tool for assessing the risks and identifying the weak spots in order to ensure the security of data as well as avoidance of resource wastage [20].
5. **The National Institute of Standards and Technology Framework:** NIST Framework is a set of guidelines for strengthening essential infrastructure. Cybersecurity with the purpose of enhancing an organization's readiness to manage cybersecurity risk via the use of standard procedures and processes [21].

4 Cybersecurity Standards

A cybersecurity standard is a set of rules that an organization must follow in order to gain permission to do certain things, such as accept online payments or store patient data. The necessity for the ISO 27000 series emerges as a result of the organization's vulnerability to cyber-attacks. Cyber-attacks are becoming more common by the day, posing a persistent danger to any sector that relies on technology [22]. The standards include some of the fundamental rules that an organization must follow in order to remain in compliance with any of the cybersecurity standards. There are several different standards that enterprises or organizations can choose from to bring special capabilities based on their needs. Cybersecurity standards can also be defined as a set of policies that must be implemented in a system to ensure compliance with any standard. Some of the standards for cybersecurity given by ISO are listed below.

1. **ISO 27000:** The necessity for the ISO 27000 series emerges as a result of the organization's vulnerability to cyber-attacks. Cyber-attacks are becoming more common by the day, posing a persistent danger to any sector that relies on technology [23].
2. **ISO 27001:** There are a number of cybersecurity standards available that are intended to protect the system. This is one of the common standards that organizations must follow in order to implement an information security management system [24]. It is made up of a set of procedures that state the rules and requirements that must be met in order for the organization to be certified with this standard.
3. **ISO 27002:** This standard provides direction for information security standards and management practices in businesses [25]. It comprises choosing, implementing, operating, and managing controls while maintaining the information security risk environment of the firm.
4. **ISO 27032:** This is a global standard that focuses on cybersecurity especially. This standard establishes guidelines for protecting information outside of an organization's walls, such as through collaborations, partnerships, and other information-sharing agreements with clients and suppliers [26].
5. **HIPAA:** HIPAA is an acronym that stands for Health Insurance Portability and Accountability Act [27]. It is the standard that hospitals must adhere to in order to ensure that their patients' data is fully protected and cannot be leaked in any way.
6. **GDPR:** GDPR is an abbreviation for General Data Protection Regulation. It is a standard established by the European government to ensure the data security of all users [28]. According to this standard, the body in charge of compliance must ensure that the user's data is secure and cannot be accessed without proper authorization.

5 Cybersecurity Using AI, ML, and DL

Table 1 given below summarizes the analysis of some of the significant contributions in the field of cybersecurity using AI, ML, and DL.

Table 1 A Brief Summary of Analysis of Literature on the Use of AI, ML, and DL in Cybersecurity

S. No.	Approach	Features	Advantages	Result
1	Surveying and assessing various strategies for using AI to improve cybersecurity [29]	Intelligent Agents, Expert Systems, and Neural Networks	More accurate and efficient detection of intrusions	Use of AI improves security
2	An overview of AI approaches that can be used in cybersecurity [30]	ANN, image processing, data mining, fuzzy systems, expert systems, and pattern recognition	AI adapts to a variety of scenarios, assists in decision-making, is accurate and speedy	Using various AI approaches to improve the performance of security systems
3	Optimization challenges resolved using a genetic algorithm [31]	ANN, Chaotic neural networks, encryption, decryption, and security	Compared to open channels, ensures maximum security	Used chaotic neural networks and GAs to encrypt and decrypt original data
4	Investigated and illustrated several AI approaches for countering cyber-attacks [32]	Intelligent Agents, Fuzzy Sets, and Genetic Algorithms used to describe an artificial immune system	Shown mobility, dynamic structure, robustness, adaptability as characteristics of non-linearity Real-time, effective protection against cybercrime	Techniques utilized in anti-cybercrime applications Use of ML in cybersecurity gives reactive real-time security
5	Used AI/ML for network security and better cybersecurity [33]	Machine learning and Artificial Intelligence	Real-time, effective security against cybercrime	Use of ML in cybersecurity gives reactive real-time security
6	AI-assisted techniques to reduce cyber-threats [34]	AI	AI applications can identify and counter potential dangers	Since advanced persistent threats are harder to detect, AI is needed
7	Includes a survey of AI cyber-methodologies for defense [35]	Intelligent agents, neural networks, expert systems	AI applications aid in the reduction of global cyber risks	Neural network applications deployed in cyber defense
8	Embeds AI agents in a cybercrime protection system [36]	System for detecting and preventing intrusions, AI agents	AI for tracking attacker and reply to attacker most effectively	Information about cybercrime with AI and a security system
9	AI used for Cybersecurity [37]	Intelligent agents, neural networks, and expert systems	Improved decision support, detection of DOS, and mobility	Best performance in detecting/managing cyberthreats, using AI systems with human aid

(continued)

Table 1 (continued)

S. No.	Approach	Features	Advantages	Result
10	Data mining and ML approaches used for greater security [38]	Data mining, ML, and cyber analytics	Algorithms for enhancing performance, complexity, and accuracy	A quick overview of how ML and data mining are used in Cybersecurity

6 Pros and Cons of Using AI in Cybersecurity

Artificial Intelligence plays an important role in cybersecurity. It is widely used in managing/maintaining Cybersecurity by various large-scale enterprises. Although AI has been seen as a panacea for all the worries related to cybersecurity, there is a flip side to this story. Here are some of the pros and cons of AI that could directly or indirectly be attributed to cybersecurity frame-works available as of date. The framework could be a simple one or maybe an AI application framework with a highly streamlined AI pipeline and pre-trained AI capabilities for cybersecurity developers.

6.1 Pros

1. It reduces human effort and is convenient for adoption and adaptation.
2. It has the ability to detect malware and new threats.
3. It is supported by various machine learning algorithms which help enterprises to protect their data from vulnerabilities.
4. ML algorithms have the ability to detect cybersecurity threats efficiently as compared to traditional cybersecurity tools.
5. It supports real-time solutions for cybersecurity.
6. It can handle a large amount of data covered under the aegis of big data.
7. Unknown threats are easier to be identified and it's only possible because AI supports a variety of Algorithms.
8. It helps in reducing the duplicate processing steps or repetitiveness involved otherwise in cybersecurity.
9. AI algorithms are meant to learn more over time.

6.2 Cons

1. AI systems work on training datasets. They are capable of producing the solutions only from the historical data. A machine cannot think by itself.

2. Some of the algorithms of AI may deceive the enterprises, because the system is trained by using existing datasets so the result may not be relevant as per requirement.
3. AI has limitations because its solution may not fulfill the requirements of detecting specific threats to cybersecurity.
4. AI can also be used by hackers asymmetrically.
5. Due to the dearth of area-specific experts, its solutions can be very expensive at times.
6. It tends to increase unemployment in organizations.
7. It is time-consuming because it takes lots of time to train specific model(s).
8. AI may have the need to refine Cybersecurity frameworks since the corresponding algorithms are highly specific to the problem.
9. It may take more time to improve the algorithm or technique that we can use for cybersecurity.

Hence, in the light of such a big list of pros and cons in favor/disfavor of using AI in cybersecurity or its frameworks, it is recommended that a larger discussion among various stakeholders needs to be organized before its integration either in the cybersecurity frameworks or cybersecurity solutions.

7 Conclusion

Cybersecurity is a fundamental and vital issue for safeguarding information, data, systems, and other resources within and across the organization. The role of AI in managing cybersecurity has been advocated by various researchers as well as practitioners. The authors have presented a summary of the role of AI in harnessing cybersecurity to its full potential. A brief discussion on the significant cybersecurity frameworks and standards has been also provided for the ready reference. Various approaches based on rule/knowledge, pattern recognition, Machine Learning, and Deep Learning are the examples and applications of artificial intelligence that might help improve cybersecurity in an enterprise. Despite the fact that AI plays a significant role in cybersecurity, it does have certain definite drawbacks. A comprehensive list of such pros and cons of using AI has been provided to prove this point. Hence, in order to harness the real benefits of AI in cybersecurity, the technology must be updated to meet the most recent needs. The starting point for ensuring this could be to redefine or fine-tune various significant cybersecurity frameworks and standards in order to get rid of the cons of using AI for cybersecurity.

8 Future Scope

Humans are used in social engineering to get access to a system by influencing human behavior. As a result, the human mind is the weakest link in a security system, which an attacker may readily exploit. Humans are used in social engineering to get access to a system by influencing human behavior. Expert systems, neural networks, and Deep Learning techniques can be used. A competent AI system may make use of current attack logs to forecast the character of future assaults and, as a result, avoid them. In the future, it may be feasible to achieve a degree of security that makes hacking extremely difficult.

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An Enhanced Secure Framework Using CSA for Cloud Computing Environments

Dinesh Parkash and Sumit Mittal

Abstract In the Ground of Cloud Computing, one of the viable approaches to accomplish security is to utilize interruption recognition frameworks, which are programming instruments used to distinguish unusual exercises in the organization. Intrusion Detection System (IDS) has become an essential part of personal computers and data security systems. IDS normally manage a lot of information traffic, and this information may contain repetitive as well as insignificant highlights. Selecting the best quality features that represent qualitative data and excluding the redundancy from it is a key aspect of IDS. This paper proposes a new approach to Intrusion Detection Systems and creates a new fitness function for Cuckoo Search Algorithms. The proposed model has been trained with respect to KDD Cup 99 dataset.

Keywords Intrusion Detection System (IDS) · Support Vector Machine (SVM) · Cuckoo Search Algorithm (CSA) · Software as a Service (SaaS) · Platform as a Service (PaaS) and Infrastructure as a Service (IaaS)

1 Introduction

Cloud computing is another type of Internet-based foundation that conveys data innovation and delivers computing resources such as operating systems, storage assets, network framework, hardware equipment, and surprisingly whole programming applications to clients at a minimal expense way [1]. Cloud computing can be portrayed as passing on handling power over the web rather than genuinely having the resources at the customer site. Cloud computing provides Service-based models like Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure

D. Parkash (✉) · S. Mittal
M.M. Institute of Computer Technology and Business Management, Maharishi Markandeshwar (Deemed to Be University), Mullana, Haryana, India
e-mail: dineshgcccs@gmail.com

S. Mittal
e-mail: sumit.mittal@mmumullana.org

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as a Service (IaaS). The word Cloud is a reference to the openness and accessibility of processing assets by the web [2].

Cloud Security is utilized as the freshest advances and insurance system to monitor information and application. In specific web applications, for example, online retail deals and online closeouts, network security has evolved into the major variable to arise in the Internet age. An IDS separates PC assaults by inspecting different information records seen in the organization. Inconsistency- and Signature-based identifications are two measures of IDS. Inconsistency identification events to determine deviations from the typical examples might be hailed as interruptions. Then again, Signature-based discovery operates designs connected with known assaults or framework weaknesses to identify interruptions. Interruption location in distributed computing is an NP-Hard issue. Hence, this issue can be talked about by a few calculations in light of transformative figuring and meta-heuristic techniques [2].

2 Related Work

Zhixia Zhang et al. [3] proposed a model based on feature reduction. This model has identified two parts. In the first part, the Integration Technique is used whereas in another part, Adaptive Selection Probability is utilised to improve the algorithm's capability to search for optimal solutions. This model proved to detect more accuracy by selecting only a few feature parameters and performed better results for IDS. Alamiedy et al. [4] gave a survey of a few calculations utilized for a peculiarity-based interruption recognition framework. The basic strategy is to further develop the execution of machine learning classifiers and first sum up the hypothetical premise of IDS. Thereafter, it talks about the component choice methods and their sorts. Anitha and Vaidehi [5] proposed a system to distinguish complex application-level attacks. It focused on bundle-level investigation arrangement. The proposed technique improves discovery ability by performing application-level convention investigation utilizing semantic order tree procedure. The convention investigation strategy removes just explicit fields subsequently giving critical inquiry space decrease. The syntax-based semantic handling technique gives a more significant level of reflection furthermore, adaptability and is a reasonable alternative to further develop location precision.

Zheng et al. [6] proposed a model that highlights subset choice as a proficient advance to decrease the element of information, which has remained a functioning examination field for many years. In a request to foster profoundly exact and quick looking through highlight subset determination calculations, a channel including a subset choice strategy joining Maximal Information Entropy (MIE) and the Maximal Information Coefficient (MIC) is proposed. In the beginning, another metric, mMIE-mMIC, is described to restrict the MIE among features while boosting the MIC between the features and the class name. The mMIE-mMIC calculation is intended to assess whether an applicant subset is legitimate for grouping. After that, looking through techniques are embraced to distinguish a reasonable arrangement in the competitor subset space, including the two-fold molecule BPSO and SFS. Finally, the order is accomplished on UCI datasets to approve the presentation of proposed work contrasted with nine present strategies. Exploratory outcomes show that much of the time, the proposed strategy acts similarly or better than the other 9 strategies as far as grouping exactness and F1-score.

Mohamud and Gerek [7] designed an overall system to recover a subset of highlights that generally describe each class of neediness. The system is all about planning a methodology that focused on (a) separating a subset of highlights that best describe every destitution class, (b) looking at what this subset means for the picked class and lastly (c) utilizing troupe models. This work made a proof that highlighted determination and characterization as sensible instruments that can be utilized for neediness classification. Navimipour and Milani [8] presented an algorithm based on CSA to plan in Cloud processing. Cuckoo Search Algorithm (CSA) follows the computation depending upon the organic product flies and commits brood parasitic conduct of some cuckoo species in blend with the Lévy flight conduct of certain birds. The speed and coverage of the proposed algorithm have shown remarkable performance, when the value of Pa is low.

Anushikha Gupta and Mala Kalra [9] proposed an IDS to detect malicious servers with the help of the Cuckoo Search Algorithm. CSA is used to optimize the feature by a fitness function. By using this approach, servers can be divided into two subcategories: safe server and attacked server. The attacked server is affected by DoS/DDoS attacks. To validate the overall performance of the machine, QoS parameters which include packet delivery rate (PDR), energy intake rate and overall postponement before and after prevention algorithm are measured. Dinesh Parkash and Sumit Mittal [10] introduced a review of the existing Cloud Security models. This article additionally presented the accuracy of SVM and Naïve Bayes utilizing the KDD dataset. This paper discussed the table appearance of the security parameters like Privacy, Integrity and Confidentiality. After the trial work, it proved that Naïve Bayes performed better when contrasted with SVM.

3 Proposed Method

In this section, we have developed an IDS that uses an optimization algorithm such as Cuckoo Search. The proposed calculation demonstrates exceptional productivity in work improvement and designing plan issues. Later exploration demonstrates that Cuckoo Search-based improvement procedures are extremely compelling and productive in contrast with the hereditary calculation and a multitude of methods like PSO. Cuckoo Search Algorithm calculation depends on the forceful proliferation system of the birds, particularly cuckoo birds used to lay their eggs in the homes of the other host birds. First of all, we have selected features randomly and processed them. After that, we have used the optimization process by using CSA Algorithm.

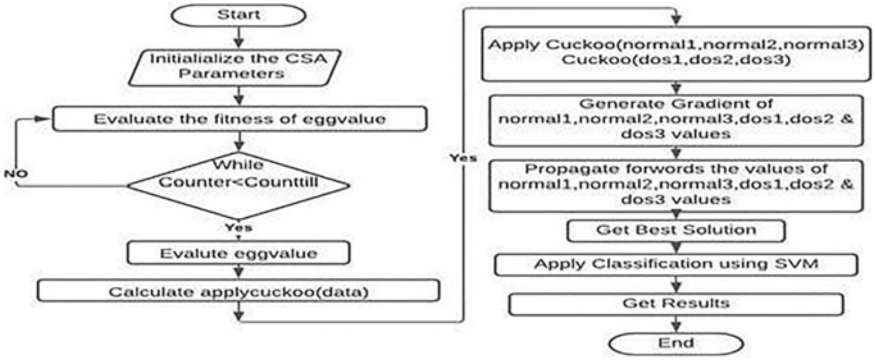

Fig. 1 Optimization using CSA algorithm

In this IDS, we have selected 3 feature sets from the KDD 99 dataset, the Feature numbers 35 (dst_host_diff_srv_rate), 36 (dst_host_same_src_port_rate) and 37 (dst_host_srv_diff_host_rate). In the CSA Algorithm, we have designed our new fitness function for optimal value.

In Fig. 1, we have performed optimization using CSA. We have used a new fitness function for this purpose. The detailed steps for optimization are discussed below.

4 Results and Discussions

In the proposed methodology, we have applied SVM for classification purpose and a detailed analysis for the same is done as follows:

1. Divide the dataset into training dataset and test dataset by using train test split utility.
2. Train the proposed model by using the training dataset.
3. After training, predict the responses for the test dataset.
4. Find the Accuracy of the proposed model by using accuracy, precision and recall parameters.
5. Create an instance of SVM and fit out the data and plot the support vectors.

Table 1 shows the input as Normal_1 values and output as Normalx1 by using the Cuckoo Search Algorithm fitness function.

As we are using 12 records of rows from 0 to 11 records after training the values, we plot a graph (Fig. 2) Total Record Count on X-axis and Dst Host Error on Y-axis. In this graph, the red color line shows the DOS values and the green color line shows the Normal values.

After training and testing the values, we have calculated the accuracy of our proposed IDS by using three parameters: Accuracy, Precision and Recall as in Table 2.

Table 1 Input (Normal_1) and after output (Normalx1)

Index	Noraml_1	Normalx1
0	1	2.9532000000000007
1	0.04	0.20400000000000001
2	0.0	0.2
3	0.03	0.203
4	0.02	0.202
5	0.03	0.203
6	0.04	0.20400000000000001
7	0.02	0.202
8	0.0	0.2
9	0.0	0.2
10	0.14	0.21400000000000002
11	0.0	0.2

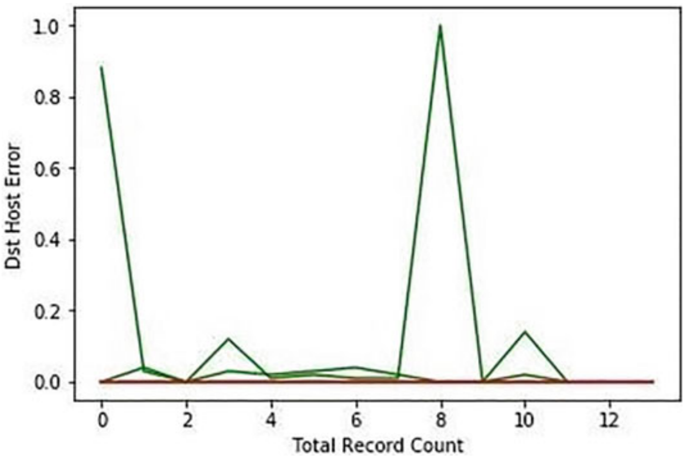

Fig. 2 Total record count (x-axis) and Dst host error (y-axis)

Table 2 Accuracy, precision and recall

Trials	Accuracy	Precision	Recall
Trial 1	87.5	0.8	0.5
Trial 2	87.5	0.8	1
Trial 3	75.5	0.5	1

By using SVM, we have found the classification of the classes of values which is shown in Fig. 3 of Cuckoo Search Algorithm. The Proposed IDS has an Accuracy value 87.5%, Precision value 0.8 and Recall value 1.0.

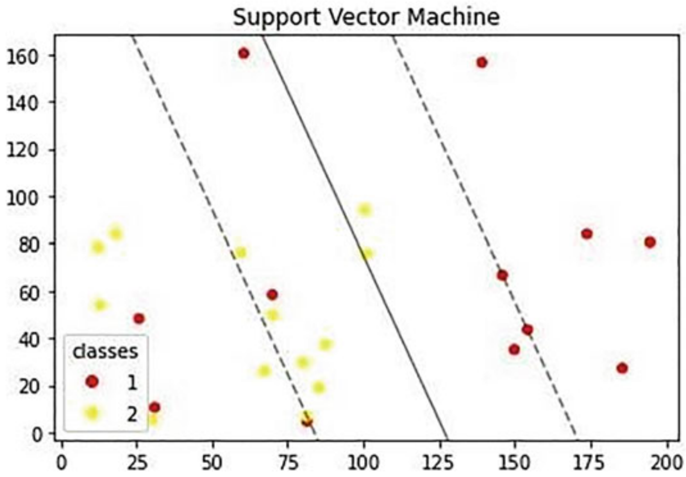

Fig. 3 Classification using SVM

From the trials conducted for the proposed IDS along with SVM and Naïve Bayes, it is observed that the proposed IDS performed better as compared to the SVM and Naïve Bayes IDS with respect to Accuracy, Precision and Recall values as shown in Tables 3, 4, and 5.

The performance of the proposed IDS in comparison to SVM and Naïve Bayes IDS is shown in Fig. 4. It is observed that the proposed IDS has Accuracy value 87.5%, Precision value 0.8 and Recall value 1.0 which is better as compared to both models.

Table 3 Comparison of Accuracy among SVM, Naïve Bayes and Proposed IDS

	SVM	Naïve Bayes	Proposed IDS
Trial 1	62.40	64.30	87.5
Trial 2	61.91	63.19	87.5
Trial 3	60.11	60.23	75.5

Table 4 Comparison of Precision among SVM, Naïve Bayes and Proposed IDS

	SVM	Naïve Bayes	Proposed IDS
Trial 1	0.4	0.5	0.8
Trial 2	0.3	0.4	0.8
Trial 3	0.4	0.4	0.5

Table 5 Comparison of Recall among SVM, Naïve Bayes and Proposed IDS

	SVM	Naïve Bayes	Proposed IDS
Trial 1	0.7	1	1
Trial 2	0.5	0.4	0.5
Trial 3	0.4	0.5	1

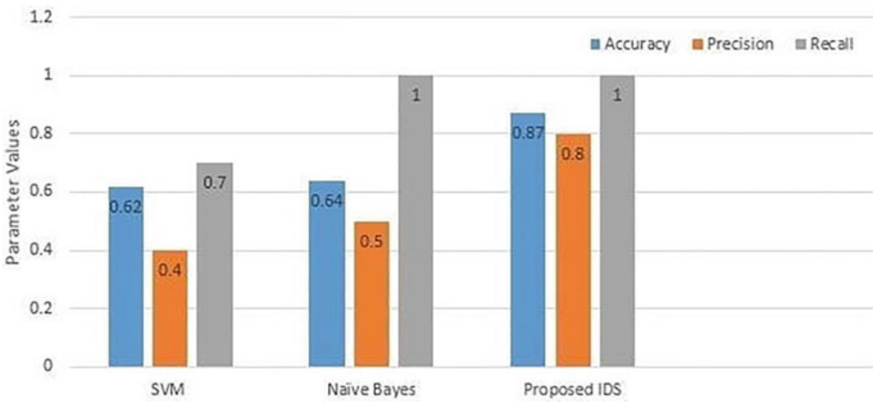

Fig. 4 Comparison of SVM, Naive Bayes and proposed IDS for 3 parameters

5 Conclusion and Future Scope

In this research work, we have proposed a secure framework for a Cloud computing environment. We have also performed optimization using Cuckoo Search Algorithm. The parameters such as accuracy, precision and Recall have been taken into consideration for the CSA optimization technique. From the preliminaries led for the proposed IDS alongside SVM and Naïve Bayes, it is seen that the proposed IDS performed better in contrast with the SVM and Naïve Bayes IDS for Accuracy, Precision and Recall parameters. We have conducted around 3 trials for CSA. By observing these trials, in terms of Accuracy, Precision and Recall we have achieved 87.5% (max.)—Accuracy, 0.8 (max.)—Precision and 1.0 (Max.)—Recall parameters.

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Wearable Devices with Recurrent Neural Networks for Real-Time Fall Detection

Sakthivel Avinash Jagedish, Manikandan Ramachandran, Ambeshwar Kumar, and Tariq Hussain Sheikh

Abstract Monitoring elderly and weak diseased people is one of the biggest issues in this modern world. Framing a technology for them is one of the wise contributions that can be done to society. More than 30% elderly people of age above 70 are falling every year due to bad health conditions. Fall identification is a significant issue in the medical care office. Elderly people are more inclined to fall than the others; accidental falls cause injuries, severe injuries and lead to death too. In our country, more than 30% are elderly people aged above 70, and they fall every year due to bad health conditions; nearly 40%–50% of elderly people fall every year most of them experiencing recurrent falls which may cause injuries, and it may lead to death too. Most of the elderly people experiencing recurrent falls which may cause injuries, to reduce the incident a system of monitoring and control is developed to detect the elderly person falls and can take immediate action, so here we considered two ways for preventing: one is smartphone-based and the other is a wearable device based recently in the fall detection wearable devices is the best choice because they are very much less in cost than the ambient-based overall features is to increase the acceptance and continue to monitor with its deep neural networks, deep learning has quickly altered the language processing domain. The LSTM is a typical recurring cell unit for deep learning models based on recurrent neural networks; here, in my paper I have proposed a new advanced version of Long Short-Term Memory (LSTM) which is Cerebral LSTM which shows better accuracy while training and testing the data and better ability to know about the time series prediction; using the RNN, the elderly person who falls is detected and with the help of the sensor the data gets collected and is allowed to training and testing validation with the MobiFall dataset; I have achieved a fall detection accuracy of about 98%.

S. A. Jagedish · M. Ramachandran (✉) · A. Kumar
School of Computing, SASTRA Deemed University, Thanjavur, Tamil Nadu 613401, India
e-mail: srmanimt75@gmail.com; manikandan75@core.sastra.edu

T. H. Sheikh
Department of Computer Science Institute, Government Degree College, Jammu & Kashmir UT, Poonch, India

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Keywords Fall detection · Embedded systems · Deep learning · Long short-term memory · Recurrent neural network · Wearable devices

1 Introduction

Accident occurs in our day-to-day life with or without knowing that it may occur [1]. Falls are very common among elderly people and cause serious health issues which may lead to fractures, and brain injuries. Falls occur at public places like temples, malls, and while attending functions too.

Moreover, more than 30–35% of the elderly person are aged above 70, and they fall every day due to bad health conditions; falls are very common in today's world with nearly 40%–50% of elderly people falling each year; here, most of the elderly persons are experiencing recurrent fall [2], in which some may cause severe injuries and lead to death in 40% of people; in such case, an automated monitoring system can detect the elderly people fall and can take immediate action [3].

So here we considered two ways of preventing the falls: one is smartphone-based and the other is a wearable device based recently on fall detection wearable devices is the best choice because they are very much less in cost than the ambient-based overall features is to increase the acceptance and continue to monitor, the aim of the paper is to design a wearable devices to detect the elderly people fall [4], the software equipped with microcontroller unit, the wearable device for fall detection should have these following basic requirement.

1. **The device should be connected to wireless mode, so that the cloud-based system gives proper alerts to users.**
2. **The wearable device should be weightless, so that the elderly people can wear it.**
3. **The running of the battery in the wearable devices should be long without a recharge, so that it can work 24/7.**

With its deep neural networks, deep learning has quickly altered the language processing domain. The LSTM is a typical recurring cell unit for deep learning models based on recurrent neural networks; here in my paper, I have proposed a new advanced version of Long Short-Term Memory (LSTM) which is Cerebral LSTM which shows better accuracy while training and testing the data and better ability to know about the time series prediction; here, in this LSTM architecture there are 3 gates: Input gate, Output gate, and Forget gate. The forget gate determines which past information is no longer necessary, the input gate picks pertinent information from the input data, and the output gate generates a new internal layer for time.

This dataset consists of Activities of Daily Living (ADL) and Falls for this developed device; there exist two sensors, Accelerometer sensor and Gyroscope sensor; now, we have taken 20 ADLs and 17 falls which occurred to 25 young adults, 17 ADL which were performed by 16 healthy persons over 65 years old [5, 6], and one data from 61 years old person; he had done all ADL and falls. Now all these collected data activities are selected on the survey and by literature analysis.

2 Related Works

Nowadays, accidental falling is the most dangerous event that elderly persons are experiencing in this fast-growing population [7–9]. Human-Computer Interaction with the sensor fusion is regarded as the best method for the problem of detection of falls in elderly people. Most of the recent works focus on methodologies used with the help of sensor networks and IoTs. But there are some external studies which mainly focus on fall detection with individual sensors, like wearable devices and depth cameras [10]; their performance was bad, and not satisfactory as they are suffering from high false alarms; the future works are on fusing the signals of various sensors and improving robustness could give high accuracy and low false alarms.

In this field, Convolutional Neural Network (CNN) is used to prevent elderly persons from falling. In computer vision, deep learning had set state-of-the-art achievement in image processing image net large-scale visual recognition challenge (ILSVRC) [11]. Here in this field, we mainly focus and make use of Convolutional Neural Network in video monitoring for fall detection; it is directly applied from each frame image in a video to learn about the vibration of human form implementation [12] of Fall detection; using a CNN is one of the solutions of fall detection.

Here in this field, some work is done related to elderly fall detection with various sensors, which are operated through indoor and outdoor tracking using an embedded system; with the help of thresholds, elderly people's fall can be detected through the readings from various sensors like [13] Temperature sensor, Accelerometer sensor, and Pulse rate sensor; these sensor readings are compared with ARM9. If any sensor readings cross the set value, then a fall will be detected.

In this field, the work done is on Edge Computing; here the collected data need not be sent to cloud, whereas wearable devices send data to devices like laptops and mobile phones for analysis in real time. MbientLab's wearable sensors are less expensive as well as open-source data analytics for data streams known as Apache Flink. [15] And (LSTM) Long Short-Term Memory model. This model is then trained and tested using the fall characterization in MobiAct dataset.

The work done in the field is that by using 3-Axis Accelerometer and NodeMCU Microcontroller unit, the elderly people fall is detected [16]. The 3-axis acceleration sensor collects the data by the movement of humans' daily activities Activity of Daily Living (ADL), and acceleration changes will determine the falling of elderly people [17]. ESP8266 is a method for receiving information in real time, and gives an alert message to the family through an online application.

3 Proposed Work

The flow process of the proposed system is shown in Fig. 1. In the sensor tile architecture main component used is STM32L476JGY which has a 80 MHz maximum

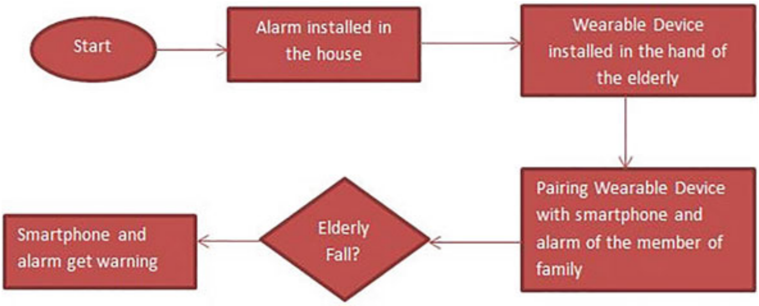


Fig. 1 Flow process of proposed system

working frequency, it is integrated with a 3D axial accelerometers sensor, gyroscope sensor, barometer, Bluetooth 4.1. On board micro controller unit is the ARM CORTEX –M4, it contains a floating point unit, 128KB of SRAM memory, and 1MB of flash memory. This Sensor Tile is used to recognize human activities. Here the accelerometer sensor and Gyroscope sensor are used to collect the data, then they are allowed for training and testing; the battery can run without charging for about 130 h (5 days 10 h); if we include gyroscope data, there will be an increase in current of 10% so battery life will be reduced to 10 h. It is shown in Fig. 2.

RNN is a basic form of deep neural networks; here whatever the output had come is returned back to the input as shown in Fig. 3; while the Convolutional Neural Network [11] is used to capture the correlation of data, RNN [18] also allows the user to capture the temporal correlation; some general formulas are used to calculate

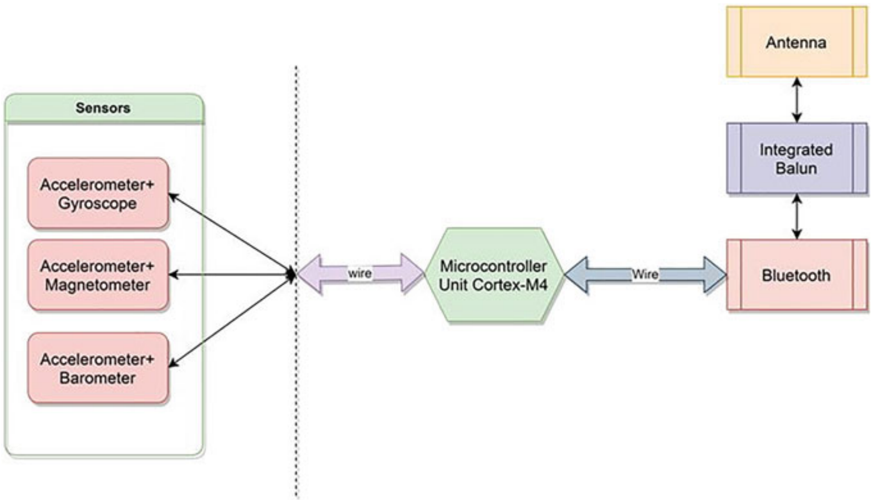


Fig. 2 Architecture for sensor tile

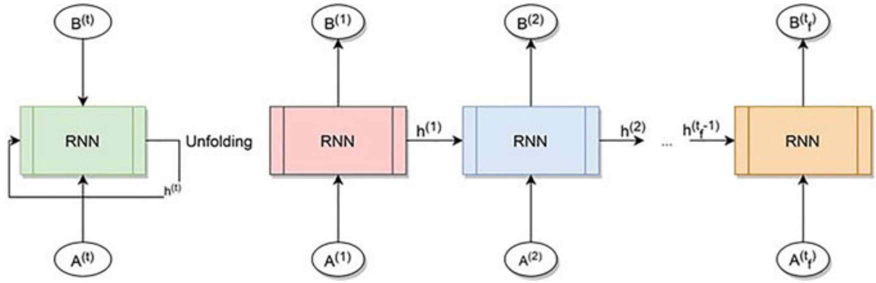


Fig. 3 RNN model

the fall where the input and output are x(t) and y(t), respectively. RNNs are ideally suitable for analyzing signal time series because of their recurrence, but they're also extremely difficult to train. RNNs are most commonly often used to manipulate a set of information in the form of lists and sequences, and signals which change with time, in particular. This category includes real-time data from accelerometer and gyroscope sensors; in this case, the data is typically checked via a sliding window with a width "ww" that relates to the post level of unfolded training.

$$B^{(t)} = wg\big(WA^{(t)} + Uh^{(t-1)} + b\big) + c \tag{1}$$

$$h^{(t)} = g(WA^{(t)} + Uh^{(t-1)} + b) \tag{2}$$

where $\mathbf{h}^{(t)}$ is said to be hidden state of the network and U, W, v, c, and w are all the parameters.

LSTM is the most important of RNN [14], which is used to learn temporal dependencies; in LSTM we have three entrances as shown in Fig. 4: Input gate, output gate, and forget gate. The input gate determines just how much of the unit is contributed to the present state, the output gate determines which part of the corresponding position is output, and the forget gate determines just how much of posts we must recall. LSTM is very easy to train and test the data, LSTM which is very easy to train and test the data, due to the temporal unfolding the output is delayed.

$$V^{(t)} = sigmoid(W_{xi}x^{(t)} + W_{si}S^{(t-1)} + b_i) \tag{3}$$

$$U^{(t)} = sigmoid(W_{x0}x^{(t)} + W_{s0}S^{(t-1)} + b_0 + b_{forget}) \tag{4}$$

$$W^{(t)} = sigmoid(W_{xw}x^{(t)} + W_{sw}S^{(t-1)} + b_w) \tag{5}$$

$$R^{(t)} = W^{(t)}R^{(t-1)} + V^{(t)}R_{in}^{(t)} \tag{6}$$

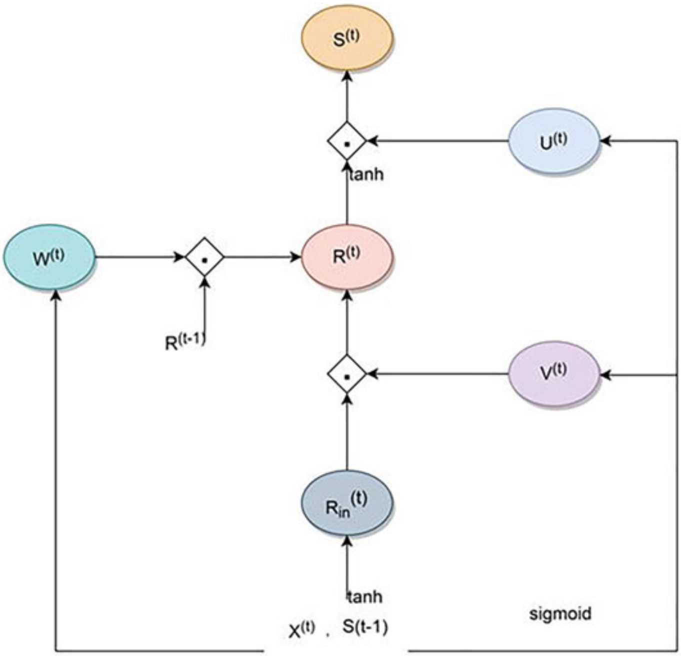


Fig. 4 LSTM Module

$$S^{(t)} = V^{(t)} tanSR^{(t)} \tag{7}$$

The architecture was implemented using the TensorFlow (TF) library with Python programming language [1]. I have used typically 80 and 20% train and test split. This paper mainly focuses on training and testing the data of the elderly people fall; there are many data set are available for fall detection such as sisfall, mobilefall, mobiact in which the Mobifall dataset is the most adequate, in this dataset include large number of data both in numbers and heterogeneity of ADL [16]; here it includes a maximum of 38 identities and in this 38 people, 23 are adult people and 15 are elderly people and a total of 4500 complete fall recording had been taken.

Mobifall is the most used embedded device which is fixed in the human body as a watch or a belt buckle; this device is attached with a three axial accelerometer which can note for a maximum of 200Mz and a gyroscope sensor, ensor is not used nor performs.

Actually, the battery can run without charging for a maximum of 5 days 10 h (130 h); if the gyroscope data is included, it will increment the current by 10% and the battery life is reduced to 10%; TensorFlow is the library used; 3D data is collected using an accelerometer sensor; with the help of RNN, we can detect the elderly people fall, then with RNN LSTM module the data is allowed to training and testing; in this process the loss and accuracy of people fall are calculated.

The collected data from the sensor are then sent for validation with this LSTM architecture. LSTM is nothing but storing short term data over a long period of time. LSTM network improves on standard RNN by being able to store this data for many states; the improved version of LSTM is named as Cerebral LSTM which gives more accuracy and more stability to understand the time prediction data analysis.

In the testing and training validation, we use two headliner classes, they are alerts and falls. Elderly people can fall in any way; it can be a proper fall or may not be a proper fall so we use background class, which is used to note the activity which is not identified as a fall [19–21], for example, strolling, bouncing, and strolling up the steps, and sitting on a seat.

4 Results and Discussion

The elderly people fall detection during their daily activities (ADL) like walking, sitting, walking slowly, walking quickly, walking upstairs, and downstairs, likewise activities of daily living are collected with two types of sensors: 3 axis accelerometer sensor and gyroscope sensor; here, 19 ADL activities consists of 19 activities of daily living ADLs and 15 fall types were undertaken by 23 younger people, and 15 ADL characteristics were undertaken by 14 active and healthy volunteers over the age of 62, as well as data through one 60-year-old participant who undertook all Daily activities and falling. Such tasks were chosen based on the survey and a literature review [22–24]; there are various subjects; the subject is nothing but elderly person's age, gender, weight, and height, likewise they are separated not only as elderly persons but also as healthy person. Now, all the collected data is implemented by TensorFlow (TF) library and Python programming for training and testing. The training dataset consisted of 25 subjects (14 elders), while the evaluation dataset consisted of 10 subjects (5 elders). We took extra measures to prevent identity bias, which happens when people are present in the test set but not in the train set. The design consistently outperformed the findings presented in the MobiFall paper on the testing data, achieving good overall sensitivity, accuracy, and specificity. We were able to achieve a high level of accuracy (95%). There were no significant differences in accuracy between young and elderly participants when it came to detecting falls (Table 1).

Table 1 Comparing both LSTM and cerebral LSTM with better accuracy

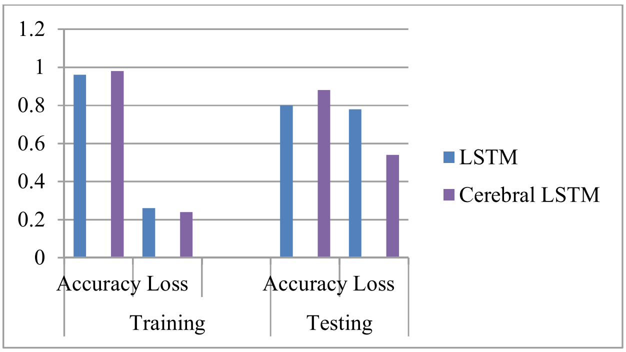
Architecture	Training	Testing
LSTM Architecture	Accuracy = 0.96 Loss = 0.26	Accuracy = 0.80 Loss = 0.78
Cerebral Architecture	Accuracy = 0.98 Loss = 0.24	Accuracy = 0.88 Loss = 0.54

```
train step = 990,loss = 0.338177,accuracy = 0.950417
train step = 1000,loss = 0.358240,accuracy = 0.945000
train step = 1000 ,model save to =./model/model.ckpt
train step = 1010,loss = 0.527391,accuracy = 0.902708
train step = 1020,loss = 0.423725,accuracy = 0.928333
train step = 1030,loss = 0.295767,accuracy = 0.959583
train step = 1040,loss = 0.277672,accuracy = 0.964271
train step = 1050,loss = 0.391387,accuracy = 0.935833
train step = 1060,loss = 0.328081,accuracy = 0.951458
train step = 1070,loss = 0.476555,accuracy = 0.914479
train step = 1080,loss = 0.442976,accuracy = 0.921667
train step = 1090,loss = 0.335490,accuracy = 0.947604
train step = 1100,loss = 0.398828,accuracy = 0.932813
train step = 1110,loss = 0.336052,accuracy = 0.947396
train step = 1120,loss = 0.404458,accuracy = 0.929792
train step = 1130,loss = 0.308622,accuracy = 0.953750
train step = 1140,loss = 0.381486,accuracy = 0.937083
train step = 1150,loss = 0.346929,accuracy = 0.943958
train step = 1160,loss = 0.389217,accuracy = 0.933333
train step = 1170,loss = 0.262177,accuracy = 0.964479
```

Result 1: Training and testing validation of normal LSTM

```
Training iter #1890000:   Batch Loss = 0.293631, Accuracy = 0.95333331823349
PERFORMANCE ON TEST SET: Batch Loss = 0.5520004630088806, Accuracy = 0.8975229263305664
Training iter #1920000:   Batch Loss = 0.278780, Accuracy = 0.9599999785423279
PERFORMANCE ON TEST SET: Batch Loss = 0.5444169044494629, Accuracy = 0.8992195725440979
Training iter #1950000:   Batch Loss = 0.282097, Accuracy = 0.9606666564941406
PERFORMANCE ON TEST SET: Batch Loss = 0.5712029933929443, Accuracy = 0.8954869508743286
Training iter #1980000:   Batch Loss = 0.300621, Accuracy = 0.9566666483879089
PERFORMANCE ON TEST SET: Batch Loss = 0.6606792211532593, Accuracy = 0.8717339634895325
Training iter #2010000:   Batch Loss = 0.286628, Accuracy = 0.9760000109672546
PERFORMANCE ON TEST SET: Batch Loss = 0.6548627614974976, Accuracy = 0.8652867078781128
Training iter #2040000:   Batch Loss = 0.380589, Accuracy = 0.9293333292007446
PERFORMANCE ON TEST SET: Batch Loss = 0.51789391040802, Accuracy = 0.8958262801170349
Training iter #2070000:   Batch Loss = 0.367941, Accuracy = 0.9313333630561829
PERFORMANCE ON TEST SET: Batch Loss = 0.5262546539306641, Accuracy = 0.9005768299102783
Training iter #2100000:   Batch Loss = 0.246875, Accuracy = 0.9900000095367432
PERFORMANCE ON TEST SET: Batch Loss = 0.5300434827804565, Accuracy = 0.8931116461753845
Training iter #2130000:   Batch Loss = 0.239135, Accuracy = 0.9840000271797180
PERFORMANCE ON TEST SET: Batch Loss = 0.5516563653945923, Accuracy = 0.8920936584472656
Training iter #2160000:   Batch Loss = 0.237177, Accuracy = 0.9873333573341370
PERFORMANCE ON TEST SET: Batch Loss = 0.5586655139923096, Accuracy = 0.8883610367774963
Training iter #2190000:   Batch Loss = 0.246776, Accuracy = 0.9846666455268860
PERFORMANCE ON TEST SET: Batch Loss = 0.5492477416992188, Accuracy = 0.8880217075347900
Optimization Finished!
```

Result 2: Training and Testing validation of Cerebral LSTM



Graph: Comparison of both normal LSTM and Cerebral LSTM

5 Managerial and Social Implications of Proposed System for Society

The primary aim of the proposed system is to analyze the level of success of the fall detection system in automatically detecting falls. To examine older adults' usage and perceptions of these devices as well as the implementation of these devices in the "real world", simulating falls or activities of daily living will save the elderly people and provide the necessary amenities in the limited time. The fall detection system reduces the risk of damage due to falling events achieving accuracy of 98% compared to the state-of-the-art methods.

6 Conclusion and Future Work

We proposed the Recurrent Neural Network RNN on a wearable tag for fall detection (watch) included with Micro Controller Units MCU; the very first process is to implement a recurrent neural network on a workstation by using the TensorFlow libraries; using the RNN, the elderly people who fall down is detected and with the help of sensors, the data gets collected, then the data is allowed to training and testing validation with the MobiFall dataset. We have achieved a fall detection accuracy of about 98%, then the network is optimized in the sensor tile wearable device, then the network gets validated with the result obtained in the TensorFlow workstation; The trained devices shows the implementation in the real time, it also validates the three abstract memory, power and battery timings. This battery runs without recharging for about 5 days 10 h (130 h).

Future works are based on the implementation of weights and processing of linear operation and non-linear operations; this is still a problem faced in this paper; two stacked LSTM provides better results compared to single and Cerebral LSTM with a low power BLE which can show a better accuracy.

Consent for Publication Not Applicable.

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Automatic Number Plate Detection and Recognition

Ayushi Pandey and Rati Goel

Abstract Nowadays many new technologies have been used in various sectors like industry, medical, traffic, etc. These technologies help in controlling, managing, and maintaining the tasks in a much easier and more efficient way. The automatic license system is a real-time embedded system that automatically detects a vehicle number plate. This system has various applications like smart security systems, smart parking systems, traffic control systems, toll management systems, etc. Automatic license plate recognition (ALPR) has many complex features because of various effects. These effects include light, speed, weather, and so on. In this work, an advanced technology for the detection of number plate has been proposed. The RGB image is converted to a grayscale image. The bilateral filtering technique is used to eliminate the noise. To detect the edges canny is applied contour, masking, and segmentation are used to detect the plate. OCR is considered to read the character. The final model analysis is done to judge the accuracy. The classification system accuracy obtained is more than 90%. This ANPR system helps in reducing human intervention and provides effortless ways for license plate detection.

Keywords Number plate recognition · Character segmentation · Image processing · OCR · License plate · OpenCV · Masking · Counter · Python

A. Pandey (✉)
Computer Science -Data Science Department, NIET, Greater Noida, India
e-mail: ayushipandey281@gmail.com

R. Goel
Computer Science-Data Science (AI) Department, ABES (IT) College of Engineering, Ghaziabad, India

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1 Introduction

In today's information technology, major improvements pertaining to all sectors/workplaces are beginning with the need for surveillance vehicles as a means of predicting information systems. With each passing day, the number of vehicles is increasing. Finding a parking space is a real challenge for a large number of professionals and academics, as well as multi-storey buildings or institutions. The guards are in charge of a large number of car parks and do not care to keep a record of the number of outgoing and arriving vehicles parked [1]. It is a very difficult task to find an empty parking space and this is very frustrating for the car driver. The absence of security guards may result in occasional carjackings. A few decades ago the number plate recognition license was a method used in the intelligent transportation system (ITS). This process alternates with human efforts to identify the number of digits. ANPR is the best way to handle this difficult situation. For vehicle testing, ANPR has been fully operational in recent years. In particular, the ANPR system contains five key steps: (1) Conversion (RGB to gray) and binarization (black and white only), (2) Filtering and contour, (3) Covering the face by removing unwanted space, (4) Segment separation of characters, and (5) (OCR) Visual character recognition. Every single letter is interrupted on a number plate in the final step in order to obtain only the essential facts for recognition [2].

The rest of the paper is arranged as follows. A review of the various methods available is presented in Sect. 2. In Sect. 3, discuss the various libraries we use. Section 4 introduces the proposed approach. And finally, we provide the test and simulation results in Sect. 5 followed by conclusions.

2 Related Work

There are many research works going on concerning vehicle number plates over the last few years credentials. Various studies have been completed just to evaluate the kind of vehicles such as a bike, bus, van, car, or scooter. Abhishek et al. [3] proposed the ANPR technique for recognizing the number plate [4]. Many types of image enhancement techniques were developed, and a filtering technique is also used by Rati Goel et al. [5]. Balaji et al. present grayscale conversion, by using multiplying the number of RGB of the particular pixel with a specified equation and threshold value to get the best result for binarization by Balaji and Rajesh [6]. In [7], detect the stone from the kidney in ultrasound image using segmentation techniques and also analysis by confusion matrix to detect accuracy. Kramthi et al. [8] discussed about revolving the original RGB image into grayscale for easy to apply techniques. Both Karthikeyan et al. [9] and Patel et al. [10] have proposed an alternative method for the detection of license plate segmentation, and for masking Sobel technique is used to detect the ROI (localization). In image processing, the Sobel mask is frequently used to detect the edge of the image. Davix et al. [11] share the steps of pre-processing to perform formerly defining the license plate position. The Sobel filter technique is used to recognize the various type of vehicles exactly by Tayo and Gideon [12]. This technique is used for detecting the edges of a vehicle. Contour is also applied to find out the vehicle, and for analysis the SVM model is used. In [13], the method of log r-theta mapping and maximum average correlation height filter was proposed to explore the kind of automobiles. Mach filtration is used for the skimpy region of interest in disordered/untidy situations. Srivastava et al. [14] proposed a hybrid OCR method for improving the recognition rate. It is also used for the recognition of input characters independently by four statistical sub-classifiers after applying the Bayes' method to analyze the results.

3 Python Libraries Used for Detection of Number Plate

There are many Python libraries used to detect and recognize the number plate as shown in Fig. 1.

A. NUMPY: Numpy is a Python library. It is a package of array processing for general purposes. Using this mathematical calculation will be easier and deliver high performance.

B. MATPLOTLIB: Matplotlib is an incredible library in Python for visualizations. By using this, we can make various types of plots for large datasets, such as histogram, scatter, bar, line, etc., to understand.

C. OPENCV: OpenCV is a Python library used for computer vision. It is free for use under the open source. There are more than 500 optimized algorithms in this library. It concentrates primarily on real-time image processing. OpenCV can run on Linux, Mac OS, and Windows.

D. EASYOCR: Optical character recognition or optical character reader (OCR) is a method used to translate the text in graphics to machine-encoded text. Graphics or visuals might be handwritten text or placards (traffic symbols, sign_boards), or

```
import cv2
import numpy as np
from matplotlib import pyplot as plt
import imutils
import easyocr
```

Fig. 1 Import libraries

printed documents (restaurant bills, bank statements, invoices). The resulting visuals are useful for extracting the information. To get better accuracy, OCR is an emergent technology in performance.

E. IMUTILS: This library has the basic function of image processing such as edge detection, sorting contour, resizing rotation and many more easier with OpenCV and Python.

4 Proposed Methodology

The proposed system will help to detect and recognize the vehicle's number on the number plate as displayed in Fig. 2. The system will first obtain images of the vehicle's number plate and then it will pre-process the image using pre-processing algorithms. In the pre-processing step, the captured image is converted into an RGB image. After pre-processing, the extraction process is carried out. The required data is obtained in the input section from various sources. Vehicle image datasets are generated by collecting photos with infrared cameras or gathering images from a variety of data stores and repositories. These datasets are used for pre-processing inputs. Various processes like RGB to grayscale conversion, filtration with contour to detect plate, and character segmentation are carried out during pre-processing. Optical character recognition and template matching can be used to extract desired outputs from the pre-processed image. As an output, the number on the number plate is obtained.

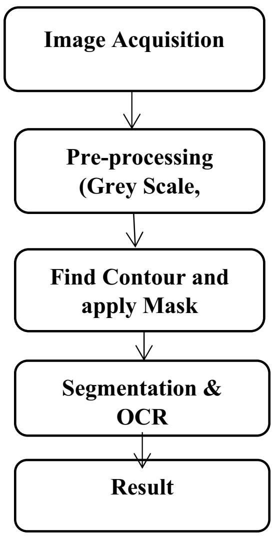


Fig. 2 Flowchart of the proposed methodology

4.1 Image Acquisition

The photo acquisition is the primary degree of pre-processing in this step, First, collect the exclusive car photographs from exclusive resources and for reading the photograph inside the matrix format we used Python code img = cv2.imread('photograph.jpg') and display picture by way of plt.imshow(img) as proven in Fig. 3. and resize the photograph, because the photograph is extra in size, which involves extra time for segmentation system and gives much less great photograph.

4.2 Grayscale Conversion

The main advantage of converting RGB images into grayscale is that RGB image consumes more space as compared to gray image [12]. Pre-processed and converted gray images are displayed in Fig. 5 and the blurred image is shown in Fig. 4.

4.3 Bilateral Filter and Canny

There is much information in every image that can be useful. In our project, we are only interested in the license plate number and the rest of the data is useless for our methodology. These types of unwanted information are called noise. A bilateral filter

Fig. 3 Input image

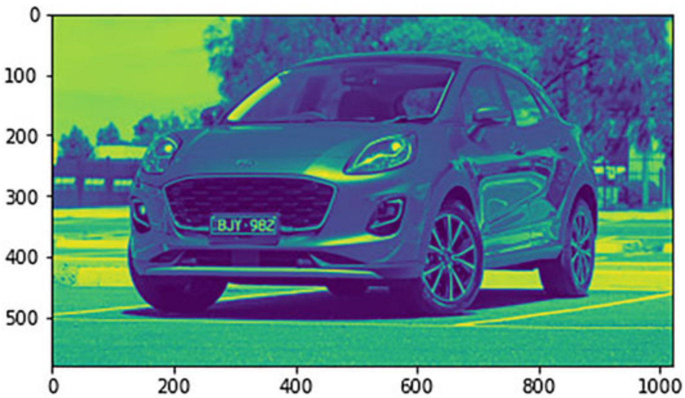


Fig. 4 Blurred image

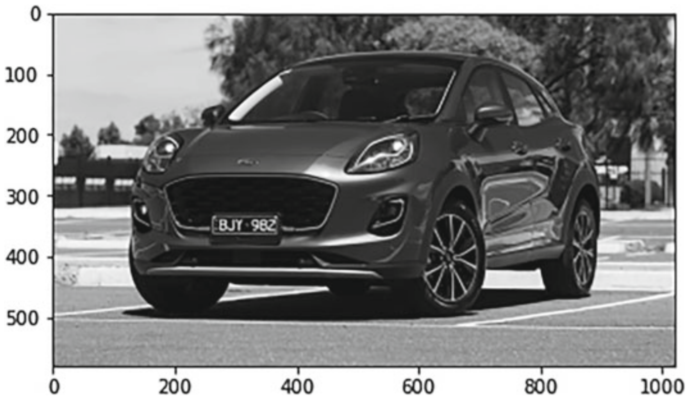


Fig. 5 Gray image

is used to remove noise or unwanted details from an image. The canny technique has been applied to detect the edges with threshold values.

4.4 Find Counter and Apply Mask

A line that joins all the points besides the image boundary is counter and the image also has the same intensity [15] as displayed in Fig. 6. The **mask** process works as if–then idiom for each element in the calling data frame. Element is used if the condition is false, else the parallel element from the other data frame is used.

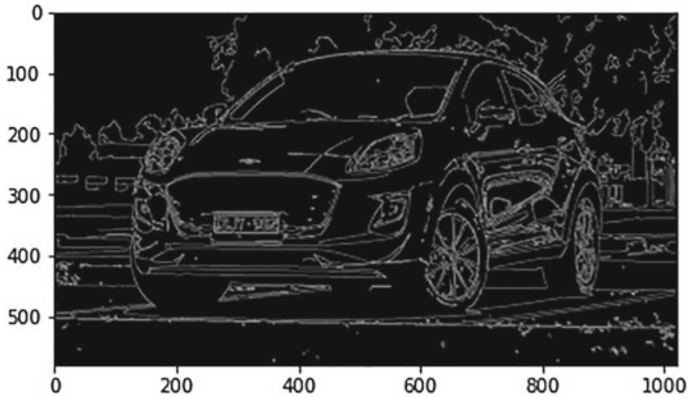


Fig. 6 Filtered and contoured image

Contour can be closed surface as required for a vehicle number plate. To find the number plate among the obtained results find the right contour, then draw a rectangle box around it, and make sure that we have detected the license plate correctly. The remaining information is useless, so use masking the entire picture except for the place where the number plate is. The masking image is depicted in Fig. 7.

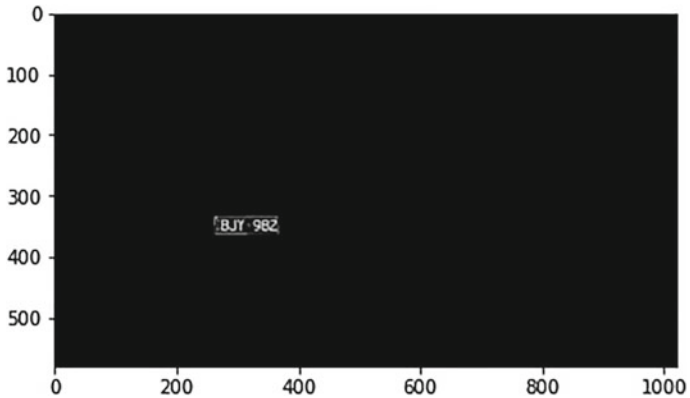


Fig. 7 Apply masking

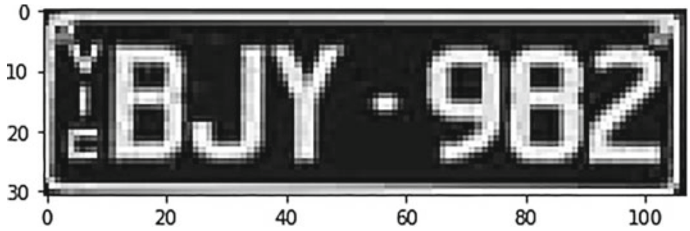


Fig. 8 Segmented image

4.5 Segmentation and Use EASYOCR

The ROI is obtained from an image on which many image processing operations including filtering are applied. The region of interest is obtained in various shapes. In any image, there may be multiple ROIs. The pixels are denoted by one if they belong to ROI and vice versa. In this step crop the image using the region of interest (ROI) segmentation method to detect the number plate and saved it as a new image. Now by using EASYOCR, read the character. EASYOCR is built in Python deep learning library, and having a GPU could speed up the whole process of detection [16] (Fig. 8).

5 Result and Implementation

The message we get after this study is to show that free and open source technologies are mature enough for scientific computing domains. Python and Python libraries are respectable for doing research in the domain of computer vision. There are 100 images considered for this implementation. For vehicle number plate detection, we have used the contour technique to detect edges. After that segmentation is done and crop the number plate, and at last to read the character apply OCR, which is followed by classification techniques. In the initial step, the dataset of vehicle images is taken, which is shown in Table 1. The images are read by Python script; after that images are converted to gray and blurred from RGB. Further, a bilateral filter is used to remove unwanted details from an image and canny is also used to detect edges. The syntax will be destination _image = cv2.Canny (source image, Threshold Value 1, Threshold Value 2). Threshold Value 1 and Threshold Value 2 represent the minimum and maximum threshold values. Only the edges that have an intensity gradient more than the minimum threshold value and less than the maximum threshold value will be displayed. The resulting image is shown in the table and after that apply contour now to deliver an image clearer in rectangular shape contour. The rest of the information is useless, so we use masking the entire picture except for the place where the number plate is. In the next step, number plate recognition **is** to segment the license plate out of the image **by** cropping it and saving it as a new image. Table 1 which includes seven actual images shows all steps that are required in detecting the number plate and Table 2 shows only the first and the last step.

Accuracy: The accuracy of the classification process is based on correct and incorrect predictions. Accuracy of the classification can be calculated by Eq. (1).

$$\text{Accuracy (ACC)} = \frac{TP + TN}{P + N} = \frac{TP + TN}{TP + TN + FP + FN} \tag{1}$$

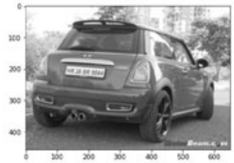
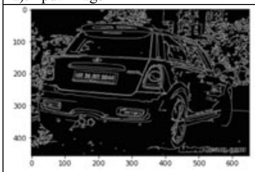
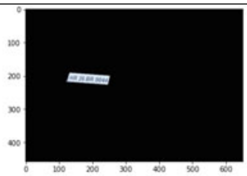
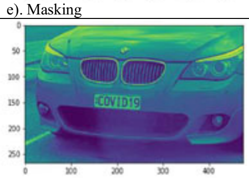
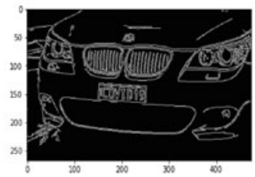
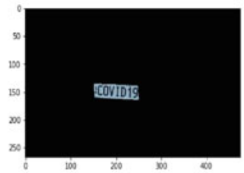
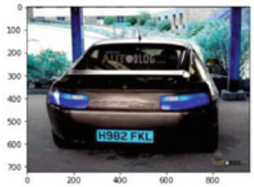
And we found that by using our methodology we find above 90% accuracy. Some sports models of the vehicle are not detected but the overall accuracy depends on the clarity of the image.

6 Conclusion

The proposed algorithm contributed to the recognition of the characters over the license plate images. The application of number plate detection techniques results in far better image visibility properties such that the output image is much superior to the original image for a specific application or predefined objectives. A detailed discussion has been carried out on applying chosen techniques as per conversion of RGB to gray and filtering requirements on the basis of final results. This is being recognized that the image pre-processing area is highly demanding.

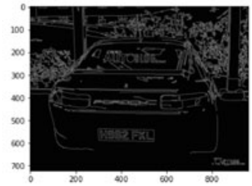
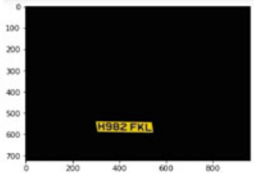
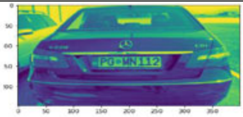
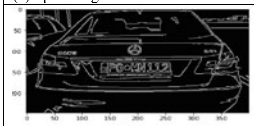
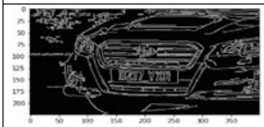
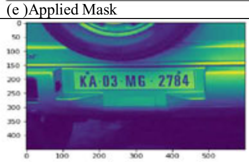
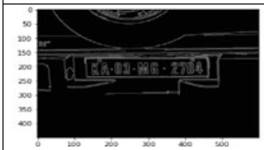
In real time, the detected images of the number plate may not be visible clearly for sports model vehicles. This needs further analysis. In the proposed work, correct and early number plate detection is presented. The presented technique calls for pre-processing, filtration, canny for edge detection, counter, overlaying, ROI segmentation and OCR for examining characters. The analysis is completed based on accuracy. Hence the efficacy of the paintings has been established. For early detection of car number plates, the ANPR techniques can be used. So the proposed method may be surprisingly useful in destiny.

Table 1 Result of the proposed methodology (a) Input image. (b) Blurred image. (c) Gray image. (d) Detect contour. (e) Image post applied masking. (f) Segmented image

1.	 a).Input Image	 b).Blurred Image	 c).Gray Images
	 d). Filtered &Detect Contour	 e). Masking	 F).Segmented and apply OCR
2.	 a).Input Image	 b).Blurred Image	 c).Gray Images
	 d). Detect Contour	 e). Masking	 f).Segmented and apply OCR
3.	 (a)Input Image	 (b) Blurred Image	 (c) Gray Image

(continued)

Table 1 (continued)

	 d).Filtered & Detect Contour	 (e)Applied Mask	 (f)Cropped no plate
4.	 (a)Input Image	 (b) Blurred Image	 (c) Gray Image
	 (d) Filtered& Detect Contour	 (e)Applied Mask	 (f)Cropped no plate
5.	 (a)Input Image	 (b) Blurred Image	 (c) Gray Image
	 (d) Filtered& Detect Contour	 (e)Applied Mask	 (f)Cropped no plate
6.	 (a)Input Image	 (b) Blurred Image	 (c) Gray Image
	 (d) Filtered& Detect Contour	 (e)Applied Mask	 (f)Cropped no plate

(continued)

Table 1 (continued)

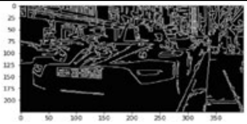
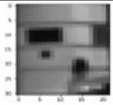
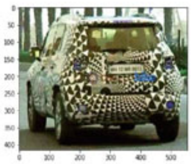
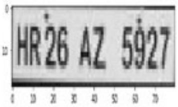
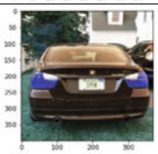
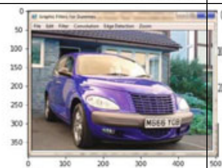
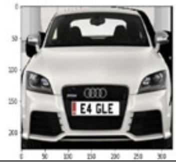
7.	 (a)Input Image	 (b) Blurred Image	 (c) Gray Image
	 (d) Filtered& Detect Contour	 (e)Applied Mask	 (f)Cropped no plate

Table 2 Resulting image (a) First step (input image). (b) Last step (detect number plate)

	(a)Ist step(Input Image	(b).Last step(Detect No. Plate)		(a)Ist step(Input Image	(b).Last step(Detect No. Plate)
1.			6		
2.			7		
3.			8		
4.			9		
5.			10		

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The Review of Recent Recommendation and Classification Methods for Healthcare Domain

Lakhvinder Singh, Dalip Kamboj, and Pankaj Kumar

Abstract Nowadays, Healthcare services are dependent on Health Information Systems (HIS). The Healthcare recommendation system plays a vital role in healthcare services, work as an essential tool for decision-making tasks. Health recommendation systems improve technology accessibility and simultaneously reduce the overload of information. Although technological advancement inside the medical domain extends back years, there are still numerous difficulties to be resolved. There are various tools and recommendations for doctors in health recommendation systems (HRS). The HRS can be based on collaborative filtering, content filtering, and knowledge filtering based or may be based on hybrid filtering-based techniques. HRS is used to evaluate patient information to derive the quality of content and aid in disease diagnosis and prediction. Patients can take medicine recommendations with the help of HRS. The classification models have discussed the existing performance metrics and comparative analysis such as LSTM, Fuzzy-Logic, CNN, CNN-LSTM, etc. These classification models have improved the precised parameters as compared with the existing deep learning models. It is used to monitor the wellness and critical condition of the patients. This study is seen to be a useful starting point and the foundation for HRS literature evaluation.

Keywords Health · Recommendation system · Classification models · Recommendation filteration methods

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L. Singh (✉)
M. M. Institute of Computer Technology and Bussiness Management MCA, Maharishi Markandeshwar (Deemed to Be University), Mullana, Ambala, Haryana, India
e-mail: akhvindersinghahuja@gmail.com

D. Kamboj
M. M. Institute of Computer Technology and Bussiness Management MCA, Maharishi Markandeshwar (Deemed to Be University), Mullana, Ambala, Haryana, India
e-mail: dalipkamboj@mmumullana.org

P. Kumar
Govt. College For Woman, Shahjadpur, Ambala, Haryana, India

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1 Introduction

The Indian medical system is expanding rapidly in terms of systems enhances, facilities, and increased spending from internal and external parties. In terms of growth and profitability, medical has been one of India's most significant industries. Healthcare facilities, diagnostic implants, drug testing, contracting, telehealth, healthcare services, medical coverage, and diagnostic supplies are components of the health industry. According to the WHO [1], health is defined as "A state of total physical, mental, and social well-being, not only the absence of illness or sickness". The recommender systems are intelligent systems that give people ideas on items that might be relevant to them. Although various approaches have been established in the past, the search continues to exist due to its extensive use in several technologies that customize recommendations and manage conflicting information. People rely on information to make decisions in their own best interests; therefore, the recommendation system seems to be a part of everyday life. As the amount of "big data" on the internet grows, recommendation systems are becoming more critical in information purification and processing. In the 1990s, effective content-based filtering procedures were required to obtain information properly. Health Recommender Systems are a recommendation system used in the healthcare sector. Professionals use these systems as a screening tool and by individuals as an individual medical advice instrument [2]. Also, as the medium of communication, the World Wide Web seems to have become the primary source of information and advice to individuals. HRS plays an essential part in selecting content during individuals' self-diagnostic queries on the internet and the subjects they are searching over. Clinicians have also utilized HRS for diagnostics and academic reasons.

1.1 Categories of Recommendation Systems

Recommendation systems are a type of content sorting that predicts user attitudes toward products they use and for which they are accountable. There are three phases of the recommendation system depicted in Fig. 1.

1.1.1 Information Collection Phase

This phase gathers information about the user to create a framework for classification and prediction that incorporates the patient's features, activities, and source information. To produce the best recommendation system must collect considerable information about the individual. Recommendation systems rely on various data sources, such as high-quality clear information that uses the patient's preferences in commodities as an input, and implicit feedback, which concludes user choices passively by evaluating the user behaviour.

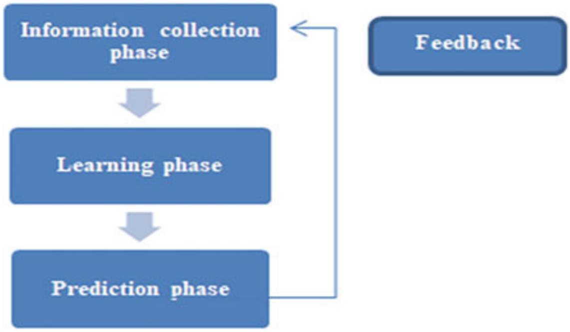

Fig. 1 Different phases of recommendation system [3]

1.1.2 Learning Phase

In this phase, learning methods are applied to the user information gathered via the information collection phase's feedback. Learning algorithms are strategies that aid in identifying patterns that are suited for use in specific scenarios.

1.1.3 Prediction Phase

This phase delivers recommendations or suggestions for the data set by examining the characteristics acquired during the learning phase. In the learning phase, the processed data generates patterns that predict the patient's way to proceed or forthcoming preferences.

The main advantages of Healthcare recommendation systems [4, 5] are discussed below:

- Healthcare recommendation systems are beneficial for doctors as well as patients.
- Patients are advised on the proper treatment of infectious diseases using a recommendation system to prevent health hazards.
- The recommendation systems also help extract essential information for medical recommendations, and the implementation of high-quality medical care therapies for sufferers helps the health practitioners.
- The Healthcare recommender system reduces the overload of the data.
- Decision making the quality of the recommendation system is high.
- It resolves the medical abbreviations issues.

Recommender systems have become a cutting-edge breakthrough in commercial enterprise. Recommendation systems, including Enterprise systems, have aided in optimizing decision-making procedures and the efficiency of the network infrastructure and facilities in healthcare services. Several applications of the healthcare recommendation system are depicted in Fig. 2 [15].

The review paper has contributed that the following steps:

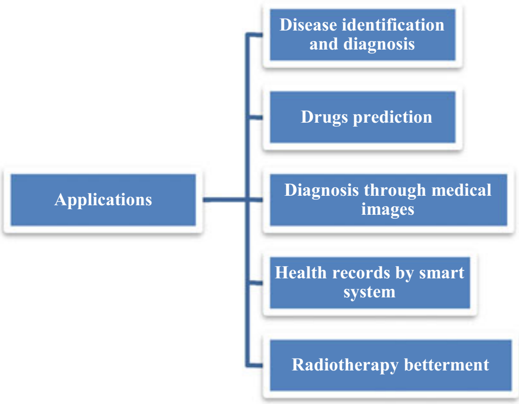

Fig. 2 Applications: healthcare recommendation system [15]

- Described that the different categories of the recommendation system and classification algorithms.
- Elaborate on the several filtration methods and the healthcare recommendation and classification method framework.
- Detailed comparative analysis study using different classification methods using CNN, DNN, CNN-LSTM, etc, with different performance metrics such as accuracy rate and precision rate.

In the field of health, the recommendation system might not only assist decision-making and prevent hazards or mistakes, but it also assists doctors and provides medication as needed, keeps a record of physiological parameters, and interacts in virtual environments via a central system. The remaining part of the paper is laid out as follows. In Sect. 2, several existing techniques of the healthcare recommendation system are surveyed. The framework of the healthcare recommendation system is explained in Sect. 3. In Sect. 4, different recommendation techniques are discussed. The techniques of the recommendation system are compared in Sect. 5. In Sect. 6, several applications of the healthcare recommendation system are explained.

2 Literature Review

Design a recommendation system for health evaluation. The proposed framework by Sood et al. [6] was based on a classification-based method using a deep neural network. The framework was divided into different stages. In the feature extraction stage, essential features were extracted from the images. For the improvement of the framework, a feature selection stage was performed. The multi-layer perceptron classification method was used for the classification of data. The performance of the proposed model was examined on real databases. The different performance parameters such as latency time, consumption of network bandwidth, execution time, Jitter, network bandwidth, and consumption of power were used to evaluate the model. Sharma et al. [7] used the deep learning approach to predict health-related risks. The framework was based not on a neuro fuzzy-based classification approach. The recommendation system classified the patients by using the patient's disease symptoms. The primary role of the fuzzy system was to predict the risk level of the disease. The collections of 1032 patients were used for the experimental evaluation of the system. The patients were given a bit of feasible advice about the serious stages of the related disorders based on the evidence presented either by vulnerability assessment to receive prompt and appropriate therapy. The different performance metrics such as accuracy, sensitivity, RMSE, and specificity were used to examine the system. Sahoo et al. [8] designed a deep learning-based healthcare recommendation system. The proposed system was based on two classification models as CNN (Convolutional Neural Network) and RBM (Restricted Boltzmann Machine). By evaluating the consistency of individuals' selections, the healthcare recommendation algorithms can locate recommended establishments. The designed deep learning methodology had provided better results than other existing methods. The proposed system had achieved 2.7 RMSE and 0.03095 MAE on 14 epochs. Deng et al. [9] proposed a deep convolutional neural network framework. The framework was based on a new CVDL termed collaboration variational deep convolutional neural network and using multi-sourced data to make effective health predictions within general practice. CVDL used a discretization auto-encoder to complement something like an interpreted ion model to train deep implicit reconstructions of element features in the spatial domain rather than observational space. Simultaneously, the CVDL was collected implicit patient information using an autoencoder computational model and a product description. As a result of such overall rating, username, and evaluation matrices, the CVDL might promote stronger implicit associations across user and item. Furthermore, to generate the greatest probability estimations regarding training parameter values, a Stochastic Gradient Variational Bayes (SGVB) framework was developed. Investigations on three different datasets revealed that the proposed model outperformed state-of-the-art composite CF algorithms by a substantial margin. Han et al. [10] designed a recommendation system for healthcare. The authors presented the matchmaker procedure across numerous diverse usage scenarios with the various degrees of existing knowledge regarding individuals. Then, using a hybrid recommender system, a list of several general practitioner suggestions was given to every individual. Then, a list of general practitioner suggestions to another individual was given using a hybrid recommendation system. A large amount of consulting records and estimated trusting relationships in medical professionals was used despite allowing and for nonlinear changes of individual connections. The proposed technique outperforms both a cognitive foundation and an information retrieval strategy in prediction accuracy. The predicted scheduling measurement boosted the performance of the model still further. Subiksha et al. [11] proposed a framework based on deep learning for the medical care system. A decentralized deep learning classification framework was designed that could effectively link a wide range of healthcare databases and services. The design was established a common format allowing integrating multiple healthcare packages, which aids in gathering information that might then be utilized as inputs for many other medical platforms' choices. NLP termed Natural Language Processing phrases were used to provide the necessary details, which would then be turned into questions. Sector Conceptual frameworks were collections of dictionaries or medical terminologies that pertain to a problem discipline. They also had a visual to help them recognize the thoughts and relationships that arise. Wenbin Yue et al. [16] described the main objectives of describing a review of typical recommendation, classification methods, and their different uses in the healthcare system. An overview was given on three different recommendation and classification methods: content-based, CF-based (collaborative filter), and HM (hybrid methods). Subsequent, they give a snapshot of 5 different application cases related to the healthcare recommendation and classification system that were TR (training recommendation), LSR (lifestyle recommendation), DR (dietary recommendation) decision-making for patients and PHYSICIANS, and disease regarded classification and prediction. Lastly, the main challenges were defined with justifications to this novel and booming area. In the Table 1, several existing techniques of the healthcare recommendation system are depicted with research gap, dataset, and performance parameters. The classification techniques used in healthcare recommendation systems with results are established in Table 2. The drawbacks and enhancements of the techniques are also established in Table 2.

Abbrevations: CNN (Convolutional Neural Network), HRS (HealthCare Recommendation System), CF (collaborative filter), HM (Hybrid Methods), LSR (lifestyle recommendation), DR (Dietary Recommendation), DNN (Deep Neural Network), CNN-LSTM (CNN-Long Short Term Memory).

3 A Framework of the Healthcare Recommendation System

The Health Care Recommendation System provides a higher level of personalization, which raises the specificity of offered advice and enhances the recipient's comprehension of individual health problems [12]. Individuals will have a more prosperous outcome with all these technologies, which will enhance the overall condition and encourage patients to maintain a healthy lifestyle—additionally, technologies aid medical professionals in illness detection and prevention. The HRS is a choice platform that ensures appropriate patient records to medical practitioners and end-users. The framework of the healthcare recommendation system is categorized into different phases: data gathering phase, patient profile generation, sentiment analysis, privacy preservation, and recommender [13]. The architecture of the healthcare recommendation framework is shown in Fig. 3.

Table 1 Existing methods based on recommendation and classification methods in healthcare systems

Author's name	Proposed method	Gap/problem definition	Dataset	Performance metrics
Sood et al. [6]	Deep learning-based recommendation system	Dataset is limited	Work on Real dataset	Accuracy, Network bandwidth, Power consumption, Jitter, Execution time, Latency, Arbitration time
Sharma et al. [7]	Deep learning and neuro fuzzy-based system	Not implemented for real-time environment	1032 patients	Accuracy, RMSE (Root Mean Square Error), Sensitivity, Specificity
Sahoo et al. [8]	RBM-CNN (Restricted Boltzmann machine)-Convolutional neural network	Inefficient privacy results	PDB dataset	RSME, MAE, Recall, Precision, F-measure
Deng et al. [9]	Collaborative filtering based health care system	Challenging implementation	CiteULike datasets	Recall
Han et al. [10]	A hybrid approach based health recommendation system	Work only on offline collected information	Collected samples	Precision rate
Subiksha et al. [11]	The deep learning-based health analyzer system	Need to enhance the methodology for better results of information retrieval	WordNet dataset	Precision, Recall
Wenbin et al. [16]	Collaborative filtering, content-based, and Hybird Methods	Low efficiency Sparsity	Large oNline recipe dataset	RMSE, MAE, MRR (Mean Reciprocal Rank)

3.1 Information Sources

Doctors conduct medical trials on individuals to diagnose tuberculosis, diarrhoea, flu, and others. Professionals need knowledge from parameters and variables to investigate and assess various ailments and discover a solution for patients. Furthermore, the amount of data collected in the medical industry has increased dramatically. Data gathering and aggregation are part of this phase.

Table 2 Classification techniques of healthcare recommendation system

Author's name	Classification technique	Results	Drawbacks	Enhancement
Sood et al. [6]	Multi-layer perceptron (MLP)	Accuracy = 85%	Time-consuming	Hybrid methods will be used for more enhancement
Sharma et al. [7]	Convolutional neural network (CNN)	Accuracy = 90%	Inaccurate classifications in complex cases	Real-time data will be collected
Sahoo et al. [8]	RBM-CNN	MAE = 0.03 RMSE = 2.7	Requirement of more data for training of the model	Optimization technique will be implemented for efficient results
Deng et al. [9]	Stochastic gradient variational Bayes	Recall = 0.75	Need to use more evaluation parameters for the reliability of the model	The precision rate of the Healthcare recommendation system will be improved with hybrid techniques
Han et al. [10]	Collaborative filtering technique	Not defined	Data augmentation issues	A matchmaking feature will be added for better performance
Subiksha et al. [11]	Supervised clustering technique	Precision-recall curve = 0.88	Inefficient results of pre-processing	Annotations text will be retrieved from the image

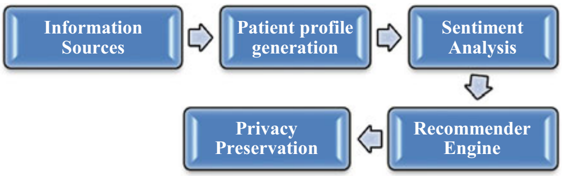

Fig. 3 Framework of Healthcare recommendation system [13]

3.2 *Patient Profile Generation*

After gathering all details about patients, the next phase is to generate a patient profile. Throughout this phase, a patient file is generated for each individual that comprises a range of information. A medical record will be maintained for each patient, detailing their health examination. The doctors, patients, hospitals, CT scans, laboratory tests, X-rays, and other providers are all included in the file.

3.3 Sentiment Analysis

In addition to supporting the patient-based recommendation system providing medical services, it's also necessary to ensure that the patient has faith in the overall network, i.e, reliability of the system to protect patient information confidentiality and privacy. Information collected from the individual, whether with or without appropriate patient records, must be kept private and not be exploited.

3.4 Privacy Preservation

The healthcare recommendation system necessitates merging heterogeneous clinical data to enhance personalized recommendation quality and enhance individual health. As a result, preserving the confidentiality of a participant's data is essential in medical trials.

3.5 Recommender Engine

Recommendations can be developed based on the rule extraction and the participant's situation. Patients take suggestions that are unique to them. Such offers might be in the form of corrective and preventive and measures, an explanation for the virus's origins, or a novel therapeutic approach.

4 Several Categories of Filtering-Based Recommender Systems

The following are the most common classifications of recommender systems: collaborative, content-based recommendation method, Knowledge-based, recommendation and hybrid recommendation techniques. The categorization of recommendation techniques is presented in Fig. 4 [14].

4.1 Collaboration Filteration

The most common type of recommendation technique is collaborative filtering. Collaborative filtering takes the data obtained from a large number of users regarding particular preferences or interests and applies it to create the necessary estimations for any specific user.

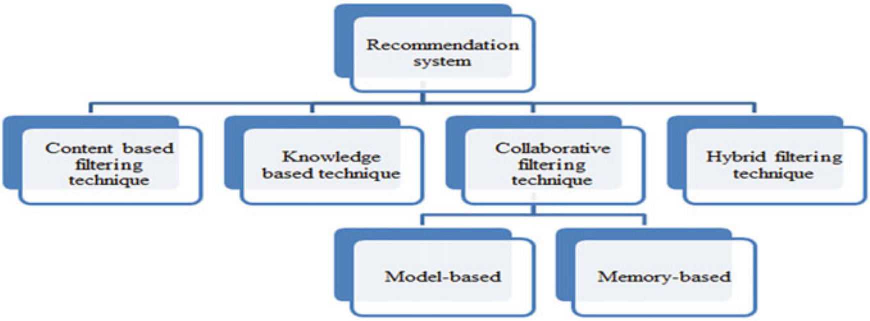

Fig. 4 Hierarchy of a recommendation system based on filtration techniques [14]

4.2 Content-Based Filteration

Content-based recommendation techniques make recommendations based on the person's profile and the object's description. Like other items, the user can receive offers based on previous usage patterns. The system looks into and analyses the reports of things that the user has previously graded and builds a profile page depending on the characteristics of those attribute values.

4.3 Knowledge-Based Filteration

Knowledge-based recommender systems analyze personal preferences, object attributes, and recommendations parameters. These strategies enable systems to explain well the link between both the individual and the objects that aids in the avoidance of pointless suggestions.

4.4 Hybrid Recommendation

Hybrid Recommender Systems combine any of the two methods in such a way that is customized to a particular sector. It is the most desirable significant indication because it incorporates all qualities from multiple Recommender systems even while eliminating any weaknesses which may emerge only when a single prediction model is employed.

4.5 *Collaboration Filtering Technique*

The fundamental goal of collaborative filtering (CF) is to collect knowledge about a former participant's actions and beliefs to determine whether or not those are equivalent to the original participant. The collaborative filtering method is the most extensively used and common practice in recommender systems. Then, it builds the recommendations on historical assessments of the participants. It is subdivided into two types: model-based and memory-based.

5 Comparative Analysis of Healthcare Recommendation and Classification Methods

There are several existing recommendation systems of healthcare; some designs are based on content technique, some are based on collaboration, and some strategies are deep neural network-based. A comparative analysis of various existing healthcare recommender systems is presented in Table 3. The content and combined technique based recommendation systems are discussed in the previous section. The fuzzy-based recommendation systems are used to predict diseases and medicine for the patients. Fuzzy logic is used to model real-world notions that are difficult to represent precisely. Fuzzy logic classification is a strategy that mimics human reasoning. The fuzzy rule-based system employs fuzzy sets and fuzzy logic to define relationships between variables and supports the representation of knowledge. Rules, such as IF–THEN, are used to support the learning process. The deep neural network plays a vital role in recommendation systems. Deep learning permits computer simulations made up of many convolutional filter applications of neural networking to acquire numerous abstraction levels for activation functions. The number of convolutional nodes, underlying interconnections, and the right to receive significant representations of the information seems to be the main changes among Deep Neural Networks (DNNs)

Table 3 Comparison of healthcare recommendation system

Platforms	Content-based	Collaborative	DNN	Fuzzy system
Recommender system for disease detection [6]	No	No	Yes	No
Patients recommender system [7]	No	No	Yes	Yes
Medical care recommender system [8]	No	No	Yes	No
Healthcare recommender system [9]	No	Yes	Yes	No
Patient doctor primary care system [10]	Yes	No	No	No
Patient evaluation system [11]	No	No	Yes	No

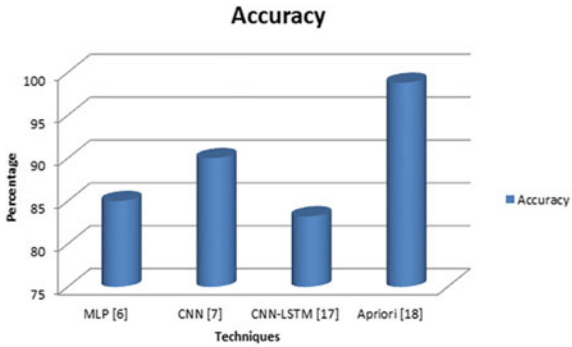

Fig. 5 Comparison Analysis various classification methods of HealthCare recommendation system: accuracy rate (%)

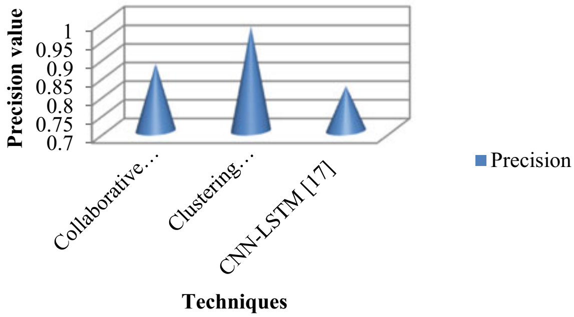

Fig. 6 Comparison Analysis various classification methods of HealthCare recommendation system: precision rate (%)

classification method. The deepest learning-based CNN, CNN-LSTM, Apriori [18] classification techniques are compared to the analysis. Apriori technique is used for association and data mining purposes in recommendation systems. CNN-LSTM [17] classification method is used for efficient results of the recommendation. The attractive characteristic of deep neural networks classification is that such features are learnt through data and use a particular learning technique rather than been built by individual experts. The results of existing deep learning techniques are graphically represented in Fig. 5. The precision rate of existing methods of the healthcare recommendation and classification method is presented graphically in Fig. 6.

6 Conclusion and Future Scope

A review process was used to conduct the literature review in this paper. HRS categorization procedures were described, and the phases were discussed. The framework of HRS and its applications are also presented. Finally, several categories of filtering-based recommender systems are discussed, and a comparative analysis of existing methods is presented. The review of existing techniques of Health Recommendation Systems with outcomes is presented in this paper. According to the significant conclusion, HRS is a potential development of medical services. There are various applications of health recommendation systems in the medical sector. The studies provided that HRS are used for different medical benefits. The existing literature demonstrated that HRS monitors the patients' health, assists the doctors, and is used in several healthcare services.

The different phases of the recommendation system are the information gathering phase, learning phase, and prediction phase. The framework of the healthcare recommendation system consists of different stages. The first stage of HRS is data gathering, the second is patient profile generation, the third is sentiment analysis, the fourth is recommender stage, and the last is privacy preservation. The Healthcare recommendation system is a new concept, and it will take time for more good research and the improvement of filtering techniques. The main issue that comes with existing systems (classification) is data privacy. The researchers should concern about privacy issues when developing healthcare systems.

In the future, to propose a model to classify different diseases in healthcare system with enhanced machine and deep learning techniques to overcome the high time consumption issue with classification existing methods. The propose a hybrid approach for recommendation to evaluate diseases and generate a recommendation to overcome the accuracy rate and error rate issues in the existing models.

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An Adaptive Distance-Based Interest Propagation Protocol for Vehicular Named Data Networks

Kaoutar Ahed, Maria Benamar, and Rajae El Ouazzani

Abstract The particular challenge in vehicular environments compared to other wireless networks are the rapidly changing topology and intermittent connectivity. The Named Data Networking (NDN) model has recently been proposed to offer new perspectives to meet the challenging demands of vehicular environments. The NDN exploits content name and eliminates the need to establish and maintain an end-to-end connection, which enables efficient communication in highly mobile vehicular environments. When combined with the VANET environment, the basic method of forwarding interest packets is flooding. However, this approach will lead to the broadcast storm problem which reduces the performance of VANETs' applications. In this work, we suggest an adaptive distance-based protocol for vehicular named data networks to mitigate the interest in broadcast storm. In this distance-based approach, each vehicle dynamically computes locally an adaptive waiting timer based on the distance between the current receiver and its neighboring vehicles. The simulation result indicates that the proposed works outperform the rapid traffic information dissemination both in terms of interest satisfaction ratio and end-to-end delay.

1 Introduction

Vehicular Ad-Hoc Networks (VANETs) [1] have been considered the most interesting technology for smart city applications. These applications can produce and consume at the same time a great amount of content. The advances in Cloud Computing (CC) and Internet of Things (IoT) have presented a real benefit to better support the additional increase of transportation and smart city problems [2–4]. Basically, in smart city and transportation applications, vehicles could not only exchange data with other vehicles and with the road-side infrastructure, but also with heterogeneous entities, i.e., mobile devices carried by pedestrians and cyclists. From the networking perspective, high reliability and minimum end-to-end delay are major challenges to

K. Ahed (✉) · M. Benamar · R. El Ouazzani
IMAGE Laboratory, School of Technology (EST), Moulay Ismail University, Meknes, Morocco
e-mail: kaoutar.ahed@edu.umi.ac.ma

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handle data delivery in smart cities and transportation. However, the traditional host-centric communication used for content delivery is significantly affected by inherent VANET, traits such as harsh wireless propagation and rapidly changing topology, resulting in intermittent connectivity among vehicles [5]. All these characteristics challenge the use of TCP/IP architecture to establish a stable connection and make difficult the data delivery in transportation and city scenarios. From this weakness of the VANET technology, several researchers are looking to define a new efficient and reliable architecture that can replace the old IP model. Accordingly, Named Data Networking (NDN) of information-centric networking (ICN) has been proposed to improve the performance of different applications, including VANET applications [6, 7]. In this model, requests are searched and routed using the content name directly. When applying the NDN paradigm in vehicular networks, the consumer broadcasts an interest packet to search for content in the whole network. When a vehicle receives the interest packet, it forwards it to every vehicle within its communication range until reaching a node that holds a copy of the content. Node with content will forward the data to the consumer. However, the uncontrolled broadcasting of interest waste network resources leads to the broadcast problem which degrades the performance of the network [8, 9]. In this work, we are dealing with these problems and suggest a new distance-based VANET routing protocol. Specifically, this paper focuses on reducing the flooding of interest packets caused by the broadcast problem in vehicular named data networks. Our proposed scheme applies a more stable route decision approach based on the prioritized adaptive waiting timer (AWT) to select as the next forwarder the more stable relay node. The distance between two vehicles is used in this scheme to adjust locally the waiting timer. We evaluated our proposed protocol with the rapid traffic information dissemination (RNDN) [10] which is a distance-based forwarding method. Simulation assessments show that the proposed adaptive protocol outperformed the rapid traffic information dissemination both in terms of interest satisfaction ratio and end-to-end delay. The rest of the paper is organized in the following manner: In Sect. 2, we discuss the most relevant related works in vehicular named data networking. Section 3 provides a description of the main research problem considered in this work. In Sect. 4, we present the architecture and algorithm of our proposed adaptive protocol. Section 5 discusses our experimental scenario and analyzes the simulation results compared to related works. Finally, Sect. 6 summarizes the work and presents future works.

2 Related Works

There are several efforts dedicated to addressing the forwarding challenges when applying NDN in the VANET environment. Among these challenges, we focus on the broadcast problem that was extensively addressed in [11]. In this section, we focus on some works in the literature that suggest a new technique to mitigate the broadcast storm. The authors in [12] propose a forwarding mechanism named Broadcast Storm Mitigation Strategy (BSMS) that aims to address the broadcast storm problem. This mechanism relies on speed and distance between two vehicles (receiver and sender) added in the interest packet received. Furthermore, BSMS employs a receiver timer counter to make the forwarding decision and thus alleviates the broadcast storm problem. In the same way, the authors in [13] suggested the Density-Aware Delay Tolerant (DADT) scheme to prioritize interest transmission among neighbor's nodes. To achieve this prioritization, DADT employs a defer timer calculated based on the distance between the current node and the distance to the last sender to forward the packet to the farthest vehicles from the sender and closest to the data producer. Another work [10] came up with rapid traffic information dissemination (RNDN) to mitigate the broadcast storm problem in vehicular named data networks. In this scheme, a defer timer based on the distance is also used to disseminate interest packets farther from the previous sender. Accordingly, nearby forwarders will wait for a longer period than the other farther forwarders. As previously mentioned, there are several research studies that use a timer to prioritize the interest propagation among neighbor nodes. Different from all the above research works, our proposed adaptive interest forwarding protocol separates a sender's communication range into zones. In contrast to the related work, each receiver determines its zone and calculates locally its adaptive waiting timer according to the zone to which it belongs.

3 Problem Statement

Named data network shows it is fruitful in wired networks by reducing the overhead needed for maintaining communication between endpoints. In vehicular named data networks, the high density in congested roads leads to choking of the transmission medium [14]. This is due to employing the broadcast nature of wireless channels that present a great benefit for vehicular communication. However, it increases the probability that the same node receives the packet from more than one neighbor which floods the network with redundant packets and results in high collision and contention [15]. The uncontrolled broadcasting increases considerably the packet collision and will delay the data delivery due to packet loss. Controlled and efficient interest forwarding schemes are necessary to decrease the delay and improve overall network performance when combining VANET and NDN technologies. In this work, we address the uncontrolled broadcasting problem and suggest an improved distance-based NDN-based VANET. Our proposed protocol uses a prioritized adaptive waiting timer based on the relative distance between a sender and neighboring nodes. In contrast to the previous solutions, our proposed protocol separates a sender's communication range into three prioritized zones to make the interest dissemination more efficient. In addition, each neighboring node will independently determine its zone and calculate locally its adaptive waiting timer according to the zone to which it belongs. The details of the suggested method will be explained in Sect. 4.

4 Adaptive Distance-Based Protocol in Vehicular Named Data Networks

In this section, we describe our proposed adaptive interest propagation protocol (AIPP). The AIPP is a lightweight propagation protocol that elects the most stable and farthest node as a forwarder while using a distance-based broadcast method. In contrast to other solutions, the suggested protocol divides a sender's transmission range into three prioritized zones as depicted in Fig. 1. The lowest priority to broadcast or rebroadcast a packet is assigned to the nearest node from the sender existing in the D_1 zone. The D_2 zone contains the further and most stable node from a sender within the sender's transmission range. The D_1 and D_2 zones are represented each by the area of a circle with a radius equal to the distance d_1, d_2, respectively, while zone 3 is formed by omitting from the sender's communication range both aforementioned zones (D_1 and D_2). The procedure of the interest packet processing of our proposed scheme is presented in Algorithm 1. A node upon receiving an interest packet checks whether the required data already exists in its Content Store (CS) or not (Line 2). The node sends the data packet if it found it in its cache (Line 14). Otherwise, the node checks whether this incoming Interest was previously included in its Pending Interest Table (PIT) (Line 3). If that's the case, the receiver node removes the packet since an equal request has already been sent (Lines 9–11). If not, i.e., the Interest packet is received for the first time, the node calculates the distance that separates it from the sender's position and schedules the packet forwarding after an adaptive waiting timer (Lines 4–7).

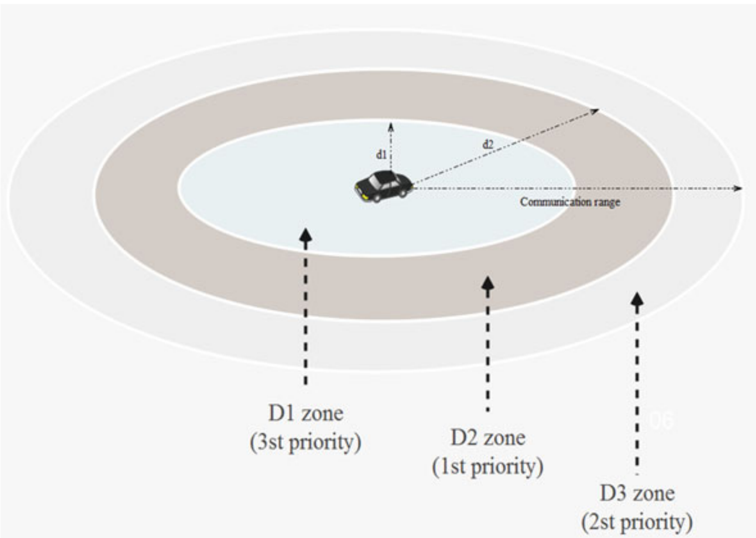

Fig. 1 Prioritized zones in AIPP

Algorithm 1 The processing of receiving DATA in AIPP

```
OnIncomingInterest [Name,Selector, NONCE]
if Content not in CS then
    if Name not in PIT then
        PIT.add (AIPP I_pkt)
        d ← CalculateDistance(r, s)
        AWT ← AWTCalculation()
        ScheduleInterest [I_pkt,AWT]
    else
        if Interest is scheduled then
            stop I_pkt transmission
            remove I_pkt transmission
else
    DATA[Name, MetaInfo, DDL, Content,...]
    Send data to face
```

Algorithm 2 The processing of receiving DATA in AIPP

```
1: OnReceivedData [Name, MetaInfo, Content]
2: if Content not in CS then
3:     if Name in PIT then
4:         Cache DATA in CS
5:         Send DATA to availabale Faces
6:         Remove PIT Entry
```

We suggested a new adaptive function to calculate the waiting timer of each node. This calculation takes into consideration the separation of the prioritized zones and is defined as follows. Let R the maximum transmission range, d_1 and d_2 represent a distance of 25% and 50% of the maximum range, respectively, Rdm_t is a random waiting between 0 and 2 ms to avoid collision and Max_t is the maximum waiting timer and equal to 5ms. Equation (1) shows the calculation of the adaptive waiting timer for each zone. For a receiver node located on the D_1 zone, its adaptive waiting timer will be computed in $0 \leq d \leq d_1$. Similarly, for receiver located on the D_2 zone, its adaptive waiting timer will be computed in $d_1 < d \leq d_2$, while the timer will be computed in $d_2 < d \leq R$ whenever a receiver node is located on zone 3. Through this equation, the smallest value of the adaptive waiting timer is always assigned to the node closer to the boundary of the zone.

$$\begin{cases} \frac{-Max_t+Rdm_t}{R}.d + Max_t, & \text{if } 0 \leq d \leq d_1, \\ \frac{-Max_T+Rdm_t}{R}.(d + R - d_2) + Max_t, & \text{if } d_1 < d \leq d_2, \\ \frac{Max_t-Rdm_t}{R}.(d - R - d_1) + Max_t, & \text{if } d_2 < d \leq R. \end{cases} \tag{1}$$

Algorithm 2 showed the operation performed by the intermediate node to process a receiving data packet. When an intermediate node receives a data packet, it verifies if the data is already stored in its CS (Line 2). If the data exist the process ends, otherwise the node checks if there is an already pending request for that content in its PIT table. If so, the node stores the data packet in its CS, forwards packet to the all available InFace in the PIT and removes the entry requesting the same data from the PIT table.

5 Performance Evaluation

5.1 Simulation Setup

In order to evaluate the implementation and performance of the proposed protocol, the NS3-based Named Data Networking Simulator (NdnSim) [16] has been used as a network simulator. As presented in Table 1, simulation settings are configured to match the IEEE 802.11a specification, as IEEE 802.11p is not available in ndnSIM. The maximum transmission range used is 250 m, and the constant velocity is set at roughly $\approx$ 30 m/s. Regarding the road structure, we considered a convoy of vehicles lined up on a road segment of 10 km in length unidirectional and perfectly straight and flat. In the conducted experiment, we varied the total density of nodes from 50 to 450 with an increase of 50 nodes per simulation scenario. A minimum of 10 simulation repetitions were run per density.

5.2 Simulation Results

Figure 2 shows the end-to-end delay (E2E) exhibited by the AIPP and RNDN schemes. Over a small node density, both schemes exhibit higher E2E delays. As the density increases, the E2E delay decreases using RNDN and the proposed scheme. This shift in performance is explained by the fact that the chances of finding neighboring vehicles to relay the packet decrease as the number of vehicles decreases. From Fig. 2, we can also notice that our proposed scheme exhibits lower delays than the RNDN scheme over all densities. The reason for decreasing the delay comes from the fact that interest transmissions are performed by the further and most stable distant forwarding node from the current forwarder node. Thus, the proposed prioritized AWT selection mechanism shows its robustness to save more time especially when the number of vehicles has increased.

Table 1 List of simulation settings

Parameter	Value
Vehicle density	1000 vehicles
Vehicle speed	30 m/s
Power transmission	5 dBm
Range	250 m
Run	10
Simulation time	300 s
Packet size	300 bytes

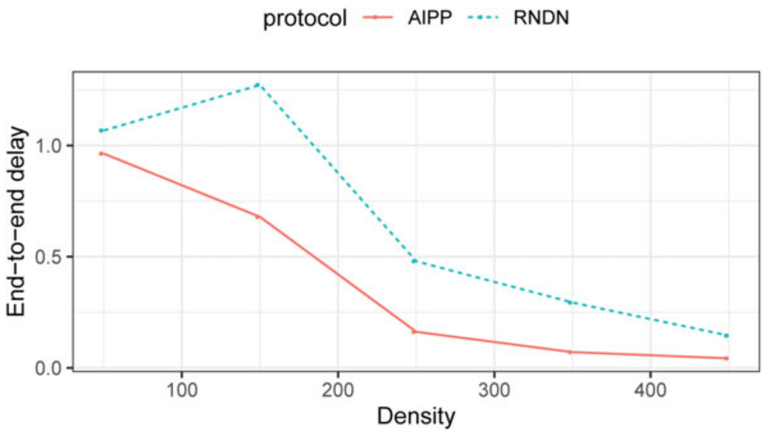

Fig. 2 Average delay versus vehicle density

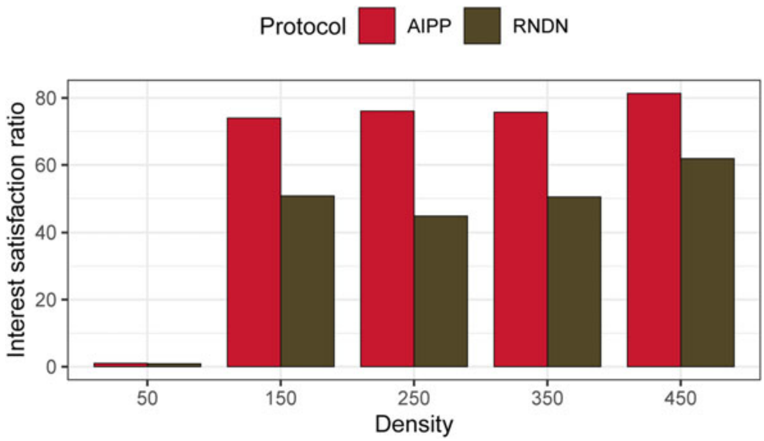

Fig. 3 Average interest satisfaction ratio versus vehicle density

The Interest Satisfaction Ratio (ISR) exhibited by the AIPP and RNDN schemes over the considered node densities is presented in Fig. 3. The general fall in interest satisfaction ratio over small densities is due to the decrease in content producers in the network which is noticed for both AIPP and RNDN schemes. When compared to the RNDN, the adaptive forwarding mechanism of the proposed AIPP protocol reveals greater performance than RNDN. The proposed scheme improved the interest satisfaction ratio by 60% as compared with RNDN for the small densities. This is because the adaptive prioritization mechanism of the AIPP decreases the Interest packet collision and consequently improves the propagation of interest.

6 Conclusions

In this work, we presented an adaptive interest forwarding protocol to tackle the inappropriate effect of the broadcast storm in vehicular named data networks during communication between vehicles. The proposed protocol applied an approach for selecting the most stable route decision based on prioritized adaptive waiting timer. In the proposed protocol, the distance between the receiver and the current forwarder node is used to adjust the adaptive waiting timer. The adaptive waiting timer will locally and independently be calculated according to the zone to which the receiver belongs. Simulation results show that the suggested scheme improves the performance as compared to rapid traffic information dissemination (RNDN) in highway scenario. The proposed protocol shows that it performs high-interest satisfaction ratio due to the stable routing decision and also reduces the average end-to-end delay. The future work will include a more detailed evaluation of AIPP considering the impact of vehicle speed and other distance-based routing protocols for the vehicular named data network.

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Comparative Study of Enhanced Round Robin Algorithms with Drrha and Other Metaheuristic Algorithms

Ritika Verma, Sarthak Mittal, Siddharth Pawar, Moolchand Sharma, and Deepak Gupta

Abstract CPU scheduling has a substantial influence on system resource usage and overall performance. Scheduling Algorithms are a technique for reducing CPU resource deprivation while simultaneously maintaining fairness among the numerous programs that utilize the resources. Round Robin is a preemptive scheduling method that significantly improves response time by restricting each operation to a certain length of time known as the Time Quantum. Various efforts have been made to calculate a time quantum value to optimize these Round Robin algorithm parameters. However, this gain in response time comes at the expense of turnaround and waiting time. In this paper, we compare the conventional Round Robin CPU scheduling algorithm to updated Round Robin algorithms such as DRRHA, as well as our suggested approaches termed MDRRHA and NDRRHA, which seek to reduce process waiting time. The Quantum value for MDRRHA and NDRRHA is derived dynamically using the arithmetic mean and the normal distribution of execution time values of tasks, respectively. The recommended solutions decrease average turnaround time and average waiting time values by up to 13%. In this research, we compare different job scheduling approaches by simulating them in a variety of test situations.

Keywords Task scheduling · Round robin · Time quantum · Normal distribution · Ready queue

Abbreviations

DRRHA	(Dynamic Round Robin heuristic algorithm),
MDRRHA	(Median Dynamic Round Robin heuristic algorithm),
NDRRHA	(Normal distribution Dynamic Round Robin heuristic algorithm),

R. Verma · S. Mittal · S. Pawar · M. Sharma (✉) · D. Gupta
Department of Computer Science and Engineering, MAIT, GGSIPU, Delhi, India
e-mail: sharma.cs06@gmail.com

D. Gupta
e-mail: deepakgupta@mait.ac.in

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SJF	(Shortest Job First),
HRRN	(Highest Response Ratio Next),
RR	(Round Robin)

Note The following terms are used interchangeably:

(i) 'Burst time' and 'Execution time'.
(ii) 'Process', 'Task', 'Job' and 'Procedure'.
(iii) 'Arrival Time' and 'Submission Time'.

1 Introduction

There can be multiple processes waiting for CPU time in an operating system. It is the job of a process scheduler [1] to provide this CPU time to various processes in a way that the processor does not remain idle, and at the same time, the processes are not waiting for a long time to get processed and are completely executed as soon as possible.

A good scheduling algorithm is a collection of policies and methods that manage the order in which work is completed and can be judged based on criteria like [1]:

1. CPU Utilization—A scheduling algorithm should be designed to keep the processor as busy as possible. It must efficiently use the processor.
2. Throughput—It is calculated as the amount of work done per unit of time. A good scheduling algorithm should maximize throughput.
3. Response time—It is the amount of time it takes to begin responding to a request. The time delay between the moment a process arrives and the first time it receives the CPU is referred to as response time.
4. Turnaround time—It is the time taken by a job or process from its submission to completion.
5. Waiting time—If multiple jobs conflict with a multiprogramming system, this is the period during which the job awaits resource allocation. The goal is to reduce the amount of time spent waiting.
6. Fairness—A good scheduler must ensure that each process receives an equitable share of the CPU.

Traditional CPU Scheduling techniques include SJF (Shortest Job First), FCFS (First Come First Serve), and LJF (Longest Job First), each having its own set of pros and downsides.

The Round Robin algorithm [1] is one of the most often-implemented algorithms. Here each process is assigned a specific time (Time Quantum). It is specifically built for the time-sharing scheme. The process scheduler iterates over the ready queue, assigning CPUs to each job at single-time quantum intervals. Here the ready queue is kept as the first in first out queue. The latest arrived process is placed at the ready queue's end. The scheduler then chooses the process from the head of the ready queue, creates a timer to stop after one quantum, and transmits it. Then any one of the following occurs:

1. The CPU burst of the procedure can be smaller than the quantum, if this is so, then the procedure freely releases the CPU. Following that, the scheduler advances to the next process in the ready queue.
2. CPU burst of the procedure is bigger than quantum, the process executes up to quantum time value then the timer is turned off and the operating system is halted. The context switch happens and the process is added to the ready queue at the end. After that, the CPU scheduler chooses the subsequent process in the ready queue.

The Round Robin [1] scheduling technique considerably improves the process's response time, albeit at the expense of waiting time and turnaround time. To circumvent these drawbacks, DRRHA [2] (Dynamic Round Robin Heuristic Algorithm) receives processes from users and pushes them to the ready queue based on increasing submission time. Each process is then placed in the ready queue and sorted using the SJF approach. The mean of the remaining burst time value of all processes present in the ready queue is calculated at the end of each round. Following that, the quantum time for each job is determined independently using Eq. (1) [2]. If the leftover execution time of the job is either equal or smaller than the quantum value, then the process completes its burst time and is expelled from the ready queue. Otherwise, the process is placed at the queue's tail and will be executed in the next round. Furthermore, when the latest processes arrive, it is inserted in the ready queue until the current round ends.

$$\boldsymbol{QTij} = \left(\frac{\boldsymbol{m}}{2}\right) + \frac{\left(\frac{\boldsymbol{m}}{2}\right)}{\boldsymbol{BTij}} \quad [2] \tag{1}$$

The key contribution of this study is the provision of two heuristics to improve the already existing DRRHA [2]. The suggested models optimize the DRRHA by lowering the average waiting time, average turnaround time, and average response time. In this research, we present statistical techniques such as Median and Normal Distribution [3] to dynamically compute time quantum value and provide a comparison of the suggested algorithms with DRRHA and other typical CPU scheduling algorithms.

Various tests and assessments were performed to measure the performance of the proposed models. The trial cases for the paper were taken from [4, 8, 20, 21] and DRRHA [2]. The dataset for one of the experiments was imported from Kaggle [18]. The second dataset for the experiment was randomly generated. The following conclusions were obtained after running experiments on the proposed model:

1. NDRRHA succeeded in optimizing average turnaround time and average waiting time compared to DRRHA. It also succeeded in reducing the average response time compared to SJF.
2. In terms of the average turnaround time and average waiting time, MDRRHA showed no substantial gains and converged with DRRHA to a significant extent.

The remainder of this work is structured as stated. The Literature review is covered in Sect. 2. Section 3 tells about the suggested technique, with 3.1 being NDRRHA and 3.2 being MDRRHA, while Sect. 4 presents the simulator and testing circumstances. Section 5 presents the Evaluation and Discussion of Simulation Results. Section 6 discusses the limitations of the proposed study. Finally, in Sects. 7 and 8, there is conclusion and a list of future works.

2 Literature Review

Since the choice of the appropriate time quantum has such a large impact on the Round Robin algorithm performance, a lot of researchers have come up with different techniques for determining the time quantum. These can be fixed time quantum or dynamic time quantum for each round or even each task. These techniques can range from using novel statistical values to applying machine learning to get the optimal time quantum.

Alhaidari et al. [2] presented a technique in which the arithmetic mean of the execution times of all the processes available in the ready queue was used to obtain a dynamic value of time quantum for process execution. The mean calculated value was further used in a mathematical equation to individually assign the execution time to each process. After the first execution of a process in the current round, the remaining execution time is used to decide whether to further execute the process or push it to the ready queue's tail. The technique significantly showed improvements in average response time compared to SJF. Also, the average waiting time and the average turnaround time were significantly improved in comparison with several CPU scheduling algorithms.

Misha et al. [4] presented a technique to enhance the traditional Round Robin algorithm by making use of the arithmetic median of the execution times of the tasks available for execution in the ready queue. Two sub-queues were maintained, light and heavy task queues. On the basis of the remaining execution time, the tasks in the ready queue were ordered in non-descending order. The technique combined the characteristics of traditional Round Robin and SJF. The suggested technique showed improvements in both average waiting time and average turnaround time compared to traditional Round Robin and IRRVQ [5].

Fiad et al. [6] presented a technique using an analytic model that takes various variables as its input and decides the sequence of task execution. In addition, the execution times of the processes were used to determine a suitable time quantum for process execution. The evaluation of several datasets showed improvement in average waiting time and average response time.

Faizan et al. [7] suggested a technique of using median of the processes, execution time, and process with minimum burst time as parameters to a mathematical equation to calculate a dynamic quantum time for task execution in the ready queue. The proposed model inherits the characteristics of FCFS, Round Robin, SJF, and a hybrid model is used for the scheduling and task execution which is available in the ready queue for execution. The hybrid model was effective in terms of throughput, average turnaround time, waiting time, and context switches.

Elmougy et al. [8], suggested a hybrid of RR and SJF algorithms to overcome the starvation problem. Here the proposed algorithm is known as SRDQ (SJF and RR with dynamic quantum) hybrid algorithm. The proposed model dynamically calculates the time quantum value using an equation and two ready queues Q1 and Q2 were made into use. The median burst times of processes are calculated, the processes having Execution time less than the arithmetic median are stored in Q1, otherwise, they are stored in Q2. The hybrid model execution on experiments showed success in decreasing both the average response time and average turnaround time.

Siva Nageswara Rao1 et al. [9] presented a technique that used the time quantum as a function of the execution time of the processes present in the ready queue. The technique determines fine-tuning of time quantum for the processes whose execution does not finish in the allotted time quantum.

Maste et al. [10] presented a technique that altered Multilevel Feedback queue (MLFQ) algorithms. Each queue has its own CPU scheduling algorithms and processes are assigned to these queues based on characteristics such as process priority, memory size, etc. The technique used a neural network to change the time quantum value in each round for the execution of the processes. The algorithm showed success in reducing overhead in MLFQ algorithms.

Biswas et al. [11] presented a better Round Robin algorithm with an efficient time slice, determined by taking into account the maximum difference between adjacent continuous processes in the ready queue. The suggested approach aims to enhance Round Robin outcomes as well as system performance.

Dave et al. [12] presented a method for positive selection of valid time quanta that combines the capabilities of a RR algorithm with a novel integration process. The suggested solution continually determines the ideal quantum time while the process is running and sets the time quantum to active depending on the time left in the ready queue for the process burst.

Fayyaz et al. [13] presented a technique in which both the arithmetic mean and arithmetic median were used for determining the quantum time value for the task execution. The approach made use of conventional Round Robin, Shortest Remaining Burst Round Robin [23] (SRBRR), and Improved Shortest Remaining Burst Round Robin [22] (ISRBRR). The decision is taken based on the comparison of the mean and median. The larger value is further used as a parameter to a mathematical equation for determining the quantum time for task execution. The performance was observed to be improved when compared to the turnaround time and waiting time of the traditional RR algorithm.

Jing et al. [14] came up with Discrete Tumor Growth Optimization (DITGO), which is to make the original Invasive Tumor Growth Optimization discretized, to perform process scheduling in cloud environments.

3 The Proposed Technique

In this paper, two techniques are put forward for the optimization of the conventional RR algorithm and enhancement of DRRHA (Dynamic Round Robin Heuristic Algorithm) by dynamically calculating the time quantum after each round for executing the tasks present in the ready queue.

3.1 NDRRHA (Normal Distribution Dynamic Round Robin Heuristic Algorithm)

Quantum time is determined by making use of the normal distribution [3]. In this technique, tasks are inserted into the ready queue depending on their submission, and the ready queue is then organized in non-descending order on the basis of execution times in the SJF manner. It computes the arithmetic mean and standard deviation of the processes in the ready queue. The dynamic quantum time is now calculated for every process present in the ready queue using a normal distribution on the basis of the previously established mean and standard distribution. The processes are carried out for the duration of calculated quantum time. Based on the remaining burst time of the task, a decision is made whether to continue executing the present process or to push it to the end of the ready queue. Once the execution round is completed, this process is repeated.

The algorithm for the NDRRHA is as follows:

Step 1: Organize the upcoming tasks in the ready queue in increasing sequence based on execution time values.

Step 2: Estimate the arithmetic mean and standard deviation of burst time of all processes present in the ready queue.

Step 3: Calculate the quantum time value with the help of normal distribution on the basis of the mean and standard deviation.

Step 4: Execute every process in accordance with its calculated time quantum. After completion of process execution, there will be two situations:

Step 4.1: If the leftover execution time is either equal to or smaller than the quantum time, the process is executed up to its remaining burst time and taken out from the ready queue.

Step 4.2: Process execution is paused if its leftover execution time is higher than its quantum time and is inserted at the ready queue tail.

Step 5: On arrival of the latest process, the given below operations are done:

1. Sorting of all procedures in ascending sequence of their execution time values in the ready queue.

2. The mean, standard deviation, and QTij values for every procedure in the ready queue are calculated again.

Step 6: When a process is finished with its execution, the mean, standard deviation, and QTij values for every process in the ready queue are calculated again.

Step 7: Redo all the steps till all the processes complete their execution.

```
Algorithm 1 Proposed NDRRHA
_____________________________________________________________________
Declarations
    Pi:   Process i
    ETij: Process i Remaining Burst Time or Execution time in Round j
    ReQ: Ready Queue having processes that are arrived
    M:   Arithmetic mean of execution time of processes
    Sd:  Standard Deviation of execution time of processes
    QTij: Time Quantum assigned to Process, Pi, in round j
_____________________________________________________________________
Input: Processes, Pi
Output: Rescheduled arrived processes, Pi
_____________________________________________________________________
BEGIN
    Submitted processes in ReQ sorted in increasing Submission Time order
    WHILE (ReQ having pending processes)
    BEGIN
      Sort all processes in ReQ based on increasing Execution Time
      M = Arithmetic Mean of Execution time of processes present in ReQ
      Sd = Standard deviation of Execution time of processes present in ReQ

      For (every process Pi in ReQ)
      BEGIN
        QTij = Generate Time Quantum using M and Sd based on Normal Distribution
        Run(Pi)
        ETij = ETij - QTij
        IF (ETij < QTij): Run(Pi) again
        Else: Push Pi at end of ReQ
      END

      For (every process Pi in ReQ)
      BEGIN
        If (ETij (Pi) = 0)
        BEGIN
          Pop (Pi) from ReQ
          M = Arithmetic Mean of Execution time of processes that present in ReQ
          Sd = Standard deviation of Execution time of processes that present in ReQ

          For (every process Pi in ReQ)

          BEGIN
            QTij = Generate Time Quantum using M, Sd based on Normal Distribution
          END FOR
        END IF
      END FOR

      IF (a new process arrived in the ready queue)
      BEGIN
        Sort all processes in ReQ based on increasing Execution time of processes
        M = Arithmetic Mean of Execution Time of processes present in ReQ
        Sd = Standard deviation of Execution Time of processes present in ReQ

        For (every process Pi in ReQ)
        BEGIN
          QTij = Generate Time Quantum using M and Sd based on Normal Distribution
        END
      END IF
      j++
    END WHILE
END
```

3.2 MDRRHA (Median Dynamic Round Robin Heuristic Algorithm)

Quantum is determined by making use of the arithmetic median in the second approach. The processes are inserted in the ready queue and the queue is arranged in non-decreasing order of their execution times as in the SJF manner. The arithmetic median of processes' execution time is calculated. The evaluated median is used as a parameter for Eq. (1) along with the execution time of the current process. Quantum time obtained using Eq. (1) is used to execute the process. A decision is taken considering the left execution time of the process, whether to further execute the current process or to push it to the tail of the ready queue. This procedure is repeated once the execution round is over.

The algorithm for the MDRRHA is as follows:

Step 1: Organize the upcoming processes in the ready queue according to an increasing sequence of burst time values.

Step 2: The arithmetic median of the execution time of the processes present in the ready queue is calculated.

Step 3: Eq. (1) is used for evaluating the quantum time of all the processes present in the ready queue, where 'm' being the arithmetic median of the execution time of processes present in the ready queue.

Step 4: Execute all processes based on their time quantum values. If the process completes execution up to its quantum time, then there exist two situations:

Step 4.1: If the leftover execution time is either equal to or smaller than the quantum time, the process is executed up to its remaining burst time and taken out from the ready queue.

Step 4.2: Process execution is paused if its leftover execution time is higher than its quantum time and is inserted at the ready queue tail.

Step 5: On arrival of the latest process, the given below operations are done:

1. Sorting of all procedures in ascending sequence of their execution time values in the ready queue.

2. The median and QTij values for every procedure in the ready queue are calculated again.

Step 6: When a process is finished with its execution, the median and QTij values for every process in the ready queue are calculated again.

Step 7: Redo all the steps till all the processes complete their execution.

Algorithm 2 Proposed MDRRHA

```
Declarations
    Pi:   Process i
    ETij: Process i Remaining Burst Time or Execution time in Round j
    ReQ: Ready Queue having processes that are arrived
    Me:  Arithmetic median of execution time of processes
    QTij: Time Quantum assigned to Process, Pi, in round j
```

```
Input: Processes, Pi
Output: Rescheduled arrived processes, Pi
```

```
BEGIN
    Submitted processes in ReQ sorted in increasing Submission Time order.
    WHILE (ReQ having pending processes)
    BEGIN
      Sort all processes in ReQ based on increasing Execution Time
      Me = Median of execution time of processes present in ReQ

      For (every process Pi in ReQ)
      BEGIN
        QTij = (Me / 2) + (Me / 2) / ETij
        ETij = ETij - QTij
        Run(Pi)
        If (ETij < QTij): Run(Pi) again
        Else: Push Pi at end of ReQ
      END

      For (every process Pi in ReQ)
      BEGIN
        If (ETij (Pi) = 0)
        BEGIN
          Pop (Pi) from RQ
          Me = Median of execution time of processes present in ReQ

          For (every process Pi in ReQ)
          BEGIN
            QTij = (Me / 2) + (Me / 2) / ETij
          END
        END IF
      END FOR

      If (a new process arrived in ready queue)
      BEGIN
        Sort all processes in ReQ based on increasing Execution time of processes
        Me = Median of execution time of processes present in ReQ

        For (every process Pi in ReQ)
        BEGIN
          QTij = (Me / 2) + (Me / 2) / ETij
        END
      END IF
      j++
    END WHILE
END
```

4 Simulation Settings

The proposed MDRRHA and NDRRHA techniques are implemented and tested in a custom-built CPU scheduling simulator [15] which is created using C++ programming language and executed on an x86_64 architecture CPU. The simulator simulates DRRHA, Round Robin algorithm, Shortest Job First algorithm, MDRRHA, NDRRHA, and HRRNHA. The simulator does the following jobs:

1. Scheduling of the processes according to respective scheduling techniques.
2. Calculation of the time quantum for each process except in the RR and SJF algorithm.
3. Process execution based on respective time quantum (except in SJF), execution time, and time of submission of the task.
4. Calculation of completion time for every process which is used as a key variable for obtaining performance metrics for a given dataset.
5. Calculating performance metrics for every dataset of processes.

The simulator accepts burst time and arrival time as inputs and calculates ATAT, ART, AWT, and context switches as output for every dataset. The Simulator does not simulate the execution of an instruction set of a process, it obtains results only based on calculations done using the equations given below:

$$\text{Turnaround Time} = \text{CT} - \text{AT} \quad [1] \tag{2}$$

$$\text{Waiting Time} = \boldsymbol{TAT} - \boldsymbol{BT} \quad [1] \tag{3}$$

*Where **CT** is Completion Time, **TAT** is Turnaround Time, **AT** is Arrival Time, **BT** is burst time.*

The simulator source code is available on Github [15].

Note: The algorithms are implemented without considering the efficiency and time complexities of implementation. The implementation only focuses on calculating the completion time of each process submitted to each algorithm.

The following diagram illustrates the working of the CPU scheduling simulator (Fig. 1).

5 Evaluation and Discussion

The performance of Algorithms is assessed over the following parameters: context switches, average waiting time, average response time, and average turnaround time.

The Evaluation process is segmented into three parts:

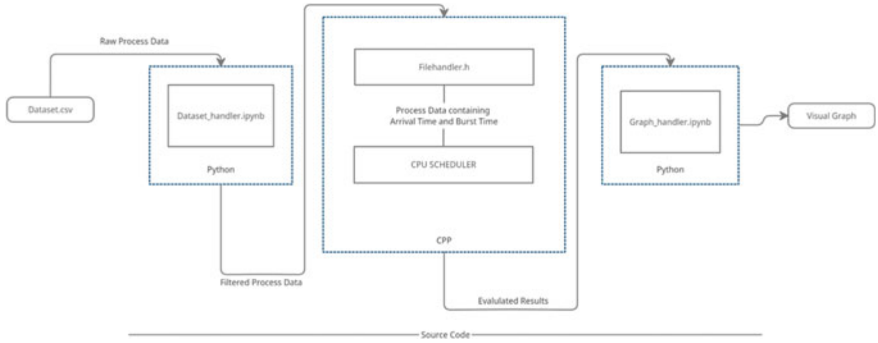

Fig. 1 Data flow in CPU scheduler

1. Performance of each algorithm including DRRHA, NDRRHA, MDRRHA, SJF, and RR, are compared considering some random trial cases and a corresponding Enhancement percentage is obtained for every Algorithm.
2. NDRRHA algorithm's performance is compared by integrating it with SJF and HRRN and a corresponding improvement percentage is obtained for both Algorithm.
3. Performance of each algorithm including DRRHA, NDRRHA, MDRRHA, SJF, and RR, are compared considering two Datasets: (1) Dataset imported from Kaggle [18] and (2) Randomly generated Dataset: (i) Non-zero Submission Time. (ii) Zero Submission Time.

5.1 Evaluating Performance of MDRRHA and NDRRHA Over Random Trial Cases and Doing Results Comparison

A. **Trial Case 1**

Two tests were conducted as shown in the table below (Instance 1 and Instance 2). These instances are taken from [4]. The performance of DRRHA, NDRRHA, MDRRHA, SJF, and RR is compared as follows (Fig. 2).

The Enhancements made by MDRRHA and NDRRHA over DRRHA for the trial case shown in Table 1 are given in Table 2 which represents a significant overall improvement attained by NDRRHA.

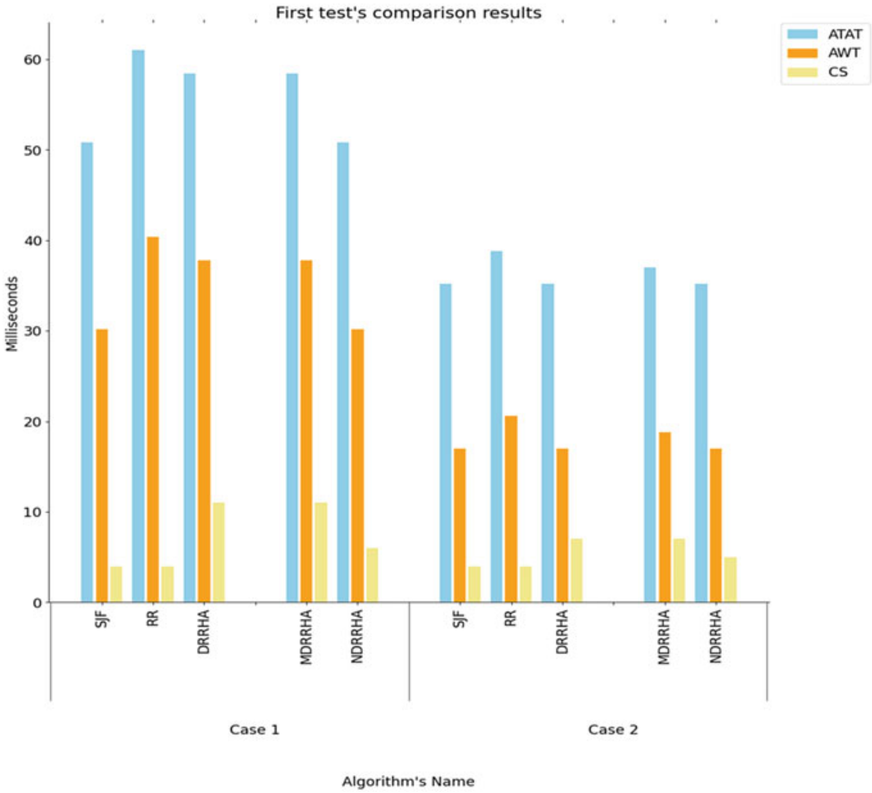

Fig. 2 Performance results comparison of all algorithms based on ATAT, AWT, and CS for First Test

Table 1 First test on a dataset taken from [14] with submission times as non-zero and zero

Process	Instance 1		Instance 2	
	Submission time	Execution time	Submission time	Execution time
P1	0	15	0	7
P2	0	32	4	25
P3	0	10	10	5
P4	0	26	15	36
P5	0	20	17	18

Table 2 The assessed Enhancement of MDRRHA and NDRRHA for the trial case given in Table 1

Trial case 1						
The metrics	Instance 1		Instance 2		Overall	
	Enhancement (%)		Enhancement (%)		Enhancement (%)	
	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)
Avg. WT	0	22.3	−10.0	0	−5.0	11.15
Avg. TAT	0	13.9	−4.9	0	−2.45	6.95
CS	0	58.8	0	33.3	0	46.05

Equation-4 [16] is considered for measuring the Enhancement percentage of MDRRHA and NDRRHA with the other three algorithms, here the difference between average waiting time and turnaround time is obtained.

$$\boldsymbol{Difference} = \left[\frac{|\boldsymbol{v}1 - \boldsymbol{v}2|}{(\boldsymbol{v}1 + \boldsymbol{v}2)/2}\right] \times 100 \tag{4}$$

where **v1** and **v2** are the least values.

B. Trial Case 2

Three tests were conducted as shown in Table 3. The data for the respective tests are taken from [20].

Table 3 Trial case 2 is taken from [20] with arrival times as non-zero and zero

Process	Instance 1		Instance 2		Instance 3	
	Submission time	Execution time	Submission time	Execution time	Submission time	Execution time
P1	0	14	0	33	0	15
P2	0	34	2	22	4	77
P3	0	45	5	48	15	30
P4	0	62	7	70	20	85
P5	0	77	9	74	–	–

Table 4 The assessed Enhancement of MDRRHA and NDRRHA on the trial case 2

Trial case 2								
The metrics	Instance 1		Instance 2		Instance 3		Overall	
	Enhancement (%)		Enhancement (%)		Enhancement (%)		Enhancement (%)	
	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)
Avg. WT	0.3	7.1	−2.1	0.5	0	0	−0.6	2.5
Avg. TAT	0.1	4.1	−1.3	0.3	0	0	−0.4	1.4
CS	13.3	46.1	13.3	28.5	40	18.1	22.2	30.9

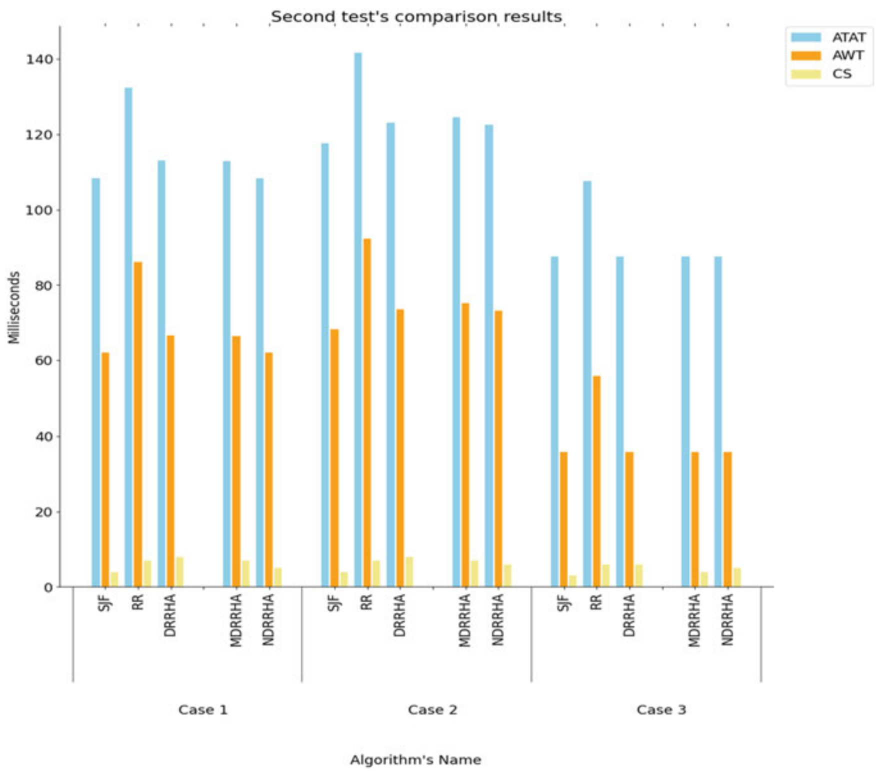

Fig. 3 Performance comparison of algorithms based on ATAT, AWT, and CS for Trial Case 2

It is clear from Table 4 that NDRRHA has a high Enhancement rate over DRRHA, while MDRRHA also showed significant Enhancement in terms of Context switches (Fig. 3).

C. Trial Case 3

Three tests were conducted as shown in the table below. The respective dataset is taken from [21], and here, the arrival time value is zero for every process. The performance results of DRRHA, NDRRHA, MDRRHA, SJF, and RR were compared (Fig. 4 and Table 5).

Table 6 shows that NDRRHA has a high context switches enhancement rate and considerable average turnaround time and average waiting time enhancement rate over DRRHA, while MDRRHA has also shown an overall fine improvement in the total number of context switches value, but its average turnaround time and average waiting time enhancement rate values can be considered as a trade-off.

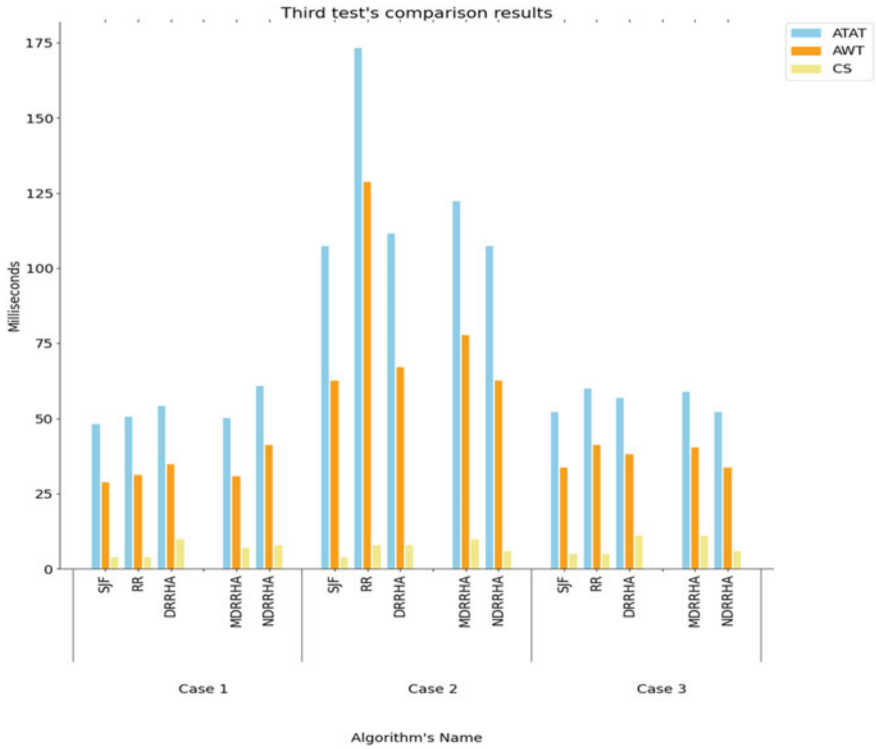

Fig. 4 Performance results comparison of algorithms based on ATAT, AWT, and CS for Third Test

Table 5 Trial case 3 performed on a dataset taken from [21] with arrival times as non-zero and zero

Process	Instance 1		Instance 2		Instance 3	
	Submission time	Execution time	Submission time	Execution time	Submission time	Execution time
P1	0	12	0	42	0	11
P2	0	11	0	32	0	10
P3	0	22	0	82	0	22
P4	0	31	0	45	0	31
P5	0	21	0	22	0	25
P6	–	–	–	–	0	13

Table 6 The assessed Enhancement of MDRRHA and NDRRHA on the trial case 3

Trial case 3								
The metrics	Instance 1		Instance 2		Instance 3		Overall	
	enhancement (%)		enhancement (%)		enhancement (%)		enhancement (%)	
	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)
Avg. WT	12.1	−17.3	−14.6	6.8	−5.2	12.5	−2.5	0.6
Avg. TAT	7.6	−11.4	−9	4	−3.7	8.2	−1.7	0.2
CS	35.3	22.2	−22.2	28.5	0	58.8	4.3	36.5

D. **Trial Case 4**

Four tests were conducted as shown in the table below, two with arrival time value as zero and the other two with arrival time value as non-zero. The respective dataset is taken from [8]. The performance results of DRRHA, NDRRHA, MDRRHA, SJF, and RR were compared (Fig. 5 and Table 7).

Table 8 shows a very high context switches enhancement rate and considerable average turnaround time and average waiting time enhancement rate of NDRRHA over DRRHA, while MDRRHA also showed a fine enhancement rate of 7.3% in terms of context switches over DRRHA and its average turnaround time and average waiting time enhancement rate values can be considered as a trade-off.

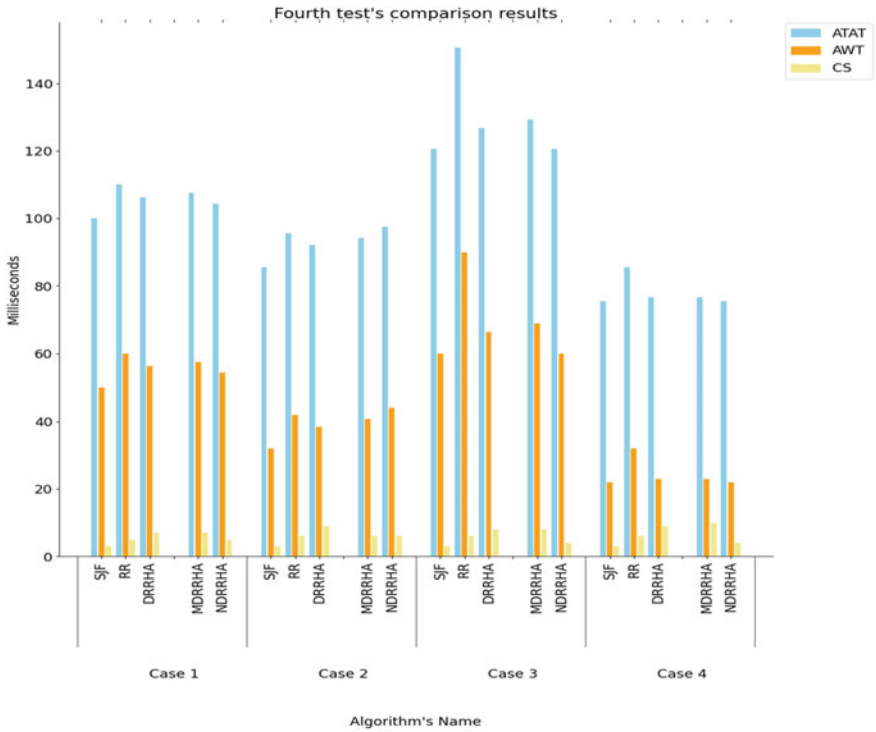

Fig. 5 Performance comparison of all algorithms based on ATAT, AWT, and CS for Trial Case 4

Table 7 Trial Case 4 performed on a dataset taken from [8] with arrival times as non-zero and zero

	Zero submission time				Non-zero submission time			
Process	Instance 1		Instance 2		Instance 3		Instance 4	
	Submission time	Execution time	Submission time	Execution time	Submission time	Execution time	Submission time	Execution time
P1	0	20	0	10	0	18	0	10
P2	0	40	0	14	4	70	6	14
P3	0	60	0	70	8	74	13	70
P4	0	80	0	120	16	80	21	120

Table 8 The assessed Enhancement of MDRRHA and NDRRHA on the 4th trial case

Trial case 4										
The metrics	Instance 1		Instance 2		Instance 3		Instance 4		Overall	
	Enhancement (%)		Enhancement (%)		Enhancement (%)		Enhancement (%)		Enhancement (%)	
	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)
Avg. WT	−2.2	3.6	−5.6	−13.3	−3.7	9.9	0	4.4	−8.7	1.1
Avg. TAT	−1.1	1.9	−2.4	−5.8	−1.9	5.0	0	1.3	−1.3	1.6
CS	0	33.3	40	40	0	66.6	−10.5	76.9	7.3	54.2

5.2 Evaluating the Performance of NDRRHA by Integrating it with SJF and HRRN (Thus Called HRRNHA) and Doing Metrics Comparison of Both Algorithms

To Evaluate the performance of integrating the Highest Response Ratio Next **(HRRN)** [1] with NDRRHA, we used the dataset considered in [16]. The dataset includes six instances, three with arrival times as zero and the other three with arrival times as non-zero. Each instance has its burst time value ordered in ascending, descending, and arbitrary order (Table 9).

Figure 6 shows the integration of NDRRHA with SJF and HRRN (thus called HRRNHA). NDRRHA integrated with SJF showed a remarkable alleviation in average turnaround time, average waiting time, and average response time in each instance. However, we found that no such improvement was observed when NDRRHA was integrated with HRRN. Hence, HRRNA will be discarded and NDRRHA will be used for further experiments along with MDRRHA.

5.3 Evaluating Performance of MDRRHA and NDRRHA Over Two Datasets and Comparing Obtained Results

I. **First Experiment using the Kaggle Dataset** (Fig. 7 and Table 10)

The dataset used for this experiment is taken from Kaggle [15]. In this experiment, the arrival time in the original dataset was given in seconds, and hence it was converted to milliseconds for each process. After dataset pre-processing, the experiment was conducted. From Figs. 8, 10, and 12, the following observations were recorded (Fig. 9).

1. The MDRRHA algorithm had a clear convergence in the performance of DRRHA with very little improvement on base DRRHA in the average, case of Average waiting time, average turnaround time, and context switches, as shown in Figs. 8 and 10 (Fig. 11).
2. The NDRRHA was successful in alleviating the average turnaround time by 13.5% and average waiting time by 13.4% compared to base DRRHA as shown in Figs. 8 and 10.
3. The MDRRHA was successful in alleviating the average response time by 33.7% compared to the SJF algorithm as shown in Fig. 12.

Table 9 Dataset taken from [16] with Arrival Time as zero and non-zero with three instances in each

Process	Dataset with submission time as zero						Dataset with submission time as non-zero					
	Instance 1 Ascending order		Instance 2 Descending order		Instance 3 Arbitrary order		Instance 1 Ascending order		Instance 2 Descending order		Instance 3 Arbitrary order	
	Submission time	Execution time	Submission time	Execution time	Submission time	Execution time	Submission time	Execution time	Submission time	Execution time	Submission time	Execution Time
P1	0	30	0	77	0	80	0	14	0	80	0	65
P2	0	34	0	53	0	45	2	34	2	74	1	72
P3	0	62	0	45	0	62	6	45	3	70	4	50
P4	0	74	0	19	0	34	8	62	4	18	6	43
P5	0	88	0	14	0	78	14	77	5	14	7	80

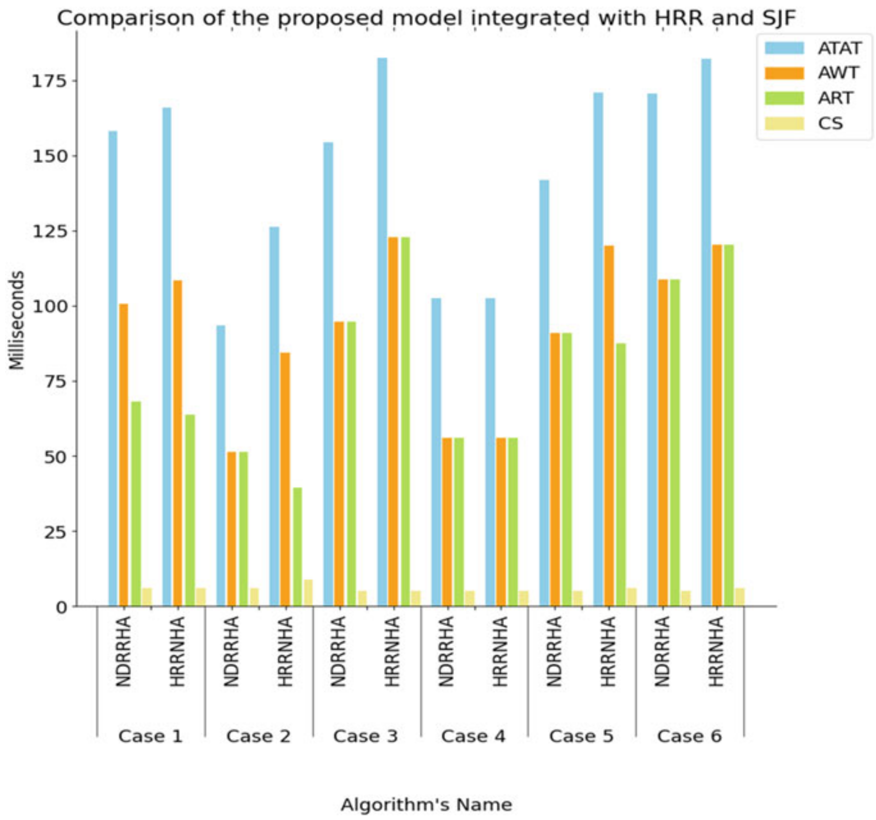

Fig. 6 Performance results comparison of NDRRHA integrated with SJF and with HRRN (HRRNHA)

4. The NDRRHA was also successful in alleviating the average response time by 14.4% compared to the SJF algorithm as shown in Fig. 12.

II. **The Second Experiment Using a Randomly generated Dataset**

A. **Considering zero Arrival time** (Table 11)

The dataset involved in this examination was obtained arbitrarily and confides a particular spectrum of the process's times of Submission and execution time. In this experiment, the arrival time was considered as 0 and the burst time range was defined

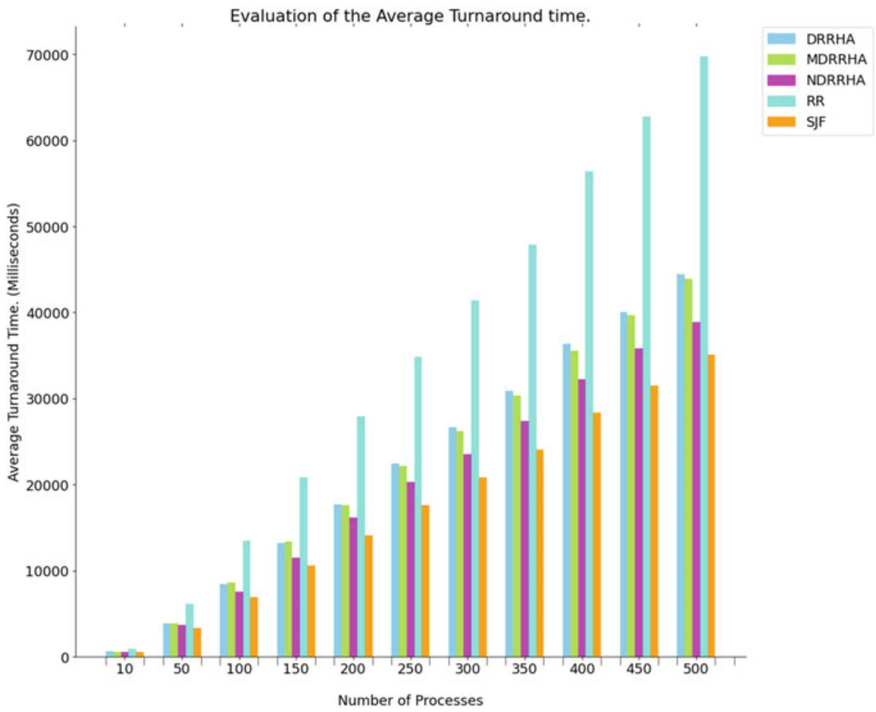

Fig. 7 Evaluation based on Average Turnaround Time considering the first experiment

Table 10 Enhancement calculated in the First Experiment

The Enhancement Rate attained by MDRRHA and NDRRHA compared with RR and DRRHA				
Metrics	RR		DRRHA	
	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)
Avg. WT	45.7	56.9	1.3	13.4
Avg. TAT	45.5	57.1	1.3	13.5
CS	90.4	129.6	2.3	50.4

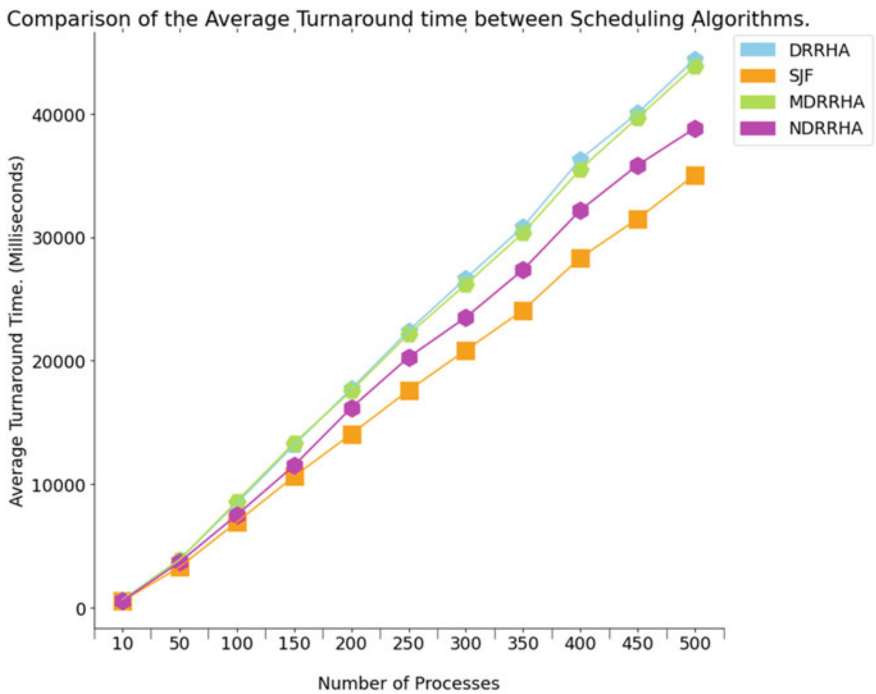

Fig. 8 All algorithms' performance comparison over the Average Turnaround Time from the first experiment

to be 100–400. The generated dataset was used for the proposed algorithms along with traditional algorithms to calculate their metrics such as average turnaround time, average waiting time, average response time, and context switches. The experiment was conducted. From Figs. 14, 16, and 18, the following observations were recorded (Fig. 13).

1. The MDRRHA algorithm again had a clear convergence in the performance of DRRHA with very little improvement on base DRRHA in terms of average waiting time, average turnaround time, and context switches, as shown in Figs. 16 and 14 (Fig. 15)
2. The NDRRHA was successful in alleviating the average turnaround time by 13% and average waiting time by 13% compared to base DRRHA as shown in Figs. 14 and 16 (Fig. 17)

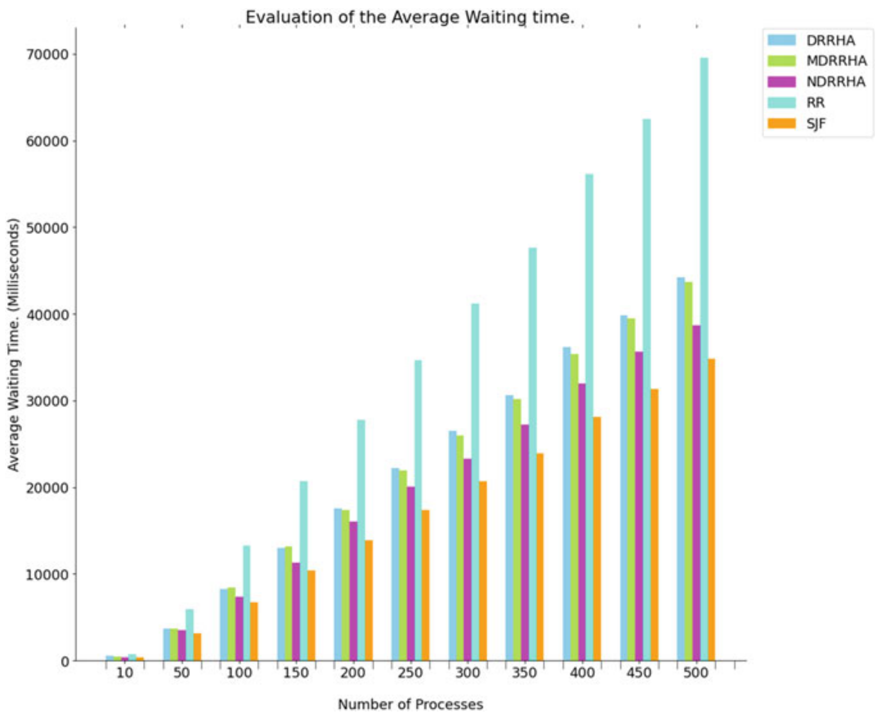

Fig. 9 Evaluation on the basis of Average Waiting Time considering the first experiment

3. The MDRRHA was successful in alleviating the average response time by 24.1% compared to the SJF algorithm as shown in Fig. 18.
4. The NDRRHA was also successful in alleviating the average response time by 5.8% compared to the SJF algorithm as shown in Fig. 18.
5. The Round Robin algorithm performed the poorest, with high values for average waiting time, average turnaround time, and context switches (Fig. 19).

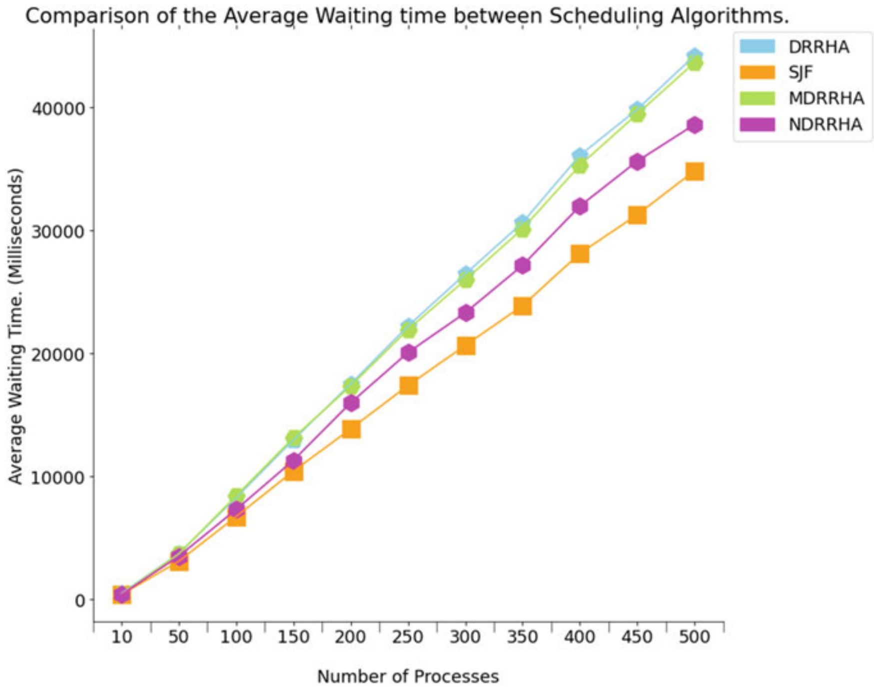

Fig. 10 All algorithms' performance comparison over the Average Waiting Time from the first experiment

B. **Considering non-zero Arrival time** (Table 12)

The dataset involved in this examination was created arbitrarily and confides a particular spectrum of the process's execution times and submission times. In this experiment, the arrival time range was defined to be 10–100 and the burst time range was defined to be 100–400. The generated dataset was used for the proposed algorithms along with traditional algorithms to calculate their metrics such as average turnaround time, average waiting time, average response time, and context switches. The experiment was conducted. From Figs. 20, 22, and 24, the following observations were recorded (Fig. 21).

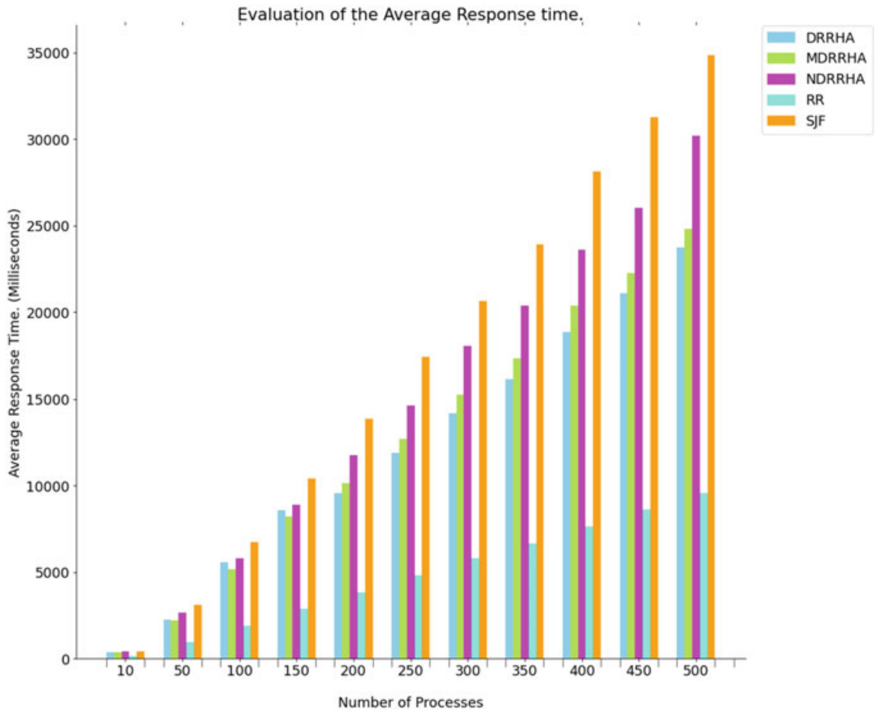

Fig. 11 Evaluation of Average Response Time considering the first experiment

1. The MDRRHA algorithm again had a clear convergence in the performance of DRRHA with very little improvement on base DRRHA in terms of average waiting time, average turnaround time, and context switches as shown in Figs. 22 and 20.
2. The NDRRHA was successful in alleviating the average turnaround time by 12% and average waiting time by 12% compared to base DRRHA as shown in Figs. 20 and 22 (Fig. 23).

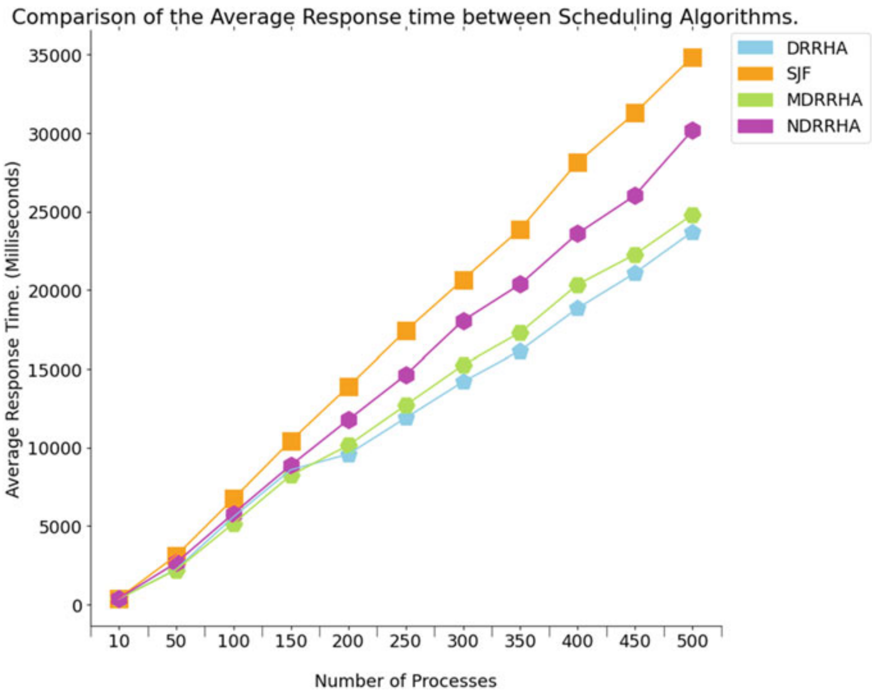

Fig. 12 Performance comparison of all algorithms based on Average Response Time considering the first experiment

Table 11 Enhancement calculated in the Second Experiment having Zero Arrival Time

The Enhancement Rate attained by MDRRHA and NDRRHA compared with RR and DRRHA				
Metrics	RR		DRRHA	
	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)
Avg. WT	50.1	61.5	0.7	13
Avg. TAT	49.9	61.3	0.7	13
CS	108.5	143.3	3	59.7

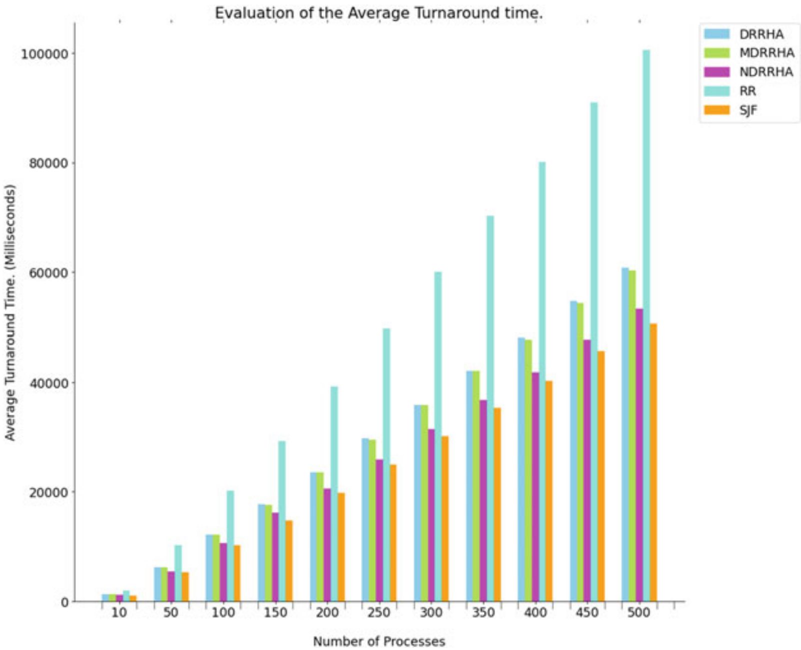

Fig. 13 Evaluation based on Average Turnaround Time considering the second experiment with Zero Arrival Time

3. The MDRRHA was successful in alleviating the average response time by 24.2% compared to the SJF algorithm as shown in Fig. 24.
4. The NDRRHA was also successful in alleviating the average response time by 5.3% compared to the SJF algorithm as shown in Fig. 24.
5. The Round Robin algorithm performed the poorest, with high values for average waiting time, average turnaround time, and context switches.

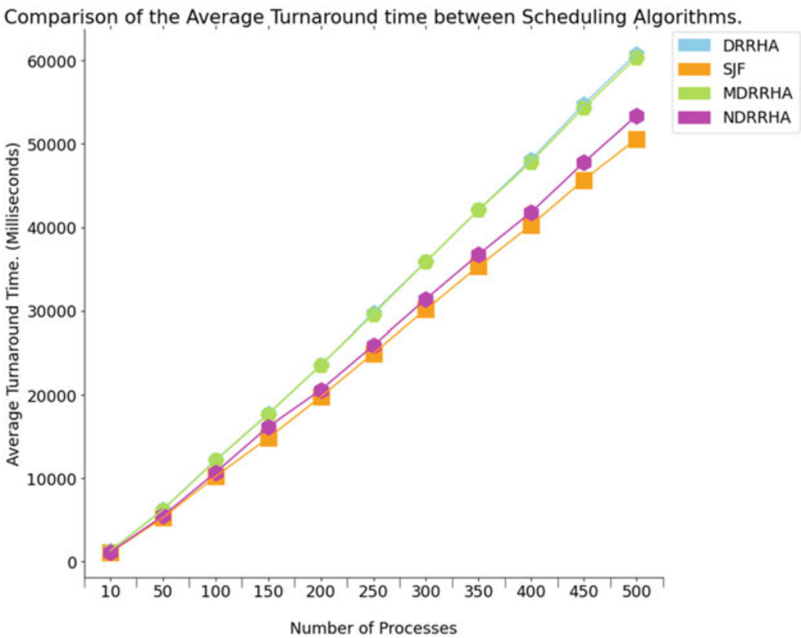

Fig. 14 Performance comparison of all algorithms based on Average Turnaround Time in the second experiment with Arrival Time as zero

When using an arbitrarily generated dataset, the Round Robin algorithm has shown the poorest results considering waiting time and average turnaround time. The result for such performance of the RR algorithm was due to fixed value of time quantum and also not implementing the remaining burst time criteria which resulted in an increase of the overhead and being inefficient. The MDRRHA had clear convergence with DRRHA while NDRRHA decreased average turnaround time and average waiting time when compared with DRRHA. NDDRHA also had better performance considering average response time when compared to the SJF algorithm.

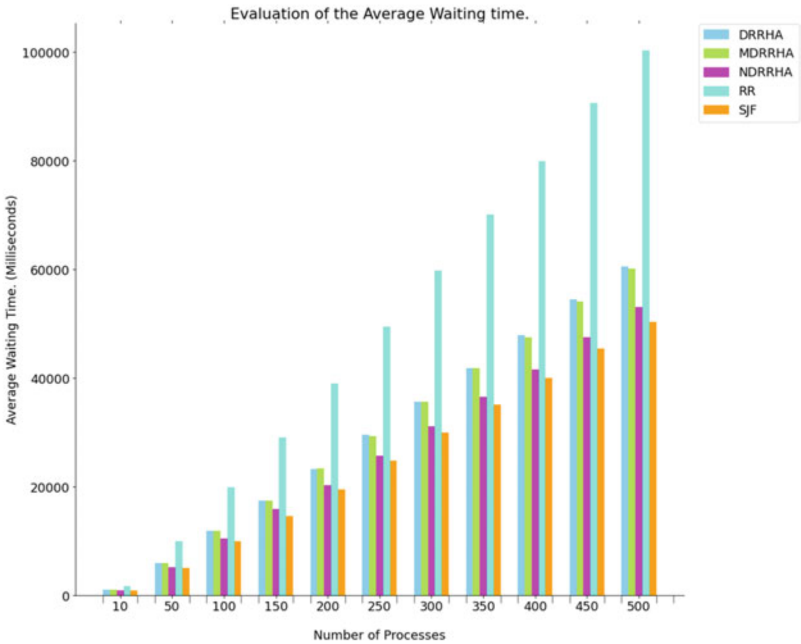

Fig. 15 Assessment based on Average Waiting Time in the second experiment with Arrival Time taken as zero for all processes

6 Limitations

The suggested approach mimics process execution by deducting the dynamically estimated time quantum from the process's remaining execution time. This, however, does not correctly measure performance parameters such as process turnaround time. The CPU scheduler would need clock ticks to monitor the precise arrival time and completion time of each process for more accurate results, however, this technique would be extremely reliant on the programming language used, operating system, and hardware utilized for testing. As a consequence, the results achieved on various computers will differ. As a result, a CPU scheduler was created that determines performance metrics only on completion time and arrival time.

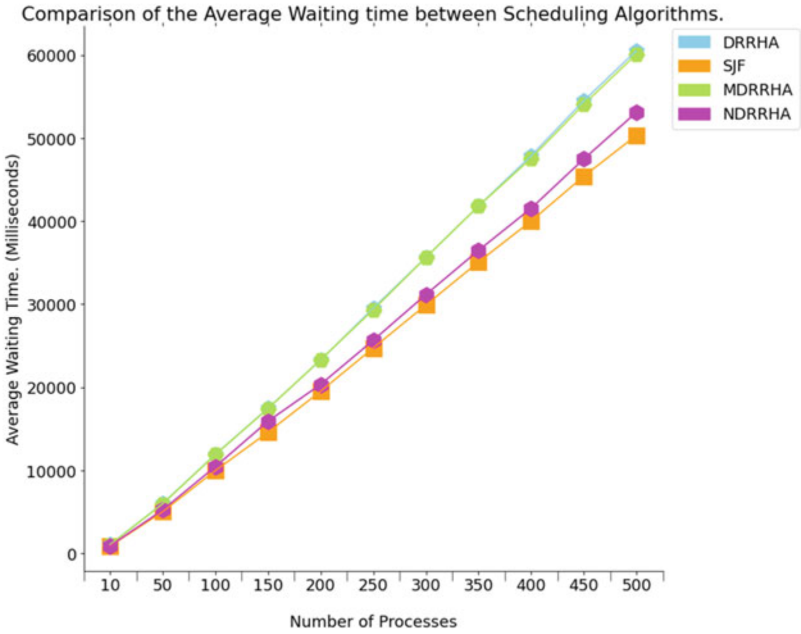

Fig. 16 Performance comparison of all algorithms based on Average Waiting Time in the second examination with Arrival Time value as zero

7 Conclusions

One of the most difficult tasks for an operating system is process scheduling. The primary contribution of this study is to improve the Round Robin algorithm and enhancement over the existing DRRHA algorithm [2]. The aim of this paper is achieved by using different statistical techniques such as arithmetic median and normal distribution in the existing DRRHA algorithm and producing its two variants which were named MDRRHA and NDRRHA. The sorting of the Ready queue is done using different metrics. Various tests and experiments were conducted on the proposed algorithms to assess the performances. It can be concluded that:

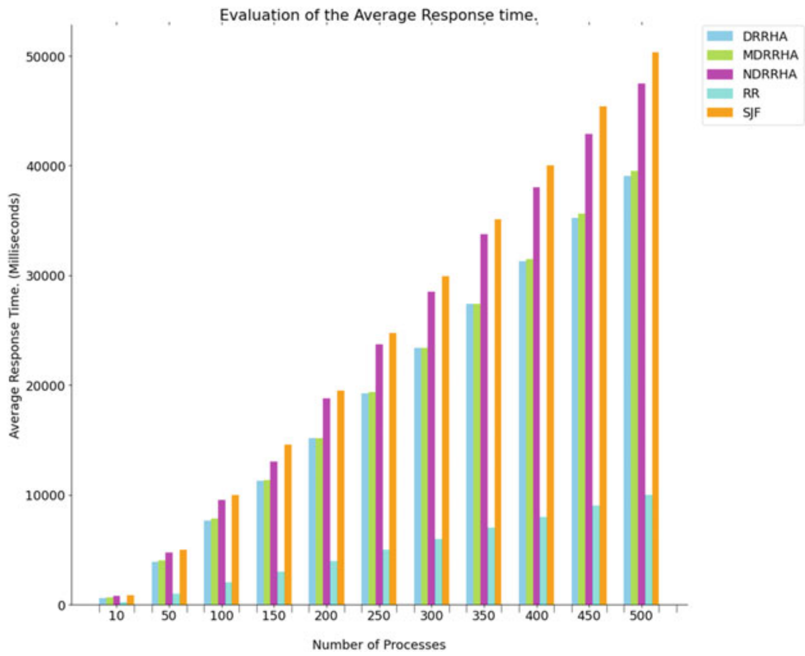

Fig. 17 Assessment based on Average Response Time considering the Non-Zerosecond experiment with Zero Arrival Time

1. MDRRHA did not show major improvements on DRRHA and had clear convergence in terms of Average turnaround time and average waiting time. However, it succeeded in optimizing the average response time compared to the SJF algorithm.
2. NDRRHA succeeded in optimizing Average turnaround time and average waiting time compared to DRRHA. Also, it succeeded in optimizing the average response time compared with the SJF algorithm.
3. No improvements were observed upon integrating HRRN with NDRRHA.

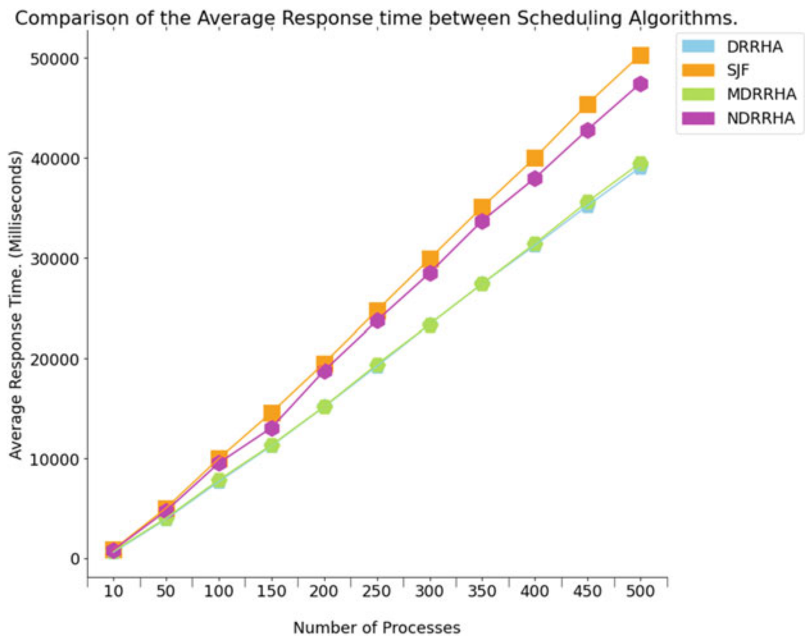

Fig. 18 Performance comparison of all algorithms based on Average Response Time considering the second examination with Arrival Time as zero

8 Future Work and Scope

This study done in this paper can be taken as an initial point by the researchers as some issues still exist which can be improved upon:

1. Modifying Eq. 1 or deriving a new Equation for calculating an individual quantum time for each process.
2. Enhancing the RR algorithm's efficiency by developing a new technique for

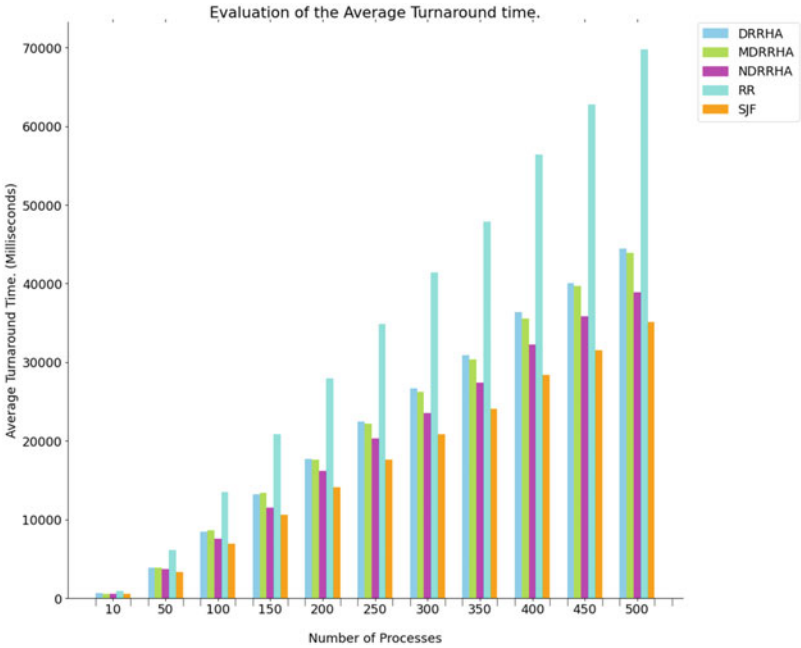

Fig. 19 Evaluation based on Average Waiting Time considering the Non-Zero second experiment with Non-Zero Arrival Time

Table 12 Enhancement calculated in the Second Experiment having Non-Zero Arrival Time

The Enhancement Rate attained by MDRRHA and NDRRHA compared with Round Robin algorithm and DRRHA				
Metrics	RR		DRRHA	
	MDRRHA (%)	NDRRHA (%)	MDRRHA (%)	NDRRHA (%)
Avg. WT	49.8	60.4	0.56	12
Avg. TAT	49.7	60.2	0.5	12
Avg. RT	109.5	142.3	4.9	58.3

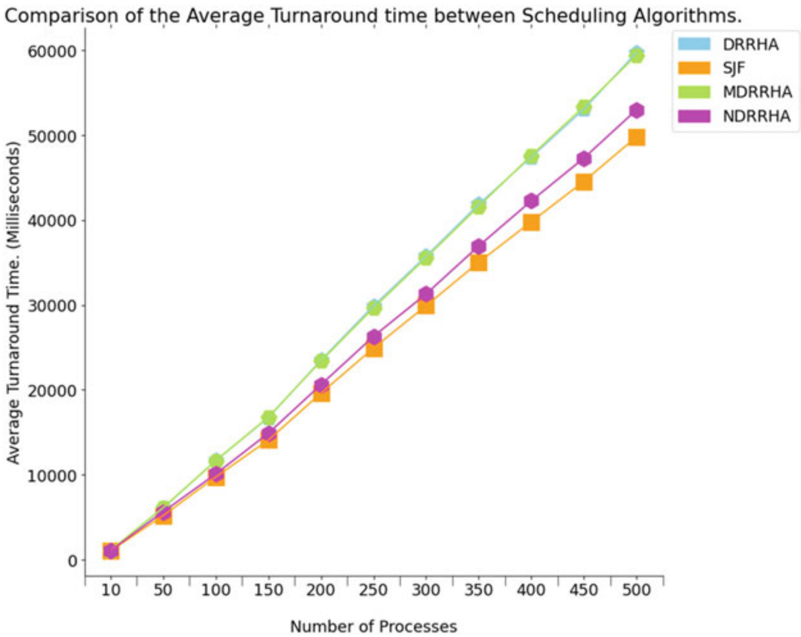

Fig. 20 Performance comparison of all algorithms based on Average Turnaround Time considering the second experiment with Arrival Time as non-zero

calculating the quantum time that incorporates dynamic quantum values.

3. Automating the prediction of best quantum value by applying innovative approaches such as fuzzy logic and neural networks.
4. Integration of the Round Robin algorithm with other metaheuristic algorithms to attain improved results.
5. Applying new techniques to sort the ready queue of the processes.
6. Making use of datasets containing a high number of processes to assess the proposed algorithms and other related process scheduling algorithms.
7. This paper doesn't cover the concept of thrashing [1], further research can be done for finding an appropriate value of the degree of multiprogramming which doesn't lead to starvation and results in higher throughput as well.

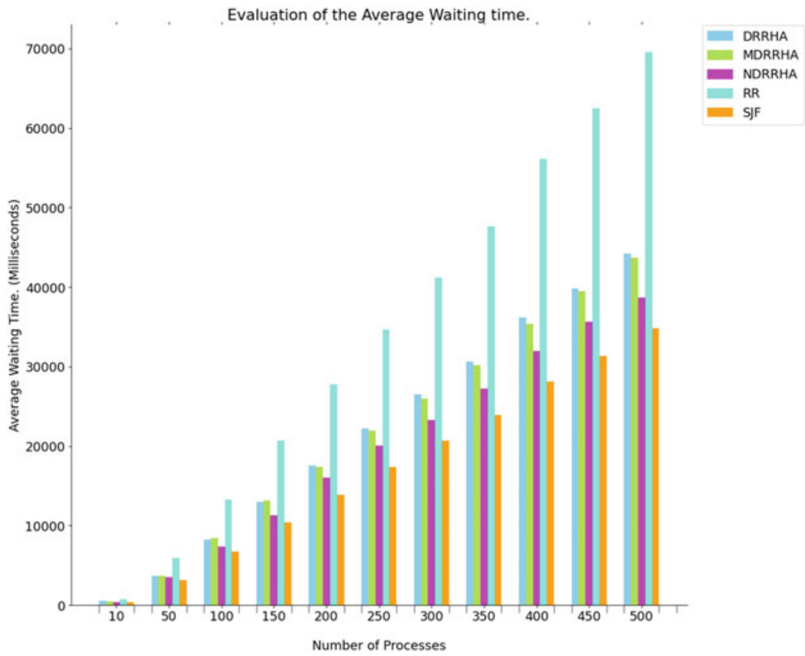

Fig. 21 Assessment based on Average Waiting Time considering the second experiment with Non-Zero Arrival Time

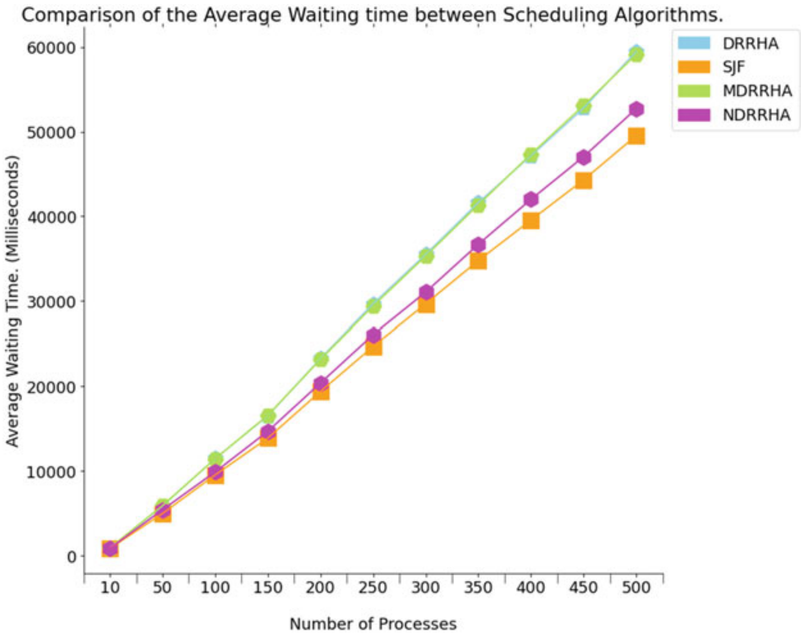

Fig. 22 Performance comparison of all algorithms based on Average Waiting Time considering the second experiment with Non-Zero Arrival Time

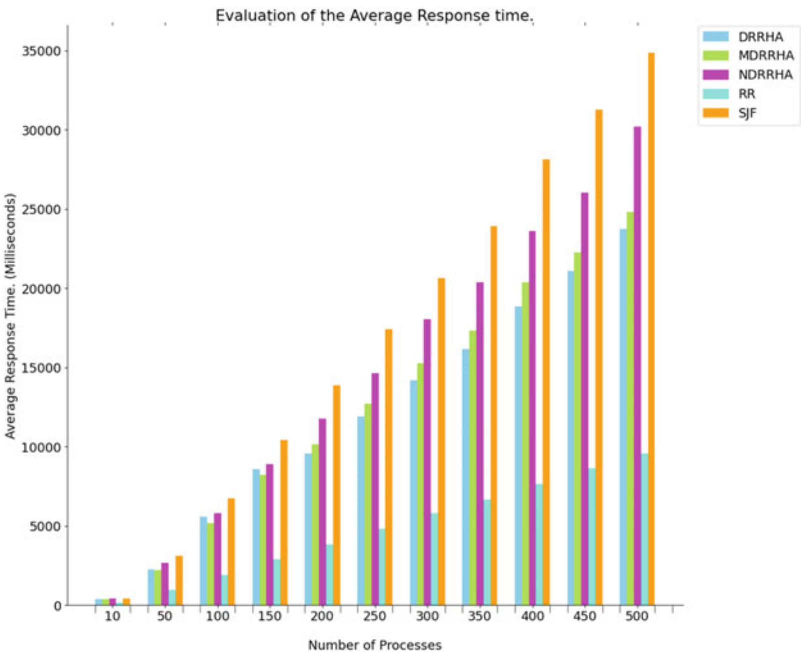

Fig. 23 Evaluation based on Average Response Time considering the second experiment with Non-Zero Arrival Time

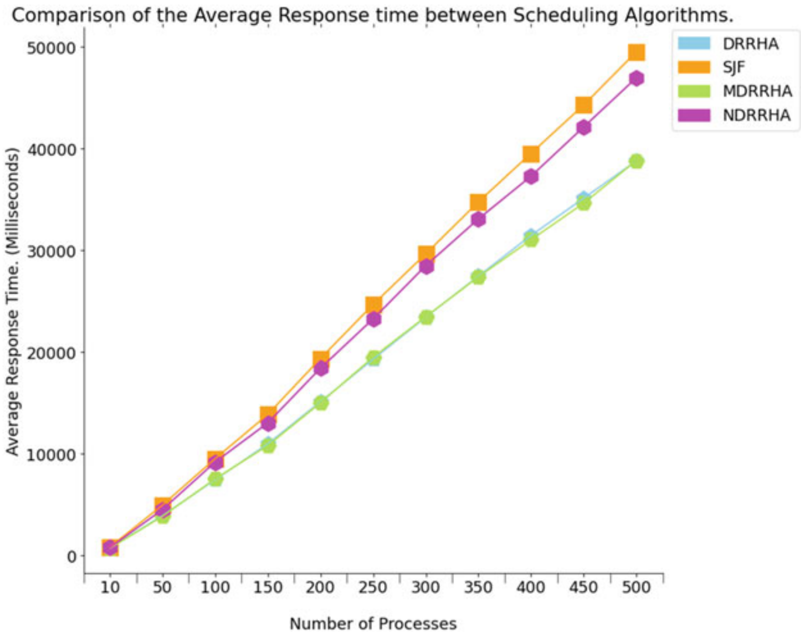

Fig. 24 Performance comparison of all algorithms based on Average Response Time considering the second experiment with Non-Zero Arrival Time

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Assessing Permeability Prediction of BBB in the Central Nervous System Using ML

Nasmin Jiwani, Ketan Gupta, and Pawan Whig

Abstract The blood–brain barrier (BBB) regulates the flow of 97.9% of the chemicals which reach the central nervous arrangement. To allow the manufacture of mind medicines for the handling of different brain illnesses, for instance, Parkinson's, Alzheimer's, and brain cancers, complexes with high penetrability be found. Several models have been created over the years to tackle this challenge, with satisfactory accurateness slashes in forecasting chemicals that cross the BBB. Nevertheless, forecasting molecules with "low" penetrability has proven to be difficult. In this research study, several machine learning classifiers such as Principal Component Analysis PCA, Neural Network SVC, and XGBoost have been compared using Molecule Net and presented in the result section. Before developing the classification model, several issues to improve the high-dimensional and unbalanced data are treated by oversampling techniques, and the high dimensionality is addressed using a nonlinear dimensionality decrease method recognized as kernel major constituent analysis has been done. A neural network with 500 epochs shows an accuracy of nearly 98% which is much better than the previous works.

Keywords Blood–brain barrier · CNS · SVC · XGBoost · Classifiers · Neural network

1 Introduction

The delivery of oxygen and food to those body tissue and functions is dependent on blood vessels [1]. These coronary arteries that support and strengthen the respiratory system have unique properties that allow them to tightly control the flow of ions, enzymes, and organisms between both the bloodstream and the brain, a process

N. Jiwani · K. Gupta
University of The Cumberland, Williamsburg, USA

P. Whig (✉)
Vivekananda Institute of Professional Studies, New Delhi, India
e-mail: pawan.whig@vips.edu

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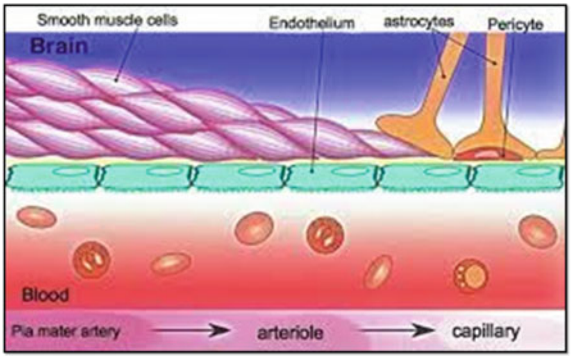

Fig. 1 Penetration of the pathogen through blood–brain barrier

known as the blood–brain barrier [2]. Modifications in these barrier features are a significant element in the pathogenesis and development of numerous neurological illnesses since they guarantee optimal neuronal activity while also shielding brain tissue from poisons and viruses [3].

Epithelial cells, which line the insides of blood vessels, have a host of different, transportation, and metabolism properties that are influenced by their interactions with other arterial, immune, and neurologic tissues. It's critical to understand how some cell types cooperate to alter border features in order to stimulate the nervous system, which is active in both sickness and sickness [4–6]. Figure 1 Shows the pathogen penetration through the blood–brain barrier.

Coronary arteries transport blood away from the heart to every cell and organelle, which is necessary for the delivery of oxygen to tissues, the removal of waste products and metabolic products from body tissue, the transmission of physiological signaling between tissues, and the communication of the peripheral immunity with every cells [7]. The vascular sapling is made up of veins and arterioles that bring plasma to organs, the capillaries bed that allows gas and nutrition exchanges within cells, and venules and veins that drain plasma through cells [8].

Contingent on anywhere they are in the vascular tree and which structure they vascularize, each segment has distinct characteristics [9]. The microvasculature, which is made up of vessels and post-vessels, has unique properties that help it meet the demands of the substance it vascularizes.[10]. Different types of blood–brain barriers are shown in Fig. 2.

In the liver, intermittent capillary contains wide gaps across the cells as well as a discontinuous BM [11]. The flow of solutes between the lungs and the blood is regulated differently by these capillaries, with consecutive perforated capillaries being one of the most limiting and disconnected blood vessels being the least complex [12]. BBB is a phrase that describes the specific attributes of the anxious scheme. CNS containers are incessant arteries that have several extra features that allow them to carefully switch the way of chemicals, ions, and lockups in plasma as well as the CNS [13–17]. The various sectional views are shown in Fig. 3.

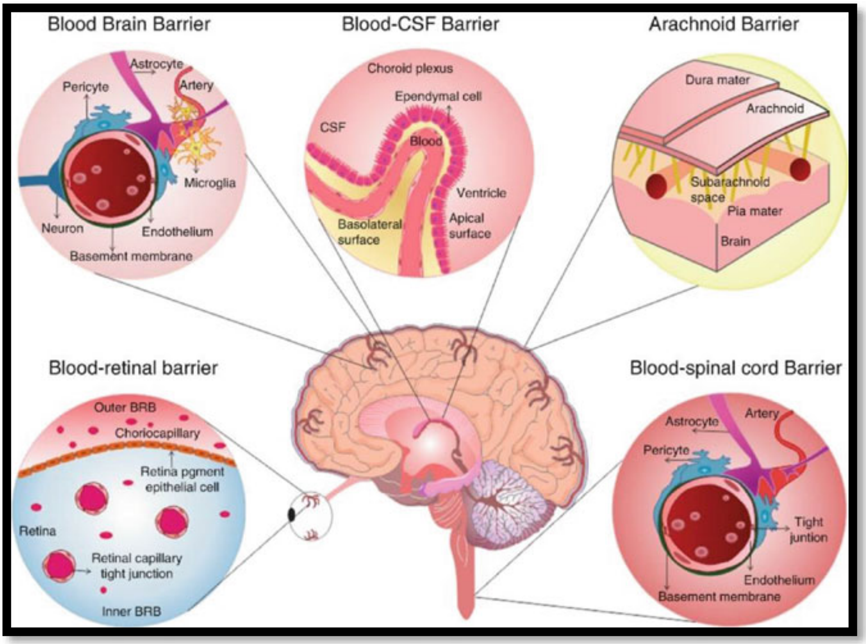

Fig. 2 Different types of Blood–Brain Barriers

2 Dataset Description

There are many open source links where the BBB Dataset is available for free to some of the sources with the link mentioned in the Table 1 [18–22]. All the datasets are different and have some different features. For the analysis in this research study, the data from the second link DSSTox public database is used [23–27].

2.1 Loading BBBP Dataset

BBBP: Total Binary labels present in the given dataset of blood–brain barrier penetration (permeability) are given below (Table 2).

(2039, 4).

Simple single-molecule line-entry system (SMILES) is a standard for expressing the composition of chemical species using short ASCII characters in the procedure of a line representation [28]. The RDKIT component can translate SMILES to chemical composition.

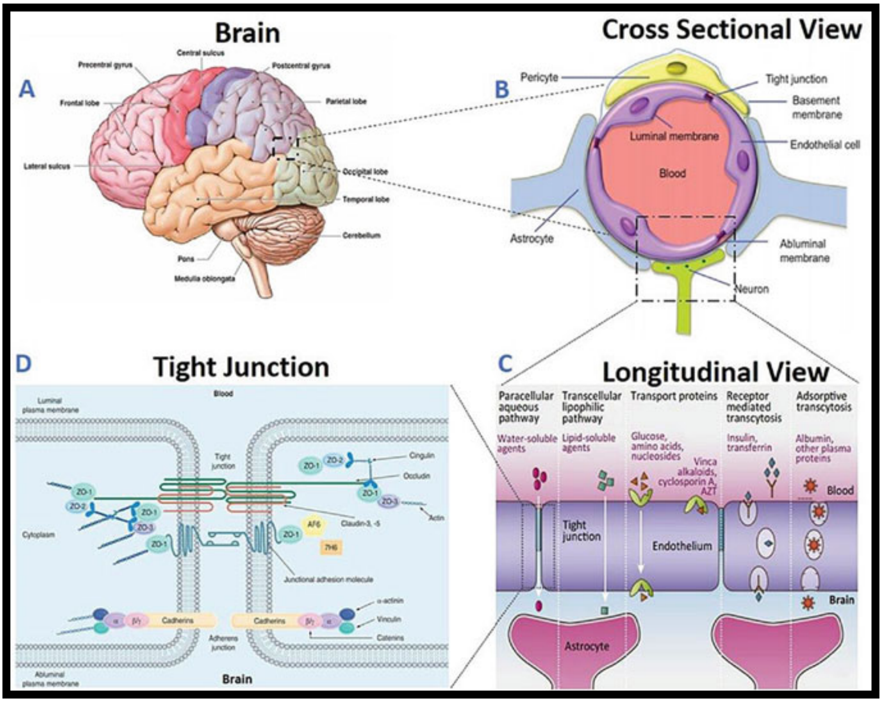

Fig. 3 Sectional view of Blood–Brain Barrier

Table 1 Different dataset available open source

Database name	URL	Type
Brainpeps	https://brainpeps.ugent.be/	Free
DSSTox	https://www.epa.gov/	Free
The carcinogic potency database	https://www.nlm.nih.gov/	Free
DRUGBANK	https://go.drugbank.com/	Free
MR-TIP datadase	https://www.mr-tip.com/	Free
Chem tree	https://academictree.org/	Commercial
Admet	https://www.admet.com/	Commercial

Table 2 BBB penetration labels

Serial number	Num	Name	P_NP
0	1	Propanolol	1
1	2	Terbutylchlorambucil	1
2	3	40,730	1
3	4	24	1
4	5	Doxacillin	1

2.2 Loading Molecular Descriptors

The Attributes dataset includes 1625 molecular markers (including 3D descriptors) produced using the Internal and external sources python library on the DSSTox database [29–32].

```
bbbp_descriptors_df.info()
<class 'pandas.core.frame.DataFrame'>
RangeIndex:  2039 entries, 0 to 2038
Columns: 1825 entries, ABC to mZagreb2
dtypes: float64(1825)
memory usage: 28.4 MB

bbbp_df['p_np'].value_counts()

1   1560
0    479
Name: p_np, dtype: int64
```

The description of the dataset is obtained by using the above commands, and it is found that, out of 2039 data values, 1560 indicate one and 479 indicate zero. This clearly shows the balancing of dataset with no ambiguity.

3 Exemplary Assessment

Models assessment is an essential step in the formation of a classical model. It aids in the selection of the finest system that represents data, as well as the forecast about how healthy the proposed framework will achieve in the forthcoming. Both techniques employ a test set to evaluate model performance to avoid fitting problems [33–35].

The various parameters which can be used to evaluate the different machine learning classifiers are mentioned below Precision (SP), Accuracy (ACC), Recall (SE), and F-score (F).

4 SVC Model

The SVC approach classifies data using a constant kernel function and performs well with large datasets. The Sequential SVC model has additional variables than the SVC model, incorporating penalty normalization and backpropagation.

5 Neural Network Model

Neural networks are basic representations of how the nervous system functions. An input layer with the transmission of the input fields, one or even more concealed nodes, and an output stratum with a unit or showing the amount of the goal field are indeed the three parts of a neural network (s). The code used in the research studies with 500 Epochs is shown below.

```
Epoch 00498: val_loss did not improve from 0.35798
Epoch 499/500
1651/1651 [==============================] - 0s 32us/step - loss:0.0397 - acc: 0.9830 - val_loss:0.51
96 - val_acc: 0.8859

Epoch 00499: val_loss did not improve from 0.35798
Epoch 500/500
1651/1651 [==============================] - 0s 29us/step - loss:0.0435 - acc: 0.9824 - val_loss:0.51
70 - val_acc: 0.8913

Epoch 00500: val_loss did not improve from 0.35798

plt.ylim(0., 1.0)
plt.plot(hist.epoch, hist.history["loss"], label="Train loss")
plt.plot(hist.epoch, hist.history["val_loss"], label="Valid loss")
```

It is clearly shown in Fig. 4 that the training loss decreases gradually as the number of epochs increase which intern increase the accuracy of predictions.

5.1 Gradient Boosting with SVC

Gradient boosting classifiers are an assembly of machine learning procedures that assimilate numerous weaker learning approaches to shape an influential prediction classical. Gradient increasing methods are usually used because of their efficiency in categorizing complicated datasets, and gradient boosting algorithms are gaining popularity.

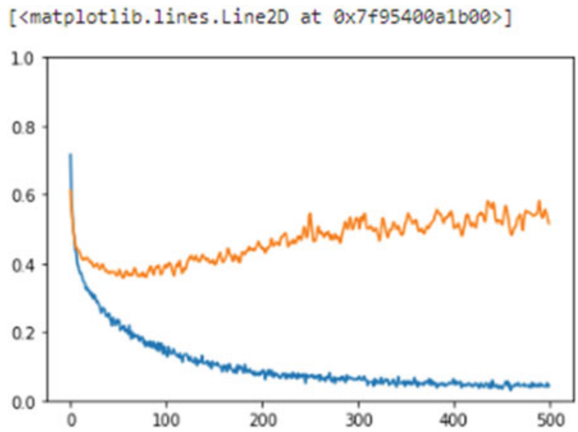

Fig. 4 Plot for training loss valid loss with several epochs

```
print(result.best_score_)
0.9859271890748204

pred = bbbp_svc_gb_calib.predict(X_test)
f1_score(y_test,pred)
0.9090909090909092

pred = bbbp_svc_gb_calib.predict_proba(X_test)
roc_auc_score(y_test,pred[:,1])
0.9263803680981594
```

5.2 Gradient Boosting with XGBoost

XGBoost is an accessible package that implements the boost method efficiently and productively. While there were other accessible versions of the method beforehand XGBoost, the introduction of XGBoost appeared to uncheck the method's strength and make the practical deep learning community pay better care to gradient increasing in particular.

6 Comparison of Results with Molecule Net

In the last few years, molecule algorithms have advanced fast. Ml algorithms have become increasingly accurate in predicting molecular characteristics because of improved techniques and the availability of larger datasets. Furthermore, owing to a lack of a common standard to assess the effectiveness of suggested approaches, algorithmic development has been restricted; novel procedures on a variety of datasets, making it impossible to judge the efficacy of future approaches.

```
sns.set(style="whitegrid")
ax = sns.barplot(x=[svc_score,nn_score,svc_gb_score,xgb_gb_score,ave_score],
            y=['SVC','NN','SVC_GB','XGB_GB','ave'])
ax.set(xlim=(0.75, None))
```

The comparison of the F1-Score is shown in the bar chart in Fig. 5. Also, the comparison among different classifiers used in the research studies is shown in Fig. 6 (Table 3).

Inference from Table 3

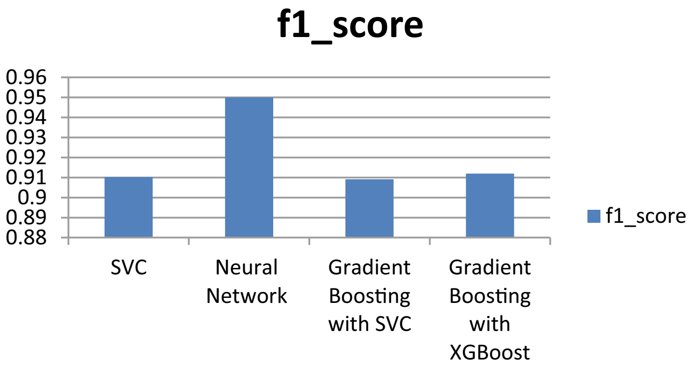

Fig. 5 Bar chart representation of F1-Score

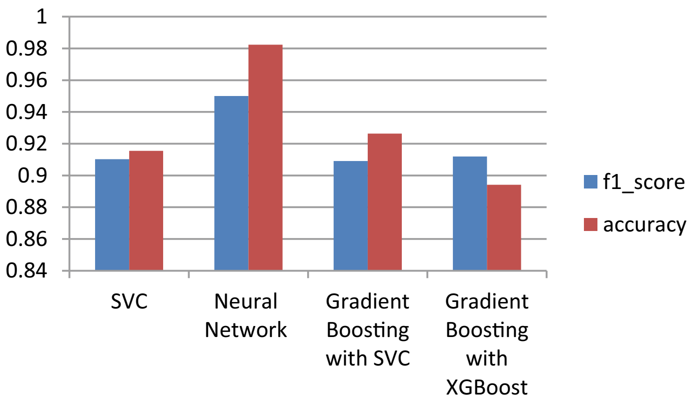

Fig. 6 Comparison of different classifiers used

Table 3 Comparison analysis of different classifiers

	SVC	Neural network	Gradient boosting with SVC	Gradient boosting with XGBoost
f1_score	0.91	0.92	0.901	0.911
Accuracy	0.915	0.98	0.926	0.894

(1) From the above table, the comparison of the F1-score has been done. The F-score, also well-known as the F1-score, is a metric for in what way precise a model is on assumed data. The F-score, which is defined as the harmonics mean of the model accuracy and recall, is a means of integrating the model exactness and memory. The F1-Score is least in GBSVC with a value of 0.90 as compared to the max value in NN about 0.92.

(2) In terms of Accuracy of Prediction, the NN classifier has the maximum 98% accuracy as compared with the Least 89% accuracy in the XGBoost Algorithm. The heatmap between different parameters is shown in Fig.7 which shows the degree of correlations among various parameters.

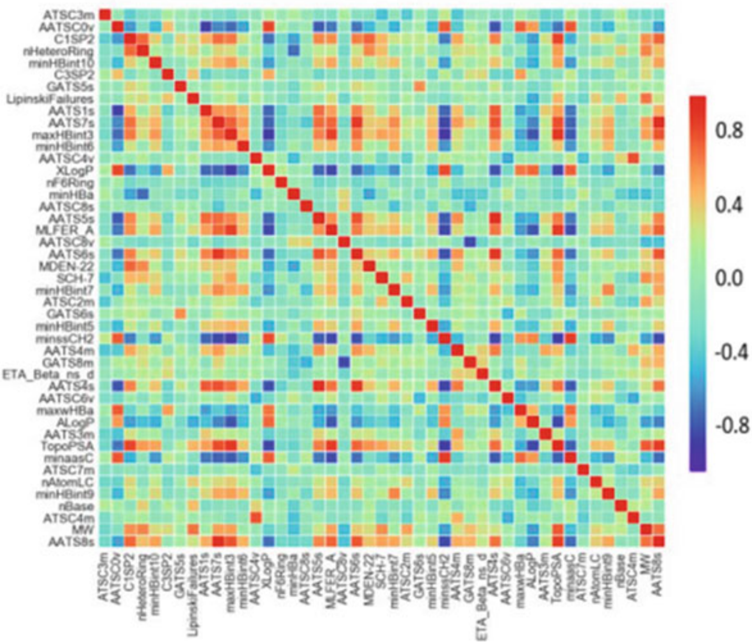

Fig. 7 Heat Map between different parameters

7 Conclusion

In this research, four classification algorithms were used to create a set of existing datasets and a majority model for estimating biochemical Membrane permeability. For addressing the early imbalanced samples of the BBB data set, imbalance-learning algorithms and feature extraction methods were created. The Comparison analysis of four different classifiers like SVM, NN, Gradient Boosting with SVC, and Gradient Boosting with XGBOOST has been done, and it is found that for the prediction of the result, the Neural network with 500 epochs shows the accuracy of nearly 98% which is much better than the previous works. Further, this research study is very helpful for researchers working in the same field.

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Effectiveness of Machine Learning in Detecting Early-Stage Leukemia

Ketan Gupta, Nasmin Jiwani, and Pawan Whig

Abstract The early identification and diagnosis of leukemia, i.e., the exact distinction of malignant leukocytes at the lowest possible cost in the early stages of the disease, is a key challenge in the domain of disease diagnostics. Considering the large frequency of leukemia, flow cytometry equipment is scarce, and the procedures available at laboratory diagnosis facilities are tedious, complex, and time-consuming. Inspired by the possibilities of machine learning (ML) in illness detection, the current critical search was done to examine the research attempting to find and categorize leukemia using ML algorithms. This research study provides a complete and systematic assessment of the current state of all available ML-based leukemia detection and classification algorithms that analyze PBS pictures. The accuracy rate of the ML techniques used in PBS image analysis to detect leukemia was greater than 93.5%, showing that the application of ML might lead to exceptional results in leukemia diagnosis from PBS pictures.

Keywords Machine learning · Leukemia · Blood cancer · Genetic · Clinical · Epigenetic

1 Introduction

Leukemia is the most prevalent kind of blood cancer across all age categories, particularly in youngsters [1]. This aberrant condition is produced by excessive blood cell propagation and undeveloped growth, which can harm RBC, and the immune system. More than 4.6% of new cases of cancer in the US are leukemia, and also, the country recorded more than 80,000 new instances of this illness in 2021 [2]. Lymphoblasts spread to additional tissues or organs like the spleen, brain, liver, and kidneys, where

K. Gupta · N. Jiwani
University of the Cumberlands, Williamsburg, USA

P. Whig (✉)
Vivekananda Institute of Professional Studies, New Delhi, India
e-mail: pawan.whig@vips.edu

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they metastasize vital tissues. Based on microscopic pictures, hematologists in cell transplant facilities can differentiate/diagnose various forms of leukemia [3, 4]. Some kinds of leukemia can be detected and discriminated more easily than others if the slide is properly stained, but additional equipment is required to determine underlying leukemia [5].

Various researches have used ML and CAD diagnostic approaches for research lab image investigation during the last two decades in the hopes of overcoming the constraints of a late leukemia diagnosis and determining its subgroups [6]. This research examined blood smear pictures to diagnose, differentiate, and count the cells in distinct forms of leukemia [7, 8]. Different Types of Leukemia are shown in Fig. 1.

Machine Learning is a branch of AI that comprises various algorithms and maths relationships, and it has been quickly applied to scientific investigation [9]. Machine Learning allows computers to be programmed without obvious knowledge and then learn from it. Outcomes of using techniques in medicinal statistics processing have been fantastic, and they've had a lot of success in detecting illnesses [10]. ML methods, according to studies, significantly aid difficult medical decision-making processes in medical image processing by extracting and then assessing the features of these images [11].

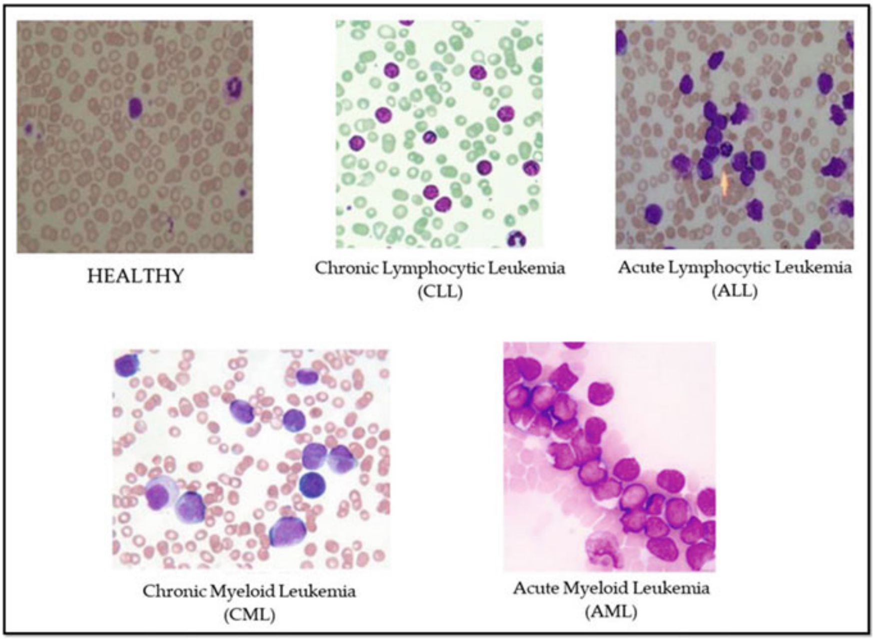


Fig. 1 Different forms of leukemia

There was an urgent demand for more complex data analysis methods which can be strong enough to provide an accurate result. Traditional approaches were incapable of analyzing such a vast volume of data or identifying data trends [12].

2 About Dataset

Acute lymphoblastic leukemia accounts for roughly 25% of all childhood malignancies. In general, distinguishing young leukemic blast from healthy cells in the blood is difficult since the pictures of the two cells are morphologically identical [12].

To train a machine learning-based classifier to distinguish normal cells from leukemic blasts (malignant/cancer cells), a dataset of cells with labels (normal versus cancer) is given [13]. The cells in this picture were segmented from microscopic photographs. Because these photos contain some staining noise and lighting flaws, they are indicative of images in the real world, however, these mistakes have been mostly corrected by us using our in-house stain color normalizing approach [14].

The data set consists of about 10 K images in which 7 K are of the patients having cancer and 3 k is normal patients means without cancer [15]. This dataset is divided into training and testing in a 70:30 ratio.

This is a difficult topic since, as previously noted, the two cell types appear to be extremely similar morphologically [16]. The expert has indicated the ground truth based on domain expertise. Also, as a result of our research over the last two years, we've realized that subject-level variability plays a major role, making it difficult to construct a classifier that can provide decent results on prospective data. Anyone interested in working on a difficult topic of medical picture categorization using newer deep learning/machine learning structures should come forward to work on this task, in our opinion [17–19].

The quality of the stained slide affects the diagnosis of leukemia in peripheral blood pictures [20]. As a result, there aren't many high-quality standard datasets accessible. The majority of research used publicly available datasets. Hematologists provide this dataset (including PBS pictures) to scholars to create and develop ML algorithms. ALL-IDB is a very common dataset and has been used in several papers, the majority of which have used machine learning approaches to diagnose and classify acute lymphoblastic leukemia (ALL) [21].

Another leukemia dataset, Benchmark for the development of ML algorithms, has been published and is utilized in certain research. The majority of scholar has only tested their suggested model on a homogenous database [22]. However, diagnosing the illness in databases with unique features is a big difficulty in a robust detection and classification approach. As a result, several researchers have used a cross-dataset of these datasets to propose a robust model and obtain trustworthy and accurate findings [23].

ML and its main subtype, deep learning, are two kinds of learning algorithms that have been employed in PBS image analysis, according to the methodologies used by the evaluated research [24]. The first method focuses on the extraction of specific picture features. These techniques are often used in the extraction of a large number of picture characteristics using mathematics and machine learning algorithms [25].

3 Libraries Used

Machine learning is an application of data processing that automates the creation of analytical models [26]. It's a field of artificial intelligence predicated on the concept that computers can learn from data, recognize patterns, and make choices with little or no human input. Various Machine learning Packages used for analyzing and predicting in detecting early-stage Leukemia are given below in Fig. 2

The shape of an array is returned by the function "shape." A tuple of integers is the shape. The lengths of the relevant array dimension are represented by these integers. To put it another way, an array's "shape" is a tuple with the number of elements per axis (dimension). The Shape of the images in the given dataset is (450,450, 3) with a Pixel count of 202,500 as calculated by the following commands. This shows the quality of the images in the dataset is fairly good for analysis [27, 28]. The image of Leukemia cells from the dataset is shown as an example in Fig. 2. Also, some more samples obtained before training are shown in Figs. 3 and 4.

```
first = plt.imread('/content/C-NMC_Leukemia/training_data/fold_0/all/UID_4_4_3_all.bmp')
dims = np.shape(first)
print(dims)
```

```
(450, 450, 3)
```

```
import glob
import numpy as np
import pandas as pd
import seaborn as sns
import tensorflow as tf
import efficientnet.tfkeras as efn
import tensorflow.keras.layers as L
import tensorflow.keras.backend as K
from matplotlib import pyplot as plt
import math, os, re, warnings, random
from sklearn.utils import class_weight
from kaggle_datasets import KaggleDatasets
from sklearn.model_selection import KFold,StratifiedKFold
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score
from tensorflow.keras import optimizers, applications, Sequential, losses, metrics
from tensorflow.keras.callbacks import EarlyStopping, ModelCheckpoint,LearningRateScheduler
```

Fig. 2 Various machine learning packages used in detecting early-stage Leukemia

```
fifth = plt.imread('/content/C-NMC_Leukemia/training_data/fold_0/all/UID_52_3_7_all.bmp
dims = np.shape(fifth)
pixel_matrix5 = np.reshape(fifth, (dims[0] * dims[1], dims[2]))
```

```
plt.imshow(first)
```

```
<matplotlib.image.AxesImage at 0x7f8f18348610>
```

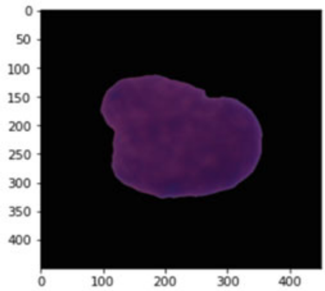


Fig. 3 Image of Leukemia cell is shown as an example

```
plt.imshow(fifth)
```

```
<matplotlib.image.AxesImage at 0x7fa3484bb0d0>
<matplotlib.image.AxesImage at 0x7fa3484a6f10>
<matplotlib.image.AxesImage at 0x7fa348426690>
```

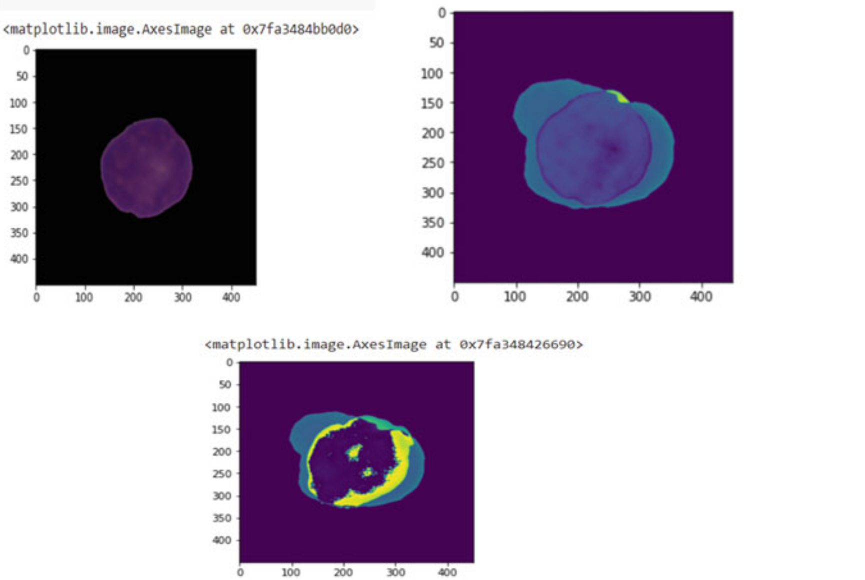


Fig. 4 Some more images of Leukemia cells

```
pixel_matrix = np.reshape(first, (dims[0] * dims[1], dims[2]))
print(np.shape(pixel_matrix))
```

```
(202500, 3)
```

4 Result and Discussion

4.1 Sklearn Cluster

There are several classification techniques to select from, and there is no single optimum clustering method for every situation. Instead, it's a good idea to experiment with a variety of clustering methods and their various combinations [29–36]. The K-means algorithm will be used. The traditional EM algorithm is "full." Using the equation, the "Elkan" variant is much more effective upon data with well-defined clusters. However, because an additional array of the forms (n samples, n clusters) is allocated, it uses more memory. Leukemia cell after k means clustering is shown in Fig. 5.

```
from sklearn import cluster

kmeans = cluster.KMeans(5)
clustered = kmeans.fit_predict(pixel_matrix)

dims = np.shape(first)
clustered_img = np.reshape(clustered, (dims[0], dims[1]))
plt.imshow(clustered_img)
```

```
<matplotlib.image.AxesImage at 0x7fa33afb0490>
```

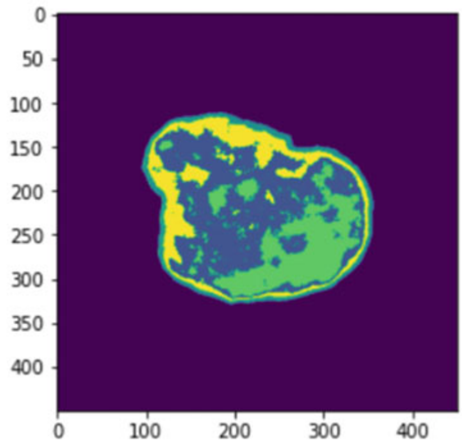


Fig. 5 Leukemia cell with K means clustering

4.2 Mpl ToolKit

By providing an axis class that really can produce a 2D projection of a 3D environment, the mplot3d toolkit provides simple 3D charting features to matplotlib. The resultant chart will resemble conventional 2D graphs in look and feel. 3D chart generated by executing the following code. The 3D chart indicates the projection of the image after clustering using blue, green, and red channels as shown in Fig. 6. Also, the corresponding histogram chart for the projection of cells is shown in Fig. 7. Cluster set of different types of Leukemia cells obtained after model evaluation is shown in Fig. 8.

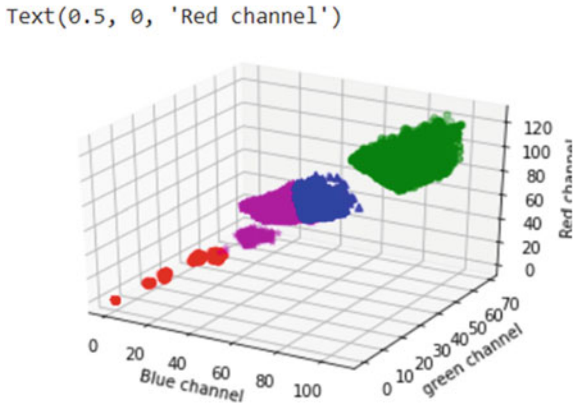


Fig. 6 3D Plot generated using mpl Toolkit

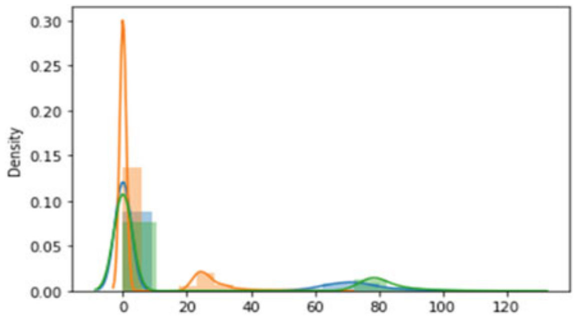
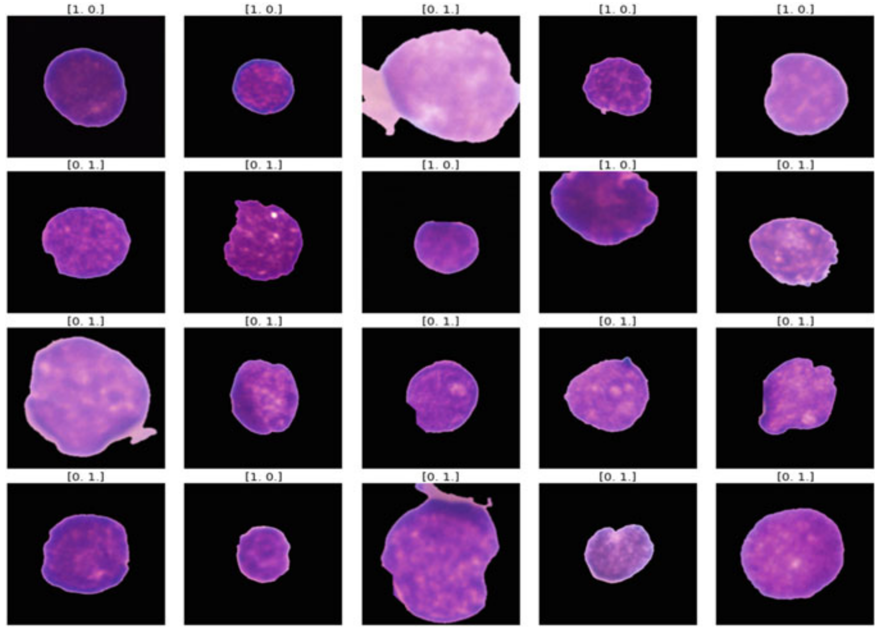
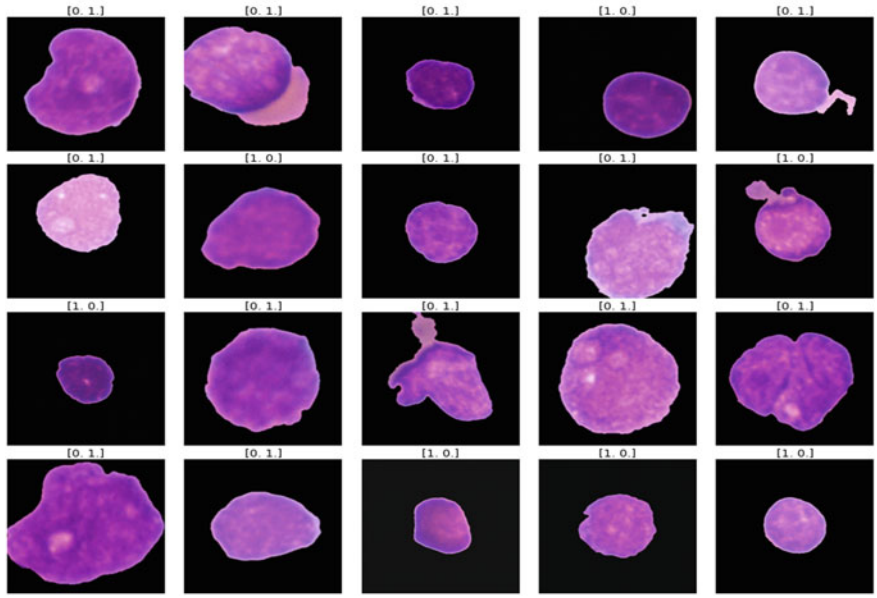


Fig. 7 Histogram chart to show a projection of the cell



(A)



(B)

Fig. 8 (**A**, **B**) Cluster set of different types of Leukemia cells obtained after model evaluation

```
from mpl_toolkits.mplot3d import Axes3D

fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')

plot_vals = [('r', 'o', ind0),
             ('b', '^', ind1),
             ('g', '8', ind2),
             ('m', '*', ind3)]

for c, m, ind in plot_vals:
    xs = pixel_matrix[ind, 0]
    ys = pixel_matrix[ind, 1]
    zs = pixel_matrix[ind, 2]
    ax.scatter(xs, ys, zs, c=c, marker=m)

ax.set_xlabel('Blue channel')
ax.set_ylabel('green channel')
ax.set_zlabel('Red channel')
```

```
# quick look at color value histograms for pixel matrix from first image
import seaborn as sns
sns.distplot(pixel_matrix[:,0], bins=12)
sns.distplot(pixel_matrix[:,1], bins=12)
sns.distplot (pixel_matrix [:, 2], bins=12)
```

Accuracy, F1 Score after 30 epochs is shown below in Fig. 9. It is found that the Average Accuracy of about 93% with the F1 Score is 0.9346 which describes the accuracy of the data set.

```
Epoch 30/30
261/261 [==============================] - 236s 903ms/step - loss: 0.1513 - accuracy: 0.9393 -
f1_score: 0.9396 - val_loss: 0.1875 - val_accuracy: 0.9346 - val_f1_score: 0.9346
#### FOLD 3 OOF Accuracy = 0.937
### Avg. Accuracy = 0.9324712554613749
 ### Avg. Weighted F1 = 0.9321610331535339
```

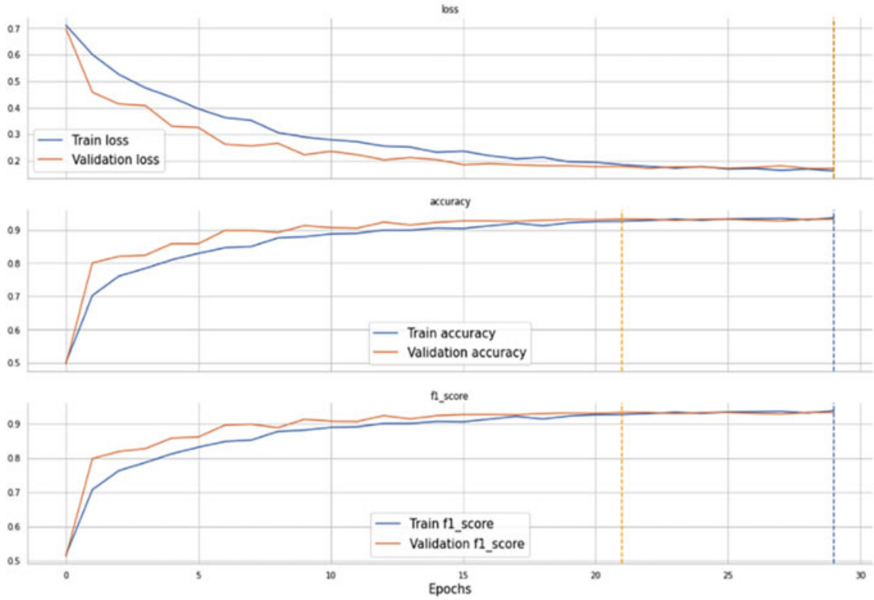


Fig. 9 Graph of accuracy, f1 score with the number of epochs

5 Conclusion

The study of blood smear images is crucial in the diagnosis of many blood-related illnesses. The early detection of leukemia, as well as the initial smears, might lead to an instant diagnosis and treatment commencement. Blood smear image analysis using machine learning algorithms can help in the identification of early-onset leukemia and the determination of subtypes with the least amount of error in the shortest amount of time, allowing treatment to begin right away. The use of innovative ML algorithms, particularly DL, in computer-aided detection (CAD) systems, whole-slide imaging (WSI), and even applications and software in hematology laboratories, might be a potential future research avenue to aid pathologists and oncologists in better identifying leukemia. A model was created utilizing neural networks using the data of 38,416 patients and control groups. This method was able to distinguish between normal and abnormal cells with 93% accuracy. As a result, it is proposed that the employment of machine learning algorithms for the analysis of blood smear pictures proceed from the modeling to the implementation phase shortly. Using machine learning to analyze leukemia smear pictures can increase accuracy, shorten diagnosis time, and deliver faster, cheaper, and safer diagnosis and treatment. Clinical specialists can use ML techniques in laboratory apps and tools in addition to conventional diagnostic approaches.

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Convolutional Neural Networks (CNN) and DBSCAN Clustering for SARs-CoV Challenges: Complete Deep Learning Solution

Gousia Habib and Shaima Qureshi

Abstract Early diagnosis of Covid-19 is a challenging task requiring congruous clinical medical imaging, which is a time- consuming process and suffers from accuracy problems due to variations between different laboratory results. The clinical symptoms of Covid-19 show resemblance with acute respiratory distress syndrome. The major clinical symptoms linked with this disease are fever, cough, headache, migraine, and breathlessness. Despite tremendous research going on, knowing the way of transmission and its early detection remains a mystery. There is no treatment as of now for this virus, so a lot of unprecedented containment and mitigation policies such as closure of business places, schools, and colleges, marriage gathering restrictions, transport restrictions, and social distancing are being employed. These policies are able to limit the transmission of covid-19, but are not always feasible. Steps must be taken to slow down the spread of this virus and make an early diagnosis of infection to save lives. This paper gives a clear idea about the introduction of Covid-19, its symptoms, post covid-19 symptoms, challenges posed by the virus, and proposed solutions for its early detection to slow down its rate of transmission. **Methods**: The proposed solution includes a clustering algorithm for massive contact tracing that helps to slow down the transmission rate, and automatic virus detection and classification network known as Convolutional Neural Networks (CNN) based upon deep domain transfer learning. **Results**: The pre-trained model VGG-19 is used and the hyperparameters of the model are tuned as per classification requirement by exploiting the concept of deep domain transfer learning. The model is implemented on publicly available chest radiography images and the system classifies the dataset as covid and non-covid images. The CNN achieves 97.35% accuracy outperform-

G. Habib (✉) · S. Qureshi
Department of Computer Science and Technology, National Institute of Technology Srinagar, Srinagar, India
e-mail: gousiahabib01phd19@nitsri.net

S. Qureshi
e-mail: shaima@nitsri.net

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ing all the existing methods. A new concept of employing nanocoating and nano sprays is also introduced in the paper. **Conclusion**: To discuss various critical challenges posed by Covid-19. Addressing those issues and proposing various solutions. Proposing clustering machine learning algorithm for massive contact tracing. Developing automatic covid-19 detection and classification system based upon automatic feature detection. Providing solutions based upon nanotechnology to slow down transmission.

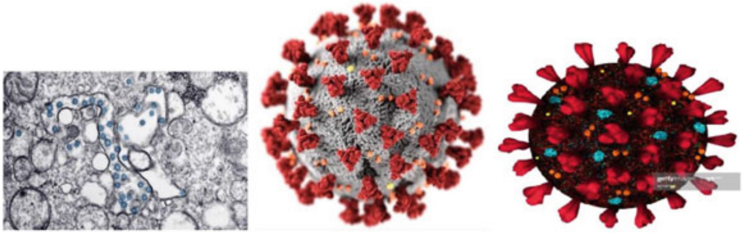
Keywords Global average pooling · NNLU · CNN · AMsgrad · SGD · ADAM · Hybrid parallelism · Max-pooling

1 Introduction

SARS-CoV (COVID-19) Outbreak is one of the world's biggest Outbreaks. A nano-sized virus engulfed the whole world. The virus was first identified in China in December 2019 and still continues to haunt the entire world. Slightly different than influenza, it is just the infectious/communicable disease caused by this nano-sized virus, which causes moderate to severe illness. Most of the people infected by this virus get mild symptoms similar to influenza and successfully recover after home quarantine without hospitalization by taking some commonly known influenza medication. Older people and those with co-morbidities like cardiovascular disease, diabetes, asthma, cancer, and some other autoimmune disease are at higher risk. They develop severe illness and show a higher rate of fatality. The most common modes of transmission are by an infected person's sneezing droplets, saliva droplets, or coughing. A person infected with virus can be symptomatic as well as asymptomatic. Asymptomatic feature of this virus can cause disaster if remains undetected. A person with undetected virus can act as a carrier and can infect hundreds of people. A lot of research is going to focus on the way how it spreads and the behavior of the virus. Covid-19 detection can be done either by physical examination by medical expert or using different testing kits.

Medical experts after observing matches multiple with symptoms of covid-19 declare the patient covid-19 positive and advise self-isolation. Rapid antigen kits (RAT) and nasopharyngeal swab test kits were first developed in India by a Pune-based My lab discovery solutions and was the first test kit to get an approval for diagnosis of this covid-19 virus. Although test kit is very helpful in covid-19 diagnosis, it is not a much reliable device as it results in many false negatives, which renders some infected persons undetected and creates a huge problem.

The RAT being a widely used quicker test for covid-19 detection is not capable of generating accurate results at the early stages of infection (person with low viral load 30%). The test shows positive only when the viral load of the person is higher than 70%, otherwise, results in false negative which makes RAT highly unreliable solution. A more reliable solution other than RAT also makes utilization of nasopharyngeal or throat swab to make the diagnosis of Covid-19. Since coronavirus is a RNA virus, the test kit transforms RNA into DNA, the molecular biology procedure called as reverse transcription, indicated by RT in RT-PCR. This test kit is designed to amplify the genetic material of the virus so that it is able to detect the virus cases even with very small viral load, thus reducing the false negatives at early stages. But still not able to meet the accuracy required for medical analysis. The paper gives a detailed description of covid-19, testing strategies, its symptoms, post covid-19 symptoms, and what are the main challenges posed by this virus? how these challenges can be coped up by using different methodologies. The structure of a nano-sized Covid-19 virus is given in Fig. 1.



a) Microscopic view b) 3D structure c) Realistic view

A clear description of Covid-19, such as how the testing is done, how to deal with mild or severe case, etc., is illustrated by the flowchart depicted in Fig. 2.

1.1 SARS-CoV Symptoms

Covid-19 symptoms range from mild to severe. The major symptoms are running nose, dry cough, gastrointestinal disorders, mild fever, and sore throat. In some severe cases, high fever, dry mouth, and even breathlessness can occur which causes death. It has been observed that some patients have some neurological disorders such as loss of sense of smell and taste. Also, some people report strokes, and thrombosis in legs, lungs, and arteries. Chest pain was observed in some serious cases because of bilateral pneumonia, which requires hospitalization. Some of the symptoms may go within 3–4 days of treatment which is followed by the recovery phase. In some severe cases, the symptoms may take even weeks to subside [1].

1.2 Statistical Analysis of SARS-CoV

Global Covid-19 statistics is depicted in Figs. 2, 3, and 4. This statistical data is publicly available for analysis as [2]

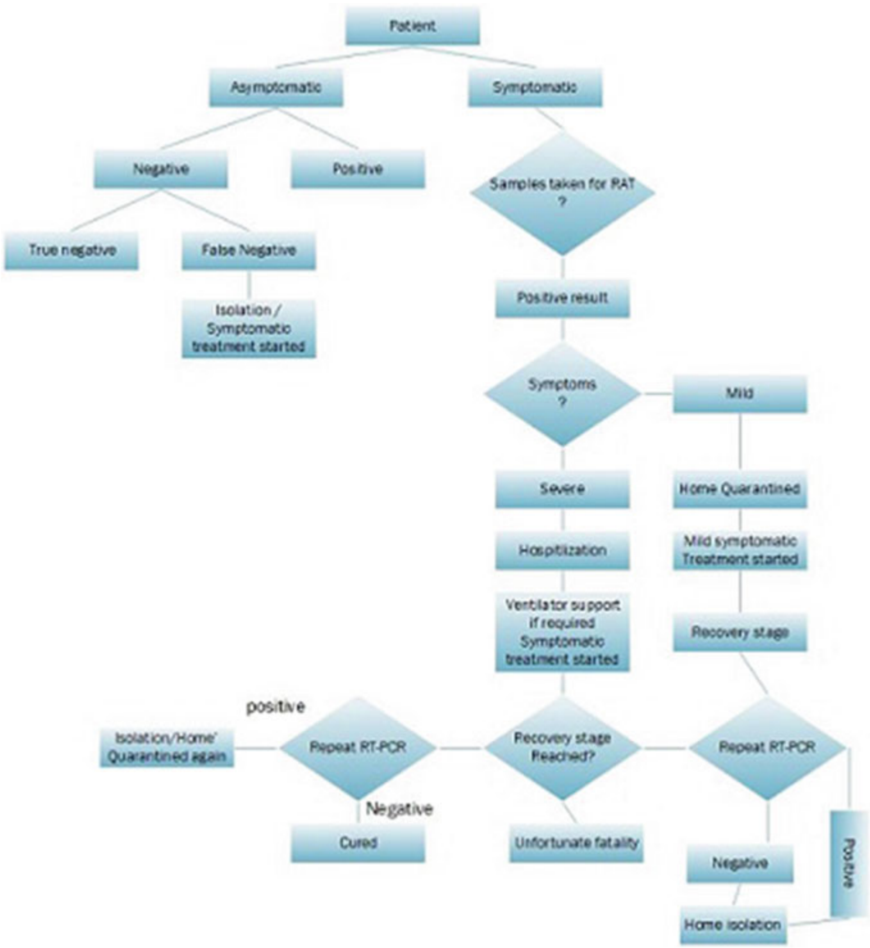


Fig. 1 Flowchart of Covid-19

1.3 Post Covid-19 Symptoms

As per current reports and review's, after Covid-19 recovery, patients are exposed to a lot of problems of post covid-19 symptoms like hair fall, brain fog, dementia, interval headaches, and dizziness. Researchers collected data of almost 620 Covid-19 positive patients and it was observed from the EEG waveform data that there were signs of impairment and disturbance in their brain [3]. Widespread inflammation may be the major cause of this brain impairment. Hair fall, persistent dry cough, stammering, epileptic attacks, and loss of vision and hearing are some other post Covid-19 Cured symptoms complained by majority of the patients. It was reported from Bhatia hospital that a patient after Covid-19 recovery got her menstrual cycle

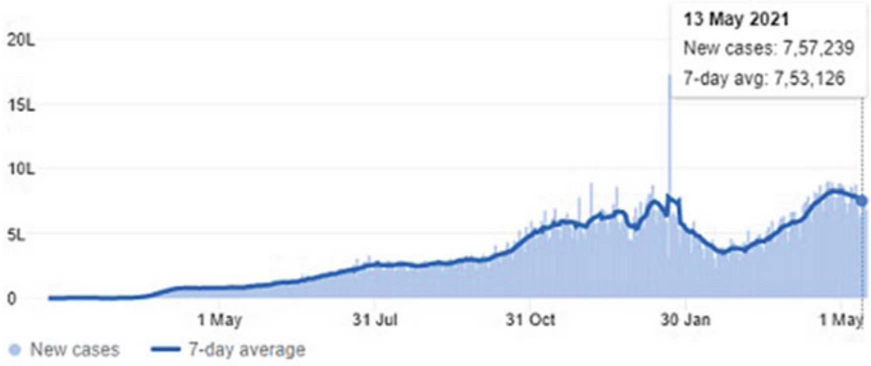


Fig. 2 No of cases per million populations worldwide

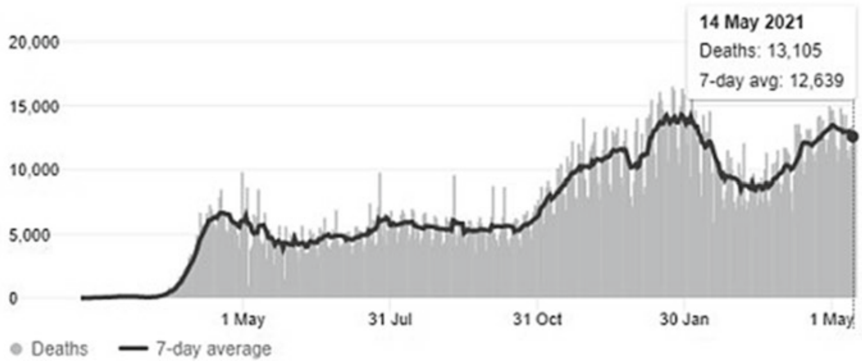


Fig. 3 No of deaths per million populations worldwide

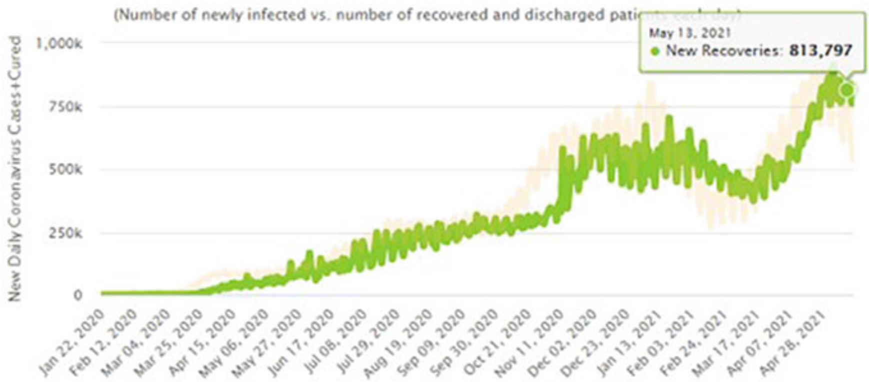


Fig. 4 No of recoveries per million populations worldwide

Fig. 5 No of serious and critical cases per million populations worldwide

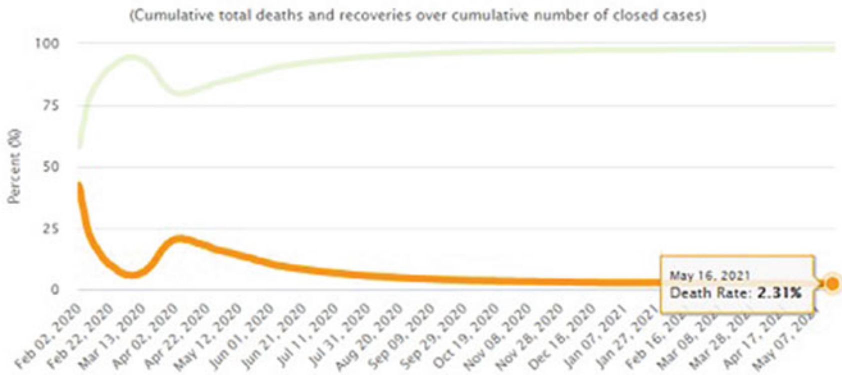


Fig. 6 Cumulative death rate per million populations worldwide

delayed by two and a half months. The Gynecologists suggest that severe Covid-19 symptoms are known to temporarily affect the menstruation cycle of women [4]. Therefore, establishment of post covid-19 clinics is of utmost need to address these post covid-19 symptoms (Figs. 5, 6, and 7).

1.4 Covid-19 Challenges

Covid-19 poses a wide variety of challenges both in developed as well as in developing countries. Developed countries gave a new shape to public healthcare system and lowered the virus transmission. They accomplished this by employing the physical distancing, washing hands frequently, making use of face masks, isolation and quarantining of infected person, closure of schools, colleges, business places, restaurants,

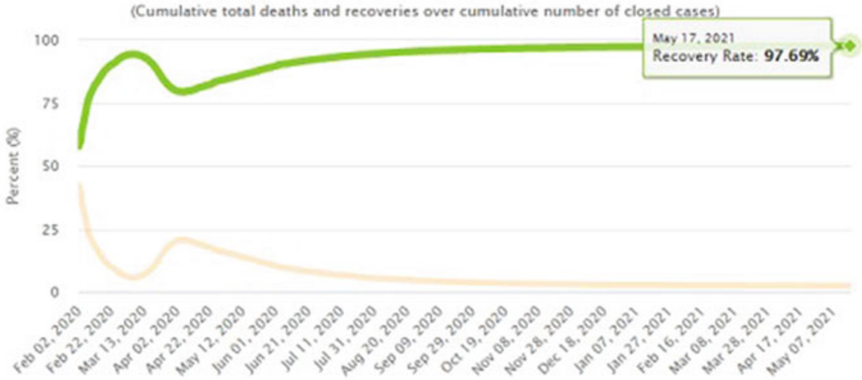


Fig. 7 Cumulative Recovery rate per million populations worldwide

clubs, avoiding marriage or religious gatherings, and making limited use of public transport with proper distance maintained. But in case of developing countries, people always live in crowded places and are not able to avail these facilities due to their weak economic background. Developing countries do not have good hygienic system or smart healthcare system to deal with such kind of health problems. As the healthcare system of such countries is not developed, it is thus compromised, lacking the basic facilities such as limited number of beds, lack of ICU units, and limited oxygen supply. Covid-19 is such a kind of disease which is wholly and solely related to respiratory system. Oxygen supply and ICU's are basic requirement for Covid-19 patients facing breathlessness issue or bilateral pneumonia caused by this disease. Lack of such facilities in developing countries leads to higher fatality which is very unfortunate. Recent reports and reviews given by the researchers suggests that washing hands frequently or making use of excessive sanitizers can cause resistance to microbes, which can be a big threat in future. Therefore, social distancing, washing hands, and making use of sanitizers is not a long-term solution. Contact tracing is another big challenge posed by covid-19. Steps must be taken to detect this disease at the earliest in order to decrease the human to human virus transmission.

The main contributions of the paper are highlighted as:

1 The paper will provide different solutions to cater these problems in developing countries with compromised healthcare systems. The solutions are based on medical testing, machine learning, and nanotechnology approach.
2 This paper discusses how these approaches can be used to make early detection of disease to save the precious human lives. And how these approaches can be used to slow down the rate of transmission of virus. The solution based upon machine learning approach has also been provided for massive contact tracing.
3 The clustering algorithm is discussed and given to make the contract tracing of the covid-19 infected persons possible on right time.

4 A novel CNN model is proposed to classify covid and non-covid images by implementing the concept of transfer learning as well as data augmentation.

1.5 Background of the Proposed Method CNN

The framework of CNN is based upon the visual process of humans. In 1950's and 1960's, Hubel et al (1968) explored the processing of visual responses in cat and monkey. Through various studies, they found that, their visual cortex responds to smaller visual fields known as local receptive fields. Receptive fields are the region in the visual space where if stimuli occur, it fires a single neuron. Adjacent cells use overlapping receptive fields also known as weight sharing. This is a distinctive property that makes Convolutional Neural Network (CNN) different from neural networks and helps in reducing exponential growth of parameters as the input grows [5]. In 1980, a unique concept of neo-cognition was introduced by Fukushima, K et al (1980) that doesn't require same training weights at all the locations. Later, the same was generalized and unraveled by Le Cunn et al, 2003. They proposed 7 layer CNN for handwriting recognition sampled in 32×32 pixel images called as LeNet model shown in fig. 3. This was the first model developed for object detection tested on MNIST dataset. But its application was limited due to huge memory requirements and processing power constraints at that time. Pal and Pal in 1993 anticipated in their survey article that neural networks would turn out to be broadly applied for image processing. Their forecast ended up being valid [6]. Egmont et al (2002) reviewed an article and surveyed the application of neural systems developed for various image processing applications [7]. Until 1990s, Bayesian discriminant and Parzen windows were well known. Since then, neural networks have dynamically been used as another choice to great examples, classifiers, and clustering techniques. Manrous Mohammad et al (2015) suggested a new method for content-based image classification and retrieval using optimized Pulse coupled Neural network [8]. Euijoon Ahn et al (2016) devised a new algorithm based upon fusion of both deep domains transferred CNN and sparse spatial Pyramid (SSP) to extract the features from the local image dictionary. It was observed from experimental evaluation of the algorithm that this method achieves the lowest error rate in comparison with the existing approaches [9]. Later on, Xiang Bai et al (2017) proposed a novel approach of CNN invariant regarded as multi-scale spatial partition network (MSP-Net) which differentiates text images by recognizing presence of text from spatial segments with varying scales of an input image from huge database of natural images. This method was able to obtain high classification accuracy and outperforms all other existing methods. Convolutional neural networks cannot be limited to non-text image only, but also finds its application for text-based image classification technique. Besides supervised learning, CNN's are capable of learning useful feature maps from huge amount of data with no labeling. General, as well as specific, features extracted from CNN can be transferred to universal classification task by exploring the idea of transfer learning. A lot of CNN frameworks were developed from 1998–2018 like LeNet [10], Alex

Net [11], VGG-16 [12], VGG-19 [13], fractal Net Google Net, Inception module given by Google, Skip connections introduced by ResNet like Inception ResNet [14], ResNeXt [15], and some other frameworks like PolyNet [16], DenseNet [17], and SeeNEt [18].

2 Related Work

According to Stemberg and Galvin (March 26, 2020, at 2:38 p.m.), coronavirus deaths in eight countries indicate that the pandemic is approaching a critical point in the United States, where an aggressive and sustained national response could save thousands—perhaps millions—of lives and protect health systems in hard-hit areas from collapse. According to the data, the death toll in the United States is rising and will soon surpass 300 deaths each day. Without a comprehensive response to prevent new infections and care for those who are sick, the United States risks following in the footsteps of other countries, which have seen rising infection rates and rising death rates. Plotting daily deaths across time gives a sense of which policies in other countries were most effective in bending the curve and saving lives.

Aggressive testing, isolation, and quarantine measures in China, for example, began in the third week of January and culminated at a key point in mid-February, when the number of new deaths decreased to around 100, kicking off a sharp decline, according to the analysis. Iran's officials originally downplayed the threat, resulting in a spike in casualties, but the tide looks to have changed about March 22. According to Ramphul et al (2020), multiple people from Wuhan, China, were hospitalized with pneumonia symptoms in December 2019. As a result of the rise in identical symptoms, the causal agent was eventually isolated from samples. It used to be known as the 2019 new coronavirus (2019-nCoV), but it was recently renamed severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and the sickness it causes has been dubbed coronavirus disease 2019. (COVID-19). The virus moved from Wuhan to other Chinese regions during the next several weeks, and after a few months, it was found in 109 nations. There have been 113,702 confirmed cases worldwide as of March 10, 2020, with 4,012 deaths reported. On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a pandemic.

On Sunday night, Donald Trump attempted to deflect mounting criticism of the stalled federal response to the coronavirus crisis by promising that more help was on the way for states facing a critical shortage of medical equipment, hospital beds, and testing facilities, according to Lacombe (Mon 23 Mar 2020 00.26 GMTL). As the death toll from Covid-19 in the United States climbed to 417, with more than 33,000 cases confirmed countrywide, a growing number of state and city leaders issued warnings to the White House that a tipping point was approaching 4,012 deaths.

Pilkington (Friday, March 13th, 2020, 22:37 GMT) The failure of America to provide quick and easy access testing to those suspected of having the coronavirus has been a key focus of criticism regarding the US response to the global pandemic threat, according to the study (last changed on Wed 18 Mar 2020 10.55 GMT). registered.

According to Blumenthal and Seervai (March 10, 2020), Coronavirus is swiftly spreading across the United States and, like earlier big epidemics, is shining a harsh focus on the country's healthcare delivery system's flaws. The first is its limited ability to provide primary care. Many Americans lack access to inexpensive primary care physicians they know and trust, as well as primary care providers who are familiar with them.

Verity et al (20 March 2020) stated that "based on a detailed examination of data from various places around the world, our best estimate for the case fatality ratio of COVID-19 in China at this moment is 138%." Although this value is lower than estimates for other corona viruses such as SARS and Middle East respiratory syndrome (MERS), it is significantly higher than the 2009 H1N1 influenza pandemic estimates.

The study [19] showed that everywhere delay methods were used to improve the economy but that they did not care about the safety of the lives of the people in their countries, as a result of which the virus spread over the world, affecting a total of 2,173,168 people. The total number of new cases is now +86,882, while the total number of deaths worldwide is 144,949. Similarly, the total number of active cases in the world was 1, 481,923, with 546,296 recovered cases. The United States had the most confirmed cases, followed by Spain, Italy, France, Germany, the United Kingdom, China, Iran, and Turkey.

Out of a total of 72 314 case records, 44 672 were classified as confirmed COVID-19 cases (62%; diagnosis based on positive viral nucleic acid test results on throat swab samples), 16 186 as suspected cases (22%; diagnosis based on symptoms and exposures only, no test was performed), and 16 186 as suspected cases (22%). 10 567 clinically diagnosed cases (because testing capacity is insufficient to satisfy present demands). (15%; this label is exclusively used in Hubei Province; no tests were conducted in these cases) However, symptoms, exposures, and the existence of lung imaging characteristics were used to make the diagnosis. 889 as asymptomatic cases (1%; diagnosis by positive coronavirus pneumonia) and 889 as symptomatic cases (1%; diagnosis by positive coronavirus pneumonia). The majority of patients (87%) were between the ages of 30 and 79, with one percent being 9 years old or younger.

3 Proposed Methodology

3.1 Clustering Algorithm for Massive Contact tracing

Contact tracing is a procedure to identify people who came in contact with an infected Covid-19 person. Performing precise massive contact tracing is very important to reduce human to human virus transmission. Early contact tracing can help in saving many precious human lives. Manual contact tracing is a cumbersome solution and consumes a lot of time. This paper comes up with great solution using machine learning clustering algorithm. Various clustering algorithms such as K-means, Mean-shift, BIRCH, DBSCAN, etc., can be used. Among all these mentioned algorithms, DBSCAN is the best solution that can be employed for efficient contact tracing. This algorithm is helpful to find patterns and interconnections between these patterns in data that is cumbersome job compared to manual pattern detection.

3.2 DBSCAN Algorithm and Why it is Best to Use?

DBSCAN is a well-known machine learning clustering algorithm. DBSCAN belongs to density-based clustering algorithm. The covid-19 can be transmitted only when a person comes in contact with the infected persons usually higher chances in dense places. There are higher chances of cases in denser area rather than in less dense areas. So density plays a very important role in contact tracing. DBSCAN is also fast and accurate to get the patterns and associations between these patterns in data than what is done manually. It views clusters as high density areas separated by regions of low density, so clusters formed by DBSCAN can be of any form unlike that of K-means algorithms which forms all the clusters of convex shaped. The density reachability property of DBSCAN algorithm is stated as: "the object p is directly density reachable from object p, if p is core object and q is in p's neighborhood" which is best given by the visualization as in Fig. 8.

In Fig. 8a, there is a direct density reachability from q to p. No direct density reachability from p to q. Thus, there is symmetric density reachability. (b) Direct density reachability from p to p_2 . In Fig. 8b, there is direct density reachability from p_2 to p_1. Direct density reachability from p_1 to q, $p \leftarrow p_2 \leftarrow p_1 \leftarrow q$, there is indirect density reachability from p to q , and q is not density reachable from p.

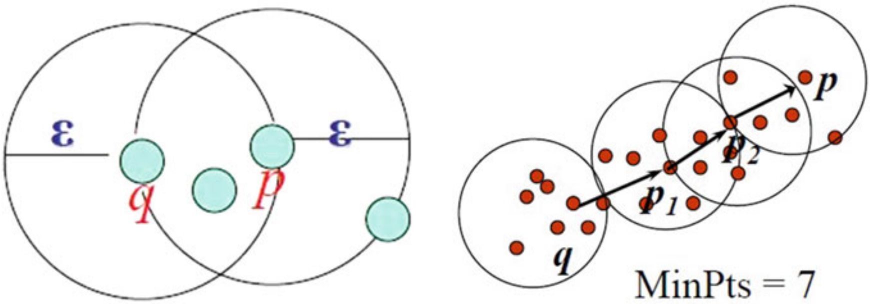


Fig. 8 **a** Density reach ability with MinPts equal to 4 **b** Density reach ability with MinPts equal to 7

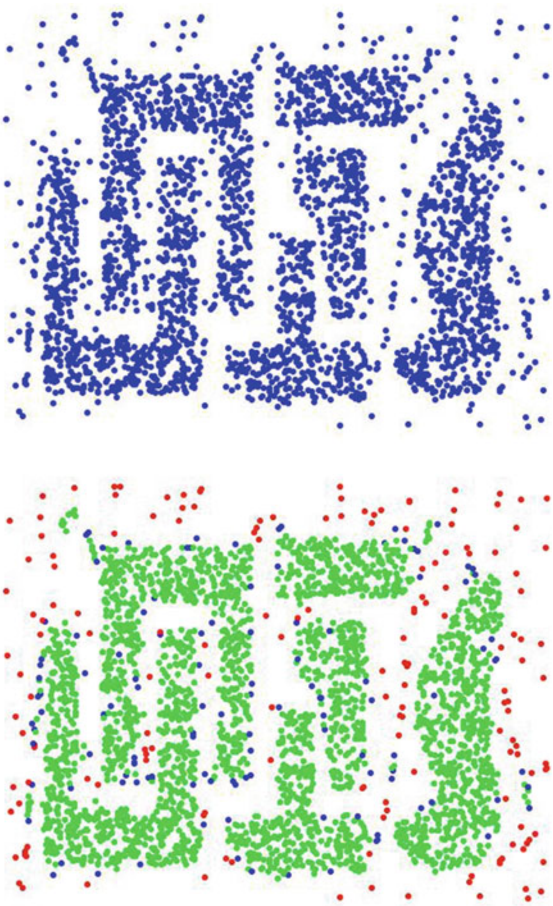


Fig. 9 **a** Original outlier points **b** Original, Core, border, and outlier points

Two parameters are used by DBSCAN algorithm minPts and eps(ϵ). minPts gives the idea of total numbers of points present in cluster together for any region which is considered as dense eps(ϵ). actually the distance metric that is used to find the points in the neighborhood of any point. Based upon these two metrics used by DBSCAN algorithms, it categorizes the data points into three ways such as Core points, Border points, and outliers. A data point is said to be a core point if

$$|Nbhd(p, \epsilon)| \geq \min(Pts).$$

And border point is a point if $|Nbhd(p, \epsilon)| < \min(Pts)$. Outlier is neither a core point nor a border point. The clear view of core, border, and outlier points is depicted in Fig. 9 as:

Algorithm steps for Covid-19 contact tracing is given as:
Step 1: Data collection
Lack of sufficient covid-19 publicly available data, the data generated from accelerometers, that models the behavior of cough and data recorded from digital infrared thermometers such as fever and timestamp recorded for each set of the observation makes the practical implementation of the algorithm not possible this time as the algorithm is in need of real-time covid-19 data. After the real-time data is available, we have to take into consideration two important points, which are: Uniqueness property must be attained as every patient entry must be unique. There must be minimum distance between the two patients and time constrain must meet.
Step 2: Application of DBSCAN algorithm on raw scattered Covid-19 real-time data to predict the possible infections by using all the important parameters of the algorithm.
Step 3: Prediction of Covid-19 infected person. Name of the person can be also used to get the possible contacts or clusters of the infected person. Obtaining all the clusters of infected covid-19 infected person from where he or she belongs. Obtaining possible infected persons within this specific cluster. The name of the person can be simply used to get the contacts of the person, either by social media, its working place data, address mentioned on social networking, fb location analysis.

Algorithm

Input PDB: Population Database
Input r: Radius
Input minPts: Density threshold
Input dist.: Distance function.
Data: label: point labels, initially not defined.
For each point in population database PDB do // iterate over every point in PDB
If label(p)! = undefined then continue // ignore already processed points
Neighborhood $N \leftarrow RANGEQUERY(PDB, dist., p, r)$ // Searching initial neighbors
If $|N| < minPts$ then // non-core points are noise
Label (p) ←Noise
Continue:
$C \leftarrow$ Next cluster label // start a new cluster
Label(p) $\leftarrow C$
Seed set ← N/p // Expand neighborhood
For each q in S do
If Label(q) =Noise then label(q) $\leftarrow C$
If Label(q)! = undefined then continue:
Neighbors $N \leftarrow RANGEQUERY(PDB, dist., q, r)$
Label(q) $\leftarrow C$
If $|N| < minPts$ then continue:
$S \leftarrow SUN$

3.3 Medical Testing-Based Solution (CBC Testing for Early Recognition of Covid-19 Disease

Another solution for early detection of disease is to get CBC test regularly. CBC is very important biochemistry test that helps early recognition of the covid-19 disease and helps in retrieving predictive information as per current research. Current testing strategy RAT and RT-PCR which is based upon nasopharyngeal or throat swab face some critical challenges such as high false-negative and varying turnaround time, making the testing highly unreliable. Current situation requires extensive testing which is limited by advanced RT-PCR infrastructure and long result wait 24 hr duration. To combat accuracy and turnaround time issues in current testing strategies, Feluda was approved by the Drug controller general of India (DCGI) for providing quicker results and without compromising accuracy, a major breakthrough in Covid-19 pandemic. Feluda a world's first test strategy employing Cas9 which makes possibility of reading a covid-19 virus-like barcode and makes a bond with matching pattern of DNA, thus forming a complex. Although upon testing on 2000 people, this is the first test achieving the 96% sensitivity and 98% specificity in comparison with the RT-PCR [19]. Despite of being so much reliable, it cannot make early detection of the Covid-19 virus as compared to CBC. CBC is very helpful in detecting the severity of disease as well. Absence of eosinophils is helpful in early diagnosis of such disease, and similarly low count is related with poor prognosis for the patient. Eosinopenia and its persistence correlated with covid-19 indicates high disease severity and less chance of recovery. Pune employs CBC testing for early detection of disease and were successful in reducing covid-19 transmission rate. The solution is not always feasible due to its expensiveness, as frequent CBC testing becomes expensive, especially for poor families.

3.4 CNN for SARS-CoV Detection Using X-RAY Chest Images

Dataset Description: The proposed model is implemented on the publically available covid-19 database depicted in Fig. 9 from Kaggle [20]. The dataset consists of 5856 x-ray scanned images. These images are labeled as Normal, bacterial pneumonia and viral pneumonia. The dataset is divided into three sets: train set consisting of about 80% of x-ray images, test set consists of 20% of images, and validation set consists of 20% of images. The snap shot of the dataset is given in Fig. 10.

Convolutional networks can be considered as the succession of convolutional layers interleaved by pooling layers and nonlinearity to make transformation of one form of activations received at one end into another form of activations at the other end using loss function. The major components of CNN are convolutional layer, pooling layer, Normalization layer, and fully connected layer which are discussed in detail in [21, 22]. We propose an architecture of CNN for early detection of

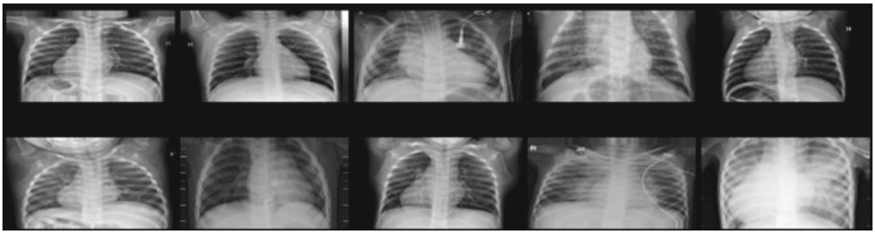


Fig. 10 Dataset snapshot

Covid-19 from CT Scans of Chest or X-ray data if sufficient data is available. The architecture of the proposed model is based upon VGG-19 pre-trained model on image-net database using the concept of transfer learning. Through this transfer learning, the general features are learnt from the database such as edges, corners, and contours. Then the proposed model is modified as per the requirement of covid-19 bilateral pneumonia detection to get the specific features. The proposed model is given as in Fig. 8, which comprises of 6 convo layers, 7 ReLu layers, 2 normalization layers, three max-pooling layers, two fully connected layer, and one soft-max layer. The proposed CNN model automatically extracts infectious features from database images and after processing through entire network performs classification of Covid-19 patients as per severity such as mild pneumonia, severe pneumonia, and non Covid-19 patients. The model uses the concept of transfer learning and learns the generic features from ImageNet database and tuning of hyperparameters were done as per the classification requirement. Once the model was implemented on the chest radiographic images of covid-19 patients, the model performs well and shows an accuracy of 97.35% which is far better than manual accuracy and can help in the early detection of covid-19 diseases. This machine learning approach can help us in early detection and hence can lead to reduction in the fatality and transmission of disease. The architecture of proposed model is given in Fig. 11.

3.5 Implementation Details/Experimental Evaluation

The testing images are classified by the proposed model into two categories, pneumonia class and Normal class as shown in Fig. 12.

After model evaluation, the metrics are shown by the graph in Fig. 13, such as accuracy, validation loss, validation accuracy, loss and lr.

The performance metrics Accuracy, precision, Recall, and F-measure are given in Table 1.

The model shows the highest accuracy rate of 97.35 on covid-19 X-Ray dataset and a precision of 89.5432. These results became only achievable after implementing the concept of data transfer learning and by making utilization of data augmentation.

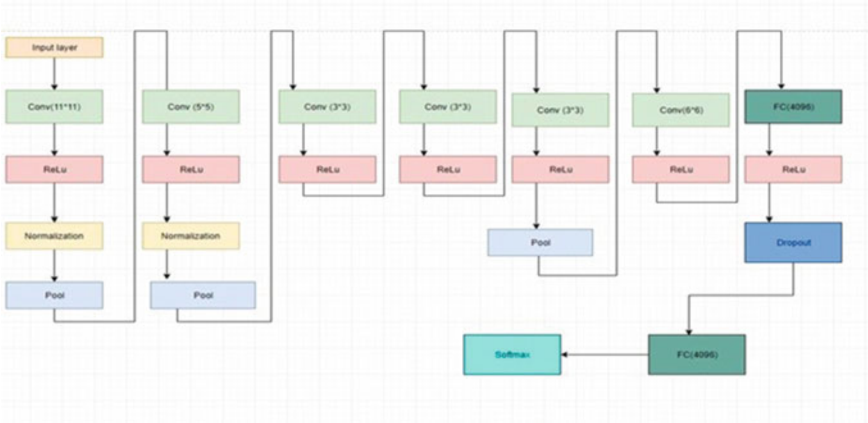


Fig. 11 Proposed model for early detection of covid-19 from CT or X-ray images

3.6 Reduction in Virus Transmission Using Nanocoatings and Nano Sprays

After the outbreak of covid-19, a lot of research was done how to make early detection of disease, to make healthcare system smart, to reduce the load of hospitals, development of medicine, and vaccine. But less attention is given on coating surface which could severely limit the transmission of covid-19. Nanotechnology can provide best solution by developing nanoparticle coatings which can limit the transmission of virus up to greater extent, and simultaneously helps in reduction of chemical usage like hand sanitizer's, fumigating chemicals, etc. These nanocoatings are composed of safe metal ions and their polymers having both antiviral as well as antimicrobial properties. These nanocoatings can be widely used in busy places such as hospitals, schools, colleges, business hubs, and public transportation. The solution will have a greater consequence to fight against this deadly virus which is supposed to stay o surfaces of near about 17 days. These nanocoatings are also very cost-effective as compared to other solutions as we can use a small amount of metal having thinning property can spread to large surfaces. Thus, we can provide an effective antiviral protection on large surfaces by using tiny amount of metal [23–25]. A lot of benefits can be reaped from these nanocoatings as can be used by anyone and can be sprayed on any kind of surface. When the Covid-19 virus comes in contact with this nanoparticle, it gets completely destroyed. So making masks and PPE kits reusable is very important for addressing the problem of inadequacy of such resources in hospitals. Also, copper nanocoating is very cheap and any middle-class person can reap the benefits of this technology in their workplaces and homes.

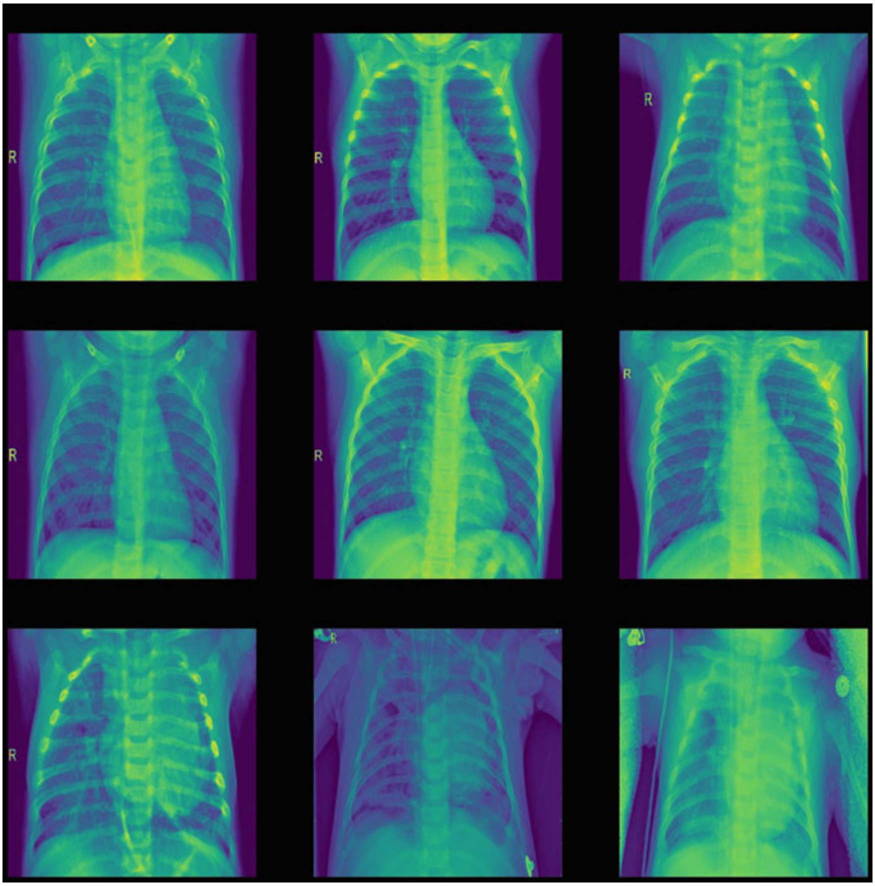


Fig. 12 Classification results

Fig. 13 Model evaluation graph

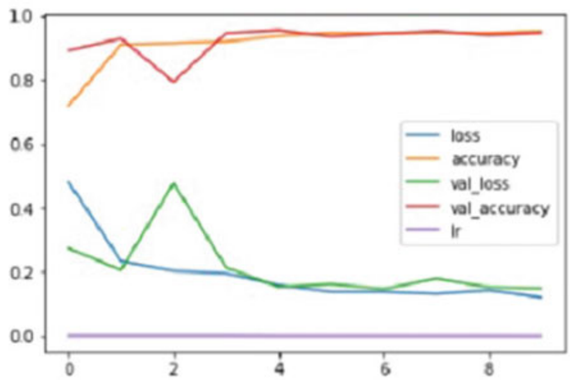


Table 1 Performance metrics table

S.no.	Performance metric	Computed value
1	Accuracy	97.35
2	Precision	89.5432
3	Recall	88.4424
4	F-measure	88.3345

4 Conclusion

Medical science alone is not able to surely bring us the lifesaving solutions such as drugs and vaccines to combat this deadly virus to overcome the threat of this ever more frequent emergency of this deadly disease. In association with medical science, we can also apply some other strategies to cut down the transmission of this virus and make the early detection of infection possible. This paper gives deep insight about various challenges posed by covid-19 and corresponding technological as well as non-technological solutions based on machine learning, nanotechnology, medical testing, to slow down its transmission. CNN is the most appropriate solution, when implemented on X-ray image dataset, does automatic feature extraction to make early detection of disease possible. CNN achieves 97.35% accuracy, outperforming the manual accuracy, making the time-consuming process faster and easier for radiologist and save lives from this life-threatening disease.

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Computational Psychometrics Analysis of Learners' Motivational Level Using Different Parameters

Ashima Bhatnagar and Kavita Mittal

Abstract Learning is an ongoing process irrespective of age, gender, and geographical location of acquiring new understanding, knowledge, behaviours, skills, values, attitudes, and preferences. Formative assessment methods have emerged and evolved to integrate elements from learning, evaluation, and education models. Not only is it critical to understand a learner's skills and how to improve and enhance them, but we also need to consider where the learner is going; we need to consider navigational patterns. The extended learning and assessment system, a paradigm for doing research, captures this entire view of learning and evaluation systems. The function of computational psychometrics in facilitating the translation from raw data to concepts is central to this paradigm. In this research study, several factors are considered for psychometric analysis of different kinds of learners, and based on a motivational level, many interesting conclusions have been drawn and presented in the result section at the end of the paper.

Keywords Computational · Psychometrics · Learning system · Evaluation system · Skills

1 Introduction

Many aspects of classrooms or learning across the country would be known to our forefathers and mothers: in classroom learning, a teacher speaking to pupils seated in rows of neatly arranged desks; the instructor instructing from a planned lesson, and the learners carefully listening. Since the beginning of the previous century, this conventional learning system has remained virtually unchanged [1]. Learners

A. Bhatnagar (✉)
JaganNath University, Haryana, India
e-mail: ashimabbhatia01@gmail.com

K. Mittal
Department of Computer Science, JaganNath University, Haryana, India

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are divided into classes, grades, and schools, among other hierarchical aggregations. Learners' education is thus predominantly catered to these groups as a one-size-fits-all encounter rather than a personalized and adaptable experience [2]. "The future is already here, it's not very fairly spread," stated science-fiction novelist William Gibson (Rosenberg, 1992). Gibson mainly refers to the idea that development is merely the expansion of what is unique to something universal and egalitarian in his comment [3].

This may be stated of the current status of learning and evaluation systems. Recent advancements in computing technology have provided us with the means to actualize many previously unrealized inventive ideas [4]. Many of these ground-breaking concepts come from the fields of education, learning, and evaluation. Computation psychology (Von Davier, 2015), [5] is a new science that lies at the crossroads of several fields. Computational psychometrics is a term that refers to a combination of machine learning algorithms (ML) analytical methods with cutting-edge theoretical psychometric research [6]. Learners' personality assessment researchers have been able to include these methods into the computational psychological assessment model because of advancements in machine learning and big analytics. The algorithmic psychological approach is currently being used in a variety of monitoring and assessment related studies, including cooperative problem-solving skills (Polyak et al., 2017), the impact of interpersonal communications on mutuality in economic decisions (Cipresso et al., 2015), and having to learn as we define here [7, 8], using different parameters. Computational psychometrics investigates not just new models for new data types, such as complicated process data, and how such models may be used to integrate or connect various aspects of teaching, learning, and evaluation [5].

In the stages of learning or studying new skills or extending one's talents, learning and assessment are inextricably interwoven [9]. While education and learning are the processes through which a person acquires information or abilities, assessment is a method of observing a learner's performance and producing data to conclude what the learner has learned [10]. Effective assessment helps to learn by giving evidence (1) of learners attaining learning goals, (2) to inform teachers' decisions, and (3) to guide future instructions, to name a few examples (Suskie, 2018). The learning system and the evaluation system may have fully autonomous relationships or be tightly related and linked in a feedback loop in which one system feeds information to the other [11–13]. The Learning and Assessment System is the name given to this combined learning and assessment system (LAS) [14, 15].

2 Model Used

This research analyzes various parameters like age, gender, and geographical area which is also represented by the different states where a person's blog has been used to calculate the motivational level of learners' while learning. The block diagram

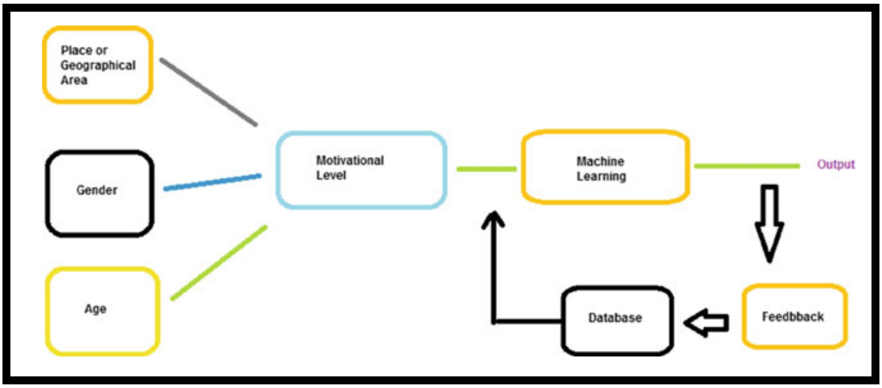

Fig. 1 Block diagram of the methodology used

of the model used to calculate the motivational level is shown in Fig. 1. Detailed primary data has been collected based on the questions given below, and after considering them, a motivational level is calculated [16–21]. This motivational level further with the help of deep learning is realized as output by considering the effect of all mentioned parameters [22–24]. The result obtained at the output is then fed and stored in the database to increase the accuracy of the machine.

3 Methodology

Following the collection of more than 500 samples, a list of various questions used to gather primary data is provided. A motivational level is calculated based on the data collected from the learners after the various replies in the ranges of Strongly Agree (5), Agree (4), Neutral (3), Disagree (2), and Strongly disagree (1) are scored.

4 Outcomes Based on Different Parameters

Outcomes were received on different parameters such as gender, age, and geographical location of learners on the bases of questions mentioned in Table 1. A total of 500+ replies were received; these were further classified based on the various criteria described above, and the results are displayed in Table 2.

Different types of charts are mentioned below on the bases of Table 2 data received. Various results after analysis are represented in the form of a Pie Chart in Fig. 2

Table 1 Questioners used to collect data

Questions	Description
1.1 Always feel motivated during learning	Learners' feel motivated and positive when they are learning
1.2 Always spend maximum time learning	Learners' spend more time learning if topics are interesting
1.3 Can spend time for learning instead of a hectic schedule	Learners' spend more time learning if topics are interesting even if they are busy
1.4 Must spend time for learning instead of physical stress	Learners' spend more time learning if topics are interesting even if they are tired
1.5 Must spend time for learning instead of emotional stress	Learners' spend more time learning if topics are interesting even if they are mentally disturbed
1.6 Always feel motivated in learning after praying or worshipping	Learners' feel motivated after praying or worship in learning if the topic is interesting and they concentrate more on learning

Table 2 Different parameters and their responses

S. no	Parameters	Responses received
1	Motivational level in learners'	527
2	Motivational level in females learners'	232
3	Motivational level in males learners'	295
4	Motivational level in Delhi & NCR learners'	356
5	Motivational level in Outside Delhi learners'	171
6	Motivational level in learners' (Age <= 18 Years)	108
7	Motivational level in learners' (Age between 19 and 22 Years)	239
8	Motivational level in learners' (Age between 23 and 30 Years)	66
9	Motivational level in learners' (Age between 31 and 40 Years)	60
10	Motivational level in learners' (Age greater than 41 Years)	54

Inference from Fig. 2: Almost 58% of learners agree that, while learning they feel motivated. Whereas 28% of learners are neutral, they may or may not be motivated while learning. It is almost 1/2 of the agreed percentage. And almost 14% of learners disagree that they are not motivated or feel positive while learning. It is almost 1/4 of the agreed percentage (Figs. 3, 4, 5, 6 and 7).

Inference from Figs. 3 to 8: In the Age-wise Pie charts, at the early age of learning motivational level is almost 56% of learners agree, 29% are neutral and 15% disagree. But as learners grow and gain experience, the agree-on percentage increases by 8%, i.e., 64%, the neutral percentage is the same, i.e., 28%, and disagree percentage decreases by half, i.e., 8%. Figure 8 is a bar chart representing age wise values.

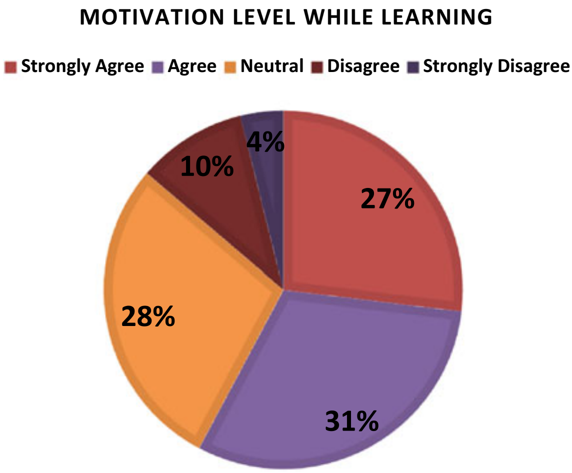

Fig. 2 Pie chart representation for calculating motivational level while learning

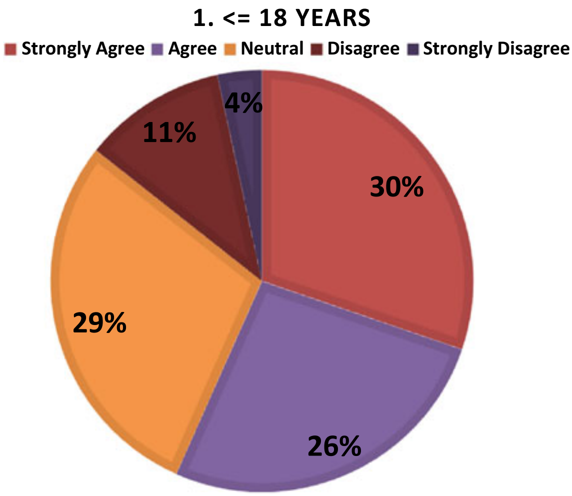

Fig. 3 Pie chart representation for calculating motivational level while learning (Age < =18 Years)

Inference from Figs. 9 and 10: In the geographical area wise Pie charts, the motivational level is 2% more outside Delhi and NCR, i.e., 59%, as compared to Delhi and NCR, i.e., 57%. Disagree percentage is exactly the same, i.e., 14%. But the neutral percentage is 2% more in Delhi and NCR than outside. Figure 11 is a bar chart representing age wise values.

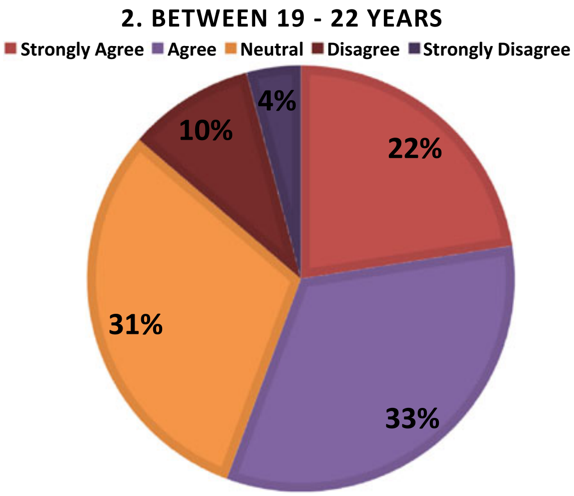

Fig. 4 Pie chart representation for calculating motivational level while learning (Age between 19 to 22 Years)

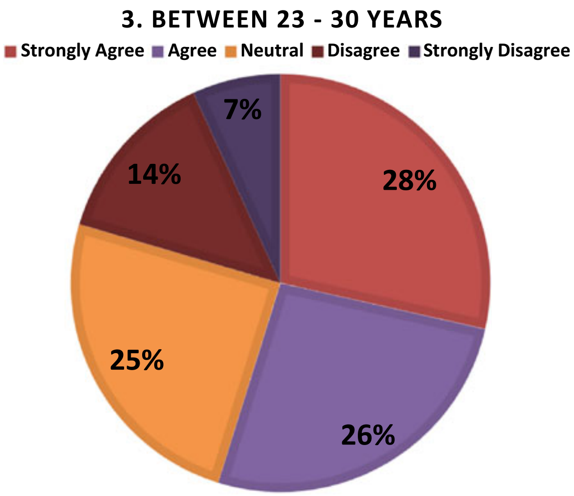

Fig. 5 Pie chart representation for calculating motivational level while learning (Age between 23 to 30 Years)

Inference from Fig. 11: The motivational level is also considered based on the region. The line plot is created from the determination of motivational level using geographic location. Agree percentage is 4 times more than disagree percentage irrespective of the area.

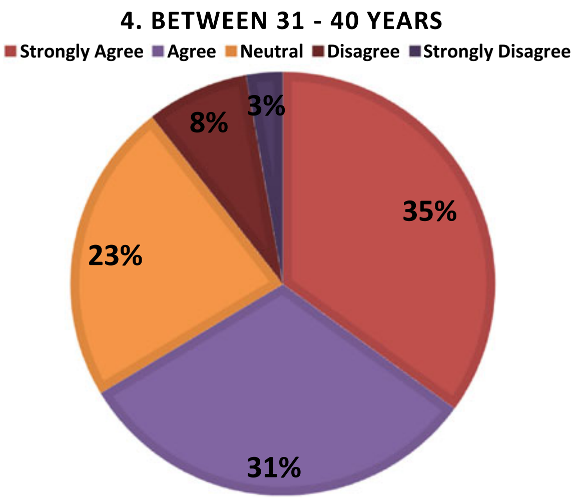

Fig. 6 Pie chart representation for calculating motivational level while learning (Age between 31 to 40 Years)

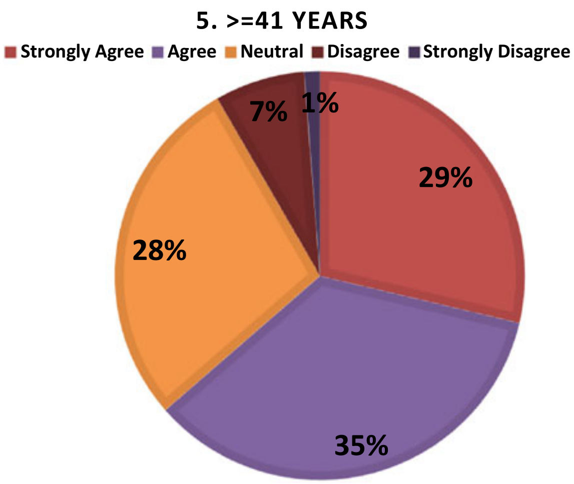

Fig. 7 Pie chart representation for calculating motivational level while learning (Age greater than 41 Years)

Inference from Figs. 12 and 13: In the gender wise Pie charts, the motivational level is 4% more in females, i.e., 60%, as compared to males, i.e., 56%. Disagree percentage is 1% less in females as compared to males. But the neutral percentage is 3% more in males than females.

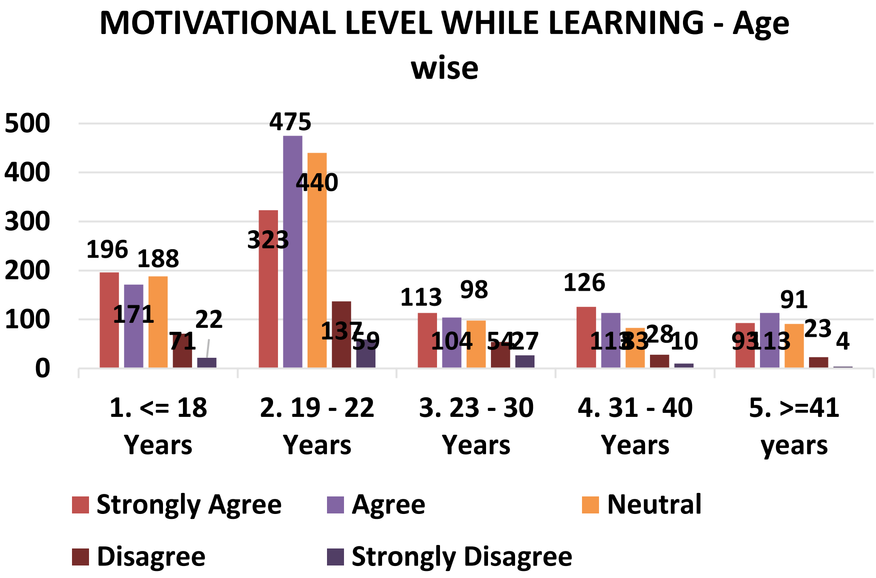

Fig. 8 Motivational level while learning considering different age groups

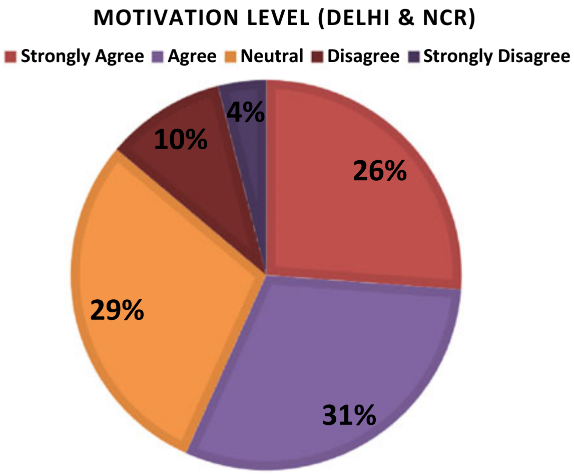

Fig. 9 Pie chart representation for calculating motivational level while learning (Delhi and NCR)

Inference from Figs. 14 and 15: The motivational level is also considered based on the bases of gender wise. From the calculation of motivational level in males and females, the line plot is drawn shown in Fig. 14 and bar chart in Fig. 15. Agree percentage is 4 times more than disagree percentage irrespective of the genders.

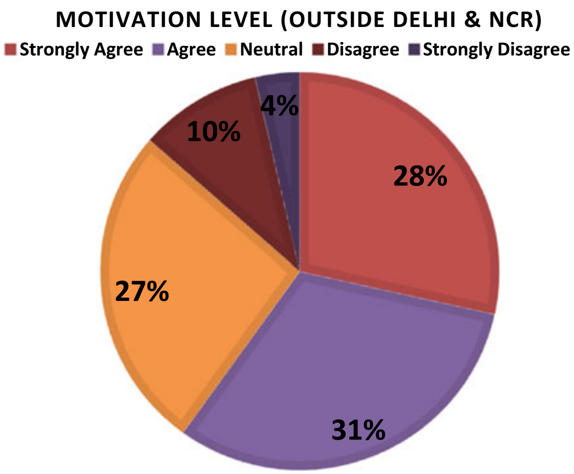

Fig. 10 Pie chart representation for calculating motivational level while learning (Outside Delhi and NCR)

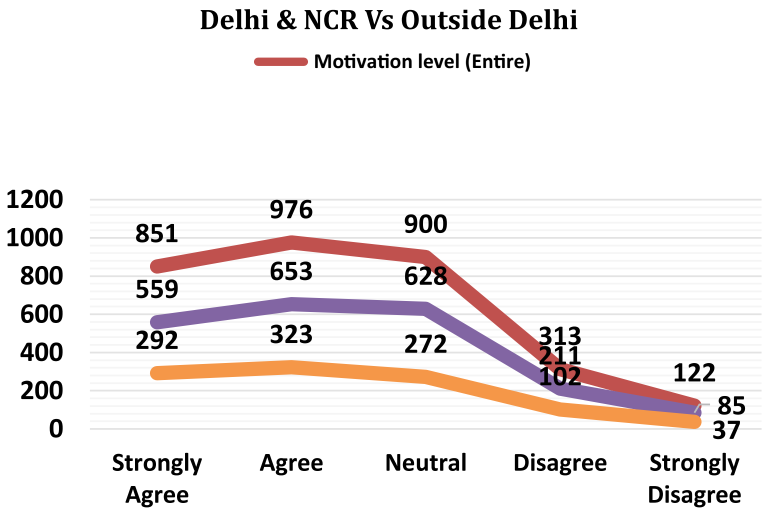

Fig. 11 Motivational level calculation considering the geographical region

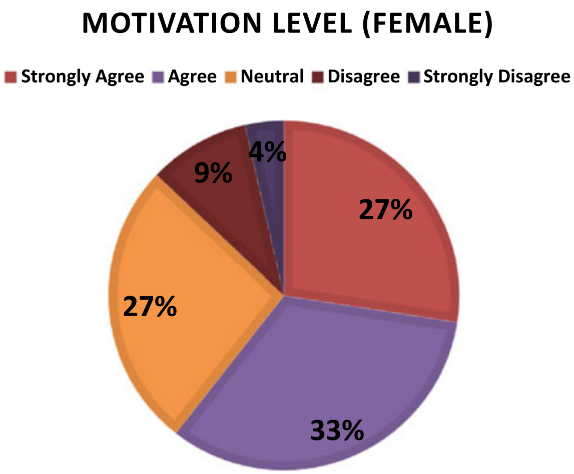

Fig. 12 Pie chart representation for calculating motivational level while learning (Female)

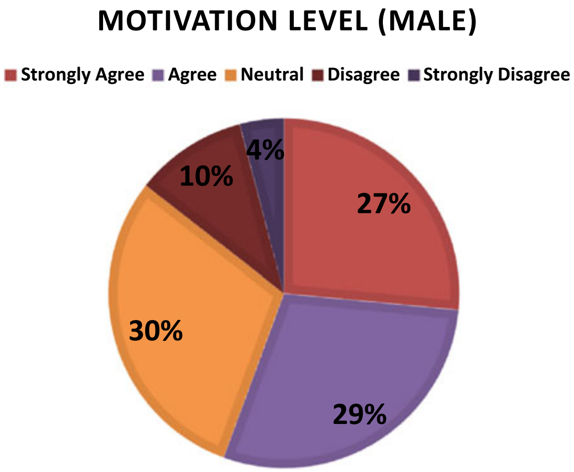

Fig. 13 Pie chart representation for calculating motivational level while learning (Male)

5 Ml Modelling

Machine learning is an area of AI technology (AI) and computer programming that concentrates on using sophisticated algorithms to mimic the way humans learn and to steadily improve accuracy.

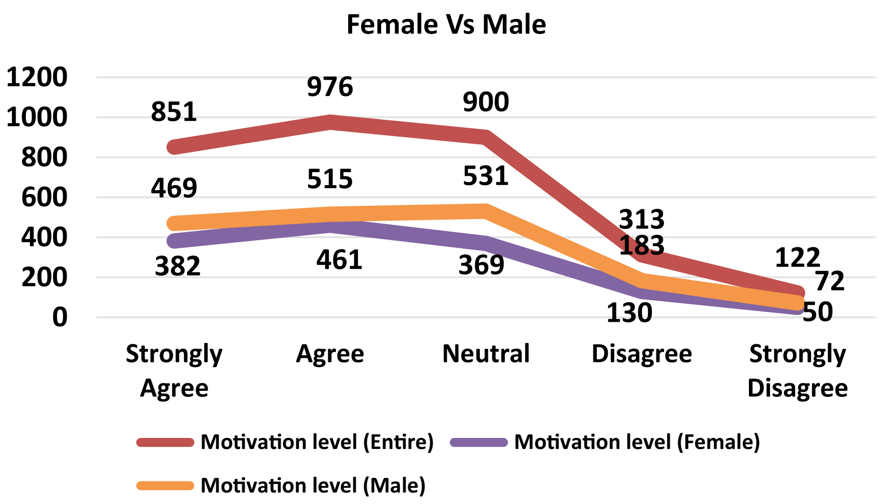

Fig. 14 Motivational level calculation considering gender wise line chart

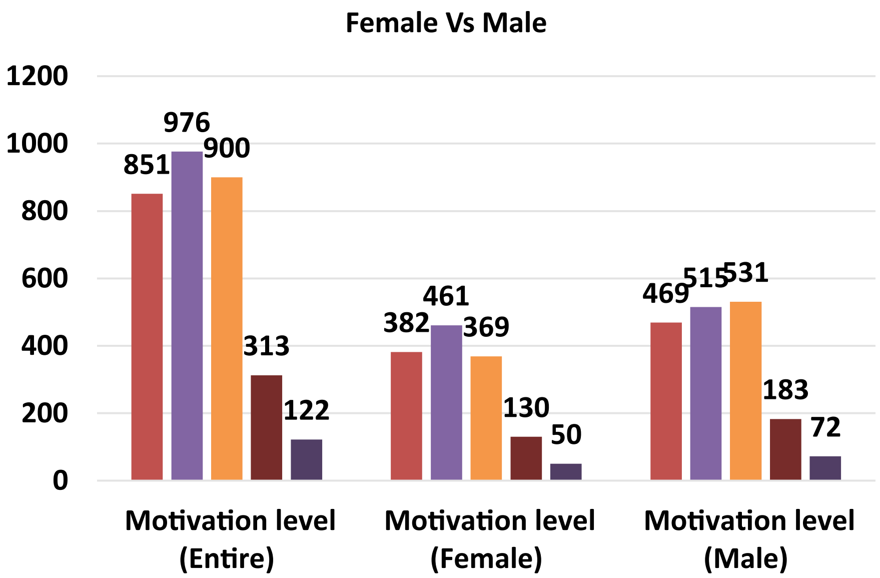

Fig. 15 Motivational level calculation considering gender wise bar chart

```
%%writefile config.yaml
input_features:
    -
        name: Learner's Age
        type: numerical
    -
        name: Learner's Educational Status
        type: numerical
    -
        name: Learner's Gender
        type: numerical
    -
        name: Learner's State
        type: numerical
    -
        name: Learning Experiences
        type: numerical
    -
        name: Learner's Highest Education / Learning State
        type: numerical

output_features:
    -
        name: Motivation Level
        type: numerical
```

Various headers in the dataset along with the questions are obtained by using df. Column as shown below. A two-dimensional tabulated data format called a Pandas DataFrame has marked axes and may contain heterogeneous data.

```
df.columns
```

```
Index(['Timestamp', 'Email Address', 'Learner's Age',
       'Learner's Educational Status', 'Learner's Gender', 'Learner's State',
       'Learning Experiences', 'Learner's Highest Education / Learning State',
       '1.1 Always feel motivated during learning',
       '1.2 Always spend maximum time for learning',
       '1.3 Can spend time for learning instead of hectic schedule',
       '1.4 Must spend time for learning instead of physical stress',
       '1.5 Must spend time for learning instead of emotional stress',
       '1.6 Always feel motivated in learning after praying or worshiping '],
      dtype='object')
```

```
y_columns = ['1.1 Always feel motivated during learning',
       '1.2 Always spend maximum time for learning',
       '1.3 Can spend time for learning instead of hectic schedule',
       '1.4 Must spend time for learning instead of physical stress',
       '1.5 Must spend time for learning instead of emotional stress',
       '1.6 Always feel motivated in learning after praying or worshiping ']
```

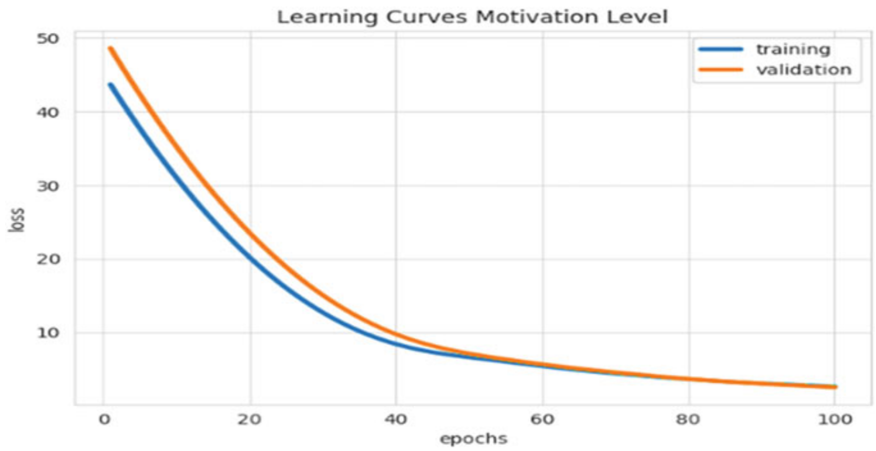

Fig. 16 Loss with Number of epochs learning curve

6 Ludwig Classifier

Deep learning models have shown to be extremely effective in a wide range of machine learning tasks in vision, voice, and language over the previous decade. Ludwig is unusual in its capacity to assist non-experts to grasp deep learning while also enabling faster model improvement iteration cycles for professional machine learning developers and researchers. Experts and researchers may use Ludwig to simplify the prototype process and speed data processing, allowing them to focus on designing deep learning systems rather than data wrangling. The following learning curve for calculating motivational level is obtained for 100 number of epochs and it is found that the loss is decreasing, and in other words, the accuracy of the machine goes on increasing as shown in Figs. 16 and 17.

7 Conclusion and Future Scope

Motivational level while learning is measured using different parameters, such as gender, age, and geographical location of learners. Motivational level in females is more as compared to males, similarly motivational level while learning depends on age, such as at the early age motivational level is high as we are in earning age, it slightly decreases but again increases as we grow older. Similarly, motivational level outside Delhi and NCR is high as compared within Delhi and NCR. Thorough holistic learning and evaluation system in this study, as well as how the computational psychometrics paradigm incorporates all of these complicated components. The motivational level is based on the premise that developing learning, evaluation,

```
Epoch 100
Training: 100% 3/3 [00:00<00:00, 337.45it/s]
Evaluation train: 100% 3/3 [00:00<00:00, 868.75it/s]
Evaluation vali : 100% 1/1 [00:00<00:00, 973.83it/s]
Evaluation test : 100% 1/1 [00:00<00:00, 872.18it/s]
Took 0.4488s
```

Motivation Level	loss	error	mean_squared_error	mean_absolute_error
train	2.6789	0.1412	2.6789	1.2556
vali	2.5668	0.5090	2.5668	1.3606
test	2.8140	0.2091	2.8140	1.2911

combined	loss
train	2.6789
vali	2.5668
test	2.8140

```
Validation loss on combined improved, model saved

Best validation model epoch: 100
Best validation model loss on validation set combined: 2.5668182373046875
Best validation model loss on test set combined: 2.814007520675659

Finished: experiment_run
Saved to: results/experiment_run
Evaluation: 100% 1/1 [00:00<00:00, 685.01it/s]
```

Fig. 17 Result obtained using deep learning

and navigation together will improve learners' chances of having a successful and complete educational and learning experience.

The motivational level is calculated using the deep learning model Ludwig Classifier and obtained over 100 epochs. It is discovered that the loss is reducing, or put another way, the machine's accuracy keeps improving. Each of the categories discussed here has new capabilities, or at the very least expansions of current ones.

Several papers are being studied at the same time that provides the details of these techniques and their assessments. While great progress has been made in the research and innovation of integrated monitoring and assessment systems, additional effort is required to refine the approaches, regularly assess them for fairness, efficacy, and validity, and scale them up. The objective is to be able to give quality educational materials and comments to all learners, regardless of ethnicity or geographic location.

Upcoming research will include computational psychometrics analysis on satisfaction level, stress level, etc., of learners. The creation of new forms of flexible study diagnosis models that are suited for learning, as well as the use of artificial intelligence (AI), machine learning, and multimodal analytic techniques to improve these psychometric models.

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Brain Tumor Segmentation

Yatender, Rahul Kumar, Jitesh, and Deepti Sahu

Abstract DIP for Medicinal examination is considered as a vital topic for artificial intelligent system. We are introducing a hybrid technique combining K-means and Fuzzy C-means clustering algorithms for determining whether a brain MR Imaging scan consists tumor or not. As K-means is a hard clustering algorithm so it is used for initial segmentation via appropriate selection of the image. And after that FCM is used to provide membership to each centroid through the distance between the cluster centroid and cluster data point, prior to obtaining best result. This distance relies upon various factors, i.e., contrast, saturation, structure, brightness, and homogeneity of the image. Based upon the provided memberships by FCM technique and automated cluster selection a sharp segmented image is obtained. This modified hybrid (hard and soft clustering) approach reduces equipment and operator error. The outcome unveils that such an approach is remarkably encouraging.

Keywords Fuzzy C-means (FCM) · Medical resonance imaging (MR imaging) · Digital Image Processing (DIP)

Yatender · R. Kumar (✉) · Jitesh · D. Sahu
Department of Computer Science and Engineering Technology, Sharda University, Greater Noida, Uttar Pradesh, India
e-mail: 2018005024.rahul@ug.sharda.ac.in

Yatender
e-mail: 2018009735.yatender@ug.sharda.ac.in

Jitesh
e-mail: 2018014918.jitesh@ug.sharda.ac.in

D. Sahu
e-mail: deepti.sahu@sharda.ac.in

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1 Introduction

Aneurysms, subdural hematomas, ischemia—these are just some of the brain injuries that can cause seizures. A more uncommon but still serious type is called brain tumor. These tumors originate in parts of your brain where thoughts are formed that control your sense of sight, touch, sound, heat, smoke that help you understand speech. There are many types of tumors, but tumors at this level cause seizures, nausea, and vomiting, difficulty with visual perception and speech comprehension. Tumor is the result of abnormal growth and cellular proliferation in the brain. If it is not identified earlier and correctly, it may lead to some serious consequences or ultimately death.

MR Images are accepted broadly to diagnose brain tumors. Therefore, improvements to tumor detection and prediction-based systems based on MRI data are needed. But in the early stages of diagnostic imaging such as MR Imaging, appropriate identification of tumor cells and the fragmentation of neighboring soft tissues is a challenging chore that could be due to the existence of low light in thought patterns or maybe complexity and abnormalities, active size and unexpected areas of the lesion.

The detection of autoimmune malformations in the diagnosis of the head tumor on MR Imaging is significant because it comes up with information regarding unusual tissue needed for planning and treatment. Research in recent publications has also reported that automated computer-assisted diagnosis and diagnosis based upon medical image assessment, could be an effective substitute as this could save a radiologist's time and regain established precision. In addition, if computed algorithms can provide robust, multidimensional tumor estimation, this automatizes the capacities which will be of great assistance in clinical administration of tumors by setting physicians free from burden of tumor exposure.

Segmentation of flat or bidimensional images under the binary partitioning approach is possible by thresholding. But by cause of the complicated structure, it is impossible to achieve a proper and unbiased threshold. Also, the limitations which come up with thresholding are that it can't be associated with colored or multi-channel images, and its very much noise sensitive (noise makes thresholding value biased). For improved and unbiased thresholding values we used restrictions like Classifiers and Clustering Methods (soft and hard clustering). Using some predefined image-related criteria (like intensity and other details) we extract homogenous patches in the region growing. Although a manual interaction is needed for finding seed pixels which comes out to be the primary limitation for it and when these seed pixels come together with their neighbors and associate refers to region growing. Scarcity of training data while using classifiers will result in over consumption of time and unexpected results. While using FCM it will firstly segment the image, then an expert system will locate lesions by matching them to the previous learnings. Traditional FCM is sensitive to noise. However, K-means is affectless of noise, but it needs perfect thresholding that's a bit difficult to attain.

On the basis of foregoing exploration, it can be considered that keeping down the limitations of each mechanism could give optimum results [19].

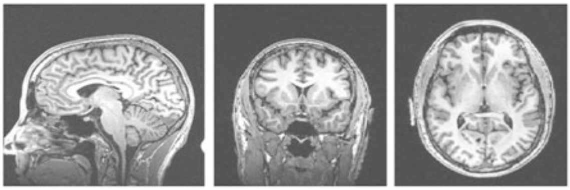

Fig. 1 Brain MR images captured from different angles, i.e., Sagittal view, Coronal view, Axial view, respectively

Within this paper, we are putting forward a contrasting hybrid technique consisting of FCM and K-means approach. It minimizes the issue of noise sensitivity associated with FCM and gray level selection. Included pixel intensity is very low as we used intensity-based pixel positioning approach in K-means clustering implementation. Updated membership (based on various image features i.e., contrast, intensity, etc.) and filtered image's cluster numbers are the basis for FCM algorithm modification.

Throughout this project we are using the Brain MR images with Axial view just because it's symmetric gives visuals of whole brain at once (see Fig. 1).

2 Related Works

Segmentation or breakdown of a medical image to identify brain tumor by any medical imaging technique is a very important practice for determining appropriate treatment in a timely manner [3]. Many brain tumor segmentation techniques in MR images have been suggested, in particular, Support Vector Machine (SVM), Fuzzy C-means (incomprehensible integration techniques) (FCM), artificial intelligence, Computational Neural networks, knowledge-established techniques, and the Expectation Enhancing process of algorithm which is highly used technique used for region-based classification as well as extracting important information from medicinal images [1].

Raghavan et al. (2015) [11] designed an approach based upon neural network using various classifiers for classification and segmentation of White Matter, Cerebrospinal Fluid, and Gray matter, and tumor affected regions and claim to acquire 83% accuracy.

Zanaty [24] developed a hybrid approach for tumor segmentation combining FCM, Jaccard similarity coefficient, and seed region growing algorithm for segmentation measurement of white and gray matter from test MR images. We also tried this approach of using hybrid algorithm but with different algorithms to get maximum accuracy. This technique obtained more than 85% score in segmentation at reasonable noise levels.

Gopal and Karnan [12] used some clustering algorithms for the brain tumor classification. Even after using Genetic Algorithm as the Optimization tool for improved results this approach achieved approximately 75% accuracy with minimal error values (neighboring values to zero).

Deng et al. [16] proposed a method of discriminative clustering and approach of future selection for automated brain tissue segmentation using MR images of brain.

Mahmoud et al. [24] proposed an automatic tumor region identification technique via MR images. The classification has been done on the basis of the type of tumor, whether the tumor is benign or malignant. Computational Neural Network techniques were used for these classifications, segmentation, and feature extraction. In the end, region interest techniques were taken for tumor localization.

Koley and Majumder [15] implemented CSM (Cohesion Based Self Merging) algorithm for locating the tumor's exact region. CSM algorithm was used because its computationally less complex and also for satisfactory results as compared to hybrid merged processes [20].

Colliot et al. [2] chose 3D MR images for segmentation. Their approach can be used on various kinds of tumors. In beginning, segmentation was done using the proposed approach. Then lesion selection has been done through FCM classification.

Lin et al. [17] proposed a hybrid approach of watershed algorithm minimizing unnecessary excessive segmentation. Furthermore, improvement is done via collaborating another algorithm with the watershed to enhance segmentation quality. Performance assessment of the suggested method is done on the grounds of image quality and qualitative validation.

The survey of the above texts has revealed that some strategies are developed to obtain only classification; some strategies are developed to detect the extraction factor and some strategies are developed to obtain the segmentation only. Vector Reduction and Feature extraction for the functional segmentation of CSF, GM, WM, infected brain region, and integrated method analysis were not performed in any of the available literary works [24]. In addition, only a few capabilities have been hauled out and therefore precision obtained in plant recognition is quite low. Also, all of the above literature missed dice similarity index (calculation of overlapping), which is a significant indicator for the precision of a brain tumor classification algorithm.

In earlier brain tumor-related studies, algorithms have used classic and standard methods like edge detection and region growing techniques for image processing. In recent years, segmentation and classification became possible through learning via supervised and unsupervised techniques for instance k-means, Support vector-machine (SVM), ANN, and for latter Fuzzy C-means (FCM) [14].

In this study, we proposed a hybrid algorithm strategy combining two algorithms: Fuzzy C-Means (FCM) and K-means (well tested by us through various studies). The aim of this research is to draw out information by segmenting images consisting tumors and to identify the tainted tissues by comparing test images with a huge dataset of resonated images. Outcomes of our research results in the belief that the preferred approach should combine clinical decision-making systems for primary diagnosis, analysis done by clinical specialists or radiologists.

3 MR Image Segmentation Techniques

3.1 Region Growing

This technique initiates with a point called seed pixel and grows the region by adding the pixels neighboring to it based on a specific threshold value. When the growth of a region stops, another seed pixel that does not belong to any other region is chosen and the process is repeated until all pixels belong to some region. Some major issues related to this method are Noise sensitivity, and occasionally manual interaction is required for seed pixel selection [21].

3.2 K-Means

It is the most important clustering and the simplest unsupervised learning algorithm. In this algorithm "K" centers are defined around which clusters will be formed. Then take the neighboring point and making it an accomplice to the nearest centroid and repeat this till every point isn't connected to some center. The sole purpose of this process is to lessen the sum of distances amidst the data point and their clusters they are akin to [18].

3.3 Fuzzy C-Means (FCM)

This gives the fuzzy values of any specific data point to be present in either of the clusters. In this method, we need to find the centroid of the data points and then measure the distance for every data point from the given centroid until the clusters formed become constant.

3.4 Support Vector Machine (SVM)

SVM algorithm lies under the umbrella of Supervised Learning algorithms. The sole intent of this method is to classify the decision boundaries, segregating the data points within appropriate groups. It selects the most extreme places to aid in the formation of these boundaries.

3.5 Artificial Neural Network (ANN)

Initially, an image is plotted onto a Neural Network [7]. Here each Neuron stands for some pixel. The Neural Network will be trained with a training sample set in contemplation to regulate the connection and weights among the nodes [18].

3.6 Hybrid Techniques

This literature describes a number of hybrid ways for analyzing magnetic resonance brain images. Zanaty [24] used a hybrid strategy for tumor segmentation that combines FCM and the Jaccard similarity coefficient, which worked well and scored about 85 percent in segmentation [15].

4 Proposed Model

See Fig. 2.

5 Proposed Method

Within this paper, we used multiple techniques to come up with the optimal result within the least time. Every step of this process is carried out via different techniques—those techniques are referenced below:

A. Gray scaling the test image: To get better differentiation of lesion across the whole image we use this technique, otherwise, if we skip this lay then we need to use CNN or Deep Learning [10].
B. Preprocessing: The main task of pre-processing is to improve the appearance of test images and to craft them for extended administration by a human or machine visual system. Furthermore, advanced processing assists in image spectrums improvement such as signal to noise ratio, removing unnecessary noise, appearance, and unwanted overlapping background parts, and maintaining its edges [8].
C. Using Center Crop augmentation: Crops are used to obtain better segmentation results. Built with an image size of (96 * 96) from a 189 * 233 database. This database will be generated as an original image patch by cropping the image from the center in size 96 * 96. This procedure is used to remove hippocampus pieces as well as sideways tumors near the skullcap.
D. Image Segmentation: Segmentation is used to find the boundaries and objects in the images [4]. Within the First Division, the pre-processed brain plotting

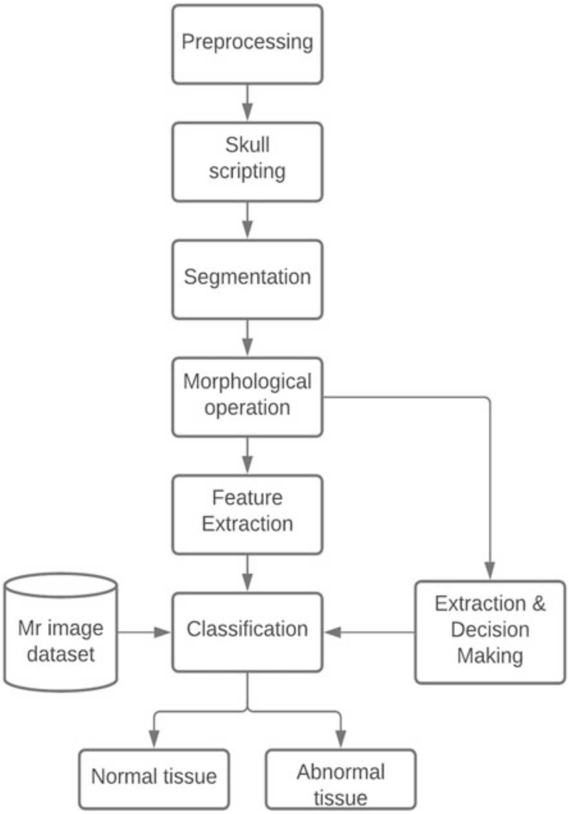

Fig. 2 Steps used in the proposed method

is transformed into a binary plotting with a threshold value of 128. All the pixel values more than the threshold are plotted white, and remaining pixels are marked black; as a result of these two values, separate regions are formed around the tainted tissue region. Then in interest of wiping out the white pixel, the morphology erosion function is performed [13]. At last, the operated zone and the first image are both separated into two equal sections and the area of the dark pixel drawn by the erode function is conceived as the Magnetic Resonance image's mask of the brain [5].

The K-Means Clustering Technique is used to carry out the segmentation procedure. It defines 'K' centers, one for each cluster. These groups must be separated by a large distance. The next stage is to associate a point from a specific data collection with the nearby center. When there are no unsettled points, the first step is over, and early grouping begins. The second step is to recalculate 'k' new centroids as the barycenter of the clusters created in the first phase. In the subsequent addition of 'K' new centroids, a new binding amidst the identical data set points and the nearest new center is required. There has been created a loop. As a result of this loop, the k centers gradually shift their locations until they no longer move [5].

FCM (Fuzzy C-means)—Based upon distance among data points and the cluster center, this method awards membership to individual data points referring to each cluster center. Datapoint closest to the cluster center has a higher percentage of members who belong to that center [23].

E. Lesion Detection/Features Extraction: Brain damage is a defect seen within brain test images, such as Computed Tomography (CT) or Magnetic Resonance Images (MRI). Feature Extraction helps locating brain tumors and assists in predicting their next stage [9]. Feature extraction falls under the dimensionality reduction process, within which, the first set of raw data is split and shortened to various untroublesome groups. So, its processing becomes much easier. Having a wide range of variables is a vital characteristic of these large datasets. Large computing resources are required to process these variables. Therefore, feature extraction helps in obtaining the finest features from big datasets by selecting and integrating variables into features, thus, effectively lowering the amount of data [22]. When the primary analysis and the desired degree of classification (line, word, character, or symbol) have been achieved, another feature removal method is used in components to determine the features, post-processing techniques, and followed classifications. It is imperative to emphasize the exclusion factor as it has a significant impact on the competence of the recognition system. Taking all mentioned factors into account, it's necessary to consider the numerous techniques available to extract features in a given domain, which consist of greater litigation chances. Feature extraction in this paper is achieved by using

- Thresholding
- Contrast: Foreground and Background.

6 Conclusion

In this proposed work various medical images like brain MR tumors and cancer images are taken for detecting the tumor. The proposed approach utilizes a mixture of various different machine learning techniques and consists of several steps including training the system, pre-processing, segmentation, classification, and feature extraction. For achieving the optimum results, we tried minimizing the limitations of each technique used. Initially K-Means algorithm is used for segmentation via appropriate selection. Implementing the K-means clustering through Intensity-based Pixel Positioning to not avoid even least amount of pixel intensity. Minimizing the noise sensitivity associated with image for FCM algorithm. Updated membership is attained by distance measurement between cluster and centroid. This measurement/membership distribution is done till optimal results are achieved. Accuracy and other results show that this approach is better than other various hybrid approaches used previously. Additionally, classifier boosting techniques can be employed to improve accuracy even further and reach a degree that allows the tools in becoming an indispensable asset in any neurological institution that deals with brain tumors.

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Analysis and Evaluation of Security and Privacy Threats in High Speed Communication Network

Pravir Chitre and Srinivasan Sriramulu

Abstract 5G technology is at the doorstep with the process of implementation going on as per "The European 5G Annual Journal/2021". The 5G Network implementation is based upon the new technologies and with the new technologies even the old security issues become more and more important. With increase of data communication and with more and more devices getting hooked on to the next generation network, the vulnerability and possible options to initiate attack increases. The 5G network is expected to open up options to use this technology for mission critical applications, which makes it important to have the security systems in place. In this paper the review of various **security threats** those are envisioned with the implementation of 6G Network using the new technologies like Software Defined Network and Network Function Virtualization. Further, the security services may be required to be implemented in the 5G network so as to take care of the security threats that may be faced in 5G Network.

1 Introduction

5G: Technology of Future is being developed with the vision to provide Ultra High Speed Communication Network along with the much sought after technology of Mobile Broadband [1, 2]. 5G is expected to provide Higher Network Capacity than 4G, Higher Density of Mobile Broadband Users, Support Device to Device (D2D) Communication, Massive Machine Type Communications, Lower Latency & Lower Energy Consumption for better implementation of IoT.

As per the 5G phase I release 15 documentation released by 3GPP and TSG (Technical Specifications Group) [3] the important features expected to be the part of 5G deployment includes as follows:

P. Chitre (✉) · S. Sriramulu
School of Computing Science and Engineering, Galgotias University, Greater Noida, UP, India
e-mail: pravir.chitre_phd19@galgotiasuniversity.edu.in

S. Sriramulu
e-mail: s.srinivasan@galgotiasuniversity.edu.in

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- **(eMBB)** : enhanced Mobile Broad Band (eMBB)
- Enhancement in Critical Communication including
  - **(URLLC)** : Ultra Reliable Low Latency Communication
  - **(HRLLC)** : Highly Reliable Low Latency Communication
- **(MTC)** : Machine Type of Communication
- **(IOT)** : Internet of Things
- **(V2X)** : Vehicle Related Communication
- Use of 5G Technology in Mission Critical Applications
- Features related to WLAN and unlicensed spectrum.

The sixth generation of WiFi, WiFi-6 which is better known as IEEE 802.11ax standard, and 5G, i.e., 5th Generation of mobile telephone system will both co-exist as these are Complementary Technologies. Once the 5G mobile technology is in place, the data communication is going to get more faster as it will be offering higher data rates for new applications along with increased network capacity [1].

The WiFi-6 will continue to be the choice of Indoor Access Network, while 5G will be the designated choice for the outdoor network. With these standards in place, the data communication is going to get more speed, lower latency and increased device density [4–6]. The next generation WiFi devices will be developed using the new technologies like:

- Software Defined Network
- Network Function Virtualization
- Network Slicing.

Using these technologies, 5G will be deployed for various applications that will enable the next-gen Smart City. But with the development of Smart Cities, 5G will be used even in mission critical, high risk applications like various important services like water supply distribution, power supply distribution, traffic control, and other along with response sensitive activities like self driving cars [1, 2].

This implementation of mission critical and response sensitive applications will give rise to new security challenges and these security challenges will call for an improved level of security protection [7–9].

For example: In case of a vulnerability in the security mechanism of smart city that may be using 5G services like water supply, If a hacker gets into this critical service of supplying water or electricity distribution to the smart city, the hacker may shutdown these critical services of electricity distribution or water supply, which may lead to catastrophic effect in the smart city [8, 9].

Due to the network architecture, 5G may see the increased impact of the failure of core infrastructures like network services such as mobile data and SMS. This can see the partial degradation of services for single network. This type of failure can be greater security threats. Hence it is required to have a strong security mechanism implemented in the 5G infrastructure so that these types of security attacks may not happen or if this type of attack is there, it can be either prevented or retaliated [10–12].

2 5G Security-A Review

The security mechanism that may have to be followed in 5G implementation needs review. With 5G overall data communication speed is expected to increase. Further, with advent of 5G user from any network operator may be able to join the network of some other operator which call for proper authentication. Hence the security mechanism that will be used in 5G network needs to be reviewed [1, 5].

2.1 Need for Security Mechanism

The features that are expected to be part of 5G implementation call for the need for security mechanism in place. The security mechanism needs to be enhanced to comply with the 5G network features like low latency and high energy efficiency. This is specifically needed as the devices are made as small as possible to be able to fit into the required systems and have to be consuming very low energy so that the requirement of the maintenance of the device is minimized. Due to this small size, and low power consumption, the authentication function is required to be kept small and at times may be required to be distributed through network slicing [1, 4].

The 5G networks are expected to be service-oriented which calls for special emphasis on the security and privacy requirements. In fact the next generation mobile networks alliance highlights the security requirements of the 5G Wireless Network. The 5G network needs to have improved resilience and network availability against the threats based on the signaling that may include overload protection that may be caused either maliciously or unexpectedly. Special security design is required in cases that may need extremely low latency and consume very less power. These security considerations also need to complying with security requirements defined in 4G as per 3GPP standards [3, 4] (Fig. 1).

Because there are more avenues through which attackers might attack, 5G poses a greater security risk. The Internet Of Things (IOT) will be enabled by this technology, which will enable a large number of connected devices [8].

IoT devices, on the other hand, are a target for cyber-criminals because they may be hijacked and used to establish a botnet, which can then be used to launch distributed denial of service (DDoS) assaults that paralyze networks. Vertical 5G use cases, such as linked autos and healthcare, this can further worsen the problem by introducing essential industry-specific security requirements. Simultaneously, 5G relies on virtual networks, which must be managed by reliable protocols [8].

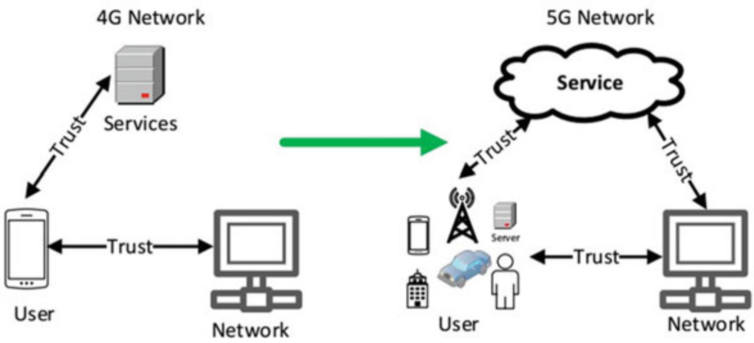

Fig. 1 Trust Model for 4G & 5G Wireless Network [4] *Note* Reprinted from D. Fang, Y. Qian and R. Q. Hu, "Security for 5G Mobile Wireless Networks," in IEEE Access, vol. 6, pp. 4850-4874, 2018, doi: 10.1109/ACCESS.2017.2779146

2.2 Types of Security Threats and Vulnerabilities

The security threats and vulnerabilities that can be faced on the 5G mobile network were shared and demonstrated in the Black Hat security conference which include the 5G vulnerabilities that allowed them to access the user location and launch the attack on the devices [1, 4, 8].

Because of the broadcast nature of wireless communications and the limited bandwidth available, security features such as authentication, integrity, and confidentiality are possible but difficult to implement. Due to the network architecture, 5G may see the increased impact of failure of core infrastructure like network services such as mobile data and SMS. This can see the partial degradation of services for single network. This type of failure can be greater security threats. In this type of attack normal communication is not disturbed [4, 8].

In terms of possible attacks, vulnerabilities, and privacy problems, contemporary cellular networks have a number of security challenges at the media access control layer (MAC) and physical layer (PHY) [1] (Fig. 2).

There can be two types of security attacks:

- **Passive Attack**
  In passive attack, the attacker uses the information from the legitimate user but does not attack directly. Through passive attack the attacker tries to use breach the data confidentiality and user privacy. In passive attack, the attacker who is not the intended receiver intercepts the message which is not meant for him as the message is originally for some other user. In cellular network, the passive attacks [1, 4, 8] are of two types:

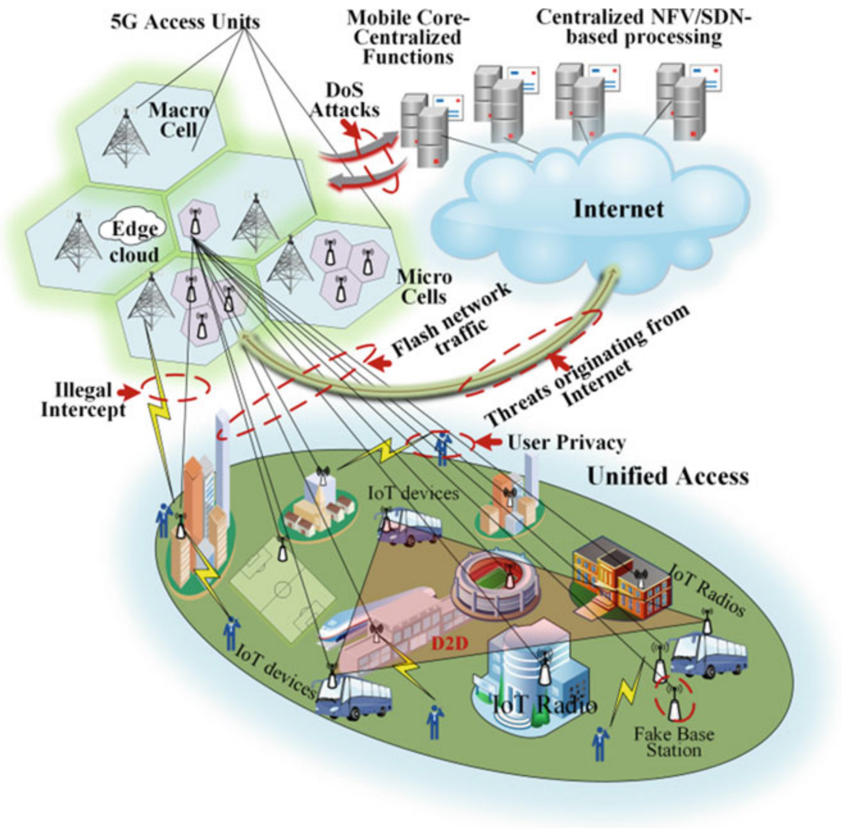

Fig. 2 5G Network and Threat Landscape [1] *Note* Reprinted from I. Ahmad, T. Kumar, M. Liyanage, J. Okwuibe, M. Ylianttila and A. Gurtov, "Overview of 5G Security Challenges and Solutions", in IEEE Communications Standards Magazine, vol. 2, no. 1, pp. 36-43, MARCH 2018, doi: 10.1109/MCOMSTD.2018.1700063

– **Eavesdropping**: Eavesdropping is a passive attack and it does not affect the normal communication. The attacks of passive nature are not easy to detect. Encryption of signal is mainly applied to prevent from this type of passive attacks. Since the signal is encrypted, signal intercepting is either not possible or in case it is intercepted, it will be of no use as decryption of signal is not possible. The encryption method that is used for communication can decide on whether the unintended receiver or eavesdropper can decrypt the communication. If the encryption method is strong, it may become difficult to eavesdrop but it can further be dependent on the computing capabilities that the eaves dropper uses [1, 4, 8] (see Fig. 3a).
– **Traffic Analysis**: Traffic analysis is another attack which is passive in nature. The unintended receiver can intercept the signal to find the information such as location and even the identities of the communicating parties. Even if the signal

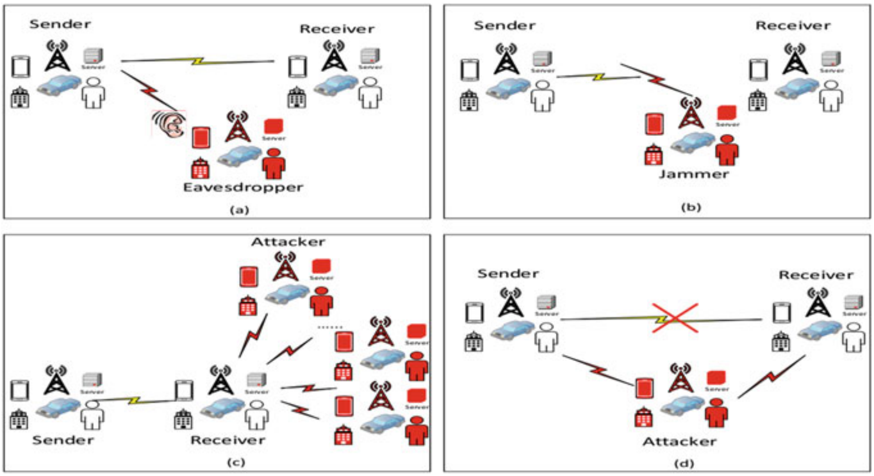

Fig. 3 Security Structure [4] *Note* Reprinted from D. Fang, Y. Qian and R. Q. Hu, "Security for 5G Mobile Wireless Networks," in IEEE Access, vol. 6, pp. 4850-4874, 2018, doi: 10.1109/ACCESS.2017.2779146

is encrypted, the unintended receiver can analyze the intercepted information to uncover the communication pattern of the parties. The attacker may misuse the information which is illegally procured and then can be a threat to the original sender of the original receiver. This type of attack does not have any impact on the legitimate communication [1, 4, 8].

- **Active Attack**
  This type of attack involves data modification or even interrupting the legitimate communication that is happening. This type of attack can be of serious nature and the attack can affect the communication directly. The passive attacks do not hinder the normal communication but with the active attacks, the communication can hamper. The Active Attacks [1, 4, 8] may include:

  – **Jamming**: Jamming is an active attack (see Fig. 3b). In this type of attack a malicious node will generate interference targeted at the intended node, purposefully, disrupting the communication of the legitimate user. Using jamming the authorized access to the radio resources can also be blocked. This type of attack can be prevented if the detection method is employed and the Malicious node is blocked. It is possible to detect the Jamming and hence preventing the jamming [1, 4, 8].
  – **Man In The Middle**: In MITM or Man In The Middle attack, attacker takes control of the communication used by the two users secretly and illegally. The attacker who takes control of the communication channel can intercept the communication and can modify or edit the original communication between two parties (see Fig. 3d). This type of attack is an active attack and can tamper with

the original communication between two parties. Using this attack, the confidentiality, integrity and the availability of network and the communication are hampered. This type of attack can be prevented if mutual authentication is implemented while setting up the communication [1, 4, 8] (see Fig. 3d).

- **Denial of Service & Distributed Denial of Service**: An adversary's network resources can be depleted by DoS assaults. DoS is a network availability violation caused by a security attack. A DoS attack can be launched via jamming. When there are multiple distributed adversaries, a DDoS can be produced. A DDoS model is shown in (see Fig. 3c). Both DoS and DDoS are active attacks that can be used at several layers. There is no method of prevention of DoS or DDoS attack. Only method is to detect these types of attacks and if detected, these attacks can be prevented [13]. DoS and DDoS will certainly become a severe danger for operators as the adoption of huge devices in 5G wireless networks increases. In 5G wireless networks, DoS and DDoS assaults can use a huge number of connected devices to attack the access network. A DoS assault can be classified as either a network infrastructure DoS attack or a device/user DoS attack, depending on the attacking target. DoS attacks on devices and users can target battery, memory, disc, CPU, radio, actuators, and sensors [1, 4, 8].
- **Replay Attack**: This is another type of Active Attack. In this type of attack, the attacker eavesdrop in the communication and instead of passively using the information, the attacker changes the messages and then resends to the receiver. In fact, the receiver gets this message and looks real, as the attacker is well aware of encryption technique and sends the original message by tampering into the message and then to the original receiver. The receiver checks the message and finds that the message is legitimate as the encryption followed in the tampered message is the correct one [1, 4, 8].
  This type of attack can be taken care off by

  1. Changing the Encryption Technique.
  2. By using different messages or techniques to share encrypted message and the keys to open the original message. This will ensure that even if the original message is tampered, same can be easily identified.

2.3 Security Services in 5G Network

The new architecture, technology, and use cases of 5G wireless networks introduce new security features and needs to the security services [4]. Using the implementation of these security services the security of the communication and data can be ensured. Four different types of security services are introduced, these are:

- Authentication: Message and entity authentication are handled.
- Confidentiality: The communication and data are kept confidential and the privacy of data and communication is maintained.

- Integrity: Protection against the modification or duplication of message or data.
- Availability: Ensuring the accessibility of the service to the legitimate users.

2.3.1 Authentication

In communication, authentication of the entity communicating is of prime importance. In fact, in 5G, the User using any cellular network is able to log on to the 5G Network. So the authentication of user/user entity will ensure that only legitimate user is able to get on board the network along with the authentication of the service providers whose services the user is using. Even in a legacy cellular network, the communication can be started only after the mutual authentication of User/User Equipment (UE) is confirmed by the Mobility Management Entity (MME). Not only entity authentication but also message authentication is ensured on the 5G Network. The nature of trust model in 5G is different from legacy cellular networks, hence the hybrid and flexible authentication management is followed in 5G network [4].

2.3.2 Confidentiality

Data confidentiality and privacy are the two characteristics of confidentiality. Data confidentiality protects data transmission from passive assaults by restricting data access to only authorized users and prohibiting unauthorized users from accessing or disclosing data. Privacy protects legitimate users' information from being controlled and influenced by an attacker. For example, privacy protects traffic flows from being analyzed by an attacker. The traffic patterns can be utilized to diagnose sensitive information such as the location of senders and receivers, among other things [4].

In 5G data encryption is widely used to ensure that the unintended user cannot extract the information from the data and information that is broadcast over the network channel. The symmetric key encryption approach encrypts and decrypts data using a single private key shared by the sender and receiver. The key is needed to be shared between the sender and the receiver and the traditional key sharing mechanism, though is powerful enough, but may not suffice with the increasing computing power in the hands of general user, who can very easily crack the key with the computing capabilities. The physical layer security may be employed, which is capable of providing confidentiality service against Jamming and eavesdropping. Because of the huge data connections, 5G privacy demands significantly more attention than conventional cellular networks.

2.3.3 Availability

The degree to which a service is accessible and useable by any lawful users whenever and wherever it is requested is described as availability. Availability assesses how resilient a system is in the face of various threats and is a crucial performance parameter in 5G. DoS and DDoS attacks are one of the most common attacks on availability, and they can prevent genuine users from accessing services. By interfering with radio signals, jamming or interference can interrupt legitimate users' communication links. 5G wireless networks have a significant difficulty in preventing jamming and DDoS assaults due to the large number of unsecured IoT devices. To improve upon jamming probability, switching probability, and mistake probability, a pseudo-random time hopping spread spectrum is proposed. To increase the identification of availability violations, resource allocation can be used in the 5G Networks [4].

2.3.4 Integrity

The proposed 5G Standards provide string authentication mechanism, but, message authentication ensures that the message's source is verified, but it offers no security against duplicate or change. The data integrity is one of the key requirements and needs to be in place for a reliable and trustworthy system. 5G is being designed to provide connectivity anywhere, anytime, and anyhow, so that the system can support a large number of applications of human needs, where the data integrity matters.

The term "integrity" refers to the ability to prevent data from being modified or altered as a result of active attacks by unauthorized parties. Insider malicious attacks, such as message injection or data alteration, can compromise data integrity. Data is more vulnerable to assault and modification than speech communications. Mutual authentication, which generates an integrity key, can be used to deliver integrity services. The authentication systems can provide message integrity [4].

3 Cryptography: A Technique in Security Solutions

Cryptography techniques using new networking protocols and **Physical Layer Security (PLS)** approaches are the two primary types of mechanisms used to combat security assaults on the 5G networks. The most often utilized security mechanisms are cryptography approaches, which are typically applied at the upper layers of 5G wireless networks using new networking protocols. **Symmetric-key cryptography** and **public-key cryptography** are the two types of modern encryption. Symmetric-key cryptography refers to encryption technologies in which a sender and receiver share a secret key. Asymmetric cryptography, also known as public-key cryptography, employs two separate keys, one of which is used as the public key for encryption and the other as the secret key for decoding [4, 8] (Fig. 4).

Unlike traditional systems, which rely on cryptography techniques to guarantee security, Physical Layer Security (PLS) has been identified as a viable security strat-

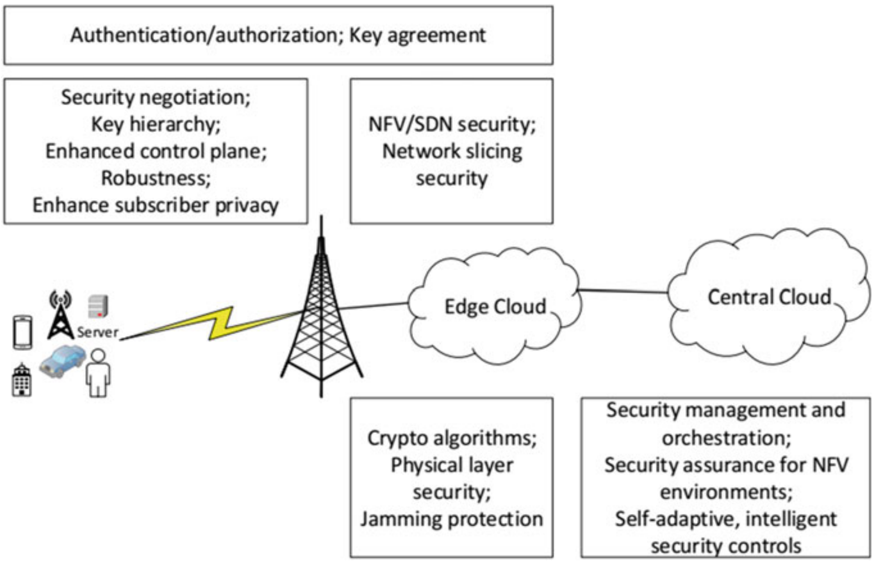

Fig. 4 Elements of 5G Security Architecture [1] *Note* Reprinted from I. Ahmad, T. Kumar, M. Liyanage, J. Okwuibe, M. Ylianttila and A. Gurtov, "Overview of 5G Security Challenges and Solutions", in IEEE Communications Standards Magazine, vol. 2, no. 1, pp. 36–43, MARCH 2018, doi: 10.1109/MCOMSTD.2018.1700063

egy for ensuring safe wireless transmissions by utilizing the unique wireless physical layer medium properties.

4 Security Challenges in SDN

SDN is the networking technology that provides innovation in 5G network and also is the main reason for security challenges. In the old technology the network was controlled by the hardware but with the innovative technology of SDN, network can be controlled by software. Also, the network intelligence is centralized into network controller. In 5G most of the network functions are implemented using SDN-based applications. This makes it convenient to create and set up Network Architecture, as desired, but this also increases the ease of attack for the attacker as the attacker or the hacker has to target the central network controller. The attacker or hacker can push in the malicious code into the network controller and run it there to create Havoc in the entire network. Hence, to protect the Network, it becomes of utmost important to stop such malicious code from entering the system [1, 11, 14].

The availability of open APIs in network equipment, the trust relationship between the controller and the applications (mostly third-party applications) authentication and authorization of applications to change or modify network behavior are the main security challenges that applications can pose to the network [14–16].

The majority of 5G functionalities will be built as applications because of the ease with which they can be modified, updated, and deployed. Application-based services will be enabled by NFV, which will bring application-based services into networking domains. As a result, protecting the network from abnormalities caused by applications will be critical. The control plane (for example, the Open Flow controller) in SDN is a centralized decision-making unit. As a result of its essential function, the controller might be highly targeted for compromising the network or carrying out malicious operations in the network. For the same reason, DoS and DDoS assaults are acceptable. Another difficulty that can be targeted to make the controller a bottleneck for the entire network is its scalability. The controller can easily become a bottleneck if the number of controllers is insufficient or the controller capabilities are insufficient to react to the queries of the data path elements [4, 6].

5 Security Solution in SDN

SDN's logically centralized control plane provides a global picture of the network and allows network elements to be configured in real time. As a result, the SDN architecture facilitates network forensics, security policy changes, and security service insertion by supporting extremely reactive and proactive security monitoring, traffic analysis, and response systems [17–19].

SDN enables rapid threat detection by capturing intelligence from network resources, states, and flows in a cycle. To study the data, change the policy, and reprogram the network, the SDN architecture provides traffic redirection through flow-tables adjustment. SDN's programmability enables dynamic security policy changes to be made without requiring individual hardware configuration. As a result of this automation, the chances of mis-configuration and policy conflicts across multiple networks are reduced. Because of the global network visibility, consistent network security policies can be installed across the network, and security services like firewalls and Intrusion Detection Systems (IDS) can be deployed on specific traffic based on globally established security policies [4, 18, 20].

6 Focus Needed While Designing and Deploying 5G Network

After having discussed the security threats and security services, we can summarize the Security requirements for the 5G Network as:

1. Special Security design is required specially in the situations where there is a requirement of extremely low latency.

2. While implementation, it is required to ensure that the 4G Network will be used as Back-haul Network, Hence, the 5G security requirements need to comply with security requirements defined in 4G 3GPP Standards.
3. Provide public safety and mission critical communication requirements through resilience and high availability
4. Improve robustness against smart jamming attacks.
5. Improve security for 5G small cell nodes like Femto Cells.
6. The design of SDN security architecture to identify and neutralize the threats as and when the same occurs need to be in place.
7. Use of security services like firewalls and intrusion detection systems are recommended.

7 Conclusion

5G wireless network can be said to be the network of the future, which can see increased use of the network for device to device communication and implementation of smart city and other next-gen projects. In this paper we tried to discuss the possible security threats that may become a major point of concern in implementation of 5G Network. We also tried to discuss on the basic security services that may be required to be implemented while using or deploying the 5G Network.

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Prediction of Age-Related Macular Degeneration (ARMD) Using Deep Learning

Viraj Vora, Kinjal Majithia, Apoorva Barot, Radhika Kotecha, and Pranali Hatode

Abstract The further proliferation of age-related eye diseases, mainly age-related macular degeneration (ARMD), is increasing the load on healthcare providers. Although ARMD does not lead to complete blindness, the disease can make it difficult for people to perform daily activities such as driving, reading, writing, cooking, etc. The unavailability of any cure for ARMD, necessitates timely actions of detecting the first symptoms of eye conditions as well as following appropriate treatment options to minimize further damage. Some of the current techniques used to detect and monitor ARMD include the Amsler's Grid, Near Vision Chart, Optical Coherence Tomography (OCT), etc. which are generally performed on paper in hospitals or clinics. This proposed solution facilitates prediction of age-related macular degeneration in patients using data collected through a Mobile application. The proposed system includes the digitization of paper-based tests as well as a novel approach for prediction of ARMD through Deep Learning. The system eliminates the need to visit a clinic and can be used by citizens from home at their discretion. The high prediction accuracy obtained while real-time testing and prediction of ARMD validates the effectiveness of the proposed approach.

Keywords Age-related macular degeneration (ARMD) · Deep learning · Machine learning · Mobile application · Eye disease prediction

V. Vora · K. Majithia (✉) · A. Barot · R. Kotecha · P. Hatode
K. J. Somaiya Institute of Engineering and Information Technology, Sion, Mumbai, India
e-mail: kinjal.majithia@somaiya.edu

V. Vora
e-mail: viraj.v@somaiya.edu

A. Barot
e-mail: apoorva.barot@somaiya.edu

R. Kotecha
e-mail: radhika.kotecha@somaiya.edu

P. Hatode
e-mail: phatode@somaiya.edu

University of Mumbai, Mumbai, India

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1 Introduction

The most frequent cause of blindness (or vision loss) in adults is age-related macular degeneration. Till the year 2020, it is expected that number of people with ARMD is about to touch 196 million worldwide according to a survey and may increase to 288 million in the next 20 years [1]. Currently, Macular Degeneration is considered a chronic disease that occurs in elderly people [2]. The macula is dependable for engrossing the central vision of eye, and all the basic activities like reading, driving, seeing faces or colors are controlled by the macula. As for longevity, age-related disorders increase the burden placed on health care providers [3, 4]. In particular, it is found that in aged people distorted vision is caused by ARMD. The first stage of ARMD is considered to be the presence of drusen (asymptomatic) macular, commonly found in fundus testing [5]. Drusen is a small amount of lipid, acellular debris that gets collected between the retinal pigment epithelium and the bruch membrane. People with macular degeneration aren't or would never be blind—but they have a difficulty in vision and cannot see fully. Although the discovery of small drusen is not in itself the diagnosis of ARMD, as drusen often occur in normal aging, the increased amount and size of drusen increases the risk of further progression in visual ARMD [5, 6]. Recent symptoms of ARMD are changes in the colour of the retinal pigment epithelium that occur before the development of local atrophy and abnormal exudative enable more established grading and separation of ARMD [7]. It is difficult for patients to visit a hospital or doctor's office every few days to check these symptoms using conventional eye methods such as Optical Coherence Tomography.

(OCT), Amsler's Grid, Near Vision Chart, etc. Alternatively, a low-cost home surveillance system can be effective to monitor the progression of the disease. Through this paper, we propose a Deep Learning based system for the prediction of ARMD. The system is a portable and easy-to-use Mobile Application that accurately as well as quickly performs ARMD tests with a simple user interface [8] for the patients. The graphical display allows the patient to communicate with a computer using a pattern detection indicator and the patient's feedback collection device. This ARMD home screening tool can alert a patient to urgently visit a doctor's office or hospital and if necessary, take anti-VEGF injections.

The rest of the paper is organized as follows: The next section briefly describes the related work accomplished with different methods and techniques. Section 3 presents the proposed system and Sect. 4 presents the implementation details which include the information on the dataset used, Machine Learning algorithms used for comparison, the implementation tools and the results obtained. Section 5 consists of managerial and social implications. Section 6 concludes the paper and presents the scope for future work.

1.1 Contribution of the work

The medical field particularly requires accurate and confirmed results of any tests that are performed on the patients, in a privacy-preserving manner. The contribution of the proposed work is as follows:

1. Unlike the traditional medical tests, the system has deployed a deep learning model which detects ARMD based on the medical history of the patient and detects early ARMD, even in absence of symptoms.
2. The existing systems in current use cannot measure the intensity of the ARMD disease of the eye. The proposed system applies the Deep Learning model on the vision test conducted through a Mobile Application and produces reports that deduce the intensity of ARMD.
3. The proposed system is patient-oriented, with a major focus on treating the difficulty faced by patients in getting the ARMD prediction tests. The system provides a low-cost, user-friendly, and efficient device (Mobile Application) for the patients, with a facility for doctors to view the reports conveniently.
4. The tests for prediction of ARMD are quite tedious when done at a clinic or a hospital. The proposed Deep Learning-based automated system saves time and efforts of the patients as well as the doctor.

2 Related Work

A research [2] on analysis of retinal images to diagnose Stargardt disease also called Stargardt macular dystrophy causes the macula to slowly decrease and there is no cure for this disease. Doctors, however, recommend that people should wear sunglasses when they are under the sun and in places where the light is bright. It was stated that diagnosis of the disease is possible by comparing the unaffected eye to the affected eye using automated algorithms and advanced histogram technique. The authors use the LABVIEW tools to install this method.

In [3], research in which correlation among preferential hyperacuity perimeter and the Amsler grid to detect disease is presented to evaluate the ability of selected perimeter hyperacuity (PHP) and Amsler grid for detection of scotomas between Stargardt disease and degeneration of macular age. A prospective, comparative, randomized trial in which 16 patients were affected by ARMD and Stargardt disease was conducted. All patients have an optometric test including discharge, better adjustment, PHP Foresee test, and Amsler grid. For the diagnosis of scotomas in both macular diseases, PHP sensitivity is 60–70%, and Amsler grid sensitivity is 85–100%. As a means of testing maculopathies, PHP sensitivity was 83%, and sensitivity of Amsler grid after calculation was 93%. As concerned to detection of ARMD scotomas and Stargardt after the analysis the Amsler grid and PHP both were able to detect them. But Amsler grid was more effective in detecting ARMD scotomas and Stargardt whereas PHP was effective for ARMD not Stargardts.

The authors of another research [4] on the algorithmic approach for detection of diseases using retinal images describe that fundus images of the retina of the human eye can provide important details about people's lives and open a window of unseen possibilities. In this way, one can systematically scan digital retinal images, predicting chronic diseases. This eliminates the need for manual eye imaging in diagnostic services. It is also possible to detect certain types of cancer and membranes in their early stages in addition to diseases such as high blood pressure, stroke, and organ dysfunction in patients with diabetes. The authors suggest that a database of visual images and accompanying details of any patient, which is routinely tested, for diagnostic tests can be easily installed.

In [5], research on wearable diagnostic systems for age-related macular degeneration is presented, wherein the authors explained A novel head-mounted point of care diagnostic system was used for detecting continuous monitoring of ARMD. By using the multiple standard graphical face techniques such as PHP, Amsler grid, threshold Amsler grid the platform enabled the accurate monitoring of AMD. The authors represented a new multi grid also known as NGRID software and they focused on the hardware part. It consisted of Oculus HMD incorporated with a single board computer. This was the initial move into an integrated system. The results of this paper were that the device was ready to implement a live demo.

A study [6] conducted on systematic review on automatic detection of ARMD in color fundus photography, the authors described that the presence of drusen in the retina points out important factors when size, number and morphology and it is correlated with risk of ARMD. They analyzed that handcrafting of corpses in color-coded images is very impactful and automated computer detection can help patients care. They also reviewed and evaluated current approaches to the developmental mechanisms of the automatic detection of the drum in the context of age-related macular degeneration.

The authors of another research [7] carried out on prediction of diabetic retinopathy and glaucoma using retinal image and data mining techniques explained that the use of accounting techniques in the medical field has been the subject of intense research in recent years. Diabetic Retinopathy and Glaucoma are two retinal infections that are major causes of blindness. Regular early diagnosis of the disease has been a daunting task—a task that requires resources. So automatic diagnosis of these diseases by computational techniques can be a good solution. In this paper, a spontaneous computational diagnostic method is proposed using retinal image analysis and data mining methods to accurately classify retinal images as affected by Normal, Diabetic Retinopathy, and Glaucoma. Three-factor analysis and sixteen-phase algorithms were analyzed and used to identify contributing features that provided better predictive results. Results showed that C4. 5 and random tree planning techniques produced 100% segmented training accuracy in classifying 45 images from the Gold Standard Database. Besides, Fisher's Ratio algorithm produced a very small and appropriate set of predictive features in retinal image training data.

In [8], a research on home monitoring of age-related macular degeneration using foresee home devices for detection of neovascularization was presented. In [9], research on age-related macular degeneration diagnostic tools was presented, wherein the authors described the development and use of hardware and software for visual inspection of patients with macular degeneration. In this way, a group of graphical patterns is displayed and patient responses are collected. The data collected are used to slow the progression of macular degeneration. Authors prioritized the proposed software and various other hardware methods to display and collect data on copyright. They demonstrated and discussed device design including the human–computer interface (HCI) smart glove. Also, the results of the division of time response for each pattern and systematic error were achieved using twenty population studies. The proposed hardware/software platform is a comparable visual test solution dedicated to patients with macular diseases such as ARMD.

In a research on prediction of eye state using KNN algorithm [10], authors explained the basic method of learning eye equipment for Eye State planning (e.g., Eyes Open or Closed) is using Electroencephalography (EEG) Data. The idea is to compare and ensure that the basic Machine Learning (ML) method (K-Nearest Neighbors KNN) can provide better predictability for certain domains (in this case prediction) than more complex ML (Support Vector Machine (SVM)), Artificial Neural methods Network (ANN), or Deep Neural Network (DNN). EEG data were collected using the EMotiv EPOC headset and each record was handwritten, consisting of 14 channels (record columns) using an open or closed camera. Test results confirmed that KNN's application provided better predictability in less time than other complex methods of ML.

Through a research [11] on eye diagram distortion and data dependent jitter in meander delay lines on printed PCBs on the basis of time domain, the authors explained that the crosstalk installed in the meander delay line produces a high amount of wave distortion and jitter that relies on data in the output port. This paper introduces a twisted rendering of the eye painting and how to generate jitter generation based on time-based analysis and in an unconventional way of an integrated transmission line. From the proposed analysis, this paper proposes jitter measurement in both short and long cases of unit delay. Eye distortion and jitter duration are predicted and estimated, respectively. To ensure jitter balance, a series of printed circuit board test vehicles with a meander delay line is constructed and tested. The rated jitter showed good consistency with these proposed jitter rating figures.

Despite these attempts by many researchers, a simple and efficient mechanism to test ARMD by patients from their home is missing. The work in this article takes motivation from the efforts of researchers in the past and proposes an ICT-based solution that uses Artificial Intelligence algorithms through a simple and user-friendly Mobile Application for prediction of ARMD. The next section presents details of the proposed solution.

3 Proposed Approach

Macular mutations are the leading cause of vision loss, affecting millions of people across the world. As a solution, a low-cost home surveillance system to effectively monitor the progression of the disease is proposed herewith. The solution is accurate and can quickly perform ARMD tests through a simple user interface.

3.1 Proposed System

The system architecture is depicted in Fig. 1. The system precisely gathers data like age, gender, alcohol consumption, blood pressure, ARMD family history, etc. of patients and uses it as an input. Further, various types of abnormalities like superior abnormality, nasal abnormality, temporal abnormality, etc., observed through Amsler tests of patients are taken as an input.

The data is pre-processed and fed to a Deep Learning model for training, testing, and validation. This Deep Learning model is set at the backend of a simple Mobile Application made available to the patients. Whenever a patient requires a test, he/she can avail it through the application and record results of various Amsler's tests.

Based on the patient's new test record, the prediction of the percentage of disease will be calculated and shown in the reports. Accordingly, the patients will be properly guided for further analysis and the doctor would assign some medicinal solutions based on the reports generated by the proposed system.

The various types of tests possible through the proposed system are shown from Figs. 2, 3, 4, 5 and 6. With several medical inputs and learning from the literature, Deep Learning is identified as suitable for the application. The Deep Learning model is well-trained on the data of various patients recorded through Amsler's Test and the model effectively learns the pattern of ARMD.

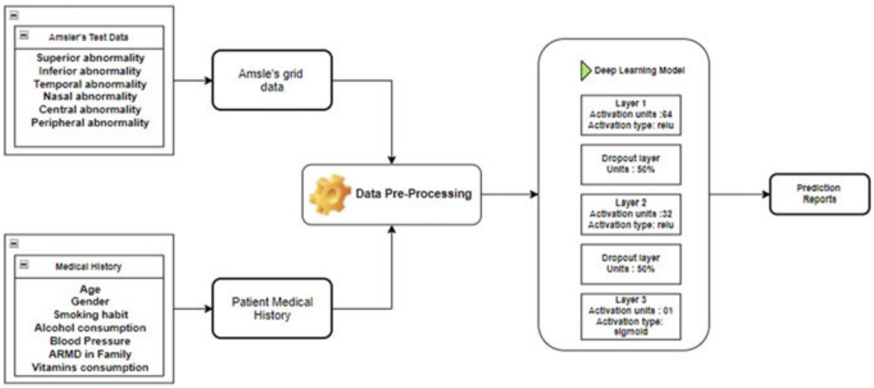


Fig. 1 Architecture of proposed system

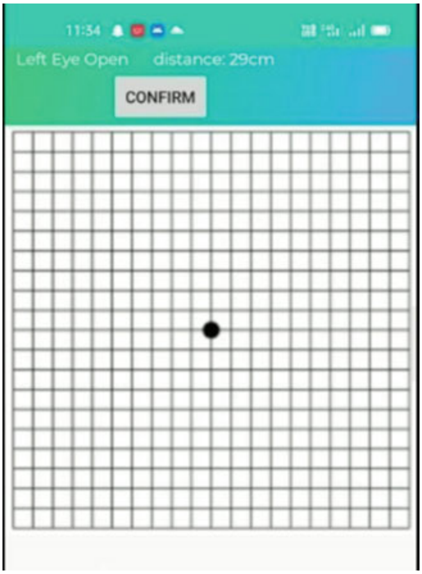


Fig. 2 Amsler's grid

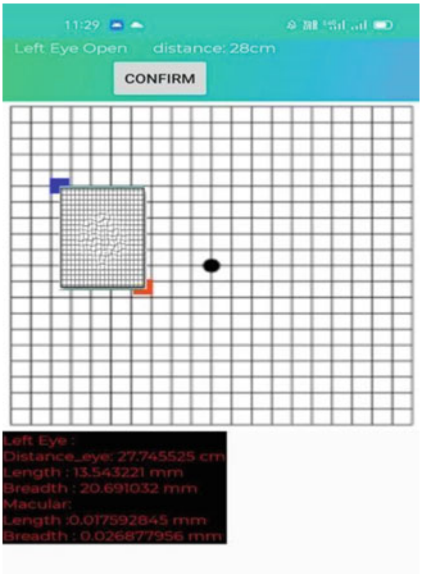


Fig. 3 Example of distortion area selected by patient

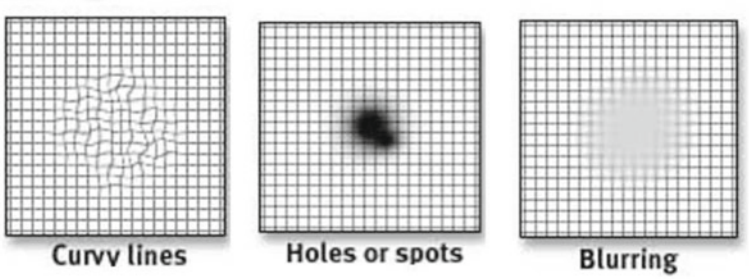
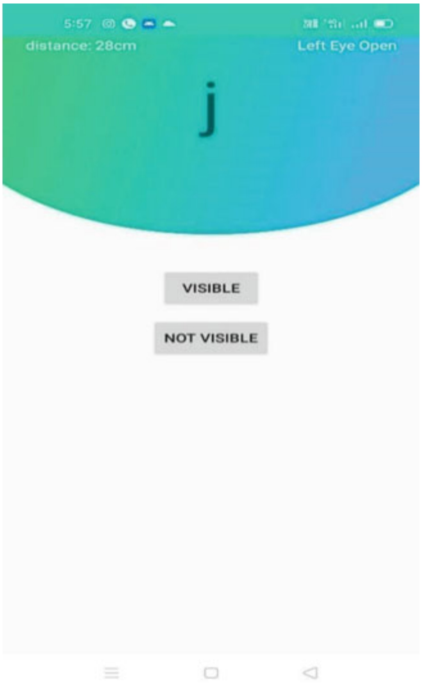


Fig. 4 Types of distortions observed through Amsler's tests (*Source* AmslerTouch: Self-testing Amsler grid application for supporting a quantitative report of age-related macular degeneration symptoms, p. 6)

Fig. 5 Near vision test



(a) **Amsler's grid test**: Initially, the patients have to hold a phone in a way where the system can detect their faces in a range. Once the face is detected, they have to cover one eye with their hand and make sure that they cannot see with the closed eye and then concentrate on the black dot which is displayed in the center of the grid for about 30 s as shown in Fig. 2. If the patients do not see any distortion, he/she can confirm the complete visibility. Else, they have to select the top-left corner and bottom right corner of the distortion area, and then

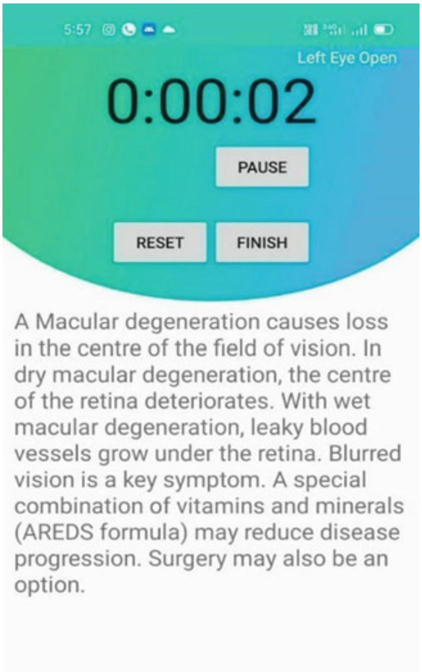


Fig. 6 Reading speed test

select the distortion type. After the patient selects a distortion type, distortion will be projected in the distorted area selected by the patient on the Amsler's grid. Similarly, the test has to be performed for the other eye.

After completing the test, the final screen visible to the patient for each eye will be as shown above in Fig. 3. As shown in Fig. 4, the system allows the user to select one of the three possible types of distortions—which can be curvy, holes also known as spots, or blurring.

(b) **Near vision test**: The patients have to take this test for each eye individually, with one eye closed, respectively. In the beginning, the patient will be shown an alphabet of a particular size. If the alphabet is visible to the patient, they will click on a button labeled as "Visible", and the next alphabet with a smaller size will be displayed. This procedure will continue until the patient cannot recognize the alphabet shown and clicks on the button label1ed as "Not Visible". Once this process is done, all the data will be stored for further analysis. The screen for Near Vision Test is shown in Fig. 5.

(c) **Reading speed test**: The patients have to take this test for each eye individually, with one eye closed, respectively. After the patients start the test, a timer will start and the patient will be shown a paragraph; they have to read that paragraph, the timer will be recording the time taken for reading that particular paragraph. While performing this test, every time a unique paragraph will be displayed to the patient. Once the test is completed, the patient will click on the finish button and the data will be stored for further analysis. The screen for Reading Speed Test is shown in Fig. 6.

4 Implementation Details and Results

To ensure the effectiveness of the proposed algorithm and to address the decision-making issue in the healthcare sector, several experiments were conducted with various data sets. In this section, the data sets used, implementation tools and the recorded results are described.

4.1 Dataset

The dataset used in this system, as shown in Table 1 consists of data records from the US National Library of Medicine National Institute of Health which is available in CSV format.

4.2 Machine Learning Methods for Comparison

To demonstrate the effectiveness of the proposed system, it is compared with the results obtained through the following algorithms: Logistic Regression, Support Vector Machines (SVMs), Random Forest Classifier, and Multi-Layer perceptron Classifier.

The Mobile Application part of the system is implemented using Flask, Java, and Android Studio. The proposed system with Deep Learning model and the Machine Learning algorithms for comparison have been implemented using Sklearn and Keras Optimizers—Adamax, Rmsprop, Binary Cross Entropy, etc.

4.3 Results

This system provides patients with two types of reports for all three tests as mentioned above. It also provides medical history in the application. The first type is individual test assessment—where the patient can check the result of all individual tests performed by them in the application as shown in Fig. 7. The second type is progress analysis—where patients can check the progression or deterioration based on the data available from the last three tests performed in the application and accordingly suggestions are given to patients, an example of this report is shown below in Fig. 8. Based on the data collected from these tests, the proposed system can provide

Table 1 Dataset composition

Column name/description	Corresponding values
Id	Patient's ID
Sid	Eys's ID
Eye	0: left, 1: right
Grader	0: Grader 1; 1: Grader 2
Peripheral FAF Image Quality (IQ)	0: poor; 1: adequate or good
Peripheral FAF Abnormality (AI)	0: no; 1: yes
Peripheral FAF Abnormality Pattern (P)	0: none; 1:hypo; 2: hyper; 3: both
Inferior peripheral FAF Abnormality (INF)	0: no; 1: yes
Nasal Peripheral FAF Abnormality (NAS)	0: no; 1: yes
Temporal Peripheral FAF Abnormality (TEM)	0: no; 1: yes
Superior Peripheral FAF Abnormality (SUP)	0: no; 1: yes
Macular FAF Image Quality (HRM_IQ)	0: poor; 1: adequate or good
Macular FAF Abnormality (HRM_AI)	0: no; 1; yes
Macular FAF Abnormality Pattern (HRM_P)	0: none; 1: hypo; 2: hyper; 3: both
Age	Patient's age
Patient's sex (Sex)	0: female; 1: male
Patient's race (Race)	0: African–American; 1: Caucasian
AMD	0: Patient has no AMD; 1: Patient has AMD
Family history	0: Patient's family has no AMD history; 1: Patient's family has AMD history
Patient's smoking status (Smoking)	0: no; 1: yes
Patient's alcohol consumption (Alcohol)	0: no; 1: yes
Patient's vitamin consumption (Vitamins)	0: no; 1: yes
Patient's AMD type (Type)	NA: controls; 0: dry; 1: wet
Patient's visual acuity (VA)	Scale: foot
	Scale: counting fingers
Visual acuity of patients with poor vision (CF)	
Patient's lens surgery (Lens)	0: clear; 1: NS; 2: IOL

the possibility of patient suffering or future chances of them being diagnosed with ARMD. Doctors can also see reports of patients registered under them and update the report accordingly if required. The Deep Learning model proposed for the system provides the best possible accuracy as compared to other algorithms.

The results of the proposed method and its comparison with other Machine Learning methods for prediction of ARMD are depicted in Fig. 9.

Logistic Regression was tested and the accuracy was found to be 82.76%, whereas the Support Vector Machine predicted the ARMD with an accuracy of 72.41%.

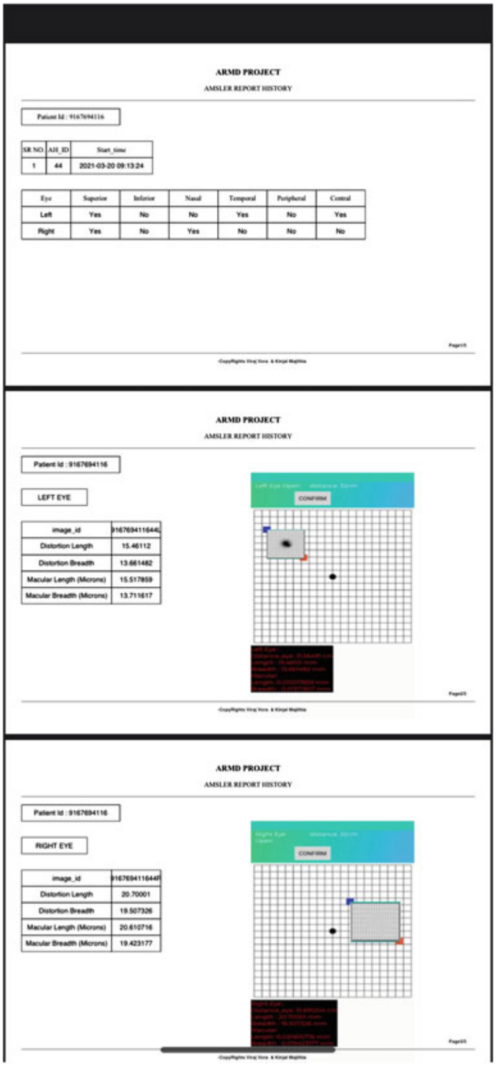
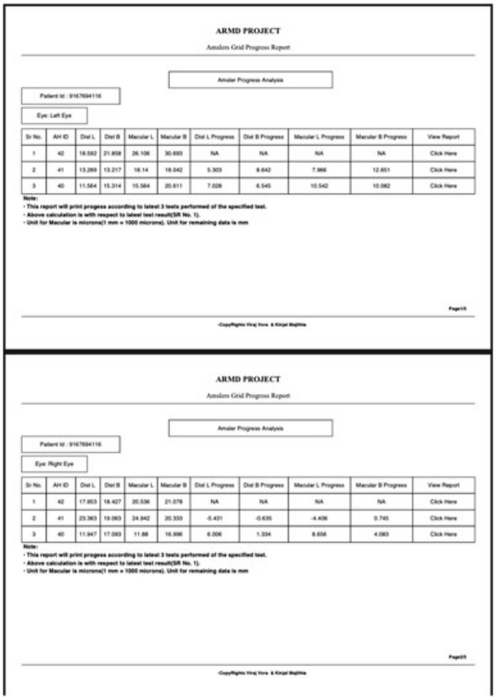


Fig. 7 Report type 1

Random Forest Classifier had an accuracy of 65.52% whereas using the Multi-Layer perceptron classifier, the accuracy was 79.12%. The low accuracy supports our assumption for the need to use Deep Learning or advanced algorithms. The Gradient Descent provides a satisfactory accuracy of 90.68%, whereas Deep Learning provides 93.89%, the best among all the predictors. This shows the success of the proposed system in implementing the objectives.



ARMD PROJECT

Amslers Grid Progress Report

Amsler Progress Analysis

Patient Id : 9167694116

Eye: Left Eye

Sr No.	AH ID	Dist L	Dist B	Macular L	Macular B	Dist L Progress	Dist B Progress	Macular L Progress	Macular B Progress	View Report
1	42	18.592	21.858	26.106	30.693	NA	NA	NA	NA	Click Here
2	41	13.289	13.217	18.14	18.042	5.303	8.642	7.966	12.651	Click Here
3	40	11.564	15.314	15.564	20.611	7.028	6.545	10.542	10.082	Click Here

Note:
- This report will print progess according to latest 3 tests performed of the specified test.
- Above calculation is with respect to latest test result(SR No. 1).
- Unit for Macular is microns(1 mm = 1000 microns). Unit for remaining data is mm

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ARMD PROJECT

Amslers Grid Progress Report

Amsler Progress Analysis

Patient Id : 9167694116

Eye: Right Eye

Sr No.	AH ID	Dist L	Dist B	Macular L	Macular B	Dist L Progress	Dist B Progress	Macular L Progress	Macular B Progress	View Report
1	42	17.953	18.427	20.536	21.078	NA	NA	NA	NA	Click Here
2	41	23.383	19.063	24.942	20.333	-5.431	-0.636	-4.406	0.745	Click Here
3	40	11.947	17.093	11.88	16.996	6.006	1.334	8.656	4.083	Click Here

Note:
- This report will print progess according to latest 3 tests performed of the specified test.
- Above calculation is with respect to latest test result(SR No. 1).
- Unit for Macular is microns(1 mm = 1000 microns). Unit for remaining data is mm

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Fig. 8 Report type 2

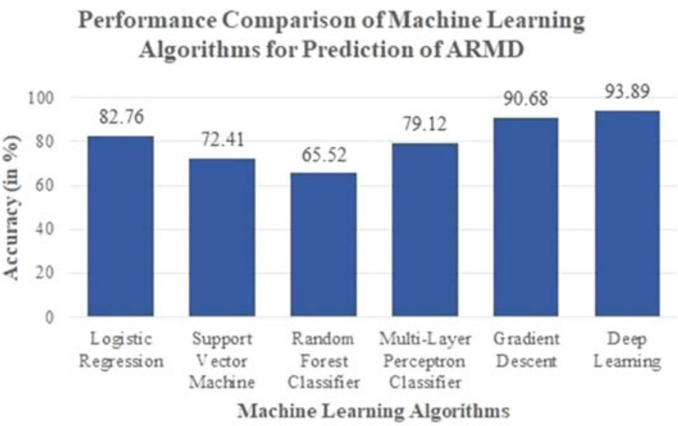

Fig. 9 Performance comparison of machine learning methods for prediction of ARMD

5 Managerial and Social Implications

The proposed system acts as a catalyst to help patients get diagnosed at the ease of their home. The ophthalmic sector of healthcare will witness a tremendous boost since the system has focused on providing an accurate and easily accessible system to the healthcare professionals that will be beneficial for research implementation as well as treatment of patients. Due to the early detection of the disease, chronic eye complications in patients are neutralized. The proposed system also offers a simple and cost-effective solution to ARMD patients by providing detailed analysis of their disease.

6 Conclusion and Future Scope

ARMD is a chronic eye disease that affects a large number of people across the globe. Patients need to physically visit hospitals or doctors for regular check-ups. The system proposes a flexible, Deep Learning based software version of current ARMD diagnostic tests like Amsler's Grid, Reading Speed Test, Near Vision Chart, and substitutes for human intervention. The proposed solution can be used via portable devices like Android phone or a Tablet, whichever is readily available with the patients at home. Deep Learning models are learned from the past data of patients and the model is applied to obtain predictions of the disease for new patients. Based on previous data and predicted data the system will compare and display the progression of the patient's health status. Key problems with current diagnostic platforms are that they are not commercially available for at-home use and don't allow automated analysis of patients' data. The proposed system not only provides flexibility to patients, but shall also provide a mechanism to continually monitor and analyze the patients' health; at the same time, forming a database of medical records that can be used for research within the privacy constraints. When deployed for real-time testing, the proposed system is found accurate and efficient. The system can be further extended to include other tests for the prediction of ARMD or other eye diseases.

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Comparative Analysis of Machine Learning-Based Approaches for Astrological Prediction of Profession

Shubhangi Bhargava, Adarsh Kumar, Surender Singh Chauhan, and Moolchand Sharma

Abstract Astrology is an ancient concept. Each person's astrological chart is unique and independent, which can be influenced by different factors. In the current world, there are no standard rules or guidelines for astrological prediction. Many applications can be used to predict and analyze data, thanks to advances in artificial intelligence. These applications make use of computers to analyze unknown, large, noisy, and complex data sets and to predict and classify them. This paper aims to establish universal rules and validate astrology by using various scientific methods. This research uses the positions of stars and planets at birth to determine the profession of a person. Logistic Regression, Naive Bayes Algorithm, and Catboost Algorithm use this information to predict a person's profession. The learning classification dataset consisted of 6248 records covering 14 different professions.

Keywords Machine learning · Astrological prediction · Prediction of profession · Artificial intelligence · Classification

1 Introduction

Astrology is a field that sparks curiosity in humans. Changes in how astrology is viewed are necessary to discover scientific theories and their relationships with them. The traditional methods of analyzing astrology are not sufficient to provide a scientific basis. Astrology refers to the belief that the alignments between stars and planets affect each individual's moods, personalities, and environments, depending on their birth dates. The positions of astronomical objects are used by the horoscopes to make predictions for people's personal lives. The analysis and similarity between the previous horoscopes are used by the astrologer to make predictions about an individual. To predict the future, they use similarity analysis and the conclusion of

S. Bhargava (✉) · A. Kumar · S. S. Chauhan · M. Sharma
Department of Computer Science and Engineering, MAIT, GGSIPU, Delhi, India
e-mail: bshubhangi2k@gmail.com

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past horoscopes to determine the likelihood of different events. Prediction of professions using Astrology is determined by the planet positions at the moment of an individual's birth.

In this paper, we attempt to identify the scientific basis using a variety of classification techniques of Artificial Intelligence. Then these techniques can be useful to automatically classify data. Many of the classification methods used here are very similar to what astrology does. The first step in prediction is to perform a variety of classification techniques of artificial intelligence that are considered black boxes for existing methods that have provided excellent results in different fields of classifying data. Next comes the discovery of the attributes that contribute to improving dynamic prediction in Astrology. Once more records are added, the system knowledge can then be updated. The classification techniques will generate rules through the results. Classification techniques are used to create the rules, which will be compared with the rules used to determine their validity. Astrology will be scientifically supported by the similarities between the rules created by classification techniques and those provided by astrology.

2 Literature Review

The recently created branch of supervised classification techniques for artificial intelligence performs well for many tasks related to classification and prediction [1]. It is also capable of handling complex and erratic data. A variety of applications including cancer analysis and diagnosis [2], weather forecasting [3], and machine translation [4], use these techniques. The paper gives a brief overview of the different machine learning techniques and their respective applications.

The influence of planets can be seen in the changing seasons, day and night, and tidal effects. Human life is also influenced by stars and planets. Astrology uses the positions of the stars and planets to predict the course and development of human life. Astrology is a science that has been able to survive the test of time. While there is plenty of literature about astrology, the scientific validity of this subject has yet to be established. Although much research has been done since the fifteenth century to establish the scientific validity of astrology, it is still not conclusive. While some researchers feel that astrology does not have scientific merit [5], others believe that it requires a thorough study of the field to make that conclusion [6]. There is a belief that predictive and not-predictive astrology are two different types of astrology. This belief is supported in part by the notion predictive astrology is the best subject for testing whether prediction can be done using it.

A combination of different learning techniques and large amounts of data on the planetary positions of individuals and their biographies can create a system capable of predicting various aspects of human life. The prediction of human life's outcomes based on the positions of planets and stars has not been well researched. Although no large-scale research has been done to support astrology's validity, initial work in these areas was done in the papers [7, 8]. To predict the profession of a person, this paper examines supervised classification algorithms of artificial intelligence like Logistic, Naïve-Bayes, and Catboost algorithms.

3 Classification Techniques

Artificial Intelligence Techniques can be used to classify and predict. There are many ways to use these techniques. However, some methods work better for certain domains than others. This is why it is essential to compare all methods and determine which one works best for each domain. Artificial intelligence classification techniques allow for the creation of a generalized hypothesis using a collection of data. This allows future predictions to be made based upon the generated hypothesis. These techniques use prior data to develop algorithms that are based upon class labels already known. Created using a training set of data, the algorithms are afterward tested against a separate test dataset for their accuracy verification. This research examines three types of classification methods, Logistic, Naive Bayes and Catboost Algorithms, for astrological prediction for the profession of an individual. Below is a brief overview of the various classification techniques used in this research.

3.1 Logistic Regression

Logistic regression uses a statistical analysis technique to predict a value using prior observations [9]. The dependent variable is modeled using a logistic function. Logistic regression models are used to predict dependent data variables by analyzing relationships between existing independent variables.

The probability of an event occurring $Y = 1$ can be described as the formula.

$$\ln\left(\frac{p}{1-p}\right) = B0 + B1X$$

Ln can be described as a natural logarithm It is a linear regression equation expected probability that for a given value X, $Y = 1$.

$$p = \frac{e^{(B0+B1X)}}{1 + e^{(B0+B1X)}}$$

3.2 Naïve Bayes Classification Algorithm

Naive Bayes algorithm can be described as a supervised learning algorithm that is based upon the Bayes Theorem. It is used to solve classification problems. Naive Bayes Classifier can be used to build fast machine learning models capable of making quick predictions. It is one of the most simple and effective Classification algorithms. It is a probabilistic classification algorithm, meaning it predicts based on the probability of an object. Practically, parameter estimation using Naive Bayes models employs the method of maximal likelihood. Naive Bayes modeling can be used even without believing in Bayesian probability.

Let there are "m" classes: C1, C2, C3, C4…C_m. Naïve assumes class to be independent conditionally [10].

$$P(X|Ci) = \prod_{k=1}^{n} P(Xk|Ci)$$

$$P(X|Ci) = P(X1|Ci) * P(X2|Ci) * \cdots\cdots * P(Xn|Ci)$$

3.3 Catboost Classification Algorithm

The name "Catboost" comes from the words "Category" and "Boosting". It is extremely powerful in two ways. First, it generates state-of-the-art results without the need for extensive data training as required by other machine intelligence methods. Second, it can provide powerful out-of-the-box support to more descriptive data formats associated with many business issues. Gradient boosting machine learning algorithm is the source of "boost", as this library is based upon gradient boosting library. Gradient boosting is powerful and can be applied to many types of business challenges, such as forecasting, recommendation items, fraud detection, and recommendation items. It performs well too. This algorithm can return excellent results even with very little data, as opposed to DL models which need to learn from a large amount of data [11].

4 Methodology

Astrology places a person's future career concerning the planetary positions at the time of birth. To find the planetary positions the following information is needed: Date of Birth; Place of Birth; Birth time of an individual. From the website http://www.astrosage.com/celebrity-horoscope/ date, place, and birth time were scrapped for people of different professions. This data was of 6248 people and the professions included were businessman, politician, cricket player, Hollywood celebrities, Bollywood celebrities, musicians, people related to literature, sportspeople, criminals, astrologers, singers, scientists, football and hockey players. The next task consisted of finding the planetary positions of these well-known personalities at their birth time. For this, free astrology API services provided by https://astrologyapi.com were used. The planetary positions corresponding to the date and birth time were then scraped. Next, the data was processed and cleaned to obtain the required fields for prediction. The profession of the person was determined by taking into account the Full Degree, House, Sign, and Sign Lord attribute for each of Sun, Moon, Mars, Mercury, Jupiter, Venus, Saturn, Rahu, Ketu, and Ascendant. This made it a total of 40 attributes. Finally, the data was modeled and Logistic, Naive Bayes, and Catboost classifications were used to predict the professions of people and determine the one that provides the best results.

5 Result

The Catboost Classification Algorithm produced better results with 14-fold cross-validation, which yielded 98.75% accuracy. Logistic Regression using 14-fold cross-validation yielded results with 51.86% accuracy, while Naive Bayes Classification using tenfold cross-validation gave results of 95.79% accuracy (Fig. 1 and Table 1).

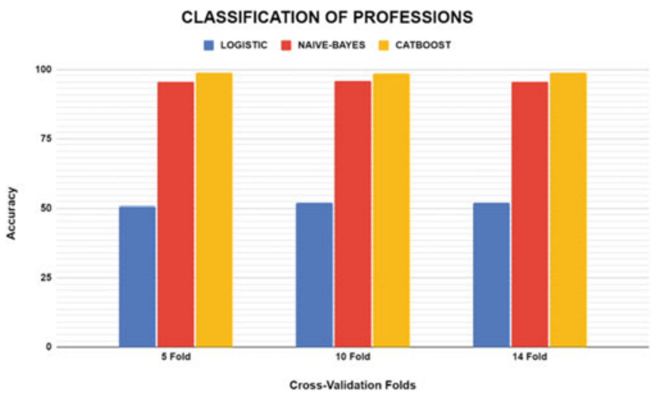

Fig. 1 Accuracy graph for classification of professions using various supervised classification techniques

Table 1 Accuracies achieved by various classification algorithms

	Logistic	Naive Bayes	Catboost
5-fold	50.8	95.6	98.39
10-fold	51.8	95.79	98.48
14-fold	51.86	95.64	98.75

6 Conclusion and Future Scope

The results shown in the figure show that the Catboost algorithm, with its 14-fold cross-validation, is more effective at predicting the profession of a person than any other algorithms. It produced the best results with 98.75% accuracy. The data set was limited to 6243 records. It contained only 14 professions, with very few records in some of the categories. So, it is possible to increase the accuracy by adding more records and other categories.

Additional information about personal details, such as knowledge level and family background, can be also included for accuracy. Other attributes, such as the strength or aspect ratio of the planets and the interrelationship of these planets, can be added for more accurate results. Working with different classifiers allows us to spot the weaknesses and strengths of each method so that we can create a classification algorithm that makes use of the strengths of the classifiers. This will increase the accuracy of prediction. Additionally, different pairs of attributes can be identified and then selected to yield more relevant results.

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Human Emotion Detection Using Deep Learning Neural Network

Naseem Rao, Safdar Tanveer, Syed Sibtain Khalid, and Naved Alam

Abstract Humans can exhibit many emotions during the day, detection of these emotions can play a very important role in technology-based human–computer interaction (HCI). To achieve the detection of emotions, there are many algorithms, based on machine learning and ANN. In the proposed methodology, we are developing an algorithm, using deep learning neural network consisting of two hidden layers, which can detect various human emotions as happy, sad, angry, neutral, sad and surprise. Using the predictive analysis, the algorithm can predict these various emotions. Kaggle datasets is used for training and validating proposed algorithm. The total data set contained 35,340 data items of which 80% is used for training of the algorithm and the remaining 20% is used for testing of the algorithm. After implementing the algorithm of ReLu and SoftMax using Deep Learning neural network, results show that the model is successfully able to predict the emotion with 90% accuracy, in a variety of emotions with different types of faces. Comparison of results with other conventional approaches toward the facial expressions shows that our model does the prediction quite efficiently by extracting the data from the testing set and converting it into a JSON format which can be used as a classifier latter on without pre-processing the image data set again and again which saves both the time and computational power.

Keywords ReLu · SoftMax · Neural network · Deep learning · Human emotion

1 Introduction

Acknowledging human feelings and gestures has piqued researchers' interest, as the ability to recognize one's gestures aids in human–computer interaction, the creation of appropriate advertising campaigns, and the culmination of augmented and enhanced interpersonal language, all by modifying humans' Emotional Intelligence ("EQ"). Some form of machine perception has emerged when machines can enjoy

N. Rao · S. Tanveer · S. S. Khalid · N. Alam (✉)
Department of Computer Science and Engineering, Jamia Hamdard, Delhi 110062, India
e-mail: navedfzd@gmail.com

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their environment. Humans utilize their senses to learn about their surroundings. As a result, machine vision attempts to imitate human perceptions to interact with their surroundings. Machines on here have a variety of techniques to collect their system's condition using cameras and sensors. As a result, by combining this data with appropriate algorithms, machine perception may be generated. The identification of human expressions may be tested in a variety of ways, including facial expressions, body posture, voice tone, and so on. We concentrated on facial expression recognition in this study. Facial Emotion Recognition (FER) is a flourishing study topic in which many breakthroughs are being made in sectors, such as machine translation systems and machine-to-human contact. Human emotion identification has sparked interest in a variety of sectors, notably human–computer interaction [1], animation [2], medical [3, 4], and safety [5, 6].

Sentiment studies employing speech patterns [7] face expressions [8], and EEG may all be used to identify emotions. Because computer vision is the most widely available of the above-mentioned methods, it offers us a quick and straightforward way to extract, categorize, and anticipate the outcomes. Many characteristics can be retrieved and trained for a reasonable face expression detection system using deep learning and notably convolutional neural networks (CNNs) [9]. Nevertheless, it's worth noting that throughout the case of facial gestures, a few portions of the face, such as the lips and eyes, provide the majority of the information, while other parts, like the ears and hair, play a little role.

The image data is not taken directly but is first converted into the written text format which contains only the pixel data in JSON format and H5 file format. These extracted databases are now used to classify the images. Using OpenCV we access an external webcam that compares each frame that it captures with the frontal face data set. After it recognizes the front of the face the data frames that are being captured are being compared and classified using the emotion data set data that we extracted before. The Final accuracy of this expression recognition model using was not predictable as various factors like hardware compatibility and webcam quality error factors could be calculated.

This paper is divided into five parts. The first part introduces the topic of deep learning and emotion detection. The second part includes the latest work that has been carried out in the field of emotion detection. The third part discusses various parts of the methodology being used in the detection and determination of human emotion. In the next part results and discussion is presented after validation, experimental results show the detected faces of emotions after that paper is concluded in the fifth part of the paper.

2 Related Work

Humans can express their feelings by changing facial emotions to show their emotional states. Emotion analysis may be done by analyzing human emotions and an algorithmic approach may be developed using Artificial Intelligence, Deep learning techniques which can help in the field of Robotics and Human–computer interaction. Applications of this algorithm have been developed in the field of emotional health care analysis, in-class for recognizing student emotions, in gender classification, and in various robotics applications to perform some tasks with the help of human facial emotions. Some of the latest works carried out in the field of emotion detection based on human face feature extraction are presented in this section and comparison table of the previous study is also shown in Table 1.

In [10], deep features are collected from the feed forward neural network layers of the Alexie, analysis is performed with linear discriminant analysis classifier technique, and the model is evaluated with the picture databases FER2013 and AffectNet. The proposed technique was shown to be more accurate and efficient in terms of detecting, monitoring, and diagnosing a patient's mental health. In [11], the author introduced an extended deep neural network model for identifying human emotional states, which is trained on two datasets: Extended Cohn Kanade (CK+) and Japanese Female Facial Expression (JAFFE) Dataset. Overall, the proposed DNN model outperforms previous algorithmic techniques for human emotion recognition, according to findings.

In [12], a strategy for emotion identification from 2D gray-level photos was described. The author performed research using the Bosphorus database and created a CNN model with an SVM classifier. A scoring system based on facial expression recognition with pre-trained convolutional neural network (CNN) models is provided in [13]. It consists of an Android mobile application, a web server, and an AI-server that has been pre-trained. Food and the environment are also expected to be graded. The scoring system currently provides three expressions (satisfied, neutral, and unhappy). In [14], a better method for predicting human emotions (Frames by Frames) is described, which uses a deep Convolution Neural Network (CNN) to depict how emotion intensity varies on a face from low to high levels of emotion. The FERC-2013 database was used to train this algorithm.

The CNN model is utilized for face expression identification in [15], and after deployment, 97.01 accuracies were attained on the Cohn-Kanade online data set. The emo F-BVP database of multimodal (facial, body gesture, speech, and physiological signals) recordings of actors portraying diverse manifestations of emotions was initially provided by the author in [16]. The collection includes audio and video sequences of performers expressing 23 distinct emotions at three different intensities, as well as face feature tracking, skeletal tracking, and physiological data. The DBN models outperform state-of-the-art approaches for emotion recognition, according to experimental data.

The author of [17] suggested a deep learning system for learning the features and classifying the emotions of EEG data at the same time. Deep learning is used on the raw signal instead of explicit hand-crafted feature extraction, which makes it different from traditional approaches. The deep learning approach provides a solution by which was before the neural CNN uses three layers of restricted Boltzmann machines (RBMs) epochs from all subjects and then fine-tuning the net subject per subject via back-propagation. Experiments reveal that the suggested framework outperforms traditional algorithms in terms of recognition accuracy [18].

Table 1 Literature review table

References	Author	Technique used	Parameters and results	Data sets	Key-points
[19]	Subraniam et al. (2021)	In this paper, the author proposed a method using CNN to detect seven different emotions	89% accuracy	FER-2013 and image data set	Deep learning, neural network
[20]	Kishan Kondaveeti and Vishal Goud (2020)	In this paper author proposes a comparison of deep learning architectures in Keras for emotion detection. Researcher is using Opencv haar cascade as a classifier and for feature extraction pre trained models such as VGG-16, ResNet152V2, inception V3 and Xception is used for detection 7 faces emotions	VGG-16 a 3.16% accuracy ResNet152v2 82.15% accuracy InceptionV3 77.1% accuracy Xception 78.1% accuracy	Cohn Kanade Dataset (CK+) Japanese female facial emotion (JAFEE) FER-2013	Facial Detection, feature extraction, classification of features using VGG-16, ResNet152v2, InceptionV3 and Xception
[21]	Babajee, Suddul, Armoogum, Foogooa (2020)	In this paper 3 layers CNN deep learning algorithm is developed for identifying 7 emotions	For 100 Epochs 79.8% accuracy is achieved	FER-2013 consists of 32,298 images where 70% of images are used for testing and 30% images used for training	Deep learning CNN

(continued)

Table 1 (continued)

References	Author	Technique used	Parameters and results	Data sets	Key-points
[22]	Pranav, Suraj, Satheesh, Supriya (2020)	In this paper two layer CNN model is used to detect 5 emotions, the output from the first CNN layer is called feature map which is Passed through ReLu for making negative values zero, drop out layer is also used to reduce overfitting into the model. Second layer follows same procedure. In the two network layer one is input and the other is output	0-Angry with 82.75% accuracy 1-happy with 88.63 accuracy 2-Neutral with 94.12 accuracy 3-sad with 98.8 accuracy 4-surprise with 91.76 accuracy	Data Set is collected by using 48 MP Camera of image size 1920 X 2560 with number of training & testing images as 2040 and 255	Keras deep learning, ReLu, SoftMax
[23]	Jaiswal, Krishnama Raju and Suman Deb (2020)	In this paper CNN based deep learning architecture is proposed for emotions recognition	In the proposed model 70.14% average accuracy is achieved for 5 emotions	There are two datasets one is Japanese Female Face Expression (JAFFE) and other is Facial Expression recognition Challenge (FERC-2013) has 32,000 images which contains seven emotions like anger, surprise, happy, sad, disgust, fear, neutral	CNN deep learning, Max pooling, flatten, SoftMax

3 Methodology

3.1 Deep Learning

Deep learning is a hierarchical learning method from a broader category of Machine Learning and the Deep learning is based on Artificial Neural Network which can be supervised or unsupervised learning. It consists of one or more hidden layers which consist of weighted inputs and transfer functions to provide a learned output based on the available inputs. The mathematical representation of deep learning follows the following equations:

$$y = f\left(\sum_{i=1}^{n} w_i + b\right)$$

where 'y' is the output of a node that is a part of one of the hidden layers. Each hidden layer has an activation function which is denoted by $f(.)$ in the above equation. This activation function is applied to the sum of products of the weighted inputs $x_i w_i$ and the bias function (Fig. 1).

3.2 Layer Transformation Functions

The hidden layer used in the algorithm consists of two separate layers. One is a convolutional layer which is transformed into a second hidden layer using an activation function. The activation function used in the algorithm is the ReLU function. The second layer is transformed into an output layer using another activation function,

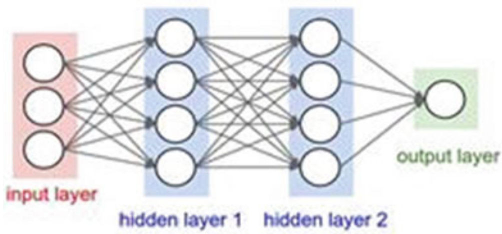

Fig. 1 Deep learning architecture of input layer, hidden layers, and output layers

Table 2 List of data items for different human emotions (ref: Kaggle dataset)

Emotion	Training	Testing	Total
Angry	3993	960	4953
Fear	4103	1018	1521
Happy	7164	1825	8989
Neutral	4982	1216	6198
Sad	4938	1139	6077
Surprise	3205	797	4002
Total	28,385	6955	35,340

the Softmax function. These ReLU and Softmax functions can be represented using the following sets of equations.

- ReLU function: $y = max(0, x)$

  Where 'x' is the input signal from the input layer and 'y' is the output to the second hidden layer.
- Softmax function:

$$ex = e^x$$

$$y' = \frac{ex}{sum(ex)}$$

  where ex is any intermediated variable and 'y' is the output of the second hidden which is transferred into the output layer.

3.3 Emotions Recognition Kaggle FER-2013 Data Set

It is a process of identifying human emotion which includes anger, fear, happiness, neutral, sad, or surprise. It is part of a vast application solution that includes human-computer interaction. For this purpose, a Kaggle data set which consists of 35,340 data items was used. These data items were divided into different emotion categories each for training and testing of the algorithm as shown in Table 2.

3.4 Algorithm

- Collecting the Images as a data set and labeling each face with one of the seven emotion classes.
- The preprocessing part has been done for all Image data set.
- Emoted faces are converted into Gray scale Images.

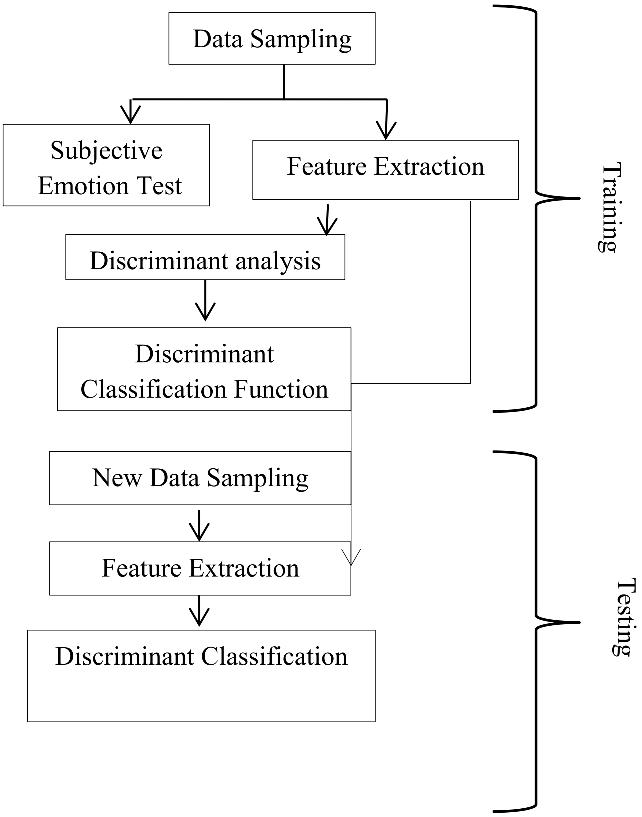

Fig. 2 Flow chart of an algorithm

- Images are fed into Input Layer as (1, 28, 28) Input Array.
- Then in the next step, numpy array is passed in to a 2D convolution layer to generate convolution features maps.
- Maxpooling method is applied as Maxpooling2D that uses (2, 2) size across the selected features to keep maximum pixel value.
- In the Next step, CNN Model Fitting done on testing images and on training images pixels values.
- Model is saved and tested for showing each emotion classes (Fig. 2).

3.4.1 Training

The first step of our algorithm comprises of sampling of the emotion data set wherein we statistically analyzed every item in the data set to group the data according to some specific parametric similarities amongst them.

Now since the training set had a large number of items in it we further form groups of the items with similar attributes by extracting the features of each item and grouping them based on that. The most notable features that could be extracted were the eye, lips, cheek, eyelids, teeth, and more.

Discriminant analysis which is a generalization of Fisher's linear discriminant analysis and it is very similar to analysis of variance and regression analyses was used to distinguish each item among themselves. Linear discriminant analysis is largely employed here to decrease the number of characteristics to a more manageable amount before classification, therefore this looked to be the most promising technique. Each of the additional dimensions is a template made up of a linear combination of pixel values.

Finally, the Discriminant classification function was used as it forms characterized groups of data with each grouped item associated with a particular emotion.

After grouping, we subjectively compared the item with a particular emotion to divide the whole dataset into 6 categories of emotion that are used in our paper.

3.4.2 Testing

As a new sample from the validation set is taken, the first function that is applied to the sample is feature extraction.

Once the features are extracted, the extracted features are compared with the characteristic features of each of the emotion categories. This is done by Discriminant classification function.

4 Results and Discussion

In this section of the results, we are showing the ability of the model to detect face expressions. As you can see various expressions have been recognized successfully after many rounds of trading and image enhancement. The results taken below imply that the model has been able to predict the emotion with accuracy. In a variety of environment and with different types of faces. When compared with other conventional approaches toward facial expressions our model does the prediction quite efficiently by extracting the data from the testing set and converting it into a JSON format which can be used as a classifier latter on without pre-processing the image data set again and again which saves both the time and computational power. Robust facial detection algorithm with invariance properties in terms of translation, scale, and pose inherent in our non-spiking version of the CNN model brings robustness to dynamical changes both in head movements and facial expressions.

5 Conclusion

The algorithm used for detection and determining the human emotion has been executed with success and the results are provided for the validation set. A total of 35,340 data items were used out of which 80% is used for training of the algorithm and the remaining 20% is used for validation of the algorithm. The data set had six different emotions all of which were used for both training and testing of the algorithm. ReLU and Softmax activation functions were used for the transformation of input layer to the output layer with two hidden layers being used.

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Psychological Impact of Using Smartphone on Four- to Ten-Year-Old Children

Savita Yadav and Pinaki Chakraborty

Abstract Children now start using smartphone at an early age and use different types of apps for increasing hours as they grow up. The aim of the present study was to assess the psychological impact of using smartphone on children and, in particular, determine if using smartphone for long hours leads to difficult behavior in children. We conducted the study on 130 children aged between four and ten years. We developed an app to collect usage statistics of smartphones. We asked parents to install the app on the smartphone they lend to their children and use it for at least 30 days. We also asked them to fill in the Strengths and Difficulties Questionnaire for their children. We found that 94 (72%) of the children used smartphone for one hour or more per day. Using smartphone for one hour or more per day was found to be associated with significantly ($P < 0.05$) higher conduct problems scale score and hyperactivity scale score among the children but had no significant effect on their emotional problems scale score and peer relationship problems scale score. Excessive use of smartphone has negative psychological effects and we recommend the use of smartphone be strictly restricted to one hour per day for children up to the age of ten years.

Keywords Children · Smartphone · Psychological impact · Difficult behavior · Hyperactivity

1 Introduction

Many children and adolescents now use screen-based devices for long hours on a daily basis [1, 2]. This makes them miss out on physical play and other outdoor and social activities. The limited physical activities that they manage to get cannot compensate for the negative effects of excessive exposure to the screen [3]. Overuse of screen-based devices affects the physiology and psychology of children [4].

S. Yadav (✉) · P. Chakraborty
Department of Computer Science and Engineering, Netaji Subhas University of Technology, New Delhi 110078, India
e-mail: savitaydv@yahoo.com

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The pattern of how children consume media has changed drastically in recent years [5]. Children now use different types of screen-based devices, viz. television, computers, tablets and smartphones [1]. The effect of these devices on children is not the same [6]. Computers and smartphones are more interactive and can be better personalized than television. Children use computers and smartphones for educational purposes as well as for leisure activities [7]. The types of apps children use on computers and smartphones and their usage patterns are important factors in determining the psychological impact these devices have on children. Children start using smartphones before other devices typically at around two years of age. Although smartphones are useful devices, they are compelling and may lead to addiction [8]. Problematic smartphone use is known to be associated with poor sleep quality, anxiety and depression in adults [9]. However, the impact of using smartphone on children has not been studied in detail so far. Children below the age of ten years are ardent users of smartphone [10] and it is necessary to study the psychological impact of using smartphone on them. The present study aimed to assess the psychological impact of using smartphone on children aged between four and ten years and determine if excessive use of smartphone leads to difficult behavior in children of this age.

2 Methodology

2.1 Instruments

We developed a mobile app to collect usage statistics of a smartphone. The app has two modes, viz. parent mode and child mode. When used in the child mode, the app runs as a background process and records which other apps are being used on the smartphone and for how long (Fig. 1). The app remains dormant and does not collect any information in the parent mode.

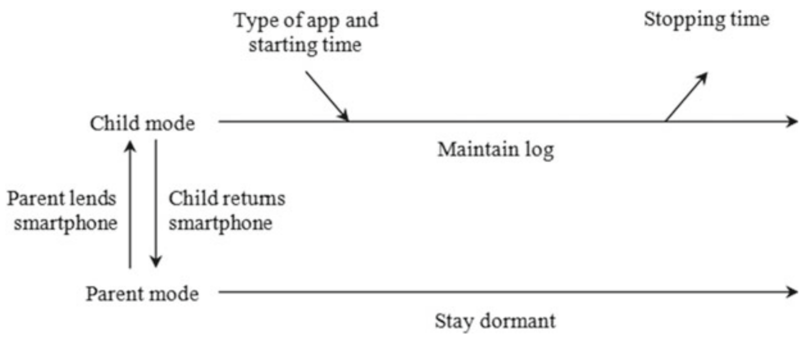

Fig. 1 Workflow of the app to collect usage statistics of smartphone

We used the Strengths and Difficulties Questionnaire (SDQ) developed by Goodman [11] to collect parents' opinion on their children's difficult behavior. SDQ has five scales, viz. conduct problems, hyperactivity or inattention, emotional symptoms, peer relationship problems and pro-social behavior. Each scale has five statements. Parents have to state whether the statements are 'not true', 'somewhat true' or 'certainly true' for their children. The internal consistency and the construct validity of SDQ have been found to be adequate [12, 13]. We used the scales of SDQ related to conduct problems, hyperactivity or inattention, emotional symptoms and peer relationship problems in the present study.

2.2 *Study Protocol*

We used our personal and professional contacts to reach out to the parents of children aged between four and ten years in January 2021. The parents were informed about the purpose and procedure of the present study. We asked the parents to install the app developed by us to collect usage statistics on their smartphone and use it for at least 30 days (Fig. 2). We asked the parents to switch the app to the child mode whenever they lend their smartphone to their children and back to the parent mode when they took it back. We also asked the parents to fill in the first four scales of SDQ. We asked the parents who had multiple children aged between four and ten years to switch the app to the child mode only when giving their smartphone to their eldest child in the aforesaid age range and fill SDQ only for the same child. This protocol ensured that we obtain accurate usage statistics of children without any interference of the usage of the same device by their parents and siblings. We were able to contact 164 parents.

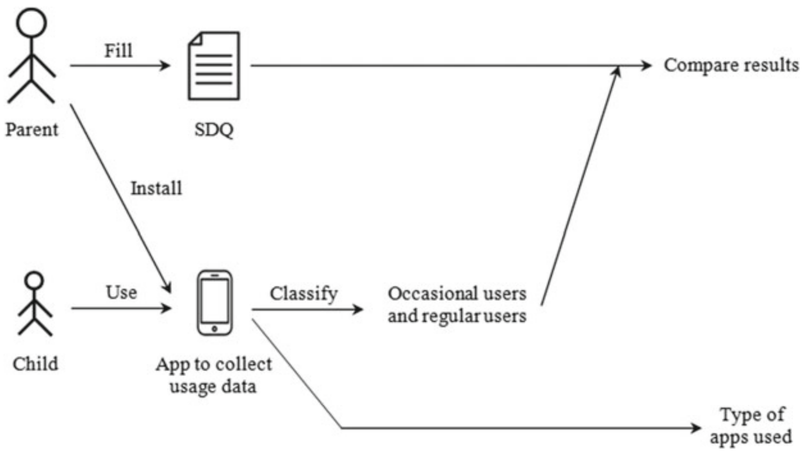

Fig. 2 Experimental protocol

However, only 130 of them consented to participate in the study, installed the app and used it for 30 days or more, and filled in SDQ for their children.

We divided the children into three age groups, viz. four to six years, seven and eight years and nine and ten years. These age groups corresponded to late-preoperational, early concrete operational and late-concrete operational developmental stages. We considered the children who used smartphone for less than one hour per day to be occasional users of smartphone and the children who used smartphone for one hour or more per day to be regular users of smartphone. The threshold of one hour was earlier used by Twenge and Campbell [14]. We also identified the types of apps that were commonly used by the children.

2.3 Data Analysis

We compared the number of occasional and regular users in each age group using chi-square goodness of fit test. We compared the average value of conduct problems scale score, hyperactivity or inattention scale score, emotional problems scale score and peer relationship problems scale score of occasional and regular users in each age group using t-test. The tests were conducted at 95% confidence level using SPSS version 26.0.

3 Results

3.1 Demographic Data

Responses were received from parents of 40 four- to six-year-old children, 41 seven- and eight-yearold children and 49 nine and ten-year-old children (Table 1). Out of them, 41% were female and 59% were male. The responses were provided by fathers for 51% children and by mothers for 49% children.

3.2 Proportion of Regular Users

We found that there were more regular users than occasional users in each of the three age groups (Table 2). Among the children aged between four and six years, 35% were occasional users and 65% were regular users. However, the difference in the number of occasional users and regular users in this age group was not statistically significant ($P > 0.05$). We found that 29% of the children aged seven and eight years were occasional users and the remaining 71% were regular users, while 20% of the children aged nine and ten years were occasional users and the remaining 80% were

Table 1 Demographic data

Parameter	Number of children
Age group	
4–6 years	40 (31%)
7 & 8 years	41 (32%)
9 & 10 years	49 (38%)
Gender	
Female	53 (41%)
Male	77 (59%)
Response submitted by	
Mother	64 (49%)
Father	66 (51%)

Note Percentages may not total 100 due to rounding

Table 2 Proportion of occasional users and regular users

Age group	Number of children			
	Occasional users	Regular users	χ^2-value	P-value
4–6 years	14 (35%)	26 (65%)	3.600	0.058
7 & 8 years	12 (29%)	29 (71%)	7.049	0.008*
9 & 10 years	10 (20%)	39 (80%)	17.163	0.000*

*$P < 0.05$

regular users. The difference in the number of occasional users and regular users among the children aged seven and eight years and the children aged nine and ten years was statistically significant (P < 0.05).

3.3 *Response to SDQ*

The average conduct problems scale score and average hyperactivity or inattention scale score were significantly (P < 0.05) higher for regular users than for occasional users in each of the three age groups (Table 3). These results imply that children who use smartphone for one hour or more per day are typically more susceptible to throwing tantrums, mood swings, restlessness and lack of concentration and self-control.

The average emotional problems scale score of regular users was significantly (P < 0.05) higher than that of occasional users in the seven and eight years age group. However, the difference in the emotional problems scale score among regular users and occasional users was insignificant (P > 0.05) in the other two age groups. Further, the difference in the peer relationship problems scale score among regular

Table 3 Summary of the responses to SDQ

Scale	Age group	Occasional users	Regular users	t-value	P-value
Conduct problems scale score	4–6 years	2.4 ± 2.0	4.0 ± 1.5	2.871	0.007*
	7 & 8 years	1.8 ± 0.8	3.6 ± 1.9	3.507	0.001*
	9 & 10 years	2.6 ± 1.3	4.3 ± 2.2	2.225	0.019*
Hyperactivity scale score	4–6 years	3.2 ± 1.9	6.2 ± 2.1	4.298	0.000*
	7 & 8 years	3.4 ± 2.5	5.8 ± 1.9	3.081	0.004*
	9 & 10 years	4.8 ± 2.8	6.3 ± 1.6	2.224	0.031*
Emotional problems scale score	4–6 years	1.9 ± 1.7	2.5 ± 1.8	1.119	0.270
	7 & 8 years	1.1 ± 1.2	3.0 ± 2.6	2.422	0.020*
	9 & 10 years	2.9 ± 1.9	2.8 ± 2.1	0.074	0.941
Peer relationship problems scale score	4–6 years	1.9 ± 1.5	2.9 ± 2.0	1.605	0.117
	7 & 8 years	2.5 ± 1.5	2.8 ± 2.2	0.376	0.709
	9 & 10 years	3.0 ± 2.6	2.8 ± 2.0	0.312	0.757

$^{*}P < 0.05$

users and occasional users was insignificant (P > 0.05) in each of the three age groups. These results imply that children have almost similar emotional stability and ability to interact with peers irrespective of the time they spend using smartphone.

3.4 Types of Apps Used by Children

Most of the children used apps of different types on smartphone (Table 4). An analysis of the usage pattern of smartphones revealed that 65% of the children used video player apps and they did so primarily to watch cartoons and educational videos. Educational apps and games were used by 35 and 27% children, respectively. Videoconferencing apps, art and craft related apps, instant messaging apps and photography related apps were used by less than 10% children.

Table 4 Types of apps used by children

Type of app	Number of children
Video player apps	85 (65%)
Educational apps	46 (35%)
Game apps	35 (27%)
Videoconferencing apps	8 (6%)
Art and craft apps	5 (4%)
Instant messaging apps	3 (2%)
Photography apps	1 (1%)

$^{*}P < 0.05$

4 Discussion

Twenge and Campbell [14] found that using screen-based devices for more than one hour per day was associated with decreased curiosity, self-control and emotional stability among subjects aged between two and seventeen years. Cho and Lee [15] found that excessive use of smartphone resulted in lack of social skills and difficulty in handling emotions among children aged between one and six years. Further, addictive use of smartphone has been associated with poor sleep quality, anxiety, depression, stress [16], attention deficit and lack of self-control [17] in children. In the present study, we found that using smartphone for one hour or more per day resulted in conduct problems and hyperactivity in children aged between four and ten years. However, no association between excessive smartphone use with emotional problems and peer relationship problems was found.

Edelson et al. [6] found that watching television has worse effects on children than using computers. We believe that the nature of the shows children watch on television and the apps they use on computers and smartphones has a bearing on their psychology. It was encouraging to find that more than one-third of the children were using educational apps on smartphone in the present study. However, large percentages of children were also found to be using smartphone primarily to watch videos and play games.

On the basis of the prior art and the results of this study, we have the following recommendations for parents regarding the use of smartphone by young children.

- Parents should install an app in their smartphone to monitor what apps their children are using and for what duration.
- Use of smartphone by children should be strictly limited to one hour in a day. Further, children should not be allowed to use smartphone at the bedtime.
- Parents should encourage children to watch videos and play with apps that have educational content on smartphone.

5 Conclusion

We found that more than two-thirds of the children aged between four and ten years who participated in this study used smartphone for one hour or more on a daily basis. We also found that excessive use of smartphone is associated with conduct problems and hyperactivity in those children but does not affect their emotional stability and peer relationships. Smartphones are a powerful technology and children are attracted to them. Judicious use of smartphone with suitable apps can play a positive role in child development, while problematic use of the same will have a negative impact on the psychology of children.

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Simulation and Analysis of Test Case Prioritization Using Fuzzy Logic

Sheetal Sharma and Swati V. Chande

Abstract Assertions are frequently used to look for logically impossible scenarios, and they're an important tool for developing, testing, and maintaining software. In order to avoid a software crash or failure, software developers add assertions to their code in locations where mistakes are likely to occur. All software, even asserted software, must be updated and maintained over time. Assertions may need to be changed as well, depending on the type of change made to the upgraded program. New claims can be made in the software's upgraded version, but old claims can be kept. During regression testing of systems that utilize assertions that leverage fuzzy logic, a new approach for prioritizing test cases is described in this work for the first time. Prioritizing test cases based on fault severity, fault detection, and assessment time are the primary goals of this method. The effectiveness of a particular test case in breaching an assertion is evaluated using fuzzy logic techniques based on the history of the test cases based on the above-mentioned criteria in previous testing operations to generate the proposed solution. The proposed system was tested by simulating it in the MATLAB SIMULINK environment and measuring its performance.

Keywords Fuzzy logic · Prioritizing · Regression · Test cases

1 Introduction

The methodical process of developing, operating, and maintaining software is known as software engineering. Going through the software test process helps to produce better-quality software. Figure 1 shows that software testing is a critical part of the SDLC's software development life cycle. In order to discover bugs in software, a team will undertake a variety of software testing tasks [1]. It's a step in the software

S. Sharma (✉)
Research Scholar, Rajasthan Technical University, Kota, India
e-mail: sheetaljoshi2e@gmail.com

S. V. Chande
IIIM Jaipur, Jaipur, India

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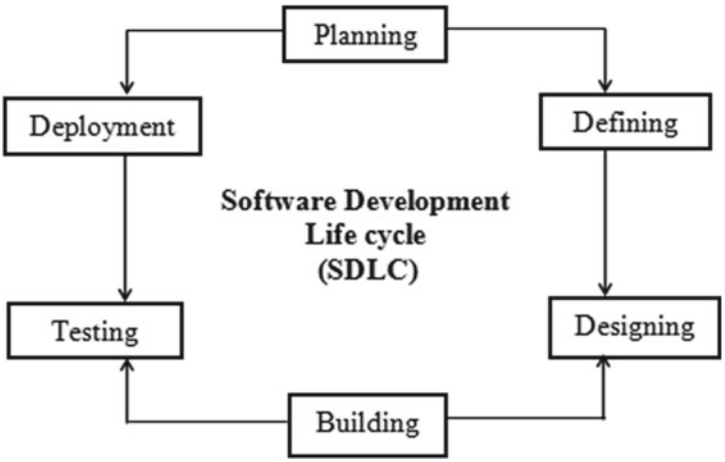

Fig. 1 Software development life cycle (SDLC)

development process that involves assessing software, such as a system, a component, and its features. Software testing is also a procedure for ensuring that a program works as intended. Software testing is the most important stage in the software development process, and it takes a substantial amount of time, effort, and money. Testing a component or system, on the other hand, is a time-consuming and costly operation. There were several authors who asserted that software testing should eat up between 40 and 70% of the development process's time and expense [2].

The present study mainly aims on the regression testing that is most widely used nowadays. The most important factor for any software is the quality of the software. From the literature, it is clearly defined that among the various types of testing approaches, regression testing plays an influential role in controlling the quality of the software. Regression testing is a procedure used after software has undergone changes. In order to re-establish the confidence that the program will execute in accordance with the specification, some test cases must be tested with the changed code [3]. It is possible to modify an existing program by integrating new logic that is created to fix a mistake or make a change. As a whole, regression testing guarantees that the unmodified elements of a program continue to perform as intended while also verifying that the updated program functions as intended as a whole.

Assertion regression testing of programs with fuzzy logic is presented in this work using a unique technique to prioritize test cases [4]. This approach's major goal is to prioritize test cases based on how likely they are to violate a particular program assertion [5]. It should be noted that violating an assertion results in the disclosure of a programming error. It is based on the history of previous testing operations that the efficacy of the test case in breaching an assertion is assessed using fuzzy logic techniques for prioritizing test cases [6]. Claims-based software testing and assertions revalidation studies reported in formed the basis for the approach [7].

This manuscript is organized as Sect. 2 in which literature review is present then in Sect. 3, we describe Basic of Fuzzy logic and our suggested fuzzy test case prioritization approach and Sect. 4 discusses conclusions and future work.

2 Literature Review

There is a dearth of previous study on the use of fuzzy logic for test case prioritizing. A fuzzy expert system is described as being used for regression testing on a telecommunications application [8]. For this study's expert system, the researchers had to gather information from a variety of sources, including consumer profiles, prior test results, failure rates, and changes in system design [9]. Despite the fact that an expert system has demonstrated promising results in the specific application for which it was developed, new applications necessitate the development of a new knowledge base. It is not possible to utilize the suggested test case selection methodology for regression testing programs using assertions since it regards the software under test as a black box.

Recently released a method for ranking test cases that rely on software agents and fuzzy logic. Software agents are being used in this research to gather information about the program's surrounding environment from a number of external sources. Some examples of these resources are an architectural model, a test management tool, a fault management tool, and a change management tool [10].

After assessing data from many sources, this method assigns a TI rating of 1 to 10 to each software module. If a module has a high TI value, it indicates it must be tested more than others. Each test case receives an LP grade based on how effectively it covers a certain software module [11]. Finally, test cases are sorted based on global priority (GP) values, which are a combination of module TI and test case LP values. The concept presented is fascinating, but the sheer volume of data that software agents would have to collect and assess would be prohibitive [12].

The method utilized to estimate the TI, LP, and GP values is also unknown. Prioritizing test cases according to their module-level coverage capabilities rather than statement-level coverage is also described. Due to the fact that most software mistakes are produced at the statement level rather than the module level, this technique is difficult to adapt and compare with the majority of the current approaches for prioritizing test cases. The primary objective of prioritizing approaches is to enhance the likelihood of finding flaws sooner in the testing process. Furthermore, the goal of the test case prioritizing approach is to reuse past test cases for future testing [13].

The major goal of the technique described in this work using fuzzy logic is to rank test cases based on their Fault severity, Fault detection and evaluation time. More specifically, given a set of test cases, our goal is to arrange them based on their projected likelihood to violate a certain program claim [14].

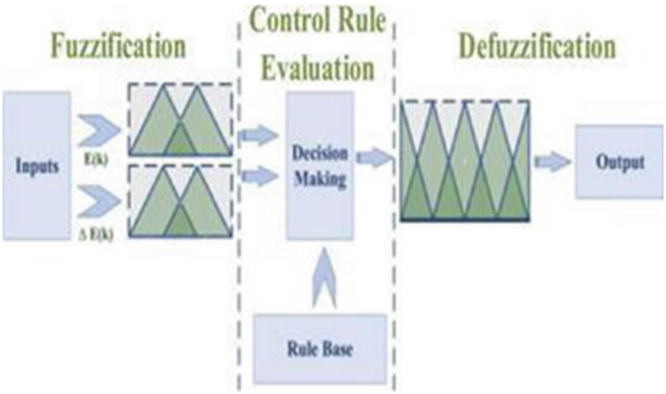

Fig. 2 Block diagram of fuzzy logic

3 Basics of FL (Fuzzy Logic)

Despite the fact that the idea of fuzzy logic has been explored since the 1920s, Lotfi Zadeh, a professor at UC Berkeley in California, coined the phrase fuzzy logic in 1965. He discovered that traditional computer logic was incapable of handling data that represented subjective or ambiguous human concepts [15].

Fuzzy algorithms have been used in a variety of disciplines, ranging from control theory to artificial intelligence. It was created to help the computer to distinguish between data that is neither true nor untrue. Something like the human reasoning process. As in, a little bit of darkness, a little bit of light, and so on [16].

FL is a computing method based on "degrees of truth" rather than the usual "true or false" Boolean logic upon which the modern computer is constructed. When examining fuzzy logic, regard it as the way thinking truly works, and binary, or Boolean, logic as a subset of it. The basic block diagram of fuzzy logic is shown in Fig. 2.

Fuzzification is the technique of converting a crisp input date into fuzzy data using knowledge base information. Fuzzification employs a variety of membership functions such as triangular, Gaussian, and trapezoidal. To begin with, the breakdown of an explicit verbal variable occurs in the form of compound language words.

The language words are the distinct aspects of this decay, which reflects a portion of the overall disease data. Non-fuzzy (crisp) input data is converted into fuzzy linguistic words using membership functions [17].

4 Basics of MF

The membership function (MF) is a graphical representation of the amount of involvement of individual inputs. The MF, which acts as a purpose of overlap among the

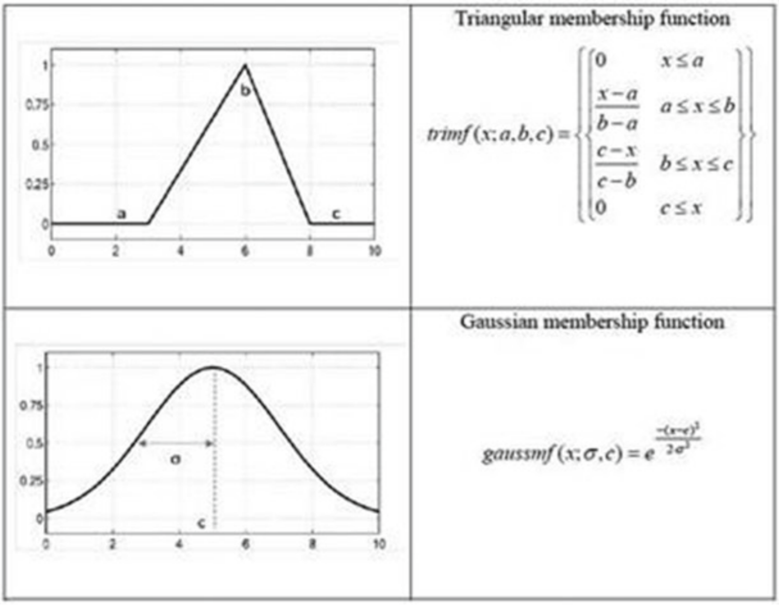

Fig. 3 Example of membership function (MF)

inputs, gives a specific value to each effort. As a result, the output response is likewise influenced by the membership function. The "configuration" or form of the membership function is an important deciding element. These are triangular, Gaussian, sigmoid, modified bell, and trapezoidal forms. The degree of membership function ranges from 0 to 1. Figure 3 depicts many forms of membership functions:

5 Formation of Fuzzy Logic

In a fuzzy logic system, fuzzy rules regulate the output variables. Fuzzy logic-based systems generate a theoretical framework for generating logical assumptions amid incorrect frames of reference. In fuzzy logic technological systems, this is referred to as approximation reasoning. Fuzzy logic uses a variety of subjects and verbs, such as fuzzy operators and fuzzy sets, as well as rule declarations such as "if–then." The "if–then" declarations are also recognized as the "if–then" statements in fuzzy logic (Fig. 4).

Fig. 4 Fuzzy-based rule system

6 Process of De Fuzzification

Defuzzification is the process of using membership functions to turn a fuzzy interference engine's output into a crisply defined one. Defuzzification methods include Mean, Centroid, First and Last of Maxima, Weighted Average, and Bisector of Area (BOA). Depending on the features of the application, an appropriate defuzzification technique is selected to carry out the defuzzification process [18].

7 Proposed Methodology

The framework shows number of test cases related to test problem are initially prioritized on the basis several factors like bug history, code information, time, etc., using Fuzzy logic, the priorities will be set. Once the prioritization has been done with the help of fuzzy classifier different clusters can be obtained by applying any one of the available clustering techniques like K-Means, etc. Further in the extension to this with the application of Machine learning the accuracy or rate of fault is detected (Fig. 5).

8 Result

We created a Fuzzy Logic controller (FLC)-based TCP and simulated it with MATLAB Simulink program to acquire the production of numerous control mechanisms, which we utilized in this study. We achieved detailed imitation grades for the FLC-based TCP scheme.

We picked three subsets for the fuzzy logic controller's input and output variables: low, medium, and high. For the membership functions, we used trapezoidal forms. The input membership variable set has been expanded (Figs. 6, 7, 8 and 9).

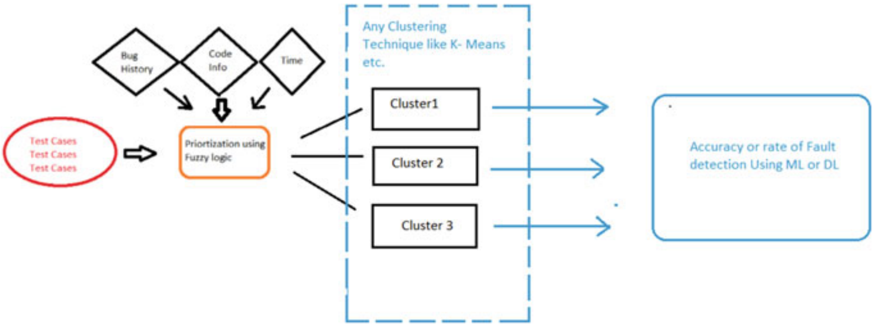

Fig. 5 Proposed framework

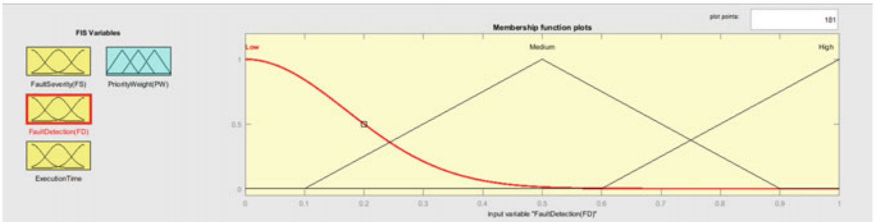

Fig. 6 MF for fault detection

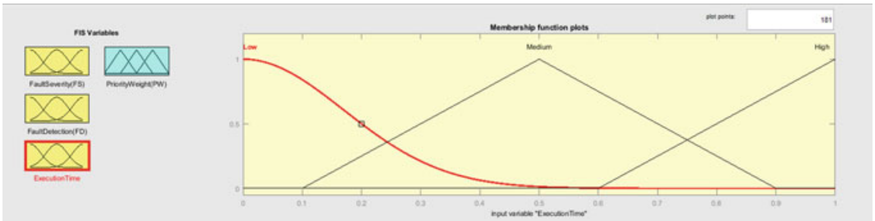

Fig. 7 MF for Execution time

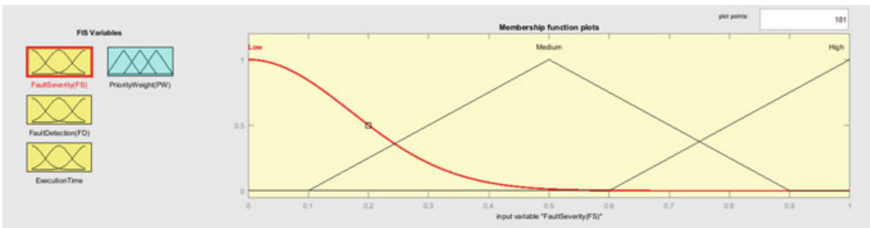

Fig. 8 MF for Fault severity

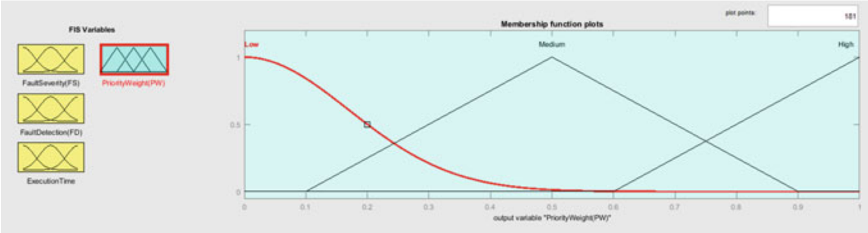

Fig. 9 MF for output variable Priority weight

9 FCR (Fuzzy Control Rules)

Fuzzy control rules have been found through system behavior analysis. To improve the overall performance of the FLC-based TCP certain control rules are defined on the basis of parameters like FD, FS, ET. On the basis of the parameters discussed above a FLC system is designed and simulated in MATLAB.

10 FCR Tuning

The fuzzy rules for the proposed system were developed and validated using MatLab Simulink. The Table 1 shows the fuzzy rules based on the defined membership functions.

Using the MATLAB Simulink program, we built and simulated the fuzzy logic algorithm-based controller (Figs. 10 and 11).

Figure 12 depicts a graphical depiction of the rule base.

Figure 13 depicts the rule viewer, which describes the functioning of the fuzzy-based controller:

After modifying the fuzzy controller in MATLAB, the FIS file was produced. The performance of the fuzzy controller was evaluated by monitoring the output of the fuzzy-based controller at various input values, as shown in Figs. 14 and 15.

Table 1 FCR detail

TCP\Output	Low	Medium	High
Low	High	High	Medium
Medium	High	High	Medium
High	Medium	Medium	Medium

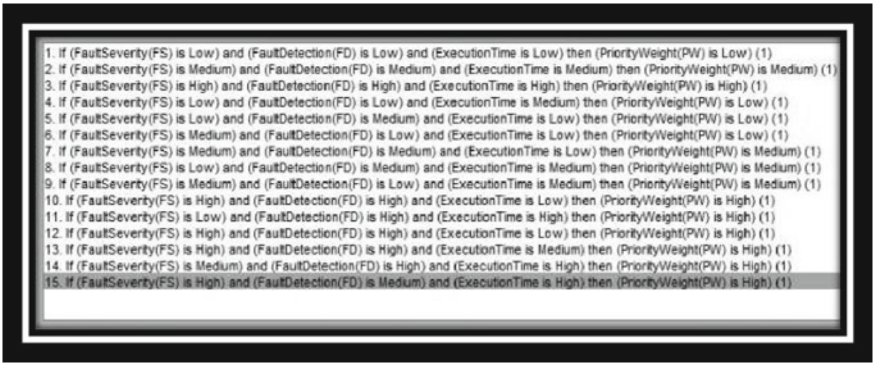

Fig. 10 FCR for fuzzy controller

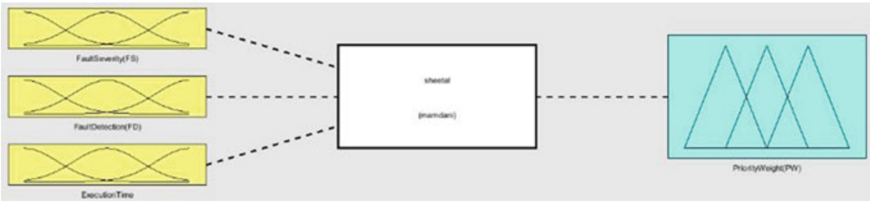

Fig. 11 Fuzzy logic design

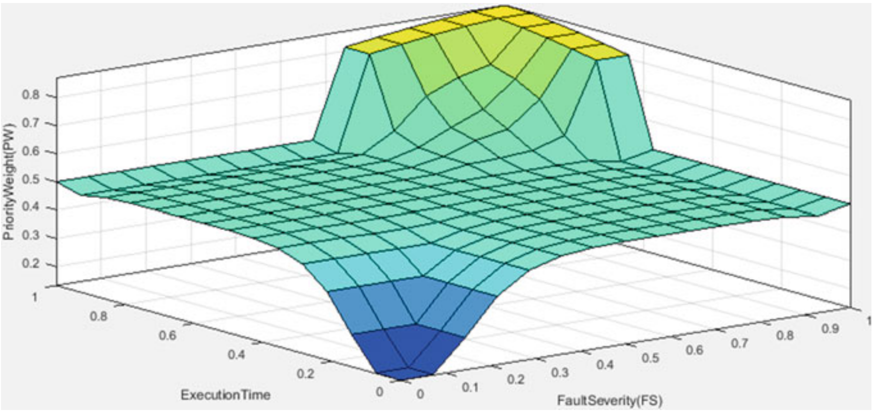

Fig. 12 Surface plot for various parameters

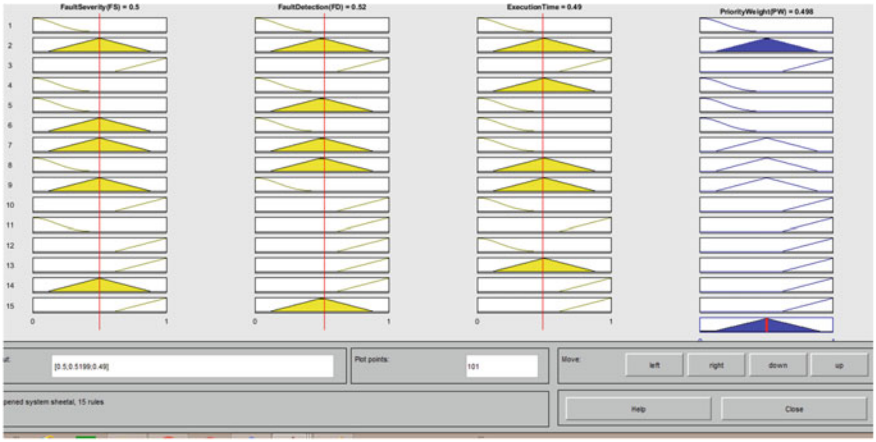

Fig. 13 Diagram of rule viewer for FLC

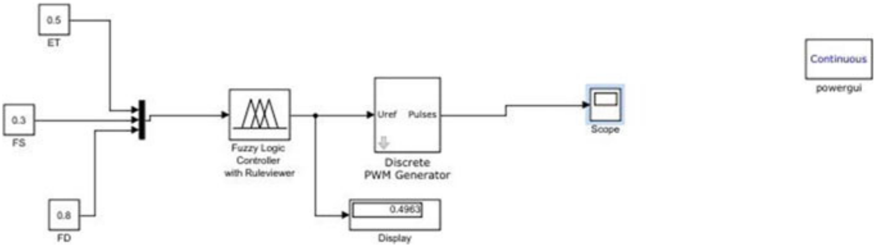

Fig. 14 FLC Simulink model for TCP

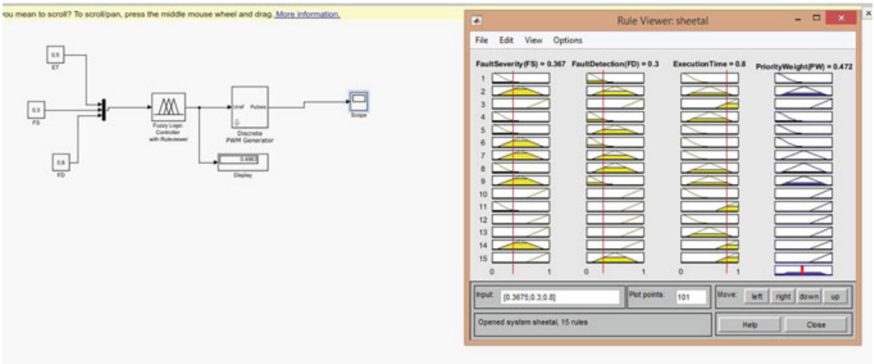

Fig. 15 The fuzzy controller Simulink model for TCP with rule viewer

11 Conclusion and Future Scope

In this work, we have found out a technique in which TCP can be done using FLC on the basis of very important factors like FS, FD, and ET. We presented a solution for the problems that occur in prioritization of Test cases efficiently using FLC. A fuzzy logic-based algorithm is proposed in this paper on the basis of the rule defined for the Priority of Test case is defined automatically using Fuzzy logic. We have tested the models toward validation using different test cases. We performed simulation of the fuzzy-based TCP model for the system to measure the performance of the system in real-life applications. Then, to formulate the Fuzzy logic-based algorithm, the Fuzzy Logic Toolbox was used in MATLAB Simulink. Our method builds on previous work in the areas of assertions-based software testing and assertions revalidation, both of which we consider important. We carried out an experiment to test the proposed method, and the results look good. However, more study is required to assess the method's suitability for commercial software.

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An Empirical Analysis of Fixed and Fuzzy-Based Traffic Congestion Control System

Amarpreet Singh, Sandeep Kang, Alok Aggarwal, and Kamaljeet Kaur

Abstract Traffic Management in an optimum way seems to be an effective way to reduce traffic congestion over various intersections. The core idea behind this optimality is to provide green time for dynamic traffic flow changes in urban areas. As the vehicles are waiting in the queue during red light time, an effective control system is required to reduce the waiting time. In a fixed time/conventional traffic system green light is turned on for a fixed time in each direction. Such systems are generally pre-programmed or the fixed delay in each direction can be controlled manually and hence requires a human operator to make the desired changes, as and when required. Also, a human operator will change this for a limited number of times in a day. However, this process can be automated by using fuzzy control systems. In the fuzzy controlled traffic systems, the on time of green light is adjusted (during each transition of traffic lights) depending on the different input parameters such as Queue length, Time of the day, Arrival Rate and Waiting Time, etc. Adjustment in number of transitions indicates the flexibility/adaptive nature of fuzzy controlled system. In this paper, the novelty in the field of traffic engineering is introduced by computing the relative significance of identified parameters. Various fuzzy models with three input parameters, i.e., Arrival rate, Queue length and Waiting Time are implemented and comparative performance analysis of the seven fuzzy models hence obtained, is presented. The performance of all the implemented fuzzy models is also compared with the conventional traffic system. A traffic simulator is implemented in MATLAB to generate the real-time traffic conditions, each system is simulated

A. Singh (✉) · S. Kang
University Institute of Engineering, Chandigarh University, Ajitgarh, Punjab, India
e-mail: apsingh13g@gmail.com

S. Kang
e-mail: sandeepkang.cse@cumail.in

A. Aggarwal
School of Computer Science, University of Petroleum and Energy Studies, Dehradun, India
e-mail: alok.aggarwal@ddn.upes.ac.in

K. Kaur
Star Academy, Yamunanagar, Haryana, India
e-mail: lotus.k30@gmail.com

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and compared for all possible combinations of traffic density. Fuzzy model with two input parameters Queue length and Waiting Time outperforms the other systems and provides 23.69% average improvement in the delay observed by the vehicles waiting in the queue.

Keywords Fuzzy traffic control · Arrival rate · Queue length · Signal transitions · Waiting delay

1 Introduction

Well-planned infrastructure and effective road management always help the people of any country to move safely from one place to another. But the unexpected growth of population in almost every part of India especially in urban areas leads to an increase in number of vehicles. As per Road Transport Year Book 2011, a total of 0.3 million number of vehicles have been registered in year 1951, whereas in year 2012 it rose to 159.5 million and may rose to 206 million to 309 million by year 2040 in countries like India [1]. On the other hand, the road infrastructure developments and road capacity are unable to meet the demands of increasing traffic. Traffic handling in almost at every intersection of urban areas uses fixed time signal controls. These controls use fixed phase system of green, yellow and red lights and are not adequate enough to handle dynamics of real-time traffic.

Traffic congestion is generally observed due to two reasons, i.e. Recurring/Expected and Non-recurring/Unexpected. It is generally easy to deal with the recurring traffic as it is occurring at the same place every day at the same time. Whereas, any random/unplanned/temporary event causes non-recurring/unpredictable traffic condition on road. The congestion problem is unfortunately growing day by day in almost every city of India such as Delhi, Mumbai, Bengaluru and Kolkata which further leads to huge wastage in economy. In India, an economic loss of 1.47 lakh crore annually has been reported in these cities as reported by global consultancy firm [2]. Moreover, an economical loss of US$124 billion was borne by United States Government in 2014 [3]. Whereas European Union suffered a loss of 1% of their GDP due to traffic congestion [4]. Further, the traffic problem will become more dreadful, if not managed properly and may cause other adverse effects on traveling time, fuel consumption and threat to environment.

To address the problem of congestion in urban areas, a lot of research in terms of Intelligent Transportation Systems (ITS) has been conducted to make traffic management systems safer, efficient and eco-friendly and plenty of solutions have been presented in literature. The paper is organized into five Sections. Section 1 describes the introduction to the problem of traffic congestion; Sect. 2 describes the research carried out in this context by different researchers. Section 3 details the implemented systems and the methodology used for finding the significance of various input parameters. Section 4 discusses the results and the conclusion of the paper is given in Sect. 5.

2 State of the Art

From the last few years, a lot of proposals in terms of Intelligent Transportation System (ITS) toward traffic light optimization have been presented. Among these proposals, Artificial Intelligence (AI) and fuzzy logic-based proposals have gained much popularity as an effective way of controlling traffic at signalized intersections in urban areas. The green time requirement and delay on each phase with optimal cycle length are calculated by Webster [5]. Fuzzy logic theory proposed by Zadeh [6] has been widely applied over traffic problems for urban areas by Pappis and Mamdani [7], Nakatsuyama [8], Favilla et al. [9], Bisset and Kelsey [10], Chiu and Chand [11], Kelsey et al. [12] and Trabia et al. [13]. The isolated intersection traffic control systems such as SCOOT [14], SCATS [15], RHODES [16], FLMuSiC [17] have also been developed. Niittymaki [18, 19] has given framework for real-time traffic systems using Lukasiewicz's multiple/many valued logic and carried out simulations using HUTSIM. Optimisation of signal timing for isolated intersections has been carried out LHOVRA [20], MOVA [21] and SOS [22] algorithms. Distributed Geometric Fuzzy Multi agent and Type-2 fuzzy set based Multi agent Controller for urban traffic system has been designed by Balaji and Srinivasan [23, 24] and these implementations are compared to Green Link Determining (GLIDE) and Hierarchical Multi agent System (HMS). Traffic controllers based on fuzzy neural network, two-stage fuzzy controller and Type-2 fuzzy logic controller (Gravitational Search Algorithm based model) designed by Cheng et al. [25], Yan Ge [26] and Bi et al. [27] respectively. Another useful proposal by (Logi et al. [28]; Pranevičius et al. [29]; Olivera et al. [30]; Das et al. [31]) to address the traffic congestion at intersections has been developed.

Apart from the above proposals, recently some new innovative ideas have been presented to alleviate the congestion over roads. A straightforward traffic modeling over urban area intersections of various cities such as Manhattan, New York has been presented and controlled the large-scale signalized intersections in an optimum way in comparison to traditional approaches. Further, to address the congestion conditions and to control the duration of green lights, framework has been presented by Bianchin and Pasqualetti to achieve the goal of optimality toward mass departure of vehicles. Later on, the proposed model and framework have been evaluated by carrying out the macroscopic and microscopic simulations [32]. Based on Webster Delay Formula, a logarithmic delay modeling paradigm has been presented in order to compute the parameters such as cycle length, vehicle delay, fuel consumption and emission. Various simulations have been carried out to meet the demands of traffic using INTEGRATION simulation software. The model proposed by Calle-Laguna et al. effectively utilized cycle length in an optimum way [33]. A novel arithmetic mean theorem approach to address the problem of congestion in India's metropolitan cities has been proposed. The system considers both static/dynamic road network conditions along with network topology parameters and finds out the nodes responsible for congestion. In 2019, Jain et al. proposed an approach utilizing RFID detectors for finding the parameters such as vehicle count and velocity [34]. Kumar et al. proposed an intelligent traffic controller, based on dynamic traffic algorithm, considered queue length, waiting time and rate, assigns the time duration for the queue formed at each road. The system is utilized as three step procedure, i.e., collection of data, processing of data, and the decision-making system [35]. For determining the priority of road-based segment along with vehicles emergency management, a framework based on traffic information optimization is developed by Maya et al. The deployed sensor nodes observe the desired traffic information and then fuzzy logic is applied for the determination of priority assignment. The applicability of congestion aware routing algorithm and simulated results show reduction in waiting time experienced by vehicles in emergency [36].

Aleko and Djahel proposed an Adaptive Traffic Light Control System (ATLCS) which ensured synchronization between the consecutive traffic lights and allow the vehicles to get the green phase by minimizing the "stop and go" procedure. ATLCS results in considerable improvement in traveling time [37]. Celtek et al. designed a Social Learning Particle Swarm-based Optimization (SL-PSO) method for real-time traffic control and simulated it using Simulation of Urban MObility (SUMO). The method is analyzed with respect to real-time traffic data of intersection in Kilis (City in Turkey) and has shown considerable improvement in average travel time [38]. Ng and Kwok applied an evolutionary algorithm-based approach for both Fixed Cycle Traffic Light (FCTL) system traffic model and Intelligent Traffic Light System (ITLS) traffic model, simulated and evaluated those for peak and non-peak traffic hours [39]. Traffic flow analysis at a junction in Bangladesh is conducted by Roy et al. using MATLAB and Arena software with the idea to minimize the queue formed at intersection and finding out the waiting time range. The analysis is conducted with respect to Webster's equation and also results in an optimum way for traffic control [40]. Sukhadia et al. described a Smart Traffic Governance System based on Artificial Intelligence that monitors the traffic scenarios in urban cities and also analyzed a range of data inputs. It is suggested that a systematic approach that considers cost and delay provides an efficient mean of traffic handling during dense traffic conditions [41].

3 Implementation

Fuzzy logic can be used to improve the traffic state at the remote intersections of the cities. Also, these systems can be combined with other AI techniques to alleviate the traffic congestion problems. From the literature survey three important parameters, i.e., Queue length (QL), Arrival Rate (AR) and Waiting Time (WT), used by many researchers were identified and their performance comparison is conducted. Queue length represents the length of roads filled due to traffic and it is proportional to the traffic density. In the implemented system, the sum of current vehicle count on all the three waiting lanes is taken as the Queue length. The vehicle count is updated after every sampling interval. Arrival rate is the rate at which vehicles reach the other three lanes which are facing red signal. More the number of vehicles reaching at the junction more is the arrival rate. Waiting Time is the total waiting time observed by the vehicles waiting at other three sides of the intersection when traffic is allowed to pass from the fourth side.

The performance comparison of different models is conducted on the basis of delay in waiting time observed by vehicles waiting for their turn to pass the intersection and the number of transitions in traffic signal in both fixed time as well as fuzzy controlled systems. Experimental simulations were conducted with all the three parameters, i.e., Queue length, Arrival Rate and Waiting Time. To adjudge the order of significance of these parameters, three more experimental simulations were conducted by eliminating one parameter in each case and another three by considering only one parameter at a time. The simulation results of 3 existing models [42–44] and 4 models implemented in this research work are compared here. The input combination of all the implemented systems is shown in Table 1. The input and output parameters, their universe of discourse, type of membership functions of each parameter and their specifications were fixed for all the experiments. The membership functions of each input and output parameters are shown in Figs. 1, 2, 3 and 4.

Also, to maintain a uniformity in experiments, same method of implication and defuzzification are selected and the rulebase formed was also similar to the maximum extent. All the fuzzy models and the fixed delay traffic systems were designed, implemented and simulated in MATLAB. Each implemented fuzzy system is compared to the fixed time model and the reduction in waiting time observed by vehicles standing

Table 1 Input Parameters considered for implementation of each fuzzy model

Input	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Arrival rate	√	√		√	√		
Queue length	√		√	√		√	
Waiting time		√	√	√			√

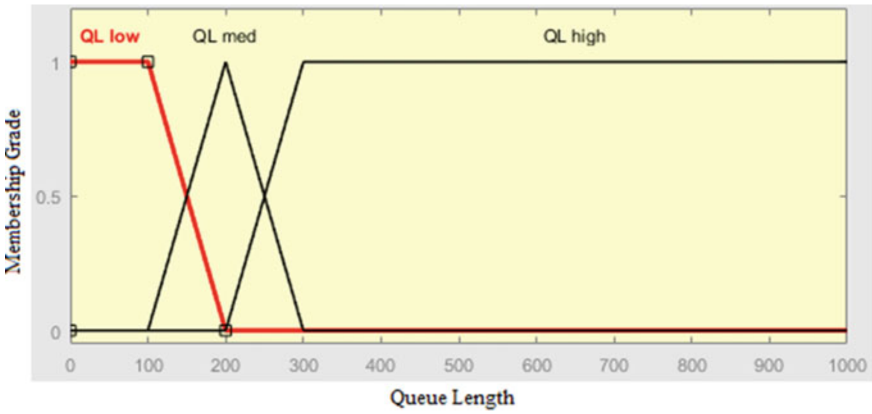

Fig. 1 Membership function specifications of input parameter: Queue Length

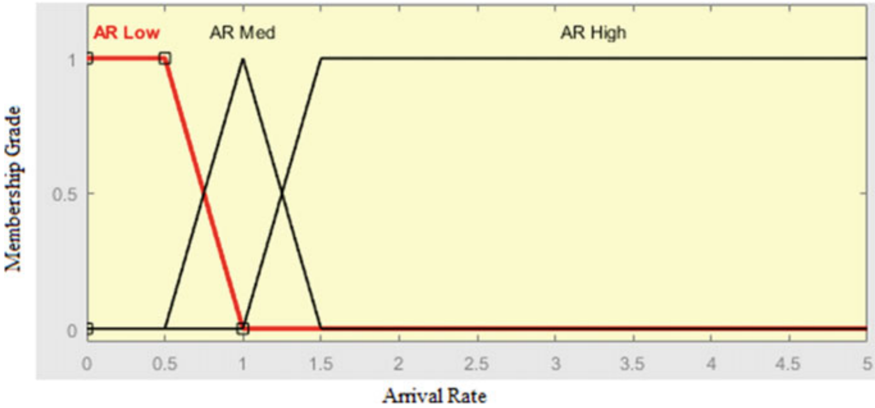

Fig. 2 Membership function specifications of input parameter: Arrival Rate

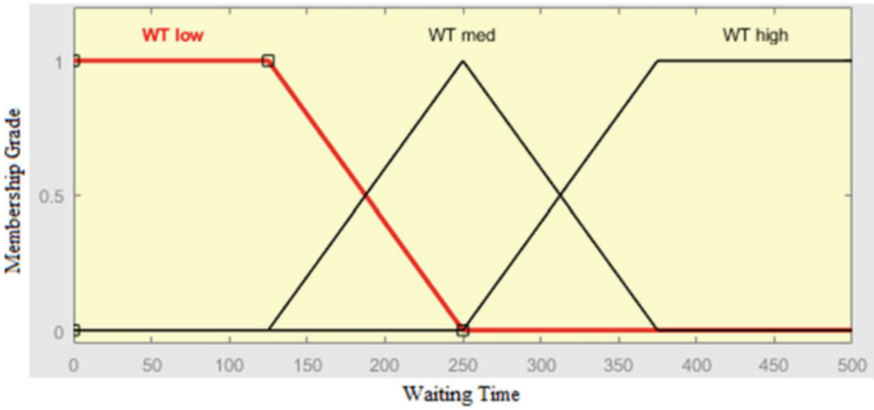

Fig. 3 Membership function specifications of input parameter: Waiting Time

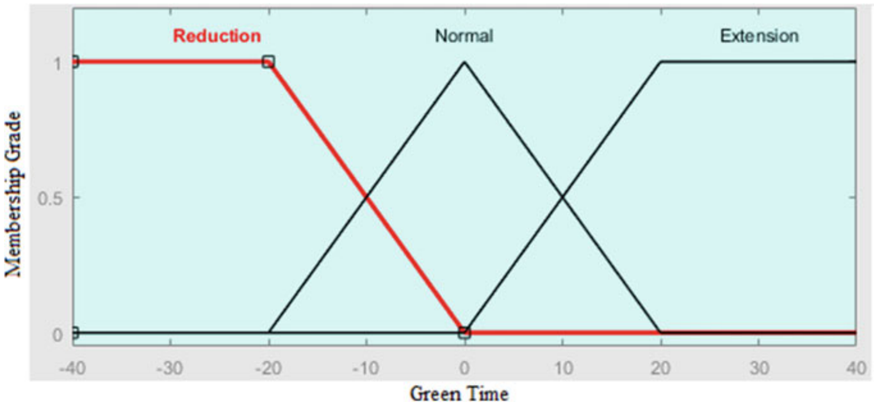

Fig. 4 Membership function specifications of output parameter: Green Time

in queue is noted and considered as improvement in system. Also, in the fixed time systems, the time allowed to pass the traffic in each direction is fixed and hence the number of traffic signal transitions in a fixed time remains same. However, when the timings of green light are controlled by the fuzzy models the number of signal transitions is varied depending upon the traffic at the intersections. This indicates the adaptability of fuzzy models and the average transitions of green lights is also compared for all the models in the next section.

4 Results and Discussion

The performance of the fixed time system and each fuzzy system is observed for varying traffic density to mimic the real-time traffic conditions. As the traffic density on each side of the road is independent of the other sides hence, 3 cases of traffic density, i.e., Low, Medium and High is considered in each direction of four-way intersection, independent of the each other and this led to total of $3^4 = 81$ cases of traffic density. Each system is simulated for 2 h with each of 81 cases of traffic density and to obtain a representative value of the entire set, this simulation was performed 20 times for each case and then an average of these readings is taken to observe the reduction in the waiting time observed by the vehicles waiting in the queue. This completed a single trial and the average improvement of 81 cases is then compared with the fixed time system to obtain the percentage improvement in the average delay observed by the vehicles standing in the queue. A total of 15 such trials were run and the average of the percentage improvement in delay observed by the vehicles waiting in queue is presented in Table 2. In this Table, results of each system are presented column wise. The reduction in delay is achieved due to flexible green time in fuzzy systems. In fixed time systems, number of transitions of traffic lights is fixed and when the transition of green light occurs at an interval of 60 s, then the total number of signal transitions occurring in 2 h is fixed and is equal to 120. However, in fuzzy systems, these signal transitions are adjusted according to the traffic density and is presented in Table 3. First column represents the case number of 81 cases of traffic density. The value listed in the table under each model is the average signal transitions for a particular case of traffic density obtained in 15 trials. Average signal transitions for every model are listed in the last row of Table 3.

Initially, four fuzzy models with two inputs and three inputs, i.e., Model 1 to 4 of were considered for experimentation. From the results of these models, it was observed that in all the runs, the performance of all the four systems is consistent and it also depicts that the fuzzy model based on just two inputs viz. Arrival Rate and Queue Length provided maximum improvement among first four fuzzy models with two and three input parameters. As the system with two parameters performed even better than Model 4 (with all the three parameters taken together), it motivates to include the comparative performance of the fuzzy systems with single input parameters. We ran three more experiments with single controlling parameters and the results obtained have unveiled another important observation about the fuzzy models. Fuzzy models

Table 2 Percentage improvement in 15 trials of each system with respect to Fixed time traffic control system

S. no	Model 1: QL and AR	Model 2: AR and WT	Model 3: QL and WT	Model 4: QL, AR and WT	Model 5: QL only
1	21.36	10.93	23.64	21.32	20.10
2	21.61	10.83	23.73	21.03	19.99
3	21.36	11.24	24.01	21.81	20.21
4	21.65	11.61	23.94	21.39	20.30
5	21.96	11.42	23.40	21.94	20.42
6	21.68	11.41	23.73	21.36	20.06
7	21.93	11.40	24.25	21.08	19.99
8	21.61	11.03	23.59	21.51	20.28
9	21.50	11.28	23.94	21.48	19.96
10	21.63	11.41	23.53	21.26	20.33
11	21.44	11.17	23.92	21.05	20.10
12	21.35	11.82	23.39	21.31	20.37
13	21.61	11.59	23.60	21.47	20.14
14	21.76	10.75	23.21	21.18	19.97
15	21.47	10.99	23.56	21.20	20.05
Average percentage improvement	21.60	11.26	23.69	21.36	20.15

with single input Arrival Rate or Waiting Time have shown negative performance but with only Queue Length (Model 5), system has provided an average percentage improvement of 20.15% over the fixed delay model. From the Table 2, it is apparent that Model 3 outperforms all other models, with average percentage improvement of 23.69%. Further, the models with Queue Length as one of its parameters perform well as compared to Model 2. Hence, it may be concluded from the current experimentations that the Queue Length is the most significant parameter among the three parameters considered for this research work. It is recommended to include this parameter for controlling traffic congestion at intersections.

5 Conclusion and Future Scope

In this paper, to compute the significance of various parameters an extensive comparative performance analysis of various fuzzy models for traffic congestion control is performed. Three existing fuzzy models with two input parameters and four other models possible with the same input parameters were designed, implemented and simulated. Five fuzzy models that perform better than conventional system, are

Table 3 Traffic signal transitions for each of 81 cases* of traffic density

Traffic Case	Model 1: QL and AR	Model 2: QL and WT	Model 3: AR and WT	Model 4: QL, AR and WT	Model 5: QL only	Fixed delay model
1	206	120	120	206	206	120
2	204	120	120	204	206	120
3	162	119	103	160	163	120
4	204	120	120	204	206	120
5	199	120	120	199	206	120
6	149	115	101	144	154	120
7	196	119	120	196	206	120
–	–	–	–	–	–	–
–	–	–	–	–	–	–
53	152	100	120	152	206	120
54	122	96	96	109	135	120
–	–	–	–	–	–	–
–	–	–	–	–	–	–
75	120	100	92	117	128	120
76	159	106	103	160	169	120
77	136	100	99	131	161	120
78	116	96	91	104	118	120
79	150	100	100	148	167	120
80	130	96	97	120	158	120
81	115	92	90	97	112	120
Average	161	110	108	159	175	120

* Only partial table is given here to reduce the space required

compared for their signal transitions at the intersection and the waiting delay observed by the vehicles waiting in queue. Model 3 with two inputs, i.e., Queue Length and Waiting Time outperforms all the compared models and the comparative performance is shown in Fig. 5.

In 15 trials, the average of percentage improvement obtained in this case is 23.69%. It is concluded that, the performance of fuzzy models largely depends of the choice of input parameters chosen to control the green light time. Out of the three parameters considered for comparison in this work, Queue Length is found to be the most significant parameters and shall not be ignored while designing a fuzzy-based traffic congestion control system. In this study, parametric specifications of all membership functions, implication operators and defuzzification method for all the models were kept same to make an authentic comparison. However, if they are changed and each system is tuned separately, the corresponding performance may improve.

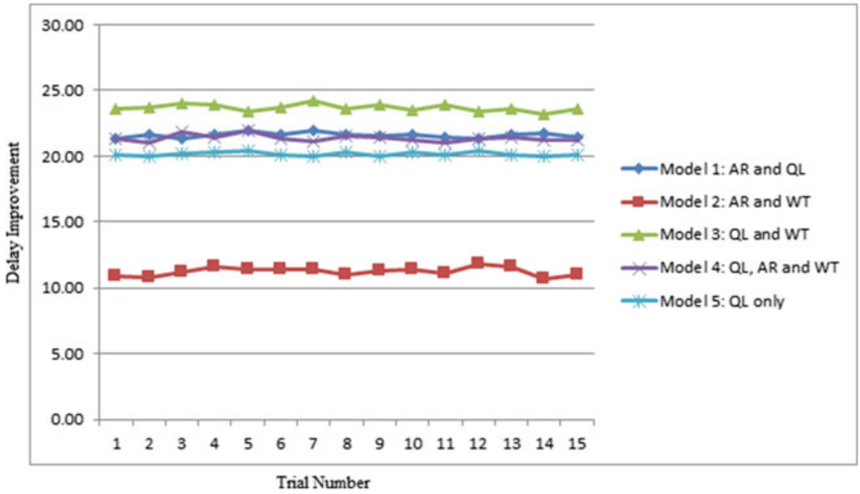

Fig. 5 Average of Percentage Improvement in Delay observed by vehicles for 81 cases of traffic density

Hence, there is a scope to implement these systems with tuned if–then fuzzy rules or parametric specifications and will be worked upon in future.

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Research Trends in Routing Protocol for Wireless Sensor Network

Subhra Prosun Paul, Shruti Aggarwal, and Sunil Chawla

Abstract Now a day Routing Protocol in Wireless Sensor Network becomes a promising technique in the different fields of the latest computer technology. Routing in Wireless Sensor Network is a demanding task due to the different design issues of all sensor nodes. Network architecture, no of nodes, traffic of routing, the capacity of each sensor node, network consistency, and service value is the important factor for the design and analysis of Routing Protocol in Wireless Sensor Network. Additionally, internal energy, the distance between nodes, the load of sensor nodes play a significant role in the efficient routing protocol. In this paper, our intention is to analyze the research trends in different routing protocols of Wireless Sensor Networks in terms of different parameters. In order to explain the research trends on Routing Protocol in Wireless Sensor Network, different data related to this research topic are analyzed with the help of Web of Science and Scopus databases. The data analysis is performed from global perspective-taking different parameters like author, source, document, country, organization, keyword, year, and number of publication. Different types of experiments are also performed which help us to evaluate the recent research tendency in the Routing Protocol of Wireless Sensor Network. In order to do this, we have used Web of Science and Scopus databases separately for data analysis. It has been observed that there is tremendous development of research on this topic in the last few years as it has become a very popular topic day by day.

Keywords Research trends · Routing protocol · Wireless sensor network

1 Introduction

Wireless Sensor Network (WSN) is composed of multiple sensor nodes which have the ability of retrieving the neighboring information, handling it, and transferring it wirelessly to the destination node. It is defined by a group of versatile sensor nodes

S. P. Paul · S. Aggarwal (✉) · S. Chawla
Department of Computer Science and Engineering, Chandigarh University, Gharuan 140413, Punjab, India
e-mail: drshruti.cse@gmail.com

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with a communication structure for controlling and monitoring data communication from source to terminal node effectively and efficiently [1]. There are various types of potential applications of WSN like traffic monitoring, robotic control, industrial automation, video surveillance, and so on [2, 3]. Physical architecture, transmission media, power consumption, hardware specification, cost, scalability, and fault tolerance are the different parameters to be considered at the time of designing Wireless Sensor Network (WSN) [4, 5]. There is some physical architecture of Wireless Sensor network are available like mesh, star, and hybrid systems [6].

At present, there are so many routing protocols available in Wireless Multimedia Sensor Network (WSN) that considers the different constraints of routing protocol design issue [7]. To improve the performance of routing protocol in Wireless Sensor Network (WSN), different parameters such as energy consumption, distance, network lifetime, and transmission time are being used [8, 9]. For the various applications of Wireless Sensor Network (WSN), different types of routing protocol are required because of their architectural specification [10]. Routing protocols are usually designed to ensure successful data transmission from one sensor node to another node in the WSN [11]. The drawback of the routing technique focuses on reduced network lifetime with better energy consumption. We have to face different challenges like node connectivity, reliability, and performance at the time of constructing a innovative routing protocol in WSN [12, 13]. Figure 1 shows the problems and design issues of different routing protocols in this network.

Routing technique in Wireless sensor Network is of two types: single path routing and multipath routing. To route data collected by every sensor node in Wireless Sensor Network from source to base station successfully is very important [14]. Some of the algorithms like Quality of Service (QoS) routing for quantum evolution, Quantum genetic energy-oriented cluster-based routing, and energy-aware security routing for big data analysis are already designed for routing in Wireless Sensor Network of Quantum Computing field [15, 16].

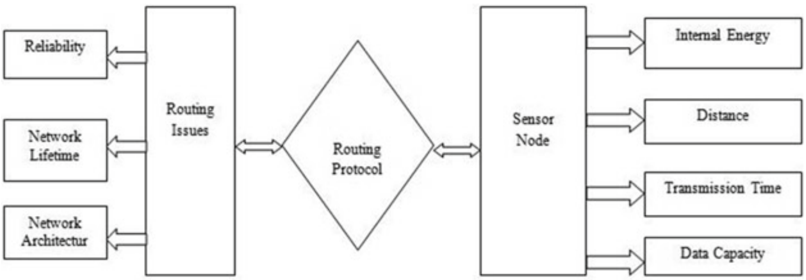

Fig. 1 Block Diagram of routing protocol with routing issues and parameters of sensor node of WSN

2 Routing Protocols in Wireless Sensor Network

Routing Protocols of WSN are being designed based on different parameters. Some routing protocols are energy-oriented efficiency-based, some are distance-based routing, some are reliability-based routing, some are security-based routing, and so on [17]. Additionally, the largest part of routing protocols is categorized in either single path routing or multipath routing [18]. Table 1 shows the last fifteen (2006–2021) years of research trends in RPWSN on the basis of single path and multipath routing.

From Table 1, we can see that most of the protocols are designed for multipath routing in WSN. Energy efficiency is the most frequently considered parameter that

Table 1 Last Fifteen Years (2017–2021) research in routing protocol for WSN

Serial No	Single path/Multipath	Year	Proposed protocol
1	Multipath	2013	Secure Ant-Based Routing Protocol
2	Multipath	2020	Energy Efficient Optimal Multipath Routing Protocol(EOMR)
3	Multipath	2019	Cluster Aided Multipath Routing Protocol(CAMP)
4	Single Path	2018	Energy Efficient and Quality of Service (QoS) aware Routing Protocol
5	Multipath	2006	Energy Balancing Multipath Routing Protocol
6	Single Path	2018	Energy Efficient Collaborative Proactive Routing Protocol
7	Single path	2016	Secure Energy Efficient Routing Protocol
8	Multipath	2010	Comprehensive Routing Protocol in Wireless Sensor Network
9	Multipath	2007	Secure and Energy Efficient Multipath Routing Protocol
10	Multipath	2018	Energy Efficient Shortest Path Routing Protocol
11	Single path and multipath	2014	Quality of Service Differentiation in Single path and Multipath Routing
12	Multipath	2009	Robust and Energy Efficient Multipath Routing Protocol (REER)
13	Multipath	2013	Energy-Balanced Dynamic Source Routing Protocol
14	Multipath	2013	A Novel Energy Efficient and Lifetime Maximization Routing Protocol
15	Multipath	2006	Energy Efficient Multipath Routing Protocol

is used in designing both single path and multipath routing protocols [19, 20]. Apart from this, we can mention also that network lifetime, robustness, Quality of Service (QoS), security are being considered during the design phase of routing protocol in this network [21]. Routing Protocols in Wireless Sensor Network.

3 Scientometric Study of Research Trends in Routing Protocols in Wireless Sensor Network

In this section, the scientific, technological, and innovational analysis of RPWSN is discussed. On the basis of keyword, year, country, author, and document the emerging research in this field are also explained. We are trying to calculate and show the entire link strength and research event analysis of key terms in this field.

3.1 Keyword Based Analysis of Routing Protocol in Wireless Sensor Network

A high-level assessment of research in the area of RPWSN states all the application areas [22] and correlated research in this field. With the help of the Vosviewer software tool, assessment is conducted using the Scopus database for research in the last twenty (20) years, as shown in Fig. 2. Elevated cloud thickness can be visualized for

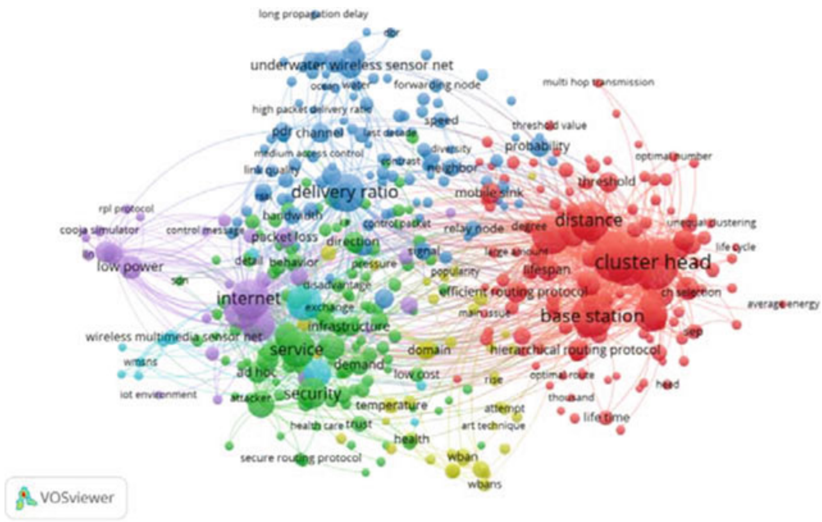

Fig. 2 Cloud Thickness of research on routing protocol based on different keywords

cluster heading, distance, lifespan, base station, average energy, the threshold value in the routing protocol domain. Service, security, quality, delivery ratio, and other parameters are extremely interrelated to cluster-based routing protocol. On the other hand, we can see that efficient routing protocol is highly related to internet, distance, delivery ratio, cluster heading, and base station. In this way, we can define that a high quantity of research is performed in this field.

3.2 Global Analysis of Research in Routing Protocol of Wireless Sensor Network

VOSviewer investigational data from Fig. 3 states that China and India have largely contributed to global research in the title research area. Researchers in UK, Iran, Germany, Bangladesh, Oman, Turkey, and the USA have strong bonding with Indians in this research field. Philippines, Iran, French, Jordan, Japan, Taiwan, and Malaysia, etc. have also tied with Chinese researchers in this field. On the other hand, Poland,

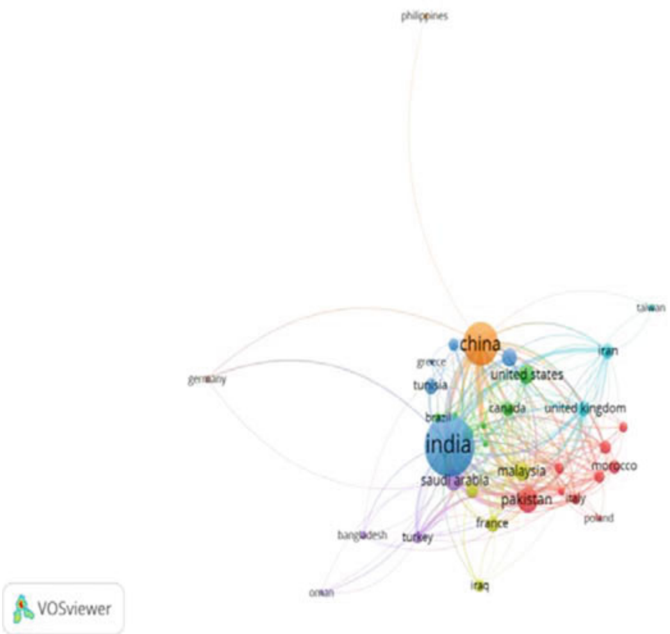

Fig. 3 Country based research trends in routing protocol

Bangladesh, Oman, and Taiwan have significant research potential for designing RPWSN.

The following trial was performed to verify the global attachment of research in RPWSN and it was observed that 36 countries from the world have participated in research related to this field. Out of these 36 countries, only three (03) countries such as India, China, and Pakistan have more than a hundred publications in this domain and around seven (08) countries like Mexico, Portugal, Hong Kong, Greece, Oman, Poland, Philippines, and Indonesia, have less than ten (10) publications each in this domain and the rest of the twenty-five (25) countries like USA, Malaysia, Iran, etc., have ten to hundred number of publications in this research domain. The highest number of citations and publications were made by Indian researchers in this field (Table 2).

3.3 Research in Routing Protocol of Wireless Sensor Network Based on Year Wise Analysis

There is another trial which is done using the Scopus database, for five years from 2017 to 2021. Fig. 4 clearly indicates that the research prominently started in 2017 and since then there has been a steady increase in research publications every year. The growing publications have increased sharply in the last five years which clearly states that a lot of work is completed in this area. About 100 research papers can be identified in the Scopus research database, every year. Out of these five years, the highest number of research works citations was seen in 2018.

3.4 Research Trends in Web of Science Database for Routing Protocol in Wireless Sensor Network

Using the Web of Sciences database, we have conducted an experiment on research trends in RPWSN for the last five years from 2017 to 2021. The assessment gives various research papers, articles in different journals and conferences. Figure 5 undoubtedly states that in recent times, there is a clear rise in RPWSN-related research papers. In this Fig. 5, it is clearly seen that out of last five years (2017 to 2021), there is the highest no of publications performed in 2020 on this specific field.

Table 2 Global analysis of research in routing protocol in WSN based on country, document, and citation (*Source* Scopus Database)

Serial no	Country	Documents	Citation	Total link strength
1	India	653	3169	433
2	China	333	1969	391
3	Pakistan	115	1070	298
4	Saudi Arabia	84	484	190
5	Malaysia	64	659	181
6	United Kingdom	41	553	139
7	Turkey	32	367	78
8	South Korea	61	331	73
9	Iran	39	346	69
10	Egypt	35	310	68
11	Algeria	40	241	63
12	United Arab Emirates	24	105	58
13	Viet Nam	28	182	56
14	France	45	324	54
15	USA	67	460	53
16	Canada	40	193	46
17	Spain	14	63	39
18	Jordan	34	282	36
19	Australia	28	241	35
20	Italy	24	531	32
21	Mexico	9	35	25
22	Portugal	9	24	25
23	Brazil	22	63	20
23	Hong Kong	5	149	19
24	Morocco	37	103	19
25	Tunisia	46	154	17
26	Russian Federation	12	18	14
27	Iraq	28	119	13
28	Japan	22	90	10
29	Germany	10	61	9
30	Bangladesh	12	197	8
31	Greece	6	76	8
32	Oman	7	51	6
33	Poland	6	11	5
34	Taiwan	12	68	3
35	Philippines	5	7	1

(continued)

Table 2 (continued)

Serial no	Country	Documents	Citation	Total link strength
36	Indonesia	7	16	0

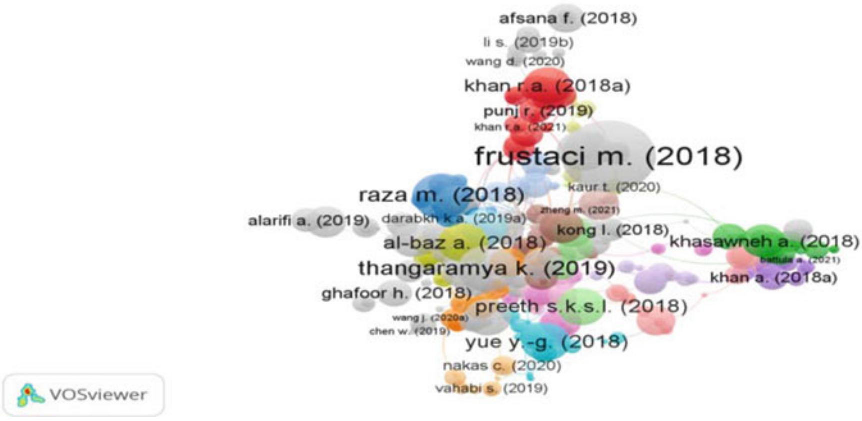

Fig. 4 Analysis of year wise citations of research growth in routing protocol of WSN

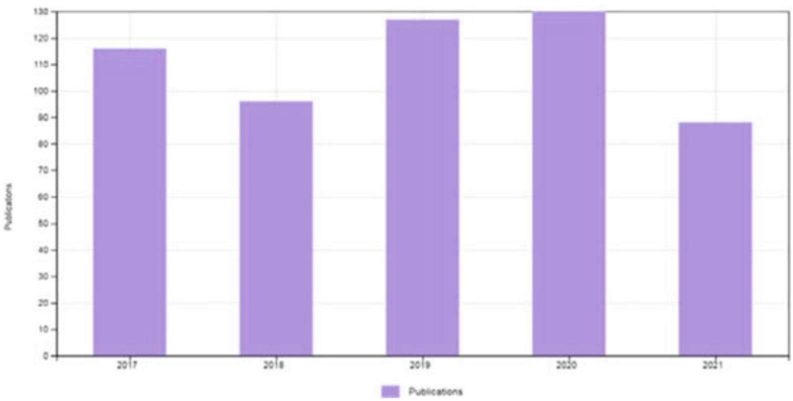

Fig. 5 Research trends on routing protocol in WSN (Year vs. No of publication)

Figure 5 and 6 present comparative research assessments of Routing Protocol in Wireless Sensor Network in the last five years (2017–2021) based on number of publications and number of citations respectively using Web of Science database.

Figure 6. shows the research growth in the Routing Protocol of WSN in the last five years (2017 to 2021) in terms of number of the citations. From this figure, we can clearly say that there is a clear exponential increasing of citation in this field of the research paper. That means RPWSN is becoming a prominent topic in the standard

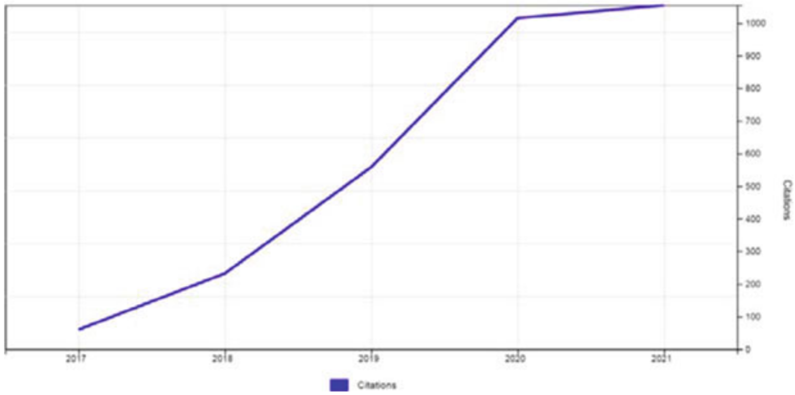

Fig. 6 Research trends routing protocol in WSN-Year versus Citation (*Source* Web of Science)

research field gradually as the citation quantity of this topic-related research paper is increasing.

Considering the Table 3 which shows the increasing development of research trends in the Routing Protocol of Wireless Sensor Network for the last five years (2017–2021) using the Web of Science database. In this table, we have taken five research papers randomly for every year and we have observed that the number of citations for every research paper is dramatically increasing in the last five years. That means the research scope of this field is developing rapidly in the last five years.

Table 3 Analysis of research trends in Routing Protocol of WSN in last five years (2017–2021), (*Source* Web of Science Database)

Year	Paper	Citations						
		2017	2018	2019	2020	2021	Total	Average
2017	Paper-1	5	18	29	42	35	129	25.8
	Paper-2	5	23	34	29	32	123	24.6
	Paper-3	1	11	21	34	13	80	16
	Paper-4	14	13	11	14	5	57	11.4
	Paper-5	1	6	7	13	4	31	6.3
2018	Paper-1	0	9	18	19	14	60	15
	Paper-2	0	1	14	19	14	48	12
	Paper-3	0	5	17	9	9	40	10
	Paper-4	0	0	10	11	7	28	7
	Paper-5	0	3	9	12	3	27	6.75
2019	Paper-1	0	0	7	43	28	78	26
	Paper-2	0	0	2	11	14	27	9
	Paper-3	0	0	6	10	10	26	8.67
	Paper-4	0	0	4	8	14	26	8.67
	Paper-5	0	0	1	9	10	20	6.67
2020	Paper-1	0	0	0	26	33	59	30
	Paper-2	0	0	0	12	20	32	16
	Paper-3	0	0	0	8	8	16	8
	Paper-4	0	0	0	4	12	16	8
	Paper-5	0	0	0	8	7	15	7.5
2021	Paper-1	0	0	0	3	10	13	13
	Paper-2	0	0	0	0	6	6	6
	Paper-3	0	0	0	0	5	5	5
	Paper-4	0	0	0	0	4	4	4
	Paper-5	0	0	0	1	2	3	3

4 Conclusion

RPWSN is the trendiest technique in different latest networking applications throughout the world [23, 24]. The intention of the routing protocol is to optimize the performance of the Wireless Sensor Network [25, 26]. Using the routing protocol, we can choose different routes efficiently and effectively in terms of time, distance, energy constraint, etc. In this research paper, a scientometric analysis of emerging research trends associated with routing protocol in wireless sensor networks is performed using Scopus and Web of Science databases. Different types of assessments are done in this paper to portray the increasing research trends in this field. The examined outcomes are very supportive for researchers working in the field of routing protocol in the WSN.

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Design and Implementation of Microstrip Patch Antenna for Biomedical Application

N. Vikram, R. S. Sabeenian, M. Nandhini, and V. Visweeshwaran

Abstract Nowadays wireless networks are being widely used due to the rise in the use of assorted electrical devices. Microstrip antenna are gaining quality for use in wireless due to their low-profile structure. A rectangular patch is designed and used for a biomedical field in this research. Rogers-RT-Duroid5880 and copper are used as a substrate and patch material. Microstrip patch antenna is intended within an operating frequency of 2.45 GHz that lies within the ISM (industrial, scientific, and medical) waveband. It gives an object's frequency with a radiation effectiveness of 88 percentage. Performance analysis of intended antenna in terms of bandwidth, return loss, gain, radiation pattern, directivity, total efficiency, and power analyzed by using advanced design system software (ADS).

1 Introduction

In medical field a good impact is made in recent years. And it's wide thought for biomedical implementation due to the properties like low profile, higher bandwidth, little dimensions with straightforward movableness. In future it's aiming to use in each stage of treatment The advantage of the system is remotely observance of the gap between doctor and patient. From previously connected papers area unit overcome during this literature like return loss, higher bandwidth, a gain of the antenna, radiation pattern specific absorption rate values, and efficiency.

Patch antennas are a lot of widespread as a result of its straightforward to style and might be changed simply to match impedance, frequency, and radiation pattern [1]. The paper makes an intended simulation, and analysis of a rectangular patch antenna for a one S-band frequency 2.45 GHz using an advance design system tool which may be used for the applications like medical, wireless space networks [2]. Offers a plan

N. Vikram (✉) · R. S. Sabeenian · M. Nandhini · V. Visweeshwaran
Department of Electronics and Communication Engineering, Sona College of Technology (An Autonomous Institution), Salem, India
e-mail: vikram.malliga@gmail.com

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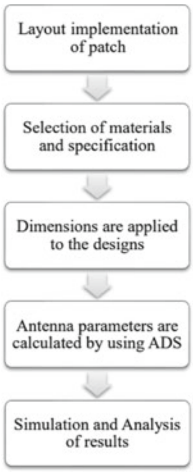
for observation of the continual healing method of bone fractures [3].The Industrial, Scientific, and Medical (ISM) band operative at 2.42–2.48 GHz [4, 5]. The projected antenna is appropriate for wearable medicine devices [6]. This antenna encompasses a large-scale improvement of wearable merchandise [7, 8]. The ultrahigh frequency antenna is employed for observing a bone fracture [9]. Medicine measuring has the development within the healthcare industry [10]. Broadband implantable microstrip patch antenna is formed for medicine applications in 2.4 GHz (ISM) band [11]. ISM bands are used for wireless power transfer, data telemetry, and power saving [12, 13]. Used for various kinds of healthcare monetization [14]. Design has been operated in ISM band and developed for on body matching applications [15]. Compare with different antennas the projected antenna has additionally served the motive of non-invasive method and low value for bone fracture monitoring system.

2 Flow Chart of Proposed Antenna



3 Design of the Antenna

The rectangular shape microstrip patch is intended with the bottom plane. The substrate is present above the bottom plane. Above the substrate patch is implicated. Linear polarization is used in this rectangular patch design. The patch design contains 3 sections, they are

- Ground plane of the patch.
- Substrate of the patch.
- Rectangular patch design.

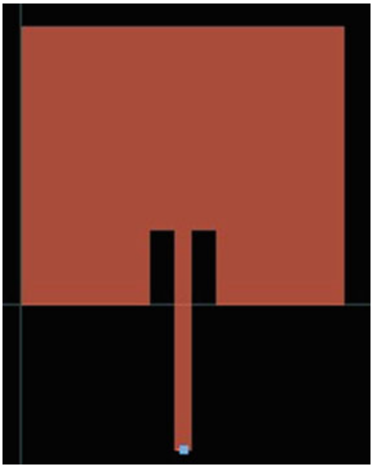


Fig. 1 Patch antenna layout style

The designed rectangular patch has a ground plane with a height of 29.2mm (Millimeter). For this proposed design, a conductor is used to produce the ground plane. A separate conducting substance is used for the ground plane and rectangle patch designs. A microstrip center line is used as a feed and the feed is also delivered at the corner of the associate antenna. This technique offers the best potency and the lowest antenna losses. The rectangular patch is commonly polarized in a linear way, resulting in decreased antenna losses. The designed fabrication process is made easy by the microstrip printing operation, and the antenna layout style is shown in Fig. 1.

4 Substrate Specification

As illustrated in Fig. 2, the rectangular patch antenna's substrate is located between the bottom plane and the rectangular patch. The dielectric constant (r) and the angle of incidence (tand) are given as r = 2.46 and tand = 0.01. Figure 2 depicts the designed substrate. This substrate is made of Rogers-RT-Duroid5880 and measures 0.79 millimeters in height. The conductor is 35 microns embedded in the substrate.

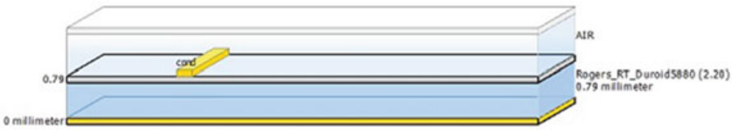


Fig. 2 Substrate of a rectangular patch

Fig. 3 3-D visualization

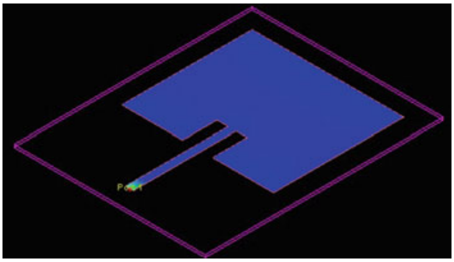


Figure 3 shows a three-dimensional image of the antenna. This rectangular patch, which resonates at 2.45 GHz, is made on the Rogers-RT-Duroid5880 substrate. If a different substrate is used instead of Rogers-RT-Duroid5880, the same tand values and dielectric constant is not being used to resonate an antenna at the ISM frequency range.

5 Simulation Results

After the layout design and substrate specifications have been determined, the planed rectangular patch's start and stop frequencies are determined. The start and stop frequencies are 2.2 and 2.7 GHz, respectively. The analysis of S parameter S11, which might represent an antenna's radiation pattern and indicates the return loss, is used to simulate antenna design. The antenna resonates at 2.45 GHz, which is also an ISM frequency range with such a return loss of—30dB. As a result, this patch type has a lot of potential for medical specialization applications. An antenna's radiation pattern is indeed the direction in which it will transmit a huge amount of power, and this is presented graphically in Advance design system software (Fig. 4).

The three-dimensional visualization of the radiation pattern is generated, which is shown in Fig. 5 with various dimensions. The designed rectangular patch for 2.45 GHz frequency has a radiation pattern in the shape of dump bell or eight shapes.

The comparison of gain, directivity, and radiated power is analyzed by using different substrates for our design with the help of advanced design system tool. It is shown in Table 1.

To determine single stub matching, conductance, reflectance, impedance matching, and double stub matching of an antenna with transmission line, a Smith chart is used. Smith chart of the patch is given in Fig. 6.

The antenna parameters are analyzed by using advance design system as shown in Figs. 7 and 8.

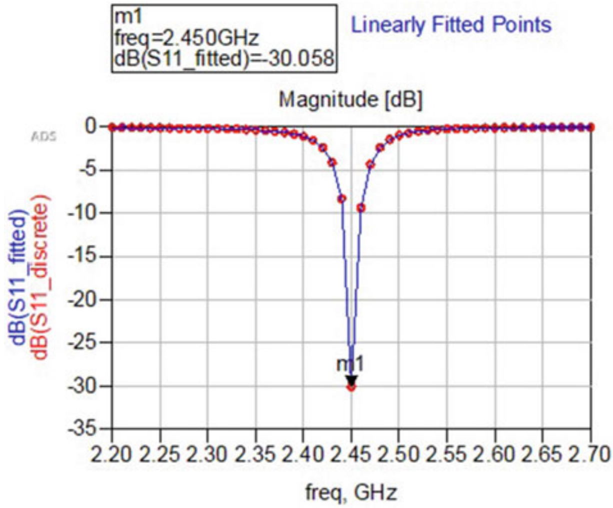


Fig. 4 S-Parameter results

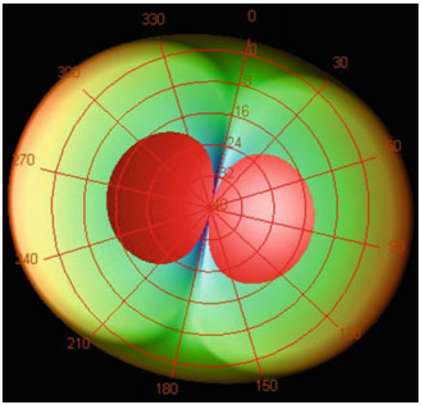


Fig. 5 Radiation pattern of rectangular patch

Table 1 Comparison table

Parameters	FR-4 substrate	$\text{Rogers}_R T_D uroid$ 5880
Frequency (GHz)	2.45	2.45
Input Power (Watts)	0.000665399	0.0024975
Radiated Power (Watts)	0.000475103	0.00221031
Directivity (dbi)	6.3446	7.52986
Gain (dbi)	4.88166	6.99928
Radiation efficiency (percentage)	71.4012	88.4966

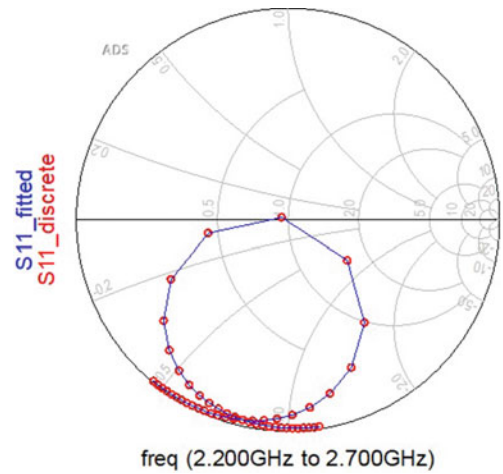


Fig. 6 Smith chart of a rectangular patch

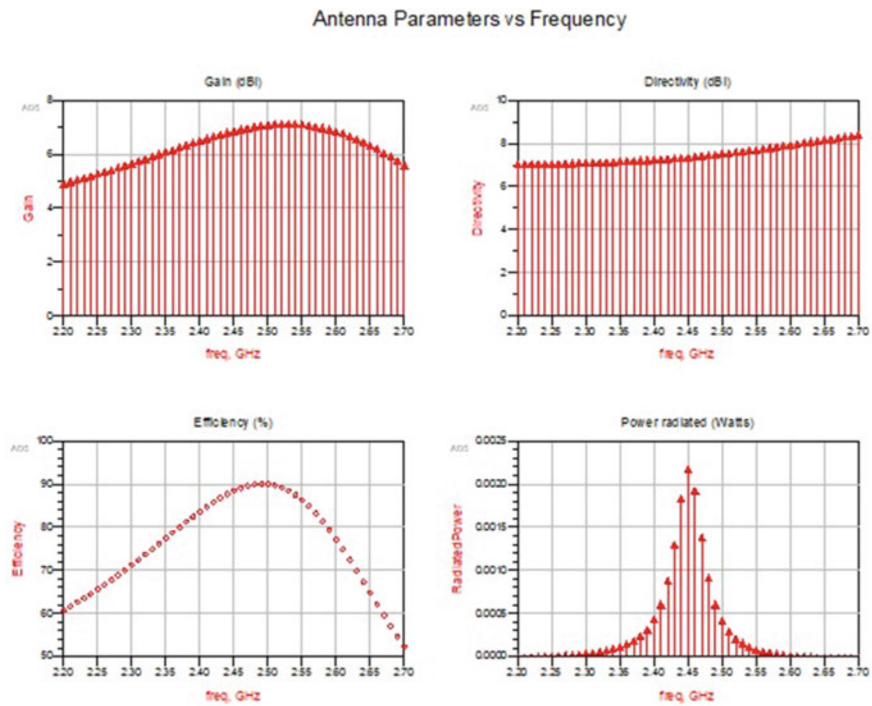
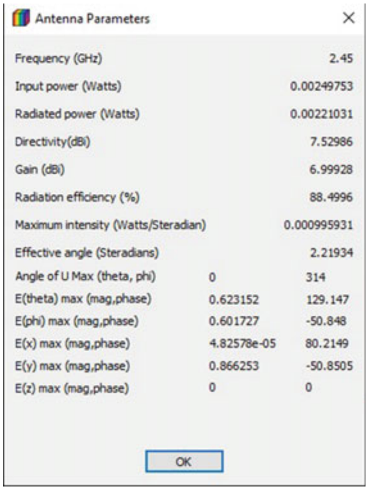


Fig. 7 Antenna parameters versus frequency

Fig. 8 Antenna parameters



6 Conclusion

In this project a linearly polarized rectangular shaped patch antenna is designed for biomedical applications which is found to have the radiation efficiency of 88 percentage when simulated in the ADS tool and the antenna does have a gain of 6.99 dBi and a directivity of 7.52 dBi, according to the results. The designed antenna has a return loss of −30 db, according to the results. It is ensured that developed antenna accomplishes a list of good properties with the help of the obtained results. By which the antenna meets more sustain more practically for the biomedical application.

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Analysis of Phonocardiogram Signal Using Deep Learning

T. Shanthi, R. Anand, S. Annapoorani, and N. Birundha

Abstract Phonocardiogram (PCG) plays an important role in the initial diagnostic screenings of patients to assess the presence of cardio-vascular abnormalities. It is also used to complement the ECG-based cardiac diagnosis for detecting cardio-vascular abnormalities. This task has been proposed to classify the heart sounds by performing deep learning technique known as CNN (Convolutional neural network). Two types of datasets were collected from the clinical environment and used as an input to this project. The experimental results show CNN provides the better results in the detection of abnormal heart sounds with good accuracy.

1 Introduction

The human heart is the most important organ in the body and supplies blood to all parts of the body. During the pumping action of the heart, the electrical and mechanical activities are done and therefore result in the flow of blood throughout the body. Phonocardiogram is a graph that represents the recording of heart sounds and murmurs obtained using stethoscope and plays a vital role in detecting abnormality and therefore it is used as the input data for our algorithm. The sounds that are obtained from a PCG are due to the vibration that occurs during the cardiac cycle of the heart. There are two sounds, namely, S1 and S2 that occur during the heart function. The first sound (S1) is produced when atrioventricular valves (tricuspid and mitral) close at the beginning of systole and the second heart sound S2 occurs when the aortic valve and pulmonary valve (semilunar valves) close at the end of systole. Sometimes there may be a chance of abnormality in the heart functions so it may result in the production of some abnormal heart sounds such as artifact, extra

T. Shanthi (✉) · R. Anand · S. Annapoorani · N. Birundha
Sona College of Technology, Salem, India
e-mail: shanthi@sonatech.ac.in

R. Anand
Sri Eshwar College of Engineering, Coimbatore, India

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systole and murmur. Phonocardiogram is preferred because of its simplicity and cost efficiency. In this project the CNN model is built with the help of keras library and classified the heart sounds into normal or abnormal. Under abnormal-artifact, murmur, extra systole heart sounds were detected in the early stage by employing deep learning algorithm.

2 Literature Survey

In the past few years many researchers have used phonocardiogram [1] in different methods to diagnose the heart disease. They used Short time Fourier transform (STFT) based spectrograms to learn typical patterns of normal and abnormal PCG signals. They underwent three different studies to generate spectrogram and to perform CNN to detect the normal and abnormal signals.

In the article [2] this study they used a one-dimensional neural network based on phonocardiogram data to create an automated classification method. For the classification of PCG data they have proposed an intelligent CNN.

In this paper [3], the datasets taken from 2016 PhysionetCinc challenge PCG signals are obtained from patients with the help of a condenser microphone mounted on a stethoscope and followed by the process of amplification and filtering. Using audio jack the signals are passed to the laptop. There are separated as 4 types namely S1, Systole, S2 and Diastole using Hidden Semi Markov Model (HSMM). Using Radial Basis Function a support vector classifier was trained on 190 recordings.

In the article [4] two different heart sounds were taken from Physionet which was classified as normal and abnormal using Convolutional Neural Network. In this method, they have adopted some Preprocessing methods to nullify the effect of noises in heart sounds. By using resampled energy method, the heart sounds are segmented as S1 and S2. The classification was done using CNN.

In this paper [5], the 2016 Physio Net /Cinc challenge database has been used to validate their algorithm. The heart sound recordings had been collected from the clinical or non-clinical environment. The various algorithms are RNN, LSTM, GRU, B-RNN, B-LSTM and CNN. The input layer is given as raw signal. CNN has given them the best results when compared to other methods. In this paper [6] They used three types of datasets and analyzed the performance using CNN, RNN, LSTM, GRU and got better results using FFT.

In this paper [7], two types of datasets were used for heart sound classification from clinical environment. The input was given as raw input signal and it passed to the recurrent hidden layers such as RNN, LSTM and GRU. The experiment used a Tensorflow deep learning framework that supports graphics processing units(GPU). The LSTM has several parameters such as learning rate, memory blocks, number of hidden layers, number of epochs and so on. LSTMs gave better results than RNNs but required more training costs compared to GRU.

In the article [8] the database was collected from various clinical and non-clinical environment. The data was collected from both normal and pathological patients and also collected commonly at aortic area, pulmonic area, tricuspid area and mitral area. The classification was based on Artificial Neural Network, SVM, Hidden Markov Model and clustering. The heart sounds were classified as normal, abnormal. All heart sound recordings are divided into two types based on expert classification of normal and abnormal. Heart valve defects are mitral valve, aortic stenosis, and valve surgery. They have used hand correction in their method of project.

In this paper [9] digital recording of the heart sound is classified as normal signal, systolic murmur signal and diastolic murmur signal. Many features are extracted for classification. The classification which is used in their study is k-NN, fuzzy k-NN and Artificial Neural Network (ANN). In this k-NN and fuzzy k-NN have highest accuracy. The heart sound was recorded using electronic stethoscope and signal is displayed on the computer. The heart sounds were classified as S1, S2, S3 and S4. Using Wave pad sound editor in NCH Software the signals were first divided. The accuracies are different for different classification.

Based on the literature survey it is evident that CNN has achieved better results in many of the cases. In our proposed method we have adopted CNN with additional features to achieve better classification accuracy.

3 Methodology

The main objective of our project is the detection of cardiac abnormalities at an early stage with the deep learning model using PCG signals. In order to meet the objective, took PCG signals as an input collected from the clinical environment as SET A and SET B, done some preprocessing techniques that help in enhancing the quality of the heart sounds and undergone CNN model building with appropriate layers considering some optimization parameters. Trained and tested the model as shown in Fig. 1.

3.1 Input Description

The input to this project is the Phonocardiogram signal. The PCG Dataset was collected from two sources, namely, Set A and Set B. Both the datasets were collected from the clinical environment. Set A was collected from the public via the iStethoscope Pro iPhone app and Set B was collected from hospitals using the Digital Stethoscope DigiScope. Set A has 4 classes namely artifact, murmur, extrasystole and normal and Set B has 3 classes namely murmur, extrasystole and normal.

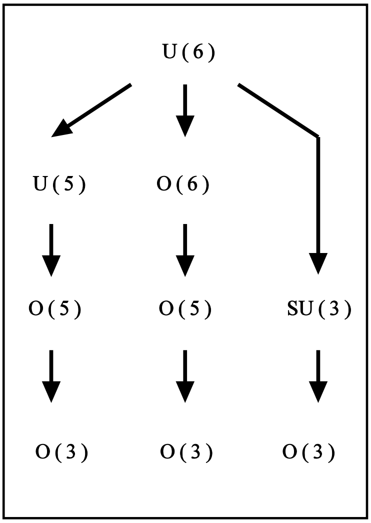

Fig. 1 Block diagram of the proposed work

3.2 Preprocessing Technique

The preprocessing technique used here is the normalization of the audio files (.wav format). It is helpful in getting the audio with highest quality with fixed padding. The features of heart sounds are extracted. The task is to extract the best features from the heart sounds within audio data.

3.2.1 Use of Librosa

In preprocessing technique, librosa is used. Librosa is a python package which is used for audio and music analysis. It provides retrieval systems for heart sound files which is collected from the clinical environment. Kaiser Fast extraction is also used here to load the librosa package to the wave file.

3.2.2 Padding Audio File

The audio file (.wav format) is padded to a duration of 12 s and sampling rate of 160000 at a fixed rate because each wave has different durations and sampling rate so here it is padded with the audio file to have a fixed duration. The normalized audio file is received from this padding which can be used as input for further process.

3.3 Dataset Description

There are two datasets considered for this project and they are preprocessed with the techniques mentioned above. The datasets are Set A and Set B. Set A has four classes namely artifact, murmur, normal and extrasystole. Set B has three classes namely murmur, normal and extra systole. The Set A dataset is loaded with each class separately by mentioning its directory and a unique label for all the four classes. Set B dataset is also loaded with each class separately by mentioning its directory and a unique label for all the three classes shown in Tables 1 and 2.

3.4 Deep Learning Architecture

In this project, we considered CNN as our architecture since it works well with the classification of heart sounds into four classes namely the artifact, murmur, normal and extrasystole.

3.4.1 Convolutional Neural Network (CNN)

The Convolutional Neural Network also known as CNN/ConvNet is used in this project to classify the heart sound wave. The input wave has been preprocessed and taken into consideration by the CNN model. To build the CNN model, we utilized the keras library. It includes the sequential model, layers, optimizers, callbacks and regularizers.

Table 1 Set A database summary

Class name	Class label
Artifact	0
Murmur	1
Normal	2
Extra systole	3

Table 2 Set B database summary

Class name	Class label
Murmur	1
Normal	2
Extra systole	3

Table 3 Hyper parameters of the model

Hyperparameters	CNN Model
Batch size	32
Optimizer	Adam
No of epochs	100

3.4.2 Building CNN Model

The model is built by the simple Sequential architecture. Since this project is based on the analysis of Phonocardiogram heart sounds we considered the sequential model. Conv1D is used here. This layer creates a convolutional kernel with an input layer and a convolution in a single spatial(or time) dimension to generate a tensor for the output. Filters and kernel size have been defined according to the layers. We have considered RELU as the activation function as it is the most used activation functions in CNN. The kernel regularizer used here is the L2. It applies a L2 regularization penalty. Maxpool1D is used and it performs operation on down sampling the input representation by taking the maximum value over a spatial window of pool size. The window will be shifted by strides mentioned in the algorithm. Batch normalization is designed to automatically standardize the inputs to a layer in the model. Used dropouts to avoid over fitting of the model. The Global Average Pooling1D (GAP) layer is used to minimize overfitting by reducing the total number of parameters in the model. Dense layer used here is 4 (since number of classes = 4). Softmax is an activation function that is used as the last layer in the model. In this project we used 21 layers to build the CNN model.

3.4.3 Model Fitting

To fit the model, first we complied the model with the loss named binary cross entropy and the metrics we considered are accuracy, precision, recall and F1 score. Optimizer used here is the Adam. The batch generator function is defined initially to make use in fitting the model to 100 epochs with 1000 steps per epoch The batch size considered here is 32. The annealer used here is the learning rate scheduler. The model is fitted by using all those parameters as shown in Table 3.

3.4.4 Saving the Model

The model is saved, and it is used to plot the graph to check the accuracy and validation accuracy.

3.5 Result and Observation

The model is plotted with respect to the training accuracy and validation accuracy. Then the model is tested with test data to observe the classification of the heart sounds into four categories as normal, murmur, extrasystole and artifact. The model showed 79% accuracy in validation and accuracy of 85% as shown in Fig. 2. The comparison of other existing methods was shown in Table 4.

The performance of the model was analyzed using confusion matrix plot and achieved better classification accuracies for the multiple class (artifact, murmur, normal, extrasystole) classification problem as shown in Fig. 3.

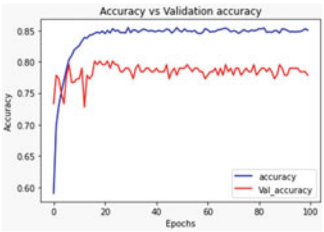

Fig. 2 Accuracy versus validation accuracy

Table 4 Performance metrices

Author method	Accuracy	Precision	Recall	F1 score
P. Gopika et al. CNN	0.80	0.85	0.79	0.82
P. Gopika et al. RNN	0.6	0.61	0.6	0.61
P. Gopika et al. LSTM	0.76	0.84	0.74	0.75
P. Gopika et al. GRU	0.78	0.8	0.78	0.78
Sujadevi VG RNN	0.53	0.55	0.53	0.54
Sujadevi VG LSTM	0.76	0.83	0.76	0.76
Sujadevi VG GRU	0.75	0.78	0.76	0.76
Proposed method	0.85	0.83	0.80	0.81

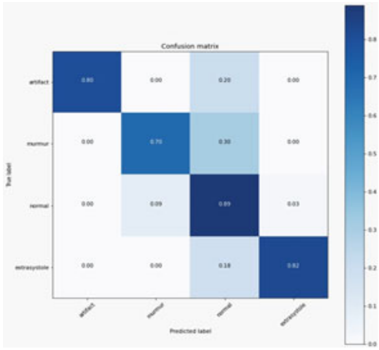

Fig. 3 Confusion matrix

3.6 Conclusion

The phonocardiogram signals (heart sounds) play a major role in the detection of cardiac abnormalities that have undergone some preprocessing techniques like the normalization of audio waves and Kaiser fast technique to load the librosa to the wave file. Then the preprocessed Heart sound files have been loaded separately and it is gone for the CNN model building and the model is saved, got an accuracy of 84% and validation accuracy of 79% and got the results in an effective way. The proposed work gave good results with CNN model by doing simple preprocessing techniques which will be helpful for the detection of cardiac abnormalities at an early stage.

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Online Exam Monitoring Application as Microservices

Sree Pranavi Ganugapati, Rakshashri Natarajan, Abhijnana Kashyap, S. Suganthi, and Prasad B. Honnavalli

Abstract With the unexpected rise of the COVID-19 pandemic, a vast majority of organizations and institutions have shifted to online modes of communication, especially educational institutions. Many hurdles popped up in due course of time, preventing the successful conduction of online examinations. Today, there is an application for each and everything and the number of users is steeply escalating. With such high rising demands and new necessities, it has become quite important to make sure the applications are easily available anytime and anywhere. Ensuring minimum downtime, frequent updates without any disruptions, and making it easily available for both developers and consumers are must-haves now. Satisfying these requirements over a monolithic architecture is not assured, hence, the microservices architecture is adopted, thus opening the door for new possibilities. This being the foundation of this project, an amalgam of how the web application we used is divided into microservices, containerization of each of them followed by pod deployment and finally using Kubernetes for service exposing and orchestration is presented in this paper. In short, an online exam monitoring system that can identify any abnormal behavior by test takers while being capable of tackling varying traffic loads is fault-tolerant and handles disaster recovery.

Keywords Cloud computing · Orchestration · Docker · Minikube · Kubernetes

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S. P. Ganugapati (✉) · R. Natarajan · A. Kashyap · S. Suganthi · P. B. Honnavalli
PES University, Bengaluru, India
e-mail: gsreepranavi@gmail.com

R. Natarajan
e-mail: raksha2000shri@yahoo.co.in

A. Kashyap
e-mail: abhijnanakashyap@gmail.com

S. Suganthi
e-mail: suganthis@pes.edu

P. B. Honnavalli
e-mail: prasadhb@pes.edu

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1 Introduction

A wide portion of organizations is moving toward microservices architecture from the conventional computing approaches in view of its various perks. Microservices architecture as opposed to the traditional monolithic architecture splits the applications into small-scale single unit services which perform unique fine-grained functions as illustrated in Fig. 1. The key advantage of microservices architecture is that each service is solely independent of the other components of the application.

Containerization is a lightweight OS-level virtualization technique to create isolated environments to run applications. A container, generated from an image during run time, is self-contained software that packages the code and its dependencies to run it in any environment without additional setup, irrespective of the platform. This technique helps achieve version control and consistency while saving repetitive labor.

Container Orchestration plays a key role in any environment with multiple nodes using containerized applications. Kubernetes is an orchestrator tool, operating at the container level that assists in the management of container workloads.

Upon deploying Kubernetes, a cluster is created which is a collection of a master node and worker nodes as shown in Fig. 2. The workers host services on them which have their own internal IPs, used for inter-container communication. To manage the pods and to get them to the desired state, an abstraction called deployment is used, which is essentially a group of pods. These deployments are controlled from the

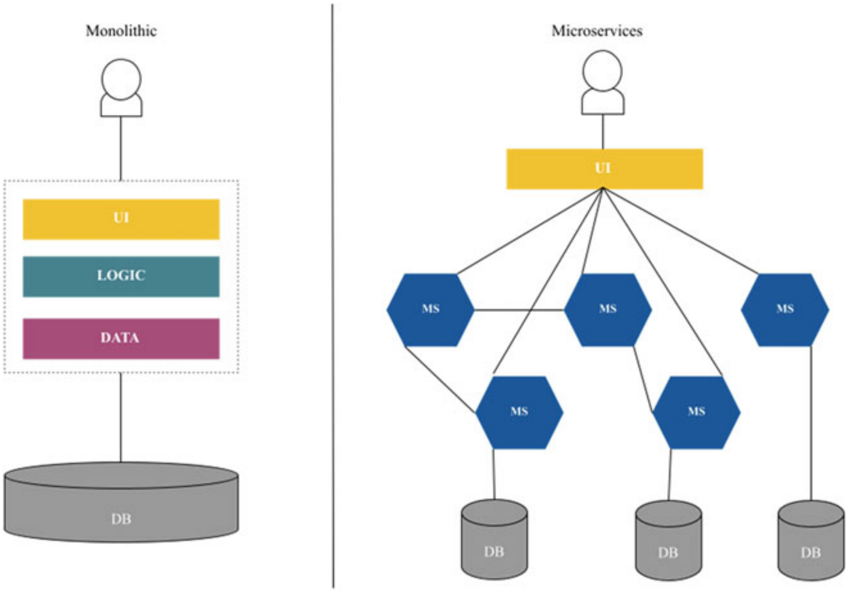


Fig. 1 Monolithic versus microservices (MS) architecture

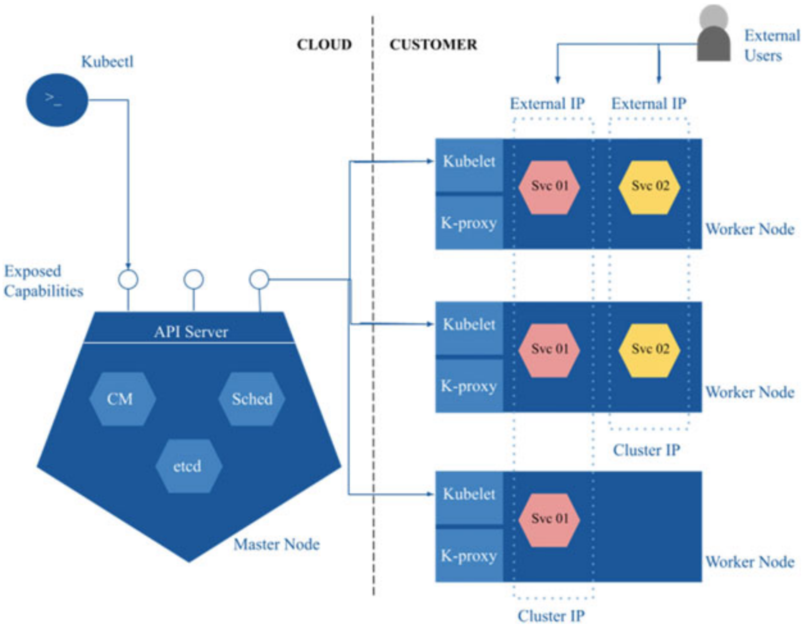


Fig. 2 Kubernetes architecture

master node using the YAML manifest. They can be externally exposed as services such that they can be accessed via the browser from outside the cluster as well.

With these concepts as the cornerstone, a monolithic web-based online exam application is transitioned into microservices, which can successfully interact with each other and handle scaling as per need, updating the specific components and keeping the overall application unscathed.

2 Problem Statement

The current COVID-19 situation has created a lot of havoc throughout the world. Due to the pandemic-induced lockdown, many organizations shut down physical operations and turned to online modes of communication. Many of the institutions considered canceling the exams while some have opted for online examinations. However, many hurdles have come up in due course of time, preventing the successful conduction of online examinations like ensuring the integrity of the examination, data privacy, the server's inability in handling large loads, Internet connectivity, and more.

2.1 Integrity of the Examination

The obvious challenge is ensuring the integrity of the exam, making sure the exam taker is not indulged in any sort of malpractice like fetching answers from the Internet, discussing answers with other test takers, or referring to course material. All of these may not be handled even if the student's camera is switched on and the invigilator is present as the invigilator might not be able to focus on each test taker at the same time, still leaving a loophole in the online exam process.

2.2 Bottlenecks at Server

A major server-side issue is handling varying loads occurring at the same time. There can be extreme and serious consequences to this: A degraded performance like reduced response time, hung screen, stuck timer, and similar such scenarios. Server crashing leads to either complete or partial loss of data or can even force full shut down or restart of the application. Something worse that could happen is the server would stop accepting data, i.e., student responds after a point in time and the students or invigilators might not be aware of it. Such high traffic can sometimes even cause serious hardware or software failures and shut it down with large downtime.

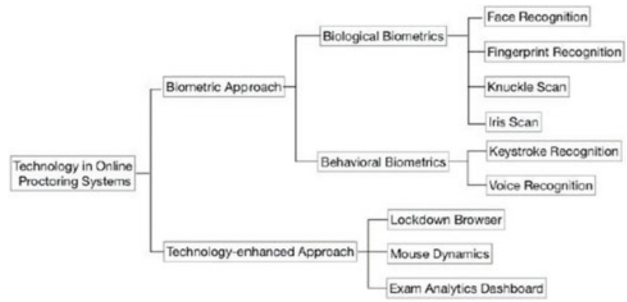
3 Literature Review

An extensive literature survey has been carried out from which, multiple inferences and insights have been drawn that were useful for the project conduction.

In [1], the two virtualization methods—Type 1 (HW level) and Type 2 (OS level)—were analyzed. Each of them was passed through 25 test cases, to understand the pros and cons of each method. As per the results, Type I, the hyper v method, successfully satisfied all the test cases and provided better results than Type2, i.e., VBox.

A system to monitor students taking up online exams, on premises, in real time via multi-factor authentication has been designed in [2]. Static authentication at the beginning and dynamic authentication throughout the exam were used. The system architecture involves 2 servers, one for exam conduction and the other for monitoring. Students are supervised via CCTV and webcam, real-time screen stream to the invigilator, and warnings given based on activity. A log for each student was maintained with their details and recordings, which can be used for further inspection.

A docker-based instructional system is presented in paper [3] and how it makes it easier for developers, testers, and the ops team to work together efficiently. The web app is sectioned into services, i.e., functional modules and using docker, an image for each was built and run to start the container. The architecture is shown in Fig. 3 (left).



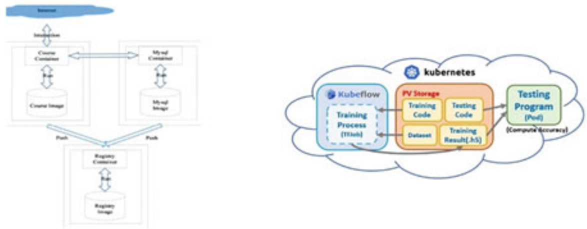


Fig. 3 Project deployment [3, 13, 15]

Paper [4] proposes a system to manage stateful applications using Kubernetes, which allows automatic redirection to healthy pods via management of secondary labels and the current role of the pod as per the availability. With this solution, recovery happens before repair in case of pod failure, thus improving recovery time by 55–70%.

Paper [5] highlights the motive and approach to migrating from monolithic to microservices. Apart from its numerous perks like maintainability, scalability, replaceability, reliability, etc., a migration strategy is proposed too. Firstly, analyze the functional components, then identify and analyze business functionalities followed by assigning them to microservices and finally creating the microservices.

A performance evaluation of multi-threaded tasks over traditional virtualization and containerization is presented in paper [6]. The results showed that it performs reasonably when running on a VM with 1 CPU and docker containers but not on par with a native OS with multi-core. Consequently, constrained resource machines do not produce good results irrespective of virtualization.

An evaluation of server scalability in k8s has been performed in paper [7]. Multiple servers had lesser CPU usage, unlike solo servers due to the load distribution among containers. However, they had delayed response time due to the scaling overhead.

Paper [8] explains how Kubernetes can be used in two ways, hosted on cloud services and self-hosted, running on a single server with Minikube, i.e., local. Containers can be deployed on Minikube using an inbuilt Docker daemon responsible for creating the containers. Additionally, rapid scaling provisions for the varying workload is also provided by Minikube.

Paper [9] presents a structured system analysis that enables us to determine all the required functions for the system. Recognizing and determining the microservices includes breaking down the system, organizing the primitive functions, and identifying how the data will be stored. A more systematic approach is when a unit of storage is used by a single microservice only. In order to prevent possible coupling issues, the primitive functions should be declared with a suitable level of abstraction.

It can be concluded from paper [10] that microservices with high complexity and low cohesion, when decomposed accurately, can increase stability and minimize errors.

Paper [11] hints that the current scaling method used by Kubernetes causes response delay, and hence does not meet certain requirements concerning quality. A forecasting model based on the AutoRegressive Integrated Moving Average (ARIMA) model is presented, which uses previous requests to project the arrival rate of future requests. This enables resource allocation using the M/M/m queuing network and improves efficiency in terms of CPU utilization and response time.

Despite the increasing popularity and usage of microservices, there exists an inadequacy regarding an appropriate testing system to attain improved quality control for microservice testing. Paper [12] proposes a testing framework comprising six phases, Unit, Integration, Single Microservice, Contract, End-to-End, and Cloud test.

Paper [13] presents a study on the current day education tools encompassing MOOC, Zoom, Skype, and eLearning platforms. In addition to these, there exist many systems for online proctoring, which make use of various technologies as depicted in Fig. 3 (top). An analysis of 12 such systems has been carried out, taking into account the volume of users, costs, and security aspects. The advocated method is a hybrid approach, including automated systems and human invigilators, to optimize students' learning and assessment efficiency.

Paper [14] puts forward a structured strategy for automating deployments. These configurations utilize algorithmic solutions which obtain parameters from the design and transform them into a capacitated task assignment (CTAP) problem. The results of this problem generate the respective deployment model. This strategy enables early generation of the deployment alternatives which makes updating the architecture easier and less expensive.

Paper [15] is focused on implementing a facial recognition system that uses a deep learning algorithm and is deployed on containers. The authors of this paper preferred hosting the application on a private cloud instead of public, thus deploying it onto a single Kubernetes node. Further, the project utilizes Kubeflow for the learning, Kubeadm to facilitate quicker and simpler creation of clusters, and an object 'TFjob' to run the container on Kubernetes. To enable users to customize objects, a function known as CustomResourceDefinition is used. The storage of dataset, programs, and results is done via PersistentVolume and PersistentVolumeClaim as per Fig. 3 (right).

4 Proposed Methodology

Firstly, a web application providing a secure test environment while recording the video shall be developed. As shown in Fig. 4, once the student successfully logs in and begins the test, the camera recording begins, and any tab/window switches are detected and necessary action is taken accordingly. As soon as the test is complete and the tab is closed, the video is downloaded which can be sent for analysis.

As per the prior discussion, the application will be forked into small microservices and individually containerized. This way, there would be less overhead while requiring fewer resources and increasing the portability of the application irrespective of the underlying software and hardware. Post containerization, containers are grouped to form pods followed by the creation of deployments. These deployments as described in Fig. 5 are exposed as services. The figure also provides insights on the inter-service dependency and the communication techniques involved.

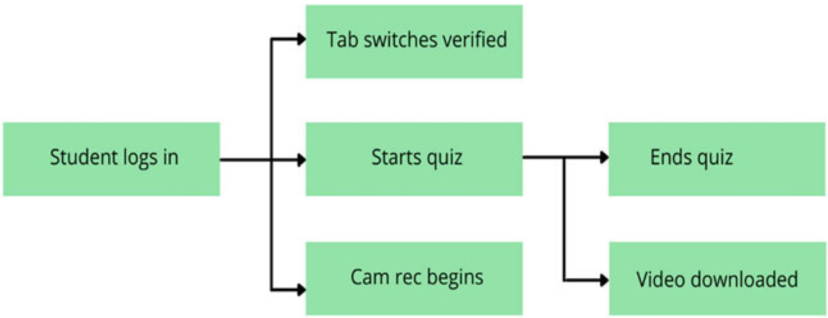


Fig. 4 Process flow of the system from the user perspective

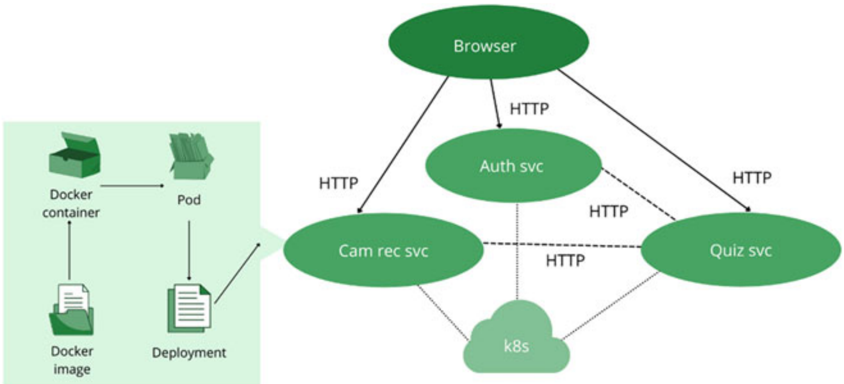


Fig. 5 Implementation flow

Now, there would be hundreds of test takers at the same time who will access the application. To avoid performance drawbacks, an orchestrator is necessary to manage the services, elastically scale and induce communication among them. This shall be achieved using Kubernetes as specified in Fig. 5.

5 Implementation

This work is developed on the basis of a monolithic web application. On opening the application, the user is prompted to log in. Upon entering a valid username and password, the quiz pops up with a few MCQs. The user has 15 s to select an option for a question, after which the selected option is verified, and the result is displayed. In the end, the user's score is set out. During the quiz, window and tab switching is verified. A yellow alert is generated on the first switch, followed by a red alert the second time which takes back to the quiz tab as demonstrated in Fig.6 (top). The third time, the quiz terminates and opens the homepage. The video recording via the webcam opens in a new tab as shown in Fig. 6 (bottom) when the quiz starts and automatically stops and downloads the recording once the quiz is closed.

5.1 *Migrating Monolithic to Microservices—Containerization*

The monolithic application is logically split up into microservices as shown in Fig. 7.

Authentication Service—Authenticates the user with the login credentials.

Quiz Service—The user is prompted to start the quiz, once the button is clicked the quiz begins preceded by instructions.

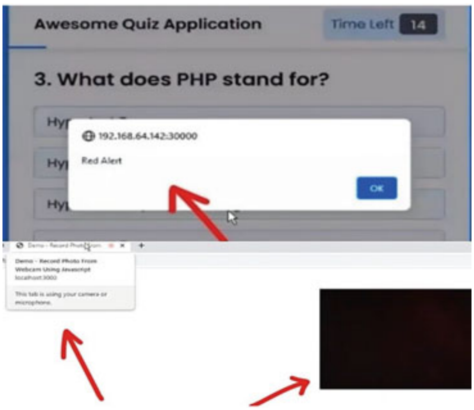


Fig. 6 Red Alert on Tab Switch (top) and Webcam starts recording in a new tab (bottom)

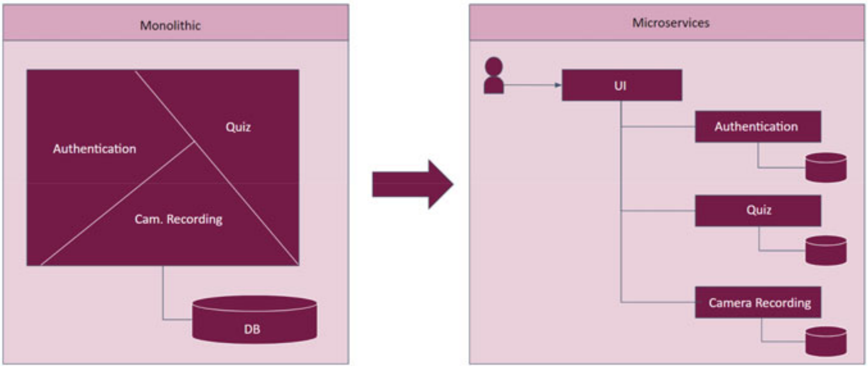


Fig. 7 Monolithic to microservices

Webcam Recording Service—The recording begins when the quiz starts, the video is displayed on the new tab simultaneously, and once the page is closed, it terminates, and the video is downloaded.

The implementation is carried out on a Windows machine. The first step is building the images using a Docker file which uses a base Ubuntu image to set up a Nginx server and host the web files. These images are pushed onto the local Docker repository for easy reuse. Each of these images is run to start the containers with exposed ports. Once the containers are up, they are accessible from the browser at localhost as illustrated in Fig. 8.

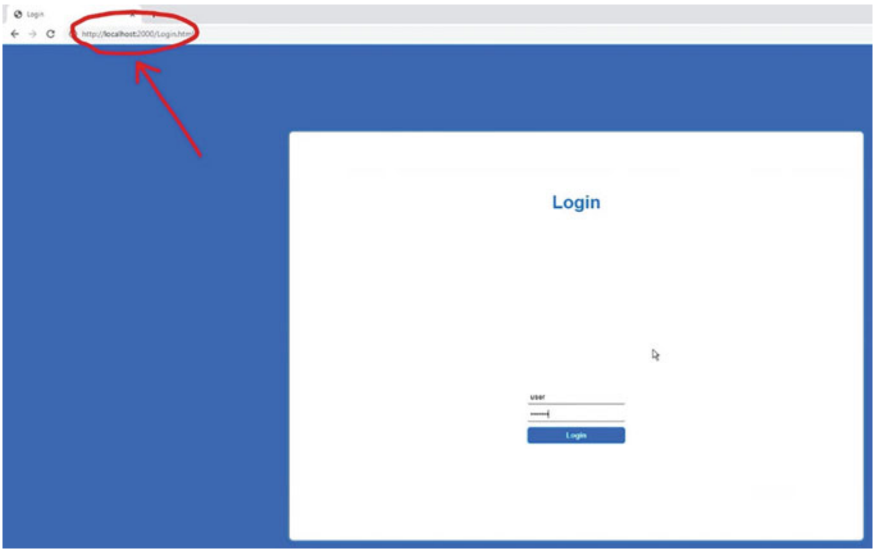


Fig. 8 Accessing from the localhost

5.2 Migrating Monolithic to Microservices—Services

The containerized data is perishable, so to avoid that we turn them into services. Using Minikube, a cluster is set up with a single node which doubles as the control plane as well as a master node. Each of these containers is put into a pod and then deployed on the cluster using YAML files. These deployments are responsible for obtaining the desired state, in turn helping with orchestration.

Each of the microservices is then externally exposed publicly as shown in Fig. 9. They are of node port kind and can be accessed via a common IP address, i.e., the cluster's IP and unique node port numbers as explained in Fig. 10.

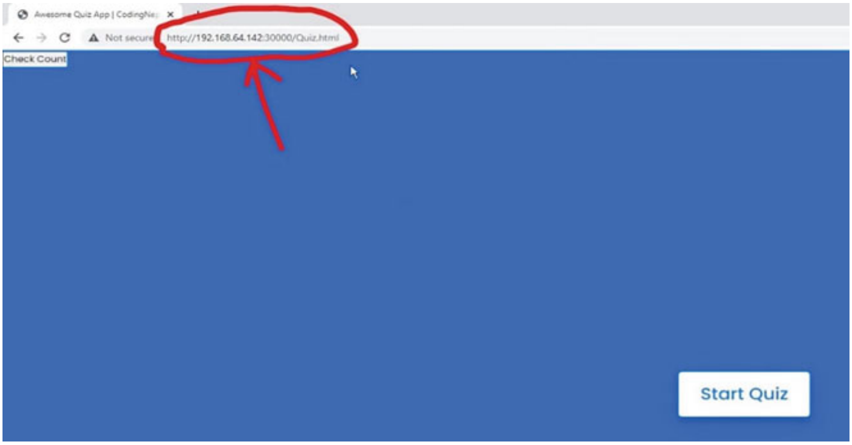


Fig. 9 Exposed service accessed

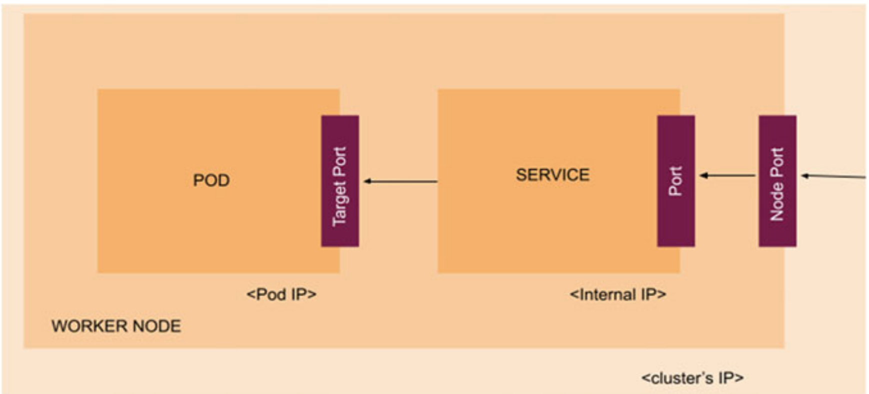


Fig. 10 Ports in a cluster

5.3 Inter-Container Communication

Every microservice is containerized separately and these containers must communicate with each other to share information and work easily. When every container is built, it is by default added into a default bridge network. As each of them is assigned their IP, they can communicate with all other containers using the IP assigned. But having all containers in the same default network is not recommended and having every container talk to every other container is never a better option in an application. So, we build a user-defined bridge where only certain applications that require networking can be added. So, in our case, we see that authentication and quiz applications are set under one user-defined bridge, and our quiz, cam, and video analysis applications are set under another bridge. In each of these user-defined bridges, all containers are assigned their own IP using which they communicate and share information with each other.

5.4 Orchestration

With multiple microservices in different pods, coordination is required for the smooth working of the application. Along with that, an important feature of the microservices architecture is being able to alter individual microservices without disturbing the other components, minimizing application downtime during maintenance, and increasing availability. As part of orchestration, the features implemented in this project are scaling and rolling updates. These can be done without editing the YAML files or re-deploying the pods, thanks to deployments.

Scaling is basically altering the number of pods, i.e., replicas based on the requirement so that even if one pod is down, the other pods will be able to offer the service. Updates are needed in case of any change in the source code. Building a new image and updating the deployment, ergo its service, via the command line tool kubectl, makes it easier, as it can be achieved without disturbing the other components and making the updated service accessible with immediate effect.

6 Results and Discussion

The microservices are up and running and can be accessed from the browser, i.e., outside the cluster. This way, the containerized content remains durable and reusable without rebuilding and re-deploying. Using k8s has made it easy to roll out updates and scale the application as per needs without disturbing the other components of the application. Additionally, it allows a CI/CD pipeline implementation as well.

The camera recording service being accessible over HTTP only couldn't record the video, as webRTC functions cannot record over HTTP connections and need

Table 1 Existing technology versus proposed solution

Existing technology	Proposed solution
Not easy to scale, time-consuming, and requires new resources	Could scale each component independently, as per the need
Deployment only after complete development	Continuous deployment, even in case of changes
Need to change and deploy the whole application again in case of alterations	Change only corresponding component during updates, without re-deployment
Any fault occurring can affect the whole application or other components	Other components are at lesser risk in case of faults
No need to take extra care toward it	Need to ensure proper establishment of all connections among the services and perform health checks

SSL for security concerns. A possible solution for this is getting an SSL certificate. However, a slight alteration is made such that the other services can use its localhost version.

Table 1 provides a comparison between the current technology and the proposed methodology.

Overall, the results observed have met the expectations and satisfied the requirements of the problem statement, in comparison to the base monolithic web application used.

7 Conclusion and Future Work

Today, there is an application for everything, furthermore, the number of users is escalating. With such high demands and new necessities, ensuring the applications are easily available anytime and anywhere with minimum downtime is a must, hence the microservices architecture. The whole application is split into microservices, where each service is containerized, and deployed. Using Kubernetes, each of them is exposed and portrayed as a single service from the external world. Following this, orchestration of the services is carried out for better performance.

Currently, only 1 node acting as the control plane is set up; in the future, more nodes, i.e., worker nodes can be added to balance the load, where the application can use free nodes in case of issues. A third party API can be easily deployed for malpractice detection using the recording. Additionally, a portal for invigilators to check flagged content can be added. These are some suggestions for future work.

Acknowledgements We take this opportunity to thank PES University and Lavelle Networks for giving us the opportunity to pursue our project and for all the knowledge and support we have received. We are grateful to the Center for Information Security, Forensics and Cyber Resilience, PES University, for organizing, managing, and helping with the entire process.

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Stress Diagnosis Using Deep Learning Techniques

Ritu Gautam and Manik Sharma

Abstract Genetic Algorithm (GA) is a very efficient and stochastic algorithm inspired by biological evolution process. It has been extensively applied to a variety of practical applications. Convolutional neural network (CNN) is the most popular deep learning technique and has yielded the most promising results in every field. In this research paper, the restricted characteristics of GA have been hybridized with the basic features of CNN to obtain a better and improved version called Restricted Genetic Algorithm based on Convolutional Neural Network (RGA-CNN). The proposed approach is tested on two different stress data sets collected from different colleges and universities. The experiential results are compared to the state-of-the-art methods such as convolutional neural network, long short-term memory (LSTM), and recurrent neural network (RNN). The results reveal that the proposed approach outperforms CNN, LSTM, and RNN in the diagnosis of stress.

Keywords Deep learning · Stress · Convolutional neural network · Long short-term memory · Performance metric

1 Introduction

Stress is an enormously prevalent disorder with a highly debilitating condition. In the medical or biological area, stress is defined as a physical, mental or emotional factors that induces mental or physical tension [1]. Stress is also defined as a feeling or circumstance experienced by people who believe that the demands placed on them are more than their ability [2]. Stress is a debilitating and serious mental disorder that can develop as a result of a variety of factors (traumatic events). Experiencing a traumatic event [3]. It is a complex reaction pattern that often has cognitive, behavioral, and psychological components [4]. Nowadays, almost every individual independent of gender, age, race, financial status, physical fitness, name, and fame is facing the venomous impacts of this human psychiatric disorder [5].

R. Gautam (✉) · M. Sharma
Department of CSA, DAV University, Jalandhar, India
e-mail: sharma4ritu@gmail.com

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Based on circumstances, people may face different types of stress such as acute, episodic acute, and chronic stress [6–9]. So, diagnosis of stress has become a challenging task for psychiatrists and psychologists.

Recently, with the help of the massive amount of data and graphical processing unit, deep learning techniques (DLT) have accelerated their performance and have come up with better solutions to problems [10]. Deep learning has outperformed machine learning techniques such as support vector machine and decision tree in different areas such as speech recognition, health care, fraud detection, and object detection [11–14]. The major contributions of this research work are summarized as follows:

- A novel hybrid approach based on Restricted Genetic Algorithm (GA) and convolutional neural network (CNN) is proposed.
- The proposed method is employed to enhance the performance of CNN, and results are also validated on two different stress data sets.
- The results of the proposed novel method are also compared with three state-of-the-art methods such as CNN, LSTM, and RNN.

The rest of the article is formulated as follows. In Sect. 2, related work has been presented. Data set description and deep learning techniques have been introduced in Sect. 3. In Sect. 4, the proposed method is discussed. Experimental results are discussed in Sect. 5. Finally, concluding remarks followed by future directions are discussed.

2 Related Work

The literature on the application of DL techniques in the diagnosis of psychological problems such as post-traumatic stress disorder, depression, Alzheimer's disease, Parkinson's disease, and epilepsy has been studied and highlighted in Table 1.

3 Materials and Methods

3.1 Data Sets

Here, two different academic fraternity stress data sets, i.e. Data set 1 (D1) and Data set 2 (D2) related to Student stress are used in Sects. 3.1.1 and 3.2.2 for analyzing the performance of deep learning techniques (CNN, LSTM, RNN, and RGA-CNN).

Table 1 Past studies based on deep learning computing techniques

Author	Technique	Disease	Accuracy	Instances
Antoniades et al. [15]	CNN	Epilepsy	87.51%	25
Camps et al. [16]	CNN	Parkinson's	90%	21
Le et al. [17]	DBN	Epilepsy	96.87%	19
Acharya et al. [18]	CNN	Depression	96%	30
Awate et al. [19]	CNN	Alzheimer's	99%	400
Mao et al. [20]	CNN	Depression	77.20	34
Banerjee et al. [21]	CNN	Post-Traumatic Stress Disorder	68%	26
McDonald et al. [22]	CNN	Post-Traumatic Stress Disorder	Not Mentioned	107
Ay et al. [23]	LSTM	Depression	99.12%	30
Cui et al. [24]	RNN	Alzheimer's	91.33%	830

3.1.1 Data Set 1 (D1)

The data set D1 stress disorder is a data set that comprises (college students, undergraduates, and postgraduates) 2507 instances and out of 73 attributes, 13 attributes are related to personal information (such as name, city, gender, age, locality residence, father's source of income, mother's source of income, college name, and pursuing education) and rest of the 60 attributes are stress indicators such as stress at the first semester of college/university, stress during final year Projects/Training, stress due to incomplete and confusing study material, stress due to biased attitude of teachers, stress due to online classes instead of physical classes in college/university, stress due to conflict with teachers, stress due to inadequate subject knowledge to teachers, stress due to vast course curriculum, stress due to deadline of submission of assignments, stress due to results/grades, stress due to academic punishments, and the stress of bullying in college/university. The responses to these questions were recorded in categorical variables (five-point Likert's scale) such as (0—never, 1—Rarely, 2—Sometimes, 3—Fairly often, and 4—Very often).

3.1.2 Data Set 2 (D2)

The data set D2 stress disorder is a data set that comprises (postgraduate students) 315 instances and out of 29 attributes, seven attributes are based on personal information (such as marital status, gender, annual income of the father, postgraduate course, course year, alcohol/drug intake, and socially active) and rest of the 22 attributes are stress indicators such as level of stress due to studies, academic marks, level of satisfaction with grades, sleeping disturbance rate after an early wake-up learning capabilities, attendance, stress about career, extra lectures to cover the syllabus, confidence at the time of admission, social circle, performance praised by teacher and parents, lack of interest in sports, confusion level regarding duties, financial stress for studies, drug/alcohol intake, rate of sound sleep, and a sleeping disorder. The answers to these questions were recorded in categorical variables (six-point Likert's scale), i.e. 1—very high, 2—high, 3—medium, 4—low, 5—very low, and 6—no stress.

3.2 Deep Learning Techniques

Deep Learning (DL) has progressed as one of the most dynamic machine learning techniques, involving learning by representation to perform different levels of information processing stations [23]. Originated from ANN, DL is characterized by multiple layers of neural networks that extract complex features from input images. DL has become prominent due to three factors: (1) good processing capabilities, (2) due to affordable hardware, and (3) recent development in research of deep learning [24]. Unsupervised, supervised, and hybrid are three different classifications of deep learning. **Convolutional neural network (CNN)** is a supervised deep learning technique proposed in the year 1980 for analyzing the imagery data. CNN is based on the concept of the neurobiological architecture of the visual cortex. As compared to the neural network, fewer parameters are needed on CNN. It is composed of a convolutional layer, pooling layer, normalization layer, and fully connected layers [25]. Speech processing, NLP, and computer vision are the most extensive applications of CNN. AlexNet, ResNet, LeNet, VGGNet, GoogleNet, and ZFNet are some recent categories of CNN [26]. **Autoencoder (AE)** is an unsupervised and generative approach to deep learning in which output behaves as input itself. An AE comprises an encoder, decoder, and stacked structure of the input, output, and hidden layers. Specifically, several input and output nodes are equal in AE [27]. Dimensionality reduction of a data set is the main purpose of AE. AE is considered to be a deep autoencoder if many hidden layers are more than one. Sparse AE, denoising AE, convolutional AE, and K sparse AE are different variations of AE [28]. Speech extraction is one important application of AE [29]. Another unsupervised deep learning approach is RNN which is a feed-forward neural network that has been extended [30]. RNN is based upon the recurrent connection for utilizing the sequential information. Moreover, this structure also has the ability of memory that stores the old data in the hidden layer coming from the input layers [31]. Therefore, RNN can be also called short-term memory that comprises input, hidden, and output layers. RNN is another popular DLT used for speech processing, bioinformatics, and NLP [32]. **Long short-term memory** (LSTM) is one of the main variations of RNN. LSTM can retain the information for a long period [33]. It is used for processing, predicting, and classifying based on time series data [34].

4 Proposed Novel Method

The success of a Genetic Algorithm (GA) is determined by the control parameters chosen (population size, crossover, mutation). Each parameter of GA has a direct impact on the quality of the results. In this manuscript, selection of parameter (mutation) in GAs along with the convolutional neural network method, i.e. restricted genetic algorithm and convolutional neural network (RGA-CNN) is proposed for the diagnosis of stress.

The purpose of restriction in GA and hybridization with CNN is to bring diversity to the population during the run in a dynamic way. The results of the proposed technique were found to be superior using a population of 100 elements and 5–10 generations in search of the best solution. The working flow of the manuscript method is shown in Fig. 1.

5 Result and Analysis

An extensive investigation has been carried out for measuring the performance of three deep learning techniques on two different stress data sets. Experimentation has been carried out using different K cross-validation methods. Results are reported on an average of 15 independent runs to attain better and meaningful full results. Moreover, minimum, maximum, and average rates of accuracy, sensitivity, and specificity are calculated and analyzed. The results are mentioned in Tables 2, 3, and 4. Table 2 shows the accuracy rate.

From Table 2, it has been analyzed that on both data sets the proposed technique RGA-CNN outperforms CNN, RNN, and LSTM deep learning techniques. The highest accuracy rate achieved by RGA-CNN on data set 1 and data set 2 is 99.20% and 99.55%, respectively. Furthermore, a minimum rate of classification accuracy achieved by LSTM on data set 1 and data set 2 are 58.32% and 70.16%, respectively. Table 3 shows the sensitivity rate of three deep learning techniques on both stress data sets.

From Table 3, it has been analyzed that the RGA-CNN achieved the greatest sensitivity rates of 99.91 percent and 99.60 percent on both datasets. Furthermore, the minimum sensitivity achieved by LSTM on data set 1 and data set 2 is 55.88% and 75.90%, respectively. Table 4 shows the maximum, minimum, and average specificity rate of three deep learning techniques on both stress data sets.

From Table 4, it has been analyzed that on both data sets, the highest specificity rate of 100% was achieved by LSTM on data set 1 and RGA-CNN deep learning techniques on data set 2. Furthermore, the minimum specificity rate achieved by LSTM on data set 1 is 80.01% and data set 2 is 42.42%, respectively.

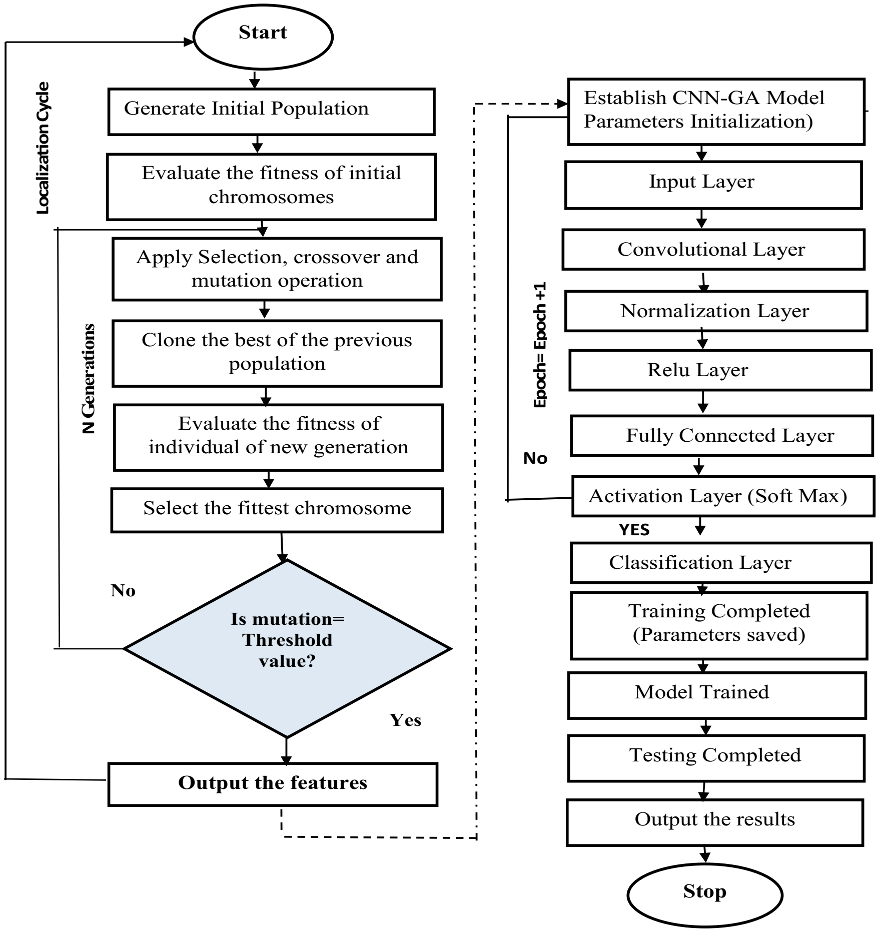

Fig. 1 Flow of proposed approach

6 Conclusion and Future Direction

In this research work, a hybrid algorithm based on GA and CNN is designed for stress diagnosis. To utilize the strength of both the algorithms and for better results, a hybrid approach of GA and CNN is proposed. To test the efficiency, the results of the proposed approach are compared with three deep learning techniques such as CNN, LSTM, and RNN on two different stress data sets. Fortunately, the results of the proposed approach were found to be more optimized with an accuracy of 99% on both data sets. Furthermore, the performance of LSTM was found to be very low on both data sets. In the future, the effectiveness of these deep-learning techniques can be evaluated for other stress-related datasets. Moreover, other hybrid variants of CNN, LSTM, and RNN need also be investigated.

Table 2 Accuracy

Accuracy			RNN (%)	LSTM (%)	CNN (%)	RGA-CNN (%)
D1	Minimum	Min	86.67	58.32	94.24	**94.61**
		Max	87.90	65.67	94.41	**95.28**
		Avg	87.28	61.05	94.35	**94.90**
	Maximum	Min	91.90	95.66	97.43	**98.57**
		Max	93.13	96.71	98.16	**99.00**
		Avg	92.42	96.16	97.78	**98.79**
D2	Minimum	Min	72.38	70.16	92.06	**94.27**
		Max	74.29	72.70	94.90	**95.00**
		Avg	73.10	71.90	93.58	**94.65**
	Maximum	Min	89.84	91.11	98.41	**98.09**
		Max	92.38	92.06	99.36	**99.00**
		Avg	91.11	91.83	98.84	**98.67**

Table 3 Sensitivity

Sensitivity			RNN (%)	LSTM (%)	CNN (%)	RGA-CNN (%)
D1	Minimum	Min	94.43	55.88	96.62	**94.27**
		Max	94.71	68.53	96.99	**96.87**
		Avg	94.52	91.26	96.78	**96.11**
	Maximum	Min	98.87	96.64	98.88	**99.19**
		Max	99.91	98.44	99.49	**99.56**
		Avg	99.53	97.47	99.12	**99.45**
D2	Minimum	Min	75.90	75.90	91.11	**93.75**
		Max	81.12	77.11	93.39	**94.44**
		Avg	77.41	76.41	92.59	**94.10**
	Maximum	Min	96.79	97.99	98.00	**98.41**
		Max	99.60	99.60	99.21	**99.56**
		Avg	98.59	99.00	98.55	**99.18**

Table 4 Specificity

Specificity			RNN (%)	LSTM (%)	CNN (%)	RGA-CNN (%)
D1	Minimum	Min	80.01	82.69	91.80	**92.36**
		Max	82.64	93.23	92.66	**93.95**
		Avg	80.98	89.93	92.14	**93.28**
	Maximum	Min	87.76	100.00	96.27	**98.12**
		Max	89.42	100.00	97.62	**98.81**
		Avg	88.68	100.00	97.03	**98.52**
D2	Minimum	Min	42.42	42.42	88.89	**92.36**
		Max	48.48	48.48	95.00	**94.59**
		Avg	45.83	46.21	92.91	**93.44**
	Maximum	Min	68.18	66.67	100.00	**98.64**
		Max	74.24	72.73	100.00	**100.00**
		Avg	70.45	69.32	100.00	**99.66**

Compliance with Ethical Standards Conflict of interest: The authors proclaim that they have no dissension of interest.

The ethical approval of this article does not contain any studies with human participants or animals performed by any of the authors.

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News Application with Voice Assistant

R. S. Sabeenian, J. V. Thomas, and V. Ebenezer

Abstract The world is moving at a fast pace and people do not usually find the time to read a newspaper or go through the news every day. A survey shows that a huge amount of time is spent commuting to workplaces and educational institutions. To convert that time into a productive one, we have developed an application that can work hands-free. This is a news application that works on web browsers both on mobile as well as desktop computers. The aim is to create an app that fetches news across various sources all around the world and displays it in an organized manner with a clean User Interface along with some hands free voice assistant features.

1 Introduction

Taking time to read a newspaper in today's world has become an impossible task. People do not find time to read the NEWS but are very eager to know what is happening around them and the whole world. The average person just spends about 10 min reading the headlines and the time spent is decreasing day by day. There is a lot of hidden news present in the later pages and no interest is shown in reading those. The main problem in today's world is people spend about 1–2 h every day travelling to work, which was not the case in those days. Commute time can be utilized in order to stay in touch with what is happening around them. We have developed a system that can be utilized in that period. This application involves human computer interaction, and it reads out the news for you from whatever source you ask for. This application can be installed in smartphones, smart tablets, cars with built in Android

R. S. Sabeenian (✉) · J. V. Thomas · V. Ebenezer
Department of Electronics and Communication Engineering, Sona College of Technology (An Autonomous Institution), Salem, India
e-mail: sabeenian@sonatech.ac.in

J. V. Thomas
e-mail: joshuavthomas.18ece@sonatech.ac.in

V. Ebenezer
e-mail: ebenezer.18ece@sonatech.ac.in

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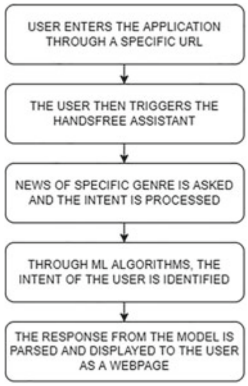
Auto or Apple car play. The individual can ask the built-in assistant for the type of news that he/she requires, and the assistant will list out the latest news from different sources and read the news aloud for the individual. The main contributions include:

- A full stack web application that has a responsive user interface.
- A pre-trained machine learning model that uses various speech algorithms.
- A handsfree virtual assistant for ease of use.
- A fully configured backend that runs on the cloud for voice and data processing.

2 Literature Survey

A machine learning model with an automated approach to classify online news using the support vector machine (SVM) since it provided good results if ample amount of data is provided to train the model. Chee-Hong Chan and his team built a model for classifying online news just with the search queries and a categorizer model that classified the news. But the problem here is that they did it as an experiment and not an application that an end user can use. This was way back in 2001, and the technology was not ahead of time to develop such products [1]. Seyyed Mohammad Hossein Dadgar in his article stated that he and his team developed a model using Term Frequency-Inverse Document Frequency (TF-IDF) and Support Vector Machine that used BBC news data-sets to classify the news with text pre-processing, feature extraction and classification. They obtained a very desirable accuracy of 97.84% for the classification. When comparing this approach with other models, it gave a greater accuracy and better classification. But classifying news from a single source is not so tedious task and when the number of data-sets increase, the accuracy will be automatically decreasing [2]. A text to speech synthesizer is developed to efficiently convert text to speech using Natural Language Processing and Digital Signal Processing Technology [3, 4]. For the correction of errors during the conversion, an effective algorithm for error detection and correction was proposed with an accuracy of 82.1% [5]. For supporting multilingual text to speech conversion, a speech recognition model with Google Speech Recognition System was implemented [6]. To collect the speech of an individual in a noisy environment, an Automatic Speech Recognition System (ASR) was developed for the everyday user. The system had the features including low-latency, customization and the ability to work without internet. The system's performance was measured in terms of ASR accuracy and speech processing speed. Further upgrades were made to the model to support multiple languages which includes Arabic Natural Language Processing (ANLP) [7–11]. Enhancing the speech comes in handy for predicting the input with more accuracy. Live understanding of the language requires more processing power and the best trained model. Using LSTM acoustic models and Deep Learning, recognition of speech with less performance degradation was achieved [12, 13].

3 Flow Process of the Proposed System



4 Methodology Used

There are some major problems that needs to be tackled while developing a platform like this. Fetching news from various source around the globe is not an easy task and obtaining it individually will make it a tiring process and sometimes repetitive. Some websites might not allow web scrapping too. So, in order to obtain the news in an efficient manner, it is better to use a restful API. News API is a REST API, which is simple, lightweight and fast with CDN all over the world. It returns JSON metadata relevant to the articles and headlines that are spread across the web. The API covers wide-ranging markets, including sources from over 55 countries. With News API, everything is fast and asynchronously cached to deliver a quick response.

After fetching the news, it is stored as an array of objects so that it can be manipulated later. The backend is developed using Alan AI which is a PAAS to develop voice assistant for web, mobile, and other smart devices connected to the internet. The intent and response are trained there based on the user input and debugged for resolving issues. After everything is done and trained, we need to develop the user interface so that the application is usable by the user. New technologies like ReactJS, NodeJS are used in order to achieve this. A beautiful user interface is developed using the flexbox and grid concepts so that the news is aligned perfectly in any devices and form-factors.

5 ALAN AI

The back-end of the application that fetches news from different APIs is built based on the ALAN AI platform. This platform helps us to develop the intent and the response that is needed and the method of communication with the end user. It promotes rapid

Fig. 1 Infrastructure deployed on the cloud as well as the user's device

development and deployment and can also be used to integrate the voice assistant in any web application or mobile Apps. After the complete integration, the personal voice assistant can be triggered by clicking the assistant or through voice commands.

Figure 1 depicts the areas of the infrastructure where Alan AI is deployed. We have separate SDK for the client and a virtual machine deployed on the cloud for voice processing and a code editor for managing a project, restarting a project, generating voice scripts, script testing and voice analysis. The SDK for the client can be used to develop software which will be discussed later. The language model used here is pre-trained and is able to understand the intent of the user. This is achieved by the following techniques:

- Speech-to-Text
- Natural language processing
- Spoken Language Understanding
- Automatic Speech Recognition
- Machine Learning

The voice processing starts on the client side where the Alan client will fetch the voice from the end user and send it to the cloud for further processing. The speech-to-text algorithm then converts the user's speech input to text through the Automatic Speech Recognition system deployed on the cloud. With the Spoken language understanding model, the paragraph patterns and phrases are evaluated so that it matches the intent that is hard coded by the developer. The phrases are given a probability score by comparing the user input and the code script, the maximum matching probability being one and the least matching probability being zero. After proper evaluation and matching, the model returns a response which can be later manipulated and turned into visual elements and voices.

The main reasons for deploying the models on the cloud are as follows:

- Serverless environment
- No maintenance
- Unlimited Scaling
- More process power
- 99.99% up-time

6 NEWS API

API stands for Application Programming Interface which stands as an intermediary and allows applications to communicate with each other. Modern API's include HTTP and REST. They are usually key value pairs when requested from the internet and later can be parsed to use in the application.

There is a need for an open-source platform or an application that provides API and third-party integration facilities for our app to use. Collecting individual API keys from various news providers across the globe is a tedious task. In search of a platform that provides good documentation and usability, we found NEWSAPI.org. News API is a simple HTTP REST API for searching and retrieving live articles from all over the web.

The platform has the following features that comes in handy:

- NEWS in the form of JSON with authors and sources
- Sources from all around the world
- Excellent documentation on usage
- Free to use and no limitations on requests

We used the classic http request to get the information as JSON, and we parsed it to obtain the information. The information i.e. the NEWS that is obtained are pushed to an array so that it can be traversed and manipulated to display the front-end or the UI element. All the http get requests are integrated together in the back-end in the ALAN AI platform itself to reduce redundancy and latency.

The next step is to classify the news according to the meta description of the source. This would have been a tedious task because a separate script must be written for web scraping, and it might be illegal while we perform in certain sites. NEWSAPI.org provided us with the meta description as well. So, when the user requests for a specific genre, the text is recognized and used to search the News based on that text.

News can be searched based on the following criteria:

- Keyword or phrase
- Date published
- Article name
- Language

The news results can be sorted as following:

- Date published
- Relevancy to search keyword
- Popularity of source

We need an API key to use the API. This is a unique value that helps to identify your requests.

7 The User Interface

This is the most important part of the project. After configuring the back-end completely, the UI should be developed in such a manner that it completely utilizes the potential of the logic written. Various technologies were used in order to make the interface beautiful and functional as well. The personal assistant button that is integrated is placed in the bottom right corner of the display for either desktop or mobile devices as it is easy to reach, and most people are used to it naturally.

ReactJS developed by Facebook was used in order to develop the frontend of the application. Each component was built individually and in a responsive manner so that the UI stays responsive to every form-factors. Figures 2 and 3 depict the UI developed using ReactJS. It makes it very easy to create interactive UIs. The different components that were built and put together are easy to update when the content changes and supports hot reload.

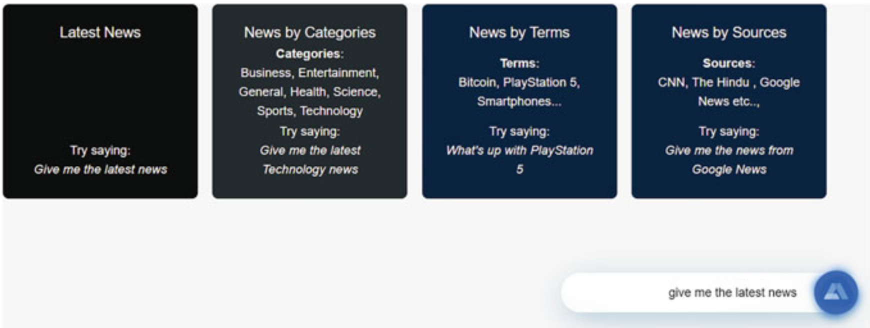


Fig. 2 User interface of the homepage with instructions on how to use the application

Fig. 3 User interface when the response is processed and displayed

8 Conclusion

In this project we developed a full-stack fully functional and responsive web application that harnesses the power of cloud and machine learning. The news app is in a beta stage and is being tested on various devices. In the future, we have planned to include a search bar to search the news based on types, sources and genre. Improve the user interface and add more sources. Include native languages with decent accents and voices, add user accounts using firebase authentication and personalized news recommendation. Faster search and indexing is still a work in progress and will be developed in upcoming days.

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Impact of Soil Degradation on the Durability of Roads and Bridges in Middle Guinea: Synthetic Geoscientific Approach and Geotechnical Perspectives

Ibrahima Diogo, Darraz Chakib, Diaka Sidibe, and Amine Tilioua

Abstract Several bridges and roads have deteriorated and become impassable in Guinea in recent decades. Because? The degradation of their supports (soils) and the crucial lack of basic geoscientific studies of their direct environments. We have set ourselves the objective of analyzing this problem in Middle Guinea and providing concrete solutions. The results of our social and state surveys (climatic, hydrological and geological services) show seasonal damage due to downpours. Our geoscientific studies reveal pedogenetic products (chemical and mineralogical) forming soil horizons (pasty and slippery on the surface), very sensitive to hydrolysis which modifies their states of stability (formation) and produce results which prevent the masters of 'works on the realities that await them and guide them to a safe approach. Our geotechnical outlook provides concrete/direct measures combating this scourge on the Labé-Mali axis; at the Linsan and Mamou-Linsan deviations, thus facilitating socio-professional journeys which have become difficult.

Keywords Middle Guinea · Roads · Bridges · Degradation · Rainfall · Pedology · Geotech

I. Diogo (✉) · D. Chakib
Applied and Marine Geosciences, Geotechnics and Geohazards Laboratory (LR3G), Faculty of Sciences Tétouan, Department of Geology, Abdelmalek Essaadi University, Mhannech 2, BP 121, 93030 Tétouan, Morocco
e-mail: dialloibrahimadiogo@gmail.com

D. Chakib
e-mail: cdarraz@uae.ac.ma

D. Sidibe
Minister of Higher Education, Scientific Research and Innovation, Former Higher Geology and Mines Institute, Boké, Guinea
e-mail: Sidibediaka1@cems-ismgb.org

A. Tilioua
Thermal and Applied Thermodynamics (2.T.A.), Mechanics, Energy Efficiency and Renewable Energies Laboratory (L.M.3.E.R.), Faculty of Sciences and Techniques Errachidia, Department of Physics, Moulay Ismael University of Meknès, B.P. 509, Boutalamine, Errachidia, Morocco

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1 Introduction

Soil degradation has been increasing in West Africa for several decades. Some people point to drought as the main culprit. In Senegal, Mali, Burkina Faso, Côte d'Ivoire, Niger, etc., authors [6–31] have tried to understand this issue according to the interfaces: soils_climate_water_soil chemistry_humans etc.

All regions of Guinea are affected by this scourge which affects rural agriculture and commerce. Road degradation and bridge collapses are recurrent. This is the case in Niala (Kindia, August 19, 2021–August 21, 2021); Macenta in August 2021 and the Kankan-Kissidougou sections and the Coyah-Mamou-Dabola axis where the muddy and pasty roads were impassable. We illustrate here the problem in Middle Guinea (Mamou and Labé, more than 80% of Fouta Djallon).

– In 2014, travel between Labé's sub-prefectures was heavily impacted. In Kansacoumma (in Labé), entry and exit to Loura was prohibited due to the existence of a section of road feared to be in a state of disrepair. In the prefectural capital of Mali (Yembering), the sub-prefectures of Lebekeré, Toubabagadji, and Bakali were unreachable as an Ebola awareness tour was planned between 7 and 11 October 2014.
– In August 2018, 14 km from Yembering and 65 km from the urban commune of Labé, the M'bagou bridge (linking Mali to Labé) broke down.
– A year later, the relay that had been defined there (120 km from Labé) was submerged on 20 July 2019 as a result of heavy rains. Five years later, no permanent solution had been found. In June 2018, in Linsan (Mamou), in the bed of the Kounkouré river (linking Middle Guinea to Lower Guinea), a bridge collapsed.

Despite the persistence of the scourge, the Geosciences_Geotech_Civil Engineering trilogy was not followed. In this present, we prepare project leaders to better tackle the subject in three parts:

– A first part for the location and presentation of the illustration areas;
– A second part to situate the logic of the work and to simulate all the factors of soil degradation (and the structures they support);
– Finally, to define a dynamic of concrete proposals adapted to the geoscientific environments of each zone, thus proposing reliable geotechnical approaches for sustainable civil engineering works.

2 Presentation of Regions of Work

2.1 Geographical Localization of the Regions

Labé and Mamou regions affected by this study are summarized in Fig. 1.

Fig. 1 Geographical location of the towns of Mali Yembering, Labé, Linsan, and Mamou

2.2 Geochronological Presentation of the Regions

Over time and under climatic effects, rocks alter and erode with different resistance (see the illustration in Middle Guinea in this Table 1.

Table 1 Natinal roads and bridges (Mamou and Labé) / Geochronology and degree of impact

Roads/bridges	Sections	Geochronology	Representation	Régions
P°1	Linsan/Environs	Protérozoïque Paléozoïque Mésozoïque	Secondary Secondary Mainly	Mamou
N°1	Linsan-Mamou	Protérozoïque Paléozoïque Mésozoïque	Mainly Secondary Secondary	
°1	Mamou-Dalaba	Protérozoïque Paléozoïque Mésozoïque	Secondary Mainly Low	
N°1	Dalaba-Pita	Paléozoïque Mésozoïque	Mainly Low	
N°1	Pita-Labé	Paléozoïque Mésozoïque	Secondary Mainly	Mamou_Labé
N°1 P°2	Labé-Mali	Paléozoïque Mésozoïque	Mainly Secondary	Labé

Table 2 Main Fouta watersheds positions in relation to the Labé, Mamou, Pita, and Dalaba

Regions	Watershed
Mamou	Kounkouré
Gaoual	Tominé
Mamou-Dalaba	Bafing
Dabola	Kaba
Dabola	Mongo

2.3 Presentation of the Hydrological Basins of the Regions

The West African hydrological complex is still the subject of several studies today [1–28], from various perspectives: climatic, hydric, flooding, or agricultural. Guinea is perceived as the water tower of the region, with most of the major sub-regional rivers having their sources there. The Senegal River (the most prominent in Middle-Guinea, enters the region's system: see basin in Table 2) and the Niger River are examples of this.

3 Materials and Method

3.1 Materials

Zotero is our bibliographic management tool. _The geo-scientific material is made up of GPS; compasses; Bags; old cards; hammers; topographic backgrounds; graph paper; Google Earth; magnifying glasses; ArcGIS; MapInfo; Online data; Global map; Autocad; Envi; and Geomatica. _The hydrological system includes rain gauges; anemometers; weathervanes; heliographies; barometers (Hg); barographs and satellite data collection and transmission systems; several synoptic stations of the METAR/SYNOP type (Mamou, Pita, Labé and Dalaba); agro-meteorological stations; a meteorological system, and finally, software for processing and producing digital data. _Sampling was carried out by drilling (hand pit) and trenches (mechanical shovels, picks, and metal cylinders). The physical parameters of soil classification were defined by a laboratory apparatus consisting of sieves, volumetric furnaces, the Casagrande dome, etc.

3.2 *Method*

Our method has three axes: bibliographic_geoscientific (qualitative and quantitative exploration, identification of factors of soil degradation); correlation of degradations/intensities; and establishment of a geotechnical guide; finally, a digital one (production of preliminary results hitherto unavailable in the country).

4 Discussions and Results

4.1 *Geology*

The geology of one of the oldest regions in the world, West Africa, has been the subject of several studies [4–13]. In Guinea, the most representative and official are made by Bering et al. (1998). The litho-geochronological complex between Mamou and Labé (Fig. 2) shows a double ***Archean*** (the Dabola series). _A ***Proterozoic*** (Rhyacian–Orosrian; Lower Rifean; Late Rifean; Oundou series; Madina Koula series; Timbo's suite; Mongo's suite). _A ***Paleozoic*** (Pita's units and the series of Falémé) ***_A Gondwanan*** and ***A Cenozoic*** (various rocks and soils).

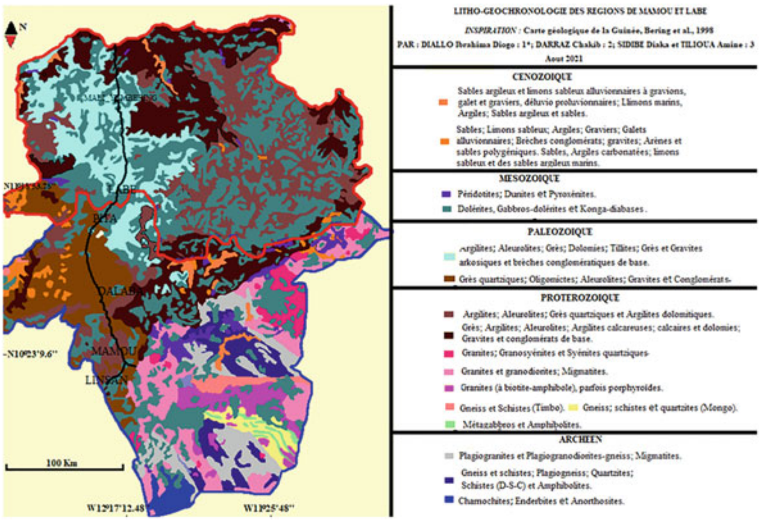

Fig. 2 Litho-chronological illustration of the Mamou and Labé regions

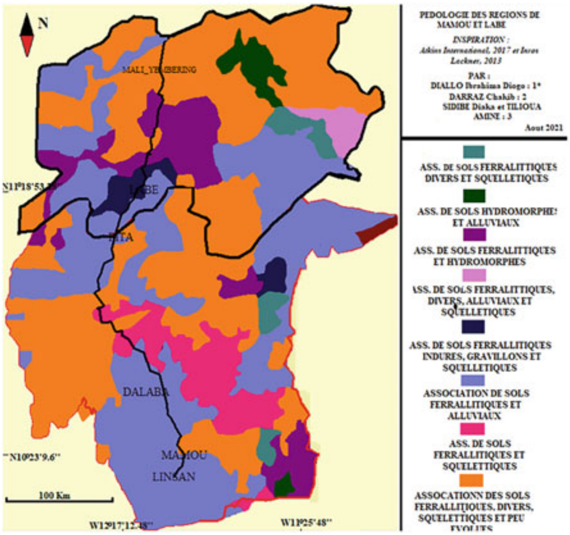

Fig. 3 Illustration of the soil types crossed in the Mamou and Labé regions

4.2 Pedology

In West Africa, land degradation is treated loosely [6–31]. Their use as building materials is more extensive [3–32]. The steps of [10–27] are a reliable means to understand this scourge, to evaluate it, and to situate it in time. The associations of ferrallitic soils (Fig. 3) are the most represented in Mamou and Labé [2–17]. There are also hydromorphic passages and various skeletal, alluvial, little evolved, and/or gravelly tendencies.

4.3 Hydrological System

The Senegal River has its source in the Fouta Djallon (Fig. 4) under the name Bafing. Its tributaries are the Téné and the Kioma (in Guinea), then the Falémé (in Senegal). The Gambia River has its source in Labé. The Kouloutou passes through Koundara before joining Casamance (Senegal). The Gomba and Tominé rivers cross at Gaoual to form the Koliba. The Kaba, its tributary the Mongo, originate in Dabola before joining Sierra Leone.

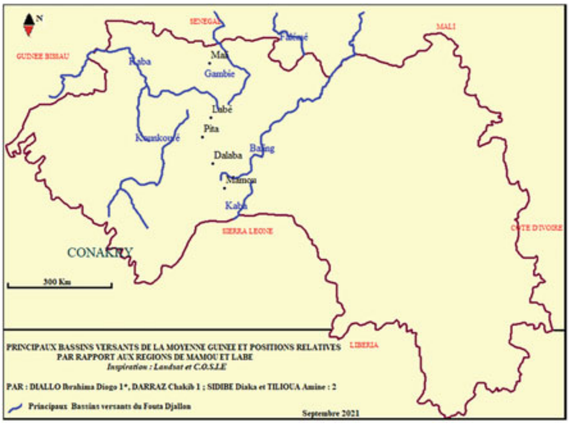

Fig. 4 Main watersheds in Fouta Djallon, including the regions of Mamou and Labé

4.4 Impact Vegetation Cover

Our mapping/teledetection approach made it possible to extract LANDSAT/LE07/C01/T1_8DAY_EVI, USGS images, dealing with the distribution of vegetation (September 2021) of Mamou and Labé (Fig. 5). The bands used are near infrared, red and blue. The correction of the effects of the soil and the atmosphere is inspired by Huet et al. (1999) according to whether EVI = G [(ƒPIR - ƒR) / (ƒPIR + C1 ƒR - C2 ƒR + L)].

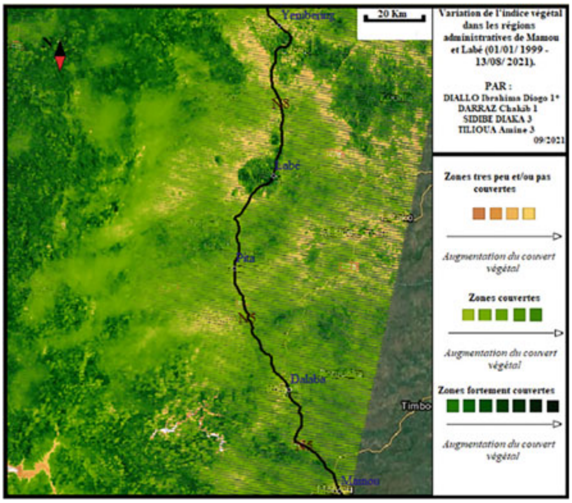

Fig. 5 Plan cover and soil degradation (Mamou/Labé, January 1, 1999–August 13, 2021)

Table 3 Main climatic factors influencing soil stability (Kankan/Siguiri/Mandiana/Kérouané)

Parameters	Regions	
	Mamou	Labé
T. m. annuelle (°C)	27.283	25.522
P.m. annuelle (mm)	13 (20 Mars–27 Nov.); 526 (max, Août)–1 (min, Déc.)	13 (6 Avril–19 Nov.); 445 (max, Août)–0 (min, Déc.)
H. m. relative annuelle (%)	26 (15 Avril–30 Nov.); 100 (15 Août) et 2 (le 1er Janvier)	23 (06 Mai–12 Nov.); 92 (17 Août) et 0 (le 21 Janvier)
Vitesse du vent (Km/H)	9.3 (30 Nov.–23. Avril)–11.7 (31 Déc.) et 7 (16 Octobre)	9.3 (01 Déc.–15 Mai)–11 (15 Jan.) et 7.6 (16 Octobre)

4.5 Climate Factors and Derivatives

Table 3 shows, according to WeatherAvenue, WeatherSpark, and infoclimat.fr, the climatic factors impacting soil stability in the Mamou and Labé regions (METAR/SYNOP weather station and Africa/Conakry time zone).

4.6 Geotechnical Approach and Prevention

Our geoscientific approach has enabled us, through its disciplinary complementarity, to index the main factors of degradation in Mamou and Labé and then to produce adapted geotechnical measures to guarantee greater durability of the structures. _Geochemically, the most representative elements of the facies are SiO_2 (with the possibility of having: Al, Fe, Ca, Na, Ti, Rb, B, Mg, Li and OH); (B, Ca, Na, K, NH_4) $(Al, B, Si)_4O_8$; (Na^+, Ca^2+, Li^+, Mg^{2+}, Fe^{2+}, $Mn^{2+\cdots)}$ (Mg^{2+}, Fe^{2+}, Mn^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, $Ti^{4+\cdots}$) $(SiO_3)_2$; (Ca, Mg) CO_3; K $(Mg, Fe)_3$ $(OH, F)_2$ (Si_3AlO_{10}); and $(Mg, Fe)O_2$; (Na, K, Ca or Pb) (Li, Na, Mg, Fe^{II}, Mn^{II} or Ca) (Li, Na, Mg, Fe^{II}, Mn^{II}, Zn, Ni, Co, Al, Fe^{III}, Mn^{III}, V^{III}, Ti or Zr) $(Si, Al, Ti)_8O_{22}$ (OH, F or Cl) The proportions of each of the chemical elements will be the subject of future reviews. _There is a strong need to fight against ***deforestation*** in Mamou and Labé. ***Humidity*** (100% in some regions, at certain times of the year) causes the most visible damage to roads (N_5 and N_8). Water erosion resulting from precipitation over long periods gradually degrades the supports of the structures, it is the case of the M'bagou bridge, among others. _The rain accentuates the total hydrolysis of the pre-existing alumina silicates mainly represented by Gibbsite [$Al(OH)_3$] in the ferrallitic soils (and alluvium) of Mamou ville, Dalaba, Pita, and Labé ville. Mali Yembering includes an association of ferrallitic/skeletal soils (with hydromorphic tendencies in the northeastern part of Labé). Poorly developed soils (alluvial, recent flooding fluvial deposits) and skeletal tendency are visible in both regions. _The vegetation/forest cover plays an important role in the stability of ferrallitic soils. It is becoming a state and social responsibility to preserve the natural, geological, and forest environment in which soils are formed.

Table 4 Geoscientific and geotechnical perspectives for mitigating soil degradation in the administrative regions of Mamou and Labé

Perspectives	Results
Encourage reforestation	Restore soil balance after one year
Study soil salinity	– Avoiding soil erosion – Preventing drought – Preserve biodiversity (fauna and flora) – In addition, prevent deforestation
Conduct a hydrological study of the regions	– Know the direction of flow of the watercourse – Avoid structures on the river bed – Avoiding water erosion
Establish a rock-soil relation	– Understand the conditions of soil formation – Establish their stabilization parameters – Understand the role of rocks in the fate of soils
To know the geochemistry of weathered facies	– To know the chemical elements released by the rocks to enter into the composition of soils – Know the nature and initial proportions of the chemical elements that form soils
Determine the state of plasticity of soils	Classify soils and know their permeability
Determine the state of plasticity of soils	Understanding soil cohesion and strength
Determine the state of consolidation of soils	Understand their reactions to compression
Know all the mechanical behaviors of soils	Evaluate the reactions of soils to all external/internal factors that could, in one way or another, affect their stability

Salinization is also a factor that can impact the vegetation cover. Depending on the water content and temperature, it could prevent desertification, erosion and thus soil degradation, and the preservation of biodiversity. Table 4 summarizes the actions to combat the causes of degradation, gives the basis for better calculations of the engineering geology on which civil engineering depends.

The production, analysis, and interpretation of the results, in more detail, related to the practical aspects of each of these perspectives will be the subject of our next works.

5 Conclusion

The Geosciences-Geotech_Engineering-Civil trilogy has enabled us to tackle the problem of soil degradation in Middle Guinea at its source and to offer a safe approach for better durability of the structures. _The facies and soils of the regions include alumina silicates; oxides of iron and aluminum; ferromagnesians; elements sodium and calcium; as well as other elements: Li, Na, Fe^{II}, Fe^{III}, Mn^{II}, Zn, Ni, Co, Al, Mn^{III}, V^{III}, Ti, Zr, etc. _The most represented soils are ferrallitic, followed by skeletal and alluvial ones, then those underdeveloped and locally hydromorphic. _The factors of degradation are mainly climatic and anthropogenic. _Water erosion; soil saturation; destruction of the plant cover are also being felt. _Our geoscientific and geotechnical perspectives recommend: reforestation; the study of soil salinity; a hydrological study of the regions; establishing a rock-soil relationship; knowledge of the geochemistry of altered facies; knowledge of the physical parameters of soils; the determination of the state of plasticity of soils; determining the state of consolidation of soils; and knowledge of their mechanical behavior.

To complete the present, in our next reviews, we'll clearly give, among other things, soil chemistries, their physical parameters and their mechanical behavior, as well as the flow directions of the main regional rivers to avoid possible water erosion of structures.

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Analysis of COVID-19 Vaccination Sentiments Using a Voting Hybrid Machine Learning Approach

Ahmed Mohammed and A. Pandian

Abstract The coronavirus was declared a pandemic by the World Health Organization, and a vaccine for it was developed and is currently being used to vaccinate people all over the world. From the beginning of the COVID-19 vaccination program, many people have refused to accept the vaccine due to widespread misconceptions and propaganda concerning the COVID-19 virus itself, whether it is real or not, and the vaccination program as well. All these misconceptions and propaganda have been spreading through word of mouth (verbal) discussion among citizens. In this study, a hybrid machine learning approach was proposed with the help of natural language processing to build a sentiment classification and prediction system using the data collected from the public regarding their opinions on the COVID-19 vaccination program. The data was collected through the Google Form. The evaluation metrics used to measure the effectiveness of the proposed work were accuracy, precision, recall, and f-measure. Various machine learning algorithms were used for the implementation. Two algorithms, namely Support Vector Machine and Bagging Classifier, outperformed the remaining algorithms with the same accuracy and precision scores of 75%, respectively. The two algorithms were considered for the voting, which served as the final hybrid machine learning model for the sentiment classification and prediction tasks. The voting classifier works by predicting an output voting class based on the highest likelihood of the combined models, which were Bagging Classifier and SVM. Using the voting classifier, accuracy, and precision scores of 75% and 75% were also obtained.

Keywords Machine learning · Natural language processing · Sentiment analysis · COVID-19 vaccination · Support vector machine · Bagging classifier · Voting classifier · Accuracy · Precision

A. Mohammed · A. Pandian (✉)
Department of Computing Technologies, Faculty of Engineering and Technology, SRM Institute of Science and Technology, SRM Nagar, Kattankulathur, Chengalpattu, Chennai 603203, Tamil Nadu, India
e-mail: pandiana@srmist.edu.in

A. Mohammed
e-mail: am8921@srmist.edu.in

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1 Introduction

COVID-19 is currently one of the most serious threats to human health, the economy, and society. There has not been a proven effective remedy for it until now. Vaccination is the most effective biomedical protection against the new coronavirus. However, public opinions, as expressed through social media and verbal conversation, may have a significant impact on the vaccination program's progress [1].

Sentiment analysis, or opinion mining, is a task of natural language processing. It classifies a user's opinions, beliefs, and feelings about the relevant product in order to determine if the user's attitude is positive, neutral, or negative [2].

Sentiment analysis is a machine learning technique that detects polarities like positive or negative ideas in a text, whole texts, paragraphs, lines, or subsections. Machine learning (ML) is a multidisciplinary discipline that combines statistics and computer science methods to develop predictive and classification algorithms [3].

The sentiments of the people interested in the conversation are conveyed in a discussion. Opinion mining and natural language processing are other terms for sentiment analysis [4].

Public opinions about the COVID-19 vaccination were collected via Google Form for sentiment analysis and prediction modeling in this study. The data was analyzed, and a model was built for sentiment classification and prediction. A conclusion was drawn based on the outcome of the analysis.

Our contributions toward this study are as follows:

i. Composition of the sentiments dataset from the collected raw data.
ii. Allocation of the target classes from the data using a rule-based approach.
iii. Classification of the sentiments into multi-classes by using our proposed rule-based method.
iv. Hybrid machine learning algorithms to train and test the model for sentiment classification tasks.
v. The evaluation of the performance of the algorithms on the dataset was conducted using four metrics: accuracy, precision, recall, and the f1 measure.

2 Related Literature

In 2021, Kwok et al. proposed a Latent Dirichlet Allocation (LDA) Algorithm to analyze Twitter sentiments among Australians. The purpose of the study is to use machine learning techniques to extract topics and sentiments on Twitter related to the COVID-19 vaccine. Between January and October 2020, the researchers collected data from Australian Twitter users using the Twitter API, which included 31,100 English tweets containing COVID-19 vaccine-related terms. They used word clouds to visualize tweets and discover high-frequency words. Nearly two-thirds of all tweets showed support for the COVID-19 vaccination, and a third expressed opposition. The top positive feelings in the tweets were trust and anticipation, while the top negative emotion was fear. The LDA Algorithm is an unsupervised learning approach, but in sentiment analysis, little or more supervision is sometimes desirable, and on top of that, the Dirichlet algorithm is a topic modeling and topic distribution approach that cannot capture relationships amongst words [1]. In 2021, Marcec and Likic proposed a Lexicon-based approach to analyze public opinions about all forms of COVID-19 vaccinations. The purpose of the study is to use tweets to examine public opinions about some of the most commonly used COVID-19 vaccinations. The Twitter API was used for the retrieval of all English-language tweets containing AstraZeneca/Oxford, Pfizer/BioNTech, and Moderna vaccine keywords, respectively. 701,891 tweets were extracted. The average sentiment of tweets was calculated using the AFINN lexicon daily. The study discovered that attitudes toward Pfizer and Moderna vaccines were positive and constant over four months. On the other hand, public opinion toward the AstraZeneca/Oxford vaccination has shifted from positive to negative over time. The AFINN lexicon is simple to use in sentiment analysis, but no lexicon is universal, and even if you discover one that is good for a sentiment task, it may be missing some words you need because the AFINN lexicon contains only up to 3300 words with their corresponding polarity scores [5]. In 2021, Islam et al. proposed a traditional machine learning approach to analyze sentiments related to the COVID-19 vaccine using survey data. Conventional machine learning algorithms were used to analyze public perceptions of the COVID-19 vaccination. Recurrent neural networks (RNNs), gated recurrent units (GRUs), LSTM, and BERT models were the techniques used. The BERT model, which was the most accurate of all the algorithms used, achieved an accuracy score of 84%. Naive Bayes, on the other hand, is the best model as a classical machine learning method, with an accuracy score of 81%. Furthermore, in terms of F1-Score, Naive Bayes, and BERT provided identical results, which is good for reducing false positives [6]. In 2021, To et al. proposed a machine learning approach to Identify Anti-Vaccination Tweets during the COVID-19 Pandemic. The goal of this study is to discover how well machine learning models perform in recognizing anti-vaccination tweets obtained during the COVID19 pandemic. Out of 75,797,822 tweets, a total of 1,651,687 tweets containing “vaccin” or “vaxx” were extracted for the research. The algorithms used were BERT, Bi-LSTM, SVM, and Naive Bayes models. The BERT models outperformed the other models with accuracy scores of 91.6% and precision scores of 93.4% in identifying anti-vaccination tweets, but the BERT model is extremely costly to use in production because it requires higher computational resources and power [7].

From the series of the literature surveyed, it was observed that there was limited sentiment analysis research focusing on survey data, and most of the existing research made use of Twitter data.

Most of the existing literature achieved pretty good results in terms of analyzing and classifying public sentiments, and they made use of large amounts of data, which is also considered good when it comes to training a machine learning model. But, some of this research did not use any metrics to evaluate the performance of the methods adopted; only a few of them did so. Those who made use of some metrics were able to achieve promising results. References [1, 5, 7] used Twitter data. The problem with Twitter data is that some portions of the population were restricted from participation because there are a lot of people who do not like to use Twitter, or even if they do, they are not willing to reveal their opinion on a given discourse. Using survey data will be more significant for this research, and it will allow us to precisely develop an optimized machine learning model for COVID-19 vaccination sentiment prediction.

3 Research Method

3.1 Problem Definition

From the beginning of the COVID-19 vaccination program, many people have refused to accept the vaccine due to widespread misconceptions and propaganda concerning the COVID-19 virus itself, whether it is real or not, and the vaccination program as well. All these misconceptions and propaganda have been spreading through word of mouth (verbal) discussion among the public. Public opinions were collected using Google Forms regarding the COVID-19 vaccination program. The data was analyzed and a machine learning model for predicting public sentiments toward the COVID-19 vaccination was developed.

3.2 Objectives

This study has the following objectives:

- To collect public opinions regarding the ongoing COVID-19 vaccination program.
- To use machine learning algorithms on the data collected and build a model for classifying and predicting a given text into a particular sentiment class.
- To develop an automated COVID-19 vaccination sentiment prediction system based on a given text.

3.3 Data Collection

For this study, primary data was used, which was collected using a Google Form and comprised of the following selected variables: gender, marital status, age range, living area, employment status, education level, and perception. Based on individual perception and other respective variables collected during the survey, a class label was assigned to represent a sentiment class for each individual's views toward the COVID-19 vaccine.

3.4 Proposed Sentiments Classification Block Diagram

The phases of classifying a perception into a sentiment class as given in Fig. 1 begin with data collection and summarization, dataset generation, data preprocessing, data cleaning, stop words and punctuation removal, special characters and numeric values removal, text stemming, features selection, and extraction using either a count vectorizer or a TF-IDF vectorizer or both, splitting the dataset into training and testing sets in a 7:3 ratio. Algorithms used for the proposed work are support vector machine, k-neighbor classifier, (multinomial, Bernoulli, and Gaussian naïve Bayes), decision tree classifier, linear regression classifier, random forest classifier, XGB classifier, bagging classifier, extra trees classifier, gradient boosting classifier, and AdaBoost classifier, classification result output, model improvement, and the final optimal model deployment.

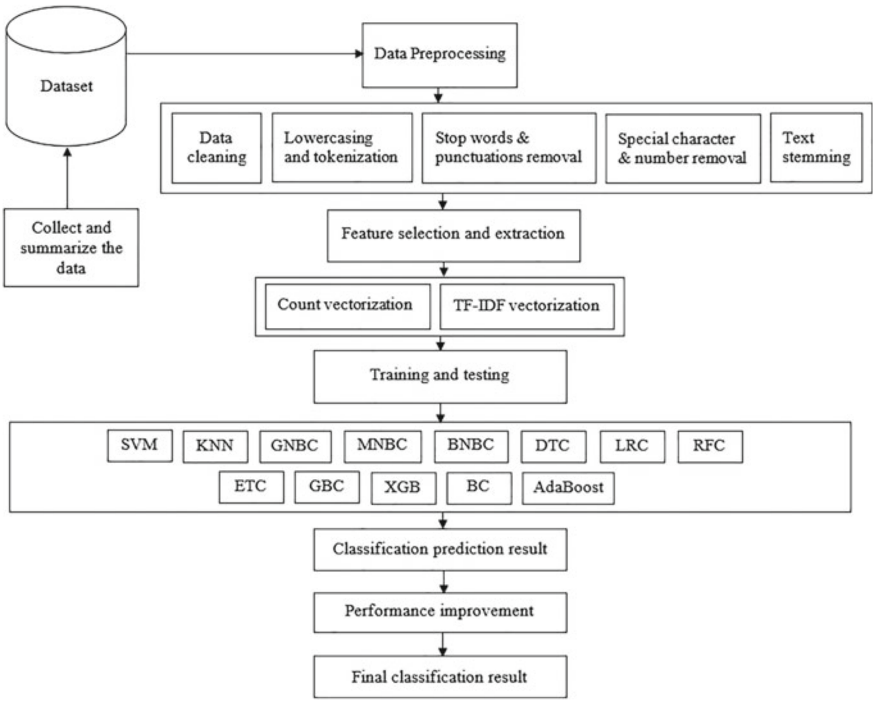

Fig. 1 Block diagram for the proposed sentiment classification model

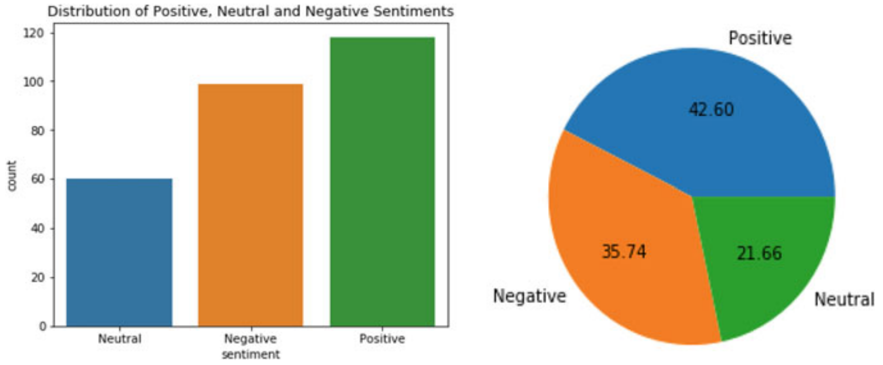

Fig. 2 Sentiments are distributed as a count and as a percentage

3.5 Exploratory Data Analysis

Figure 2 depicts the data distribution counts for the negative, positive, and neutral sentiment classes, respectively, in number and percentage equivalent.

4 Implementation

Figure 3 depicts the algorithmic procedures followed for the initial sentiment classification of the dataset used for the respective classes, which are negative, positive,

Input: Survey Data S, Perception in the data P
Output: Sentiment Class SC
Start
1. **FOR** each Perception Pi ∈ S ∀ i=1 to S
2. **IF** most of the words in P are Positive **THEN**
3. **CLASSIFY** P **AS** Positive **AND APPEND** P to SC
4. **ELSEIF** most of the words in **P** are Negative **THEN**
5. **CLASSIFY** P **AS** Negative **AND APPEND** P to SC
6. **ELSE CLASSIFY** P AS Neutral **AND APPEND** P to SC
7. **END FOR**
End

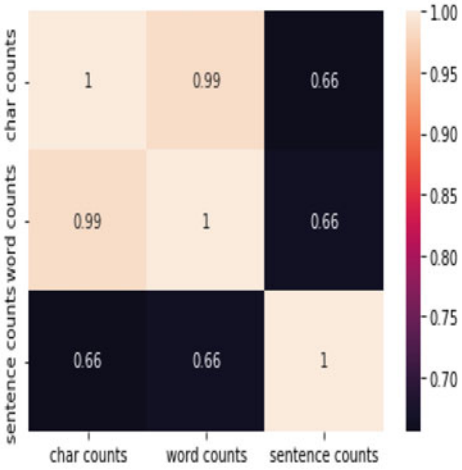

Fig. 3 Dataset sentiment classification algorithm and correlation matrix

and neutral. The other diagram on the right-hand side depicts the correlation matrix for the corresponding sentences, words, and character counts of the perception text string with their respective correlation scores. It shows how each class variable is related to another variable, and the diagonal correlation scores show that each and every class variable is perfectly correlated to itself.

Figure 4 depicts the word cloud for the most frequently occurring positive sentiments in the corpus. Most of the keywords that appear on the word cloud above are positive in nature, even though you might get some that are not, which happened due to a misclassification error. Classification error is inevitable in machine learning. That is why it is always good practice to improve the algorithm's accuracy in order to reduce the said error.

Figure 5 depicts the treemap for the most frequently occurring negative sentiment corpus. Most of the keywords that appear on the treemap above are negative in

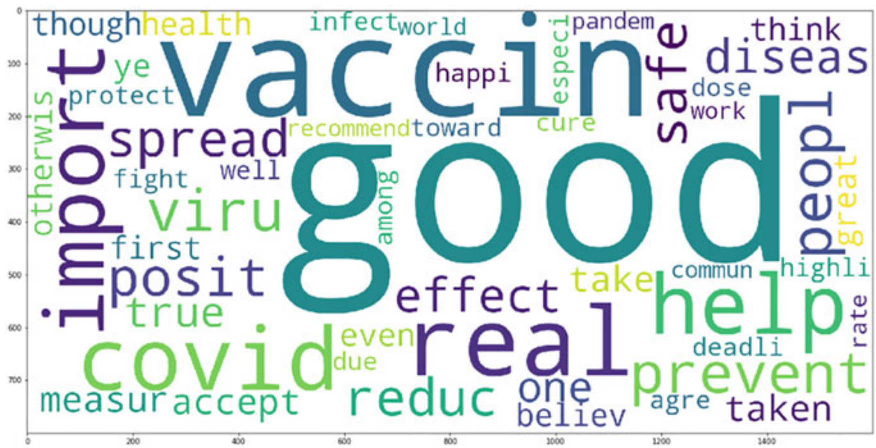

Fig. 4 Word cloud for the positive sentiments corpus

Fig. 5 Tree map for negative sentiments corpus

nature, even though you might get some that are not, which happened due to a misclassification error. Type I and Type II errors are inevitable in machine learning. That is why it is always good practice to improve the algorithm's accuracy in order to reduce the said errors.

5 Result and Discussion

In this study, public sentiments were analyzed and classified into positive, negative, and neutral based on public perceptions of the COVID-19 vaccination program. Various supervised machine learning algorithms were used for sentiment classification and prediction. The evaluation metrics employed to measure the effectiveness of this work are accuracy, precision, recall, and f-measure.

Table 1 shows that using the TF-IDF vectorizer for feature selection and extraction with a maximum of 277 features, the accuracy and precision scores obtained are 75% from both the bagging classifier and the support vector machine algorithms respectively.

Table 2 shows that 75% accuracy and precision scores were obtained respectively for the voting classifier. The goal of using a voting classifier is to predict an output sentiment class based on the support vector machine and bagging classifier combined models' highest likelihood score.

Table 3 compares the proposed work with the existing related works cited. Based on the table presented above, [5] used a machine learning approach with multi-class classification, but the accuracy achieved was not promising. Islam et al. [6] used only a rule-based approach even though they achieved a promising result. To et al.

Table 1 Algorithms performance using TF-IDF vectorizer technique

Algorithm	Accuracy	Precision
Support vector classifier	0.75	0.75
Bagging classifier	0.75	0.75

Table 2 Voting classifier performance report

Class	Precision	Recall	F1 score	Support
Negative	0.70	0.84	0.76	38
Neutral	0.86	0.40	0.55	15
Positive	0.81	0.81	0.81	31
Accuracy	0.75			84
Macro average	0.79	0.68	0.70	84
Weighted average	0.77	0.75	0.74	84

Table 3 Comparison of the proposed and existing methods

S/N	Paper	Rule-based method	Machine learning method	Multi-class	Accuracy score %
1	[5]	No	Yes	Yes	41
2	[6]	Yes	No	No	84
3	[7]	Yes	Yes	Yes	–
4	Proposed work	Yes	Yes	Yes	75

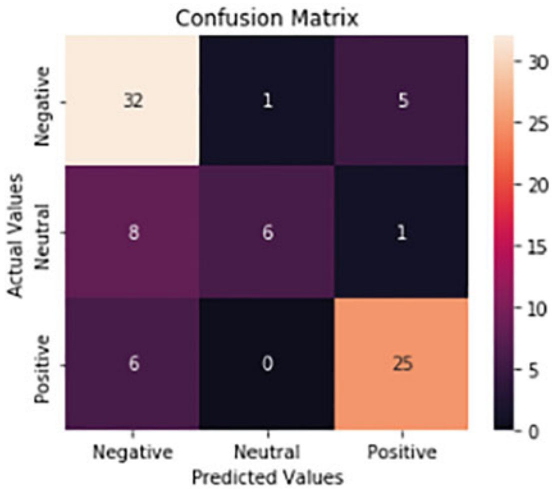

Fig. 6 Confusion matrix of the voting classifier

[7] used both rule-based and machine learning approaches with multiple classes, but unfortunately, the accuracy of the work was not mentioned in the work.

Figure 6 is the confusion matrix for the voting classifier, which is the final model for the sentiment classification and prediction task. The performance metrics of the candidate model can be calculated from the above confusion metrics. Type I and Type II errors can also be determined from it. In essence, the confusion metric is essential in measuring and evaluating a machine learning model. Figures 7, 8, and 9 show the respective test cases for the classes of positive sentiment, neutral sentiment, and negative sentiment.

6 Conclusion

In this study, an automated sentiment classification system was built using a hybrid machine learning approach with the help of natural language processing for sentiment classification and prediction of the data collected from the public regarding opinions about the COVID-19 vaccination program. The data was collected through

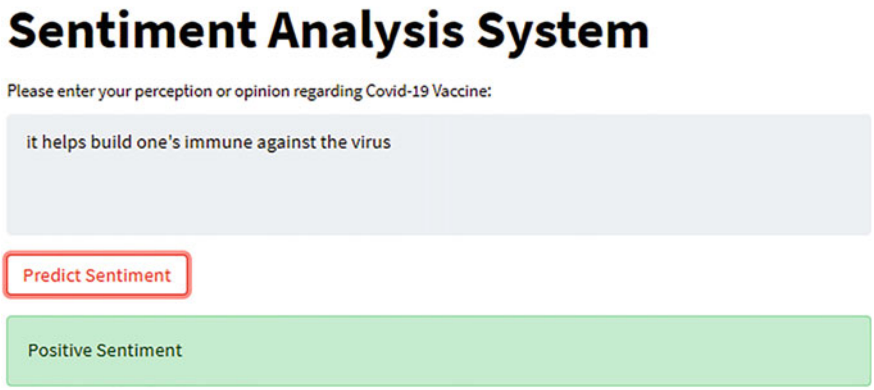

Fig. 7 Prediction of positive sentiment based on the given text

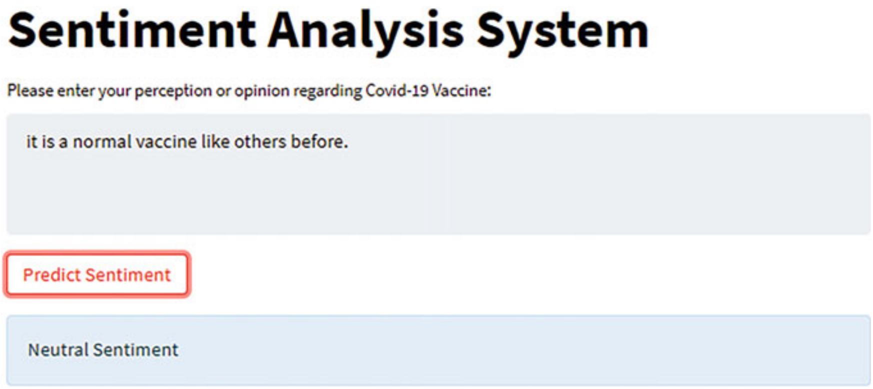

Fig. 8 Prediction of neutral sentiment based on the given text

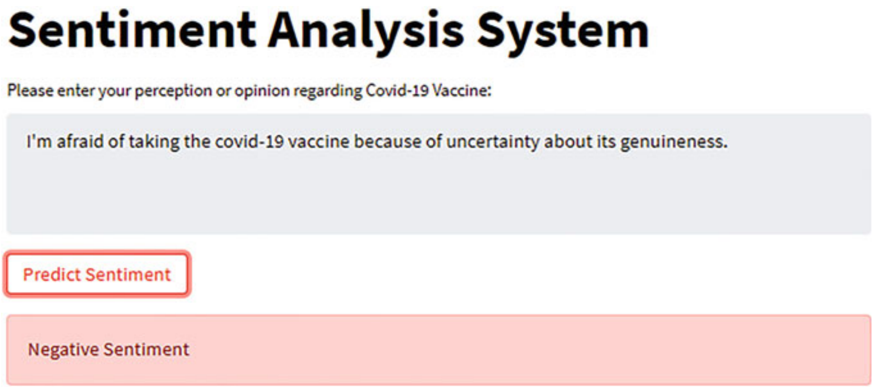

Fig. 9 Prediction of negative sentiment based on the given text

the Google Form. The evaluation metrics used to measure the performance of the proposed work were accuracy, precision, recall, and f-measure. Various machine learning algorithms were used for the implementation. Two algorithms, namely Support Vector Machine and Bagging Classifier, outperformed the remaining algorithms with the same accuracy and precision scores of 75%, respectively. The two algorithms were considered for the vote, which served as the final hybrid machine learning model for the sentiment classification and prediction tasks. The voting classifier works by predicting an output voting class based on the highest likelihood of the combined models, which were Bagging Classifier and SVM. Using the voting classifier, accuracy and precision scores of 75% and 75%, respectively, were also obtained. Hence, the model is considered good at classifying public sentiments regarding the COVID-19 vaccination program. Based on the survey carried out, it appears that the majority of perceptions towards the COVID-19 vaccination are positive, followed by negative ones. The educational levels of those who participated in the survey were predominantly graduates. According to age groups, they were mostly 20–30 years old. According to gender, they were mostly male. The living areas were mostly urban, and according to marital status, they were mostly single.

7 Future Work

In the future, a deep learning approach will be considered for building a sentiment classification and prediction model for COVID-19 vaccination, and the model will be deployed for everyone's consumption.

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Abstractive-Extractive Combined Text Summarization of Youtube Videos

Pavitra Walia, Tanya Batra, Sarvesh Nath Tiwari, and Ruchi Goel

Abstract Automatic text summarization is a data-driven technique for coping with today's huge amounts of textual material. The purpose of this study is to look into a novel way for generating abstractive summaries of huge documents. The lack of precision gained by very intricate models seeking to provide abstractive summaries necessitates the development of a new strategy. In this paper, we looked into combining extractive and abstractive summaries in a two-step process to get more accurate final summaries. The purpose of this research is to make the process of writing a summary as simple as feasible while still maintaining accuracy.

Keywords Extractive summarization · Abstractive summarization

1 Introduction

The fascination of humankind with the short form of content has transformed the world of technology. From 60 word news articles to 60 s videos, the content we consume might be increasing in number, but it is decreasing in size. At times like this, having an accurate summary of the content makes a user much more informed about their decision to consume the whole of that content or not. Summarization is indeed a well-explored topic in the world of Machine Learning and Natural Language. In situations like this, having an accurate summary of the content allows a user to make a more informed decision about whether to consume the entire piece of content or not. But language generation has been a big roadblock in the path. Hence, most research has been on a single type of summarization.

P. Walia · T. Batra (✉) · S. N. Tiwari · R. Goel
Maharaja Agrasen Institute of Technology, New Delhi, India
e-mail: tanyabatra308@gmail.com

R. Goel
e-mail: ruchigoel@mait.ac.in

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1.1 Types of Summarization

Summarization is broadly classified into two major categories: Extractive and Abstractive Extractive summarization is the conventional way used, as mentioned above, to obtain the most important parts of the video to make a summary. The text summary obtained contains exact sentences from the video. Abstractive summarization is the less explored way of summarization. This gives importance to the context and generates new sentences to join important elements of the video instead of directly picking sentences. This ensures that the summary is more precise without losing meaning or going out of context.

While NLP-based summarization is not a new concept, most of the work done till now has been about exploring various algorithms to generate either extractive summaries or extractive summaries only. There are limited studies that are available for abstractive summarization since it requires more knowledge about the text as opposed to extractive summarization. The field of combining the two approaches is even less explored.

Although, purely extractive summaries are oftentimes more successful than automatic abstractive summaries, it is because abstractive summarization methods deal with problems such as semantic representation, inference, and natural language generation, which is more difficult than data-driven approaches such as sentence extraction.

In this research paper, the aim is to generate an abstractive summary of long form content. This technique is justified by the fact that abstractive summarization models fail when the content size is huge. And this problem can be catered to by extracting the important sentences from the content and then using a model to generate an abstractive summary [1].

For this, we will use a two-step approach in which we will first use the latest approach of generating an extractive summary and use this summary to generate an abstractive summary of the same content.

2 Literature Survey

Mutlu et al. [2] suggested the usage of an extensive feature space to determine the importance of sentences. Further, a Long Short-Term Memory (LSTM)-based Neural Network (LSTM-NN) was proposed to divide the sentences into two major categories: summary-worthy or summary-unworthy. In this model, the syntactic and semantic features were processed in a separate LSTM and later combined with the output vectors in another layer. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.

Elbarougy et al. [3] proposed a graph-based system, in which the document is represented as a graph, with the sentences as the vertices. Using a modified PageRank algorithm, each node is given a starting score equal to the number of nouns in the phrase. As more nouns signify more information, nouns are employed as the sentence's initial rank. A final summary is created using cosine similarity between phrases. This incorporates sentences which have more information and are well related to one another.

Rahul et al. [4] looked into the various Deep Learning models and methodologies for generating text summaries that have been proposed up to that moment. After weighing the pros and cons of using transformers, phrase analysis, graph-based approaches, textual entailment, clustering, and other methods, it was found that extractive summarizing is easier to generate than abstractive summary.

Gidiotis and Tsoumakas [5] proposed a divide-and-conquer approach to improve the accuracy of extractive summaries of long-text documents by dividing the text into smaller segments, generating individual summaries of each segment and finally combining them together to get the final summary.

Moirangthem and Lee [6] proposed a temporal hierarchical pointer generator network to deal with long texts. Multiple timescale architecture was used to implement the model where error backpropagation was utilized. This approach tried to embody the working of a biological neural network and achieved satisfactory results.

Huang et al. [7] proposed the usage of two encoders to generate abstractive summary, first is a sequential document encoder, and second is a graph-structured encoder. This was suggested to ensure that global context and local characteristics are retained in the text. The results showed improvement when compared with a model without a knowledge graph.

Alami et al. [8] proposed an unsupervised approach to generate summaries on Arabic text. The approach involved the proposed approach which is divided into two major processes, learning process and summarization process, with many stages. The first stage is data pre-processing, and the second stage is clustering the data set. In the third stage, clusters of topics and associated terms are built. Further, a matrix representation of each document is created. Next, the model learned unsupervised features of the text using several unsupervised deep learning and ensemble learning models. Finally, the final summary document is generated by identifying and removing duplicate sentences.

Liu et al. [9] used a neural network attention mechanism to select the most relevant k number of sentences in a document. This is followed by a beam search algorithm to generate an abstractive summary. This model conducts experiments on data available in the Chinese language exclusively.

3 Proposed Method

3.1 Problem Statement

With the abundance of available content on the internet, it has become increasingly difficult to determine relevance of long-form content (like YouTube videos) [10, 11]. While extractive summarization does provide the gist of the content, its context-free and verbatim approach makes it less reliable than abstractive approach.

3.2 Method

In this research paper, we propose combining the extractive and abstractive methods of summarization to utilize the advantages of both the steps. During the first step, by using extractive model, we can easily obtain the important sentences from a long text. This step is necessary as abstractive models cannot work on a large piece of text in a single go and thus need to break context to generate summary for the content. In the second step, we use abstractive model and use the extractive summary generated from first step as the input and finally obtain the consolidated abstractive summary of the text [12, 13].

In the proposed method, the following steps are taken:

- YouTube video is chosen, and its link is obtained. This video's content will be used for summarization.
- SRT file of the captions is generated to be used for text summarization.
- The data is pre-processed using standard steps.
- The obtained pre-processed data is used to generate summaries using the models as explained in Fig. 1.

3.2.1 Extractive Summarization

Here we utilized the Hugging Face Pytorch transformers library to run extractive summarizations. This works by first embedding the sentences, then running a clustering algorithm, finding the sentences that are closest to the cluster's centroids [14].

3.2.2 Abstractive Summarization: Pegasus

The model uses Transformers Encoder-Decoder architecture. The encoder outputs masked tokens while the decoder generates Gap sentences. This call this new training method as Gap Sentence Generation. Instead of blocking out individual words like

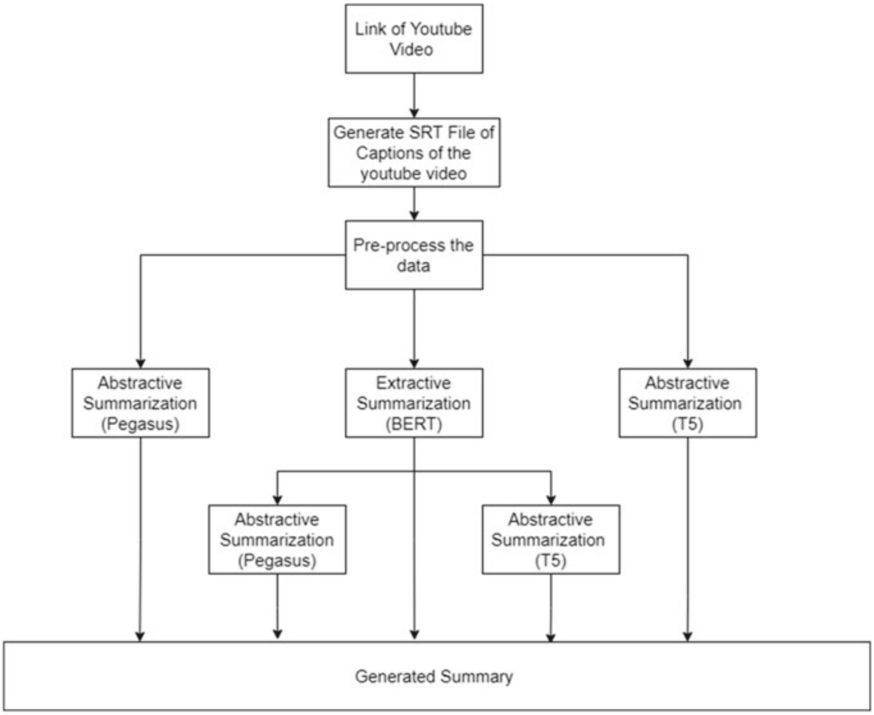

Fig. 1 Proposed architecture

in BERT, they mask out complete sentences and ask the model to estimate which ones are missing. The model improves at abstractive summarization-like tasks as it seeks to obtain the underlying missing context [15].

3.2.3 Extractive+Pegasus Model

This proposed model uses the combined approach. In this, the original content is fed to the extractive model and the output of this model is fed to the Pegasus abstractive model to obtain the final summary.

3.2.4 Abstractive Summarization: T5

T5 Transformer is an Encoder-Decoder architecture where both the input and targets are text sequences. This gives it the flexibility to perform any Natural Language Processing without modifying the model architecture in any way, the processing task can be completed [16].

3.2.5 Extractive+ Abstractive T5 Model

The mixed technique is employed in this proposed model. To obtain the final summary, the original content is input through the extractive model, and the output of this model is supplied into the T5 abstractive model.

4 Results and Discussion

Rouge (Recall-Oriented Understudy for Gisting Evaluation) score is one of the most common scoring algorithms that is used to determine the extent of similarity between generated content and reference content. We have used Rouge-1 and Rouge-L to determine the quality of summaries generated by our proposed models. While Rouge-1 measures unigram overlap, Rouge-L measures longest matching sequence.

This paper proposed the combination of extractive and abstractive summarization models to achieve higher accuracy with respect to humangenerated summaries. Standard dataset "XLSUM" was used, and summaries were generated using an extractive model, an abstractive model and two combinations of extractive and abstractive models.

The obtained Rouge-1 scores are mentioned in Table 1 and Rouge-L scores are mentioned in Table 2. From the obtained data, it can be observed that the BERT-Extractive-Summarizer gives least Rouge scores. The proposed model using both extractive and abstractive summarizer shows great improvement in Rouge scores as compared to stand-alone extractive summarizer. This can also be observed from Fig. 2. Therefore, after analyzing, it is elucidated that extractive + abstractive models achieved good results in terms of improvement in rouge scores.

The effects of the abstractive models in conjunction with extractive models are better than the individual extractive and abstractive ones from Tables 1 and 2. The main reason is that the abstractive can fully express the semantics of the document and extractive can get the most relevant and important sentences out of the input text. Our model combines the advantages of extractive and abstractive summarization

Table 1 Rouge 1 score of the proposed models

Type (model)	F1	Precision	Recall
Extractive summarization (Bert-extractive summarizer)	0.1709	0.4859	0.1087
Abstractive summarization (Pegasus)	0.4791	0.4688	0.5148
Extractive + Abstractive Summarization (Pegasus)	0.4189	0.4121	0.4501
Abstractive summarization (T5)	0.2056	0.3528	0.1515
Extractive + Abstractive Summarization (T5)	0.2085	0.3303	0.1600

Table 2 Rouge L score of the proposed models

Type (model)	F1	Precision	Recall
Extractive summarization (Bert-extractive summarizer)	0.1120	0.3238	0.0711
Abstractive summarization (Pegasus)	0.4208	0.4133	0.4511
Extractive + Abstractive Summarization (Pegasus)	0.3471	0.3425	0.3725
Abstractive summarization (T5)	0.1340	0.2315	0.0985
Extractive + Abstractive Summarization (T5)	0.1387	0.2216	0.1058

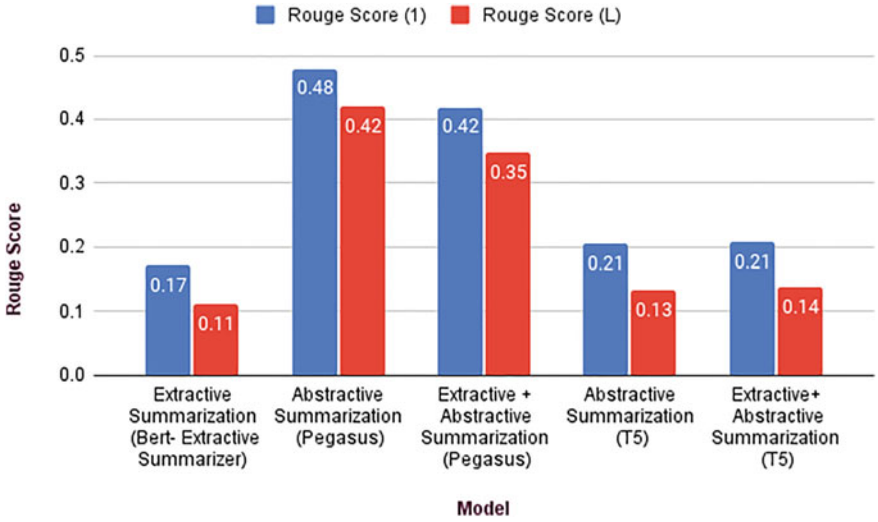

Fig. 2 Comparison of rouge score of the proposed models

techniques. First, we obtain important sentences through the extractive model, and then the extractive summary is fed as an input to an abstractive summarization logic so as to obtain the ideal summary of the input text.

5 Conclusion

Text summarization is an important application of Machine Learning and Natural Language Generation. While extractive summarization techniques directly pick the important sentences from the content, abstractive summarization techniques are much more complex to implement because they need to retain the context of the content.

This research paper examined the approach of combining extractive and abstractive models by taking the output of the extractive model and using it as an input in an abstractive model. This approach gave better accuracy as compared to extractive summarization as well as one of the abstractive models that were examined.

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Distributed Kubernetes Metrics Aggregation

Mrinal Kothari, Parth Rastogi, Utkarsh Srivastava, Akanksha Kochhar, and Moolchand Sharma

Abstract In today's era of development we always come across situations where we are actually running our application and it suddenly crashes. At that point K8trics come into picture. K8trics (Ketrics) will be a Kubernetes (K8s) native metrics aggregator which will leverage Linux Kernel's eBPF capabilities to efficiently capture the data from the kernel space. Collect environment and service aware metrics from a distributed system. Network Metrics like SYN timeouts, TCP retransmissions, DNS misses, Req/sec, and request latencies (p. 50, 75, 90, 95, 99, 99.9). Application Level Metrics like dynamic logging, USDT, resource usage, and CPU profiling. Service aware policy enforcement Network policies: K8trics in conjunction with Hyperion can support extremely complex network policies but the goal would be to be able to present a POC firewall. Application Level policies: K8trics in conjunction with Hyperion can support extremely complex application level policies but the goal would be to be able to present a POC socket blocker.

M. Kothari · P. Rastogi · U. Srivastava · A. Kochhar · M. Sharma (✉)
Department of Computer Science and Engineering, Maharaja Agrasen Institute of Technology, PSP Area, Plot 1, Sector-22, Rohini, Delhi 110089, India
e-mail: moolchand@mait.ac.in

U. Srivastava
e-mail: utkarsh@sagacious.dev

A. Kochhar
e-mail: akankshakochhar@mait.ac.in

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1 Introduction

K8trics (Ketrics) will be a Kubernetes (K8s) native metrics aggregator which will leverage Linux Kernel's eBPF capabilities to efficiently capture the data from the kernel space. K8trics is a Distributed Highly Available Kubernetes Metrics Aggregator. Unlike other cloud native metrics aggregator solutions, K8trics is being designed with ease of user space as well as kernel space extensibility. K8trics is composed of the following major components: Hyperion—For efficiently aggregating metrics from each node. K8trics Kube Controller—For orchestrating all node metrics aggregators. Prometheus—For persisting time series data. Useful metrics aggregation is extremely important and at the same time extremely difficult to get right. K8trics along with Hyperion is designed to efficiently gather all the metrics that a developer may need from the user space as well as the kernel space. Along with the ability to easily scrape metrics and present in an expressive UI, K8trics also intends to allow extending the linux kernel to dynamically inject capabilities like DoS prevention, TLS parsing, etc.

eBPF and WASM are at the heart of K8trics. Using eBPF to collect metrics has been done by certain projects like: Cloudflare eBPF Prometheus Exporter, Hubble by Isovalent, Pixie by Pixie Labs, etc. WASM is also a very prominent technology being used to extend the functionality of envoy proxy by Lyft. Combining the above mentioned technologies to collect extremely crucial metrics should be feasible.

Rivera et al. [1] Project should be able to gather the following metrics from a distributed system: SYN timeouts, TCP retransmissions, DNS misses, Req/sec, Latency (p. 50, 75, 90, 99, 99.9, etc.), etc. Project will also attempt to gather the following metrics but may be restricted due to the time constraints: Limited L7 payload visibility, uprobes on compiled programs (which can generate DWARF), Block I/O, CPU Usage per container, Memory usage per container, CPU profiling based flame graphs, etc. Project must offer developer extensibility at the following sections: API should be extensible, i.e. should support HTTP watch streams, NMA should be userspace extensible, i.e. should allow the loading of custom WASM binaries without process restart. NMA should be kernel space extensible, i.e. should allow the loading of eBPF programs without process restart or kernel restart.

Service aware policy enforcement—Network policies: K8trics in conjunction with Hyperion can support Troia et al. [2] extremely complex network policies but the goal would be to be able to present a POC firewall. Application Level policies: K8trics in conjunction with Hyperion can support extremely complex application level policies but the goal would be to be able to present a POC socket blocker.

2 Literature Review

Simonsson [3], Bélair et al. [4], The background in this paper is focusing on a novel Chaos Engineering approach to actively injecting system calls into containers to check their observability. The methods in this paper include analyzing all kinds of system calls and utilize their different levels of monitoring techniques to reason about the behavior under perturbation. The evaluation in this paper is done on the three real world applications: transfer client, a reverse proxy server, and a micro-service oriented web application. The limitations of this paper includes that here the CHAOSORCA does not focus on a specific monitoring approach.

Marcos et al. [5], Miano et al. [6], Baidya et al. [7], The work in these paper focuses on the fast packet processing using the Computer networking and Network functions to be more precise using the concept of Scholz et al. [8] Extended Berkeley Packet Filter (eBPF) and eXpress Data Path (XDP). Where Karlsson et al. [9], Enberg et al. [10] XDP will help to process packets closer to the Network Interface Card (NIC). Tools used in the paper are iproute2, bpftool, llvm-objdump, and BPF Compiler Collection (BCC). Limitations of paper include eBPF uses restricted subset of C language libraries and does not support operation with external libraries, Presence of Non-static global variable but eBPF program supports only static global variable till date, Limited stack space.

Miano et al. [11], Hong et al. [12], covers The extended Berkeley Packet Filter (eBPF) is a recent technology available in the Linux kernel that enables flexible data processing. However, so far the eBPF was mainly used for monitoring tasks Cassagnes et al. [13] such as memory, CPU, page faults, traffic, and more, with a few examples of traditional network services, e.g., that modify the data in transit. In fact, the creation of complex network functions that go beyond simple proof-of concept data plane applications has proven to be challenging due to the several limitations of this technology, but at the same time very promising due to some characteristics (e.g., dynamic recompilation of the source code) that are not available elsewhere. Based on our experience, this paper presents the most promising characteristics of this technology and the main encountered limitations, and we envision some solutions that can mitigate the latter. We also summarize the most important lessons learned while exploiting eBPF to create complex network functions and, finally, we provide a quantitative characterization of the most significant aspects of this technology.

In 2018 Bertrone et al. [14], this paper focuses on accelerating Linux Security with eBPF iptables since most used packet filtering mechanisms in Linux kernel over 20+ years centered on iptables. But slowly and gradually this technique cannot cope up with modern requirements. So, the use of eBPF with iptables i.e. BPF-IPTABLES made it much more easier and efficient since eBPF does not require any additional kernel module and offers to compile and inject the code dynamically. The design of bpf-iptables include: semantics of iptable firewall policies and the data plane architecture. In the evaluation author clearly mentioned the chart of comparison of UDP and TCP throughput where iptables and bpf-iptables show similar results for smaller throughput but as the throughput increases the Mayer et al. [15] performance of iptables decreases and bpf-iptables perform great.

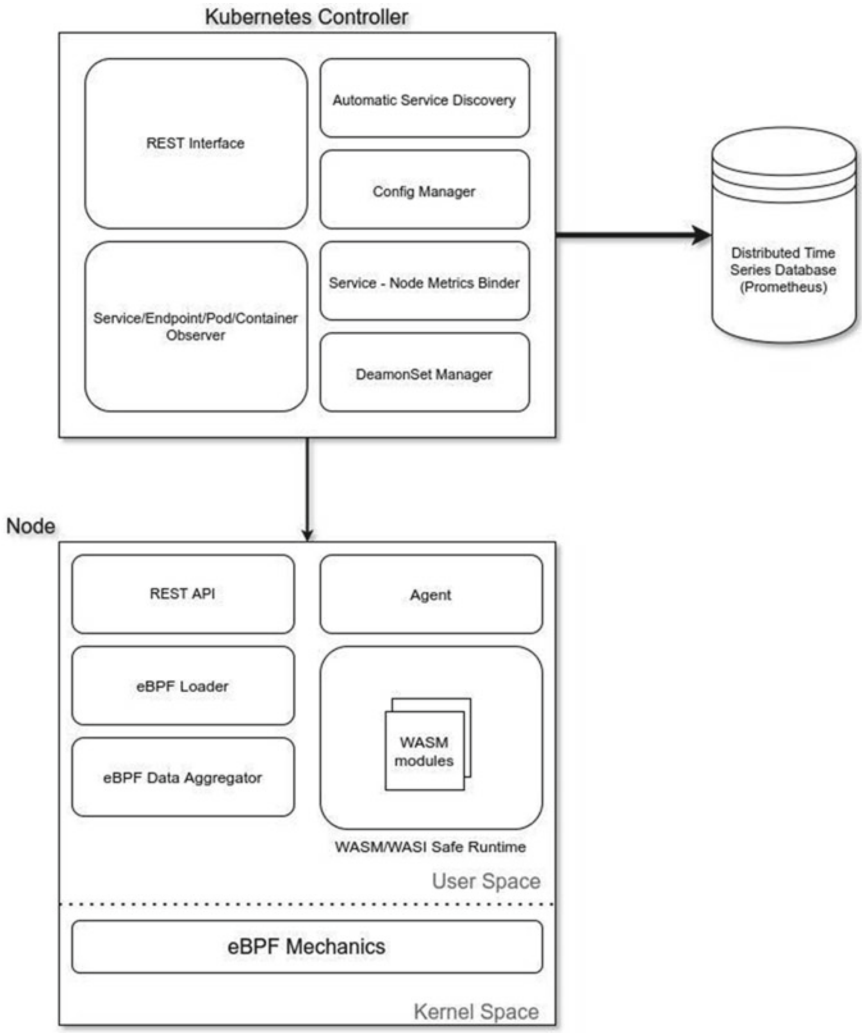
3 The Architecture

Core K8trics architecture will be primarily made up of 3 components.

Node Metrics Aggregator (NMA)—Component will be responsible for injecting WASM binaries in the WASM/WASI runtime for userspace and injecting eBPF based code in the kernel space. An internal WASM chain will mimic Linux Kernel's network stack, providing custom hooks for the WASM binaries to bind. In conjunction it will expose metrics on the '/metrics' endpoint. This component will ***not*** make any assumptions of the workload orchestrator and hence theoretically should be able to support multiple Linux based environments like Kubernetes, Docker Swarm, Nomad, Bare Metal, VMs, etc.

Kubernetes Controller—Component will be responsible for the following operations:

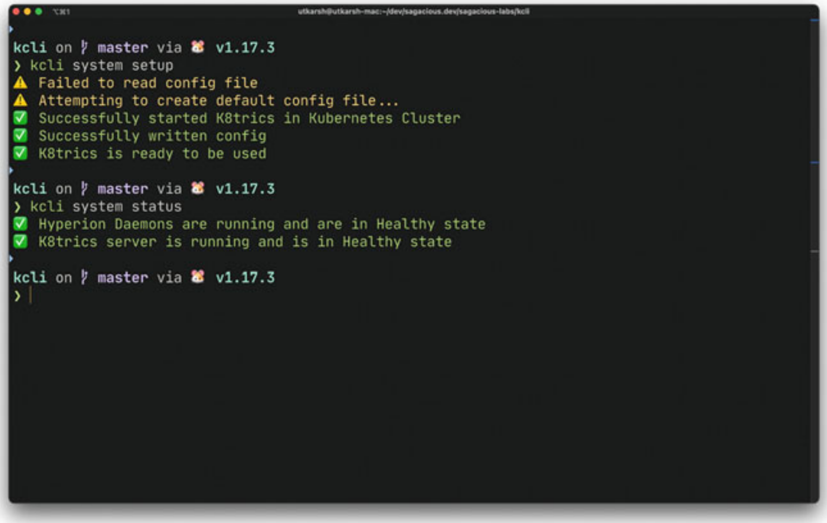
a. Orchestrating NMA in a distributed environment like Kubernetes—Hence a control plane for the NMA.
b. Auto discover services, endpoints, pods, containers running in the cluster.
c. Combining streaming data from the NMA components with the service discovery data.
d. Persisting data on a Time Series database.
e. Providing a REST based API for controlling the entire stack.



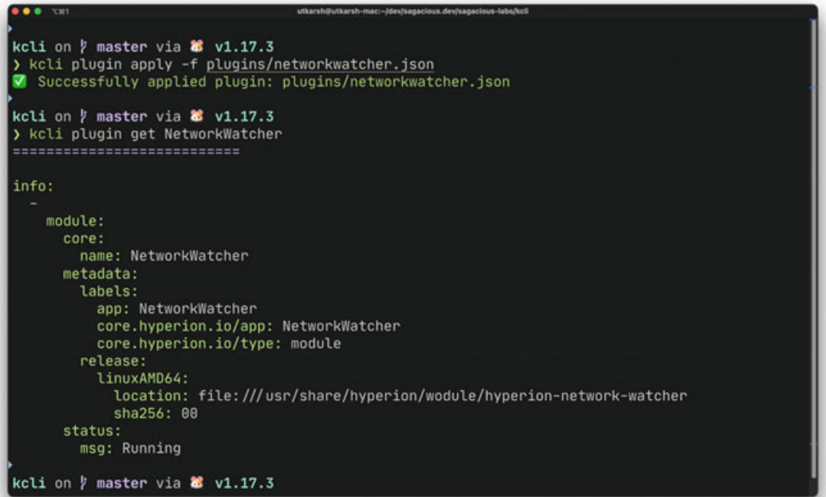
Time Series Database—Component will be responsible for persisting time series data on the disk. Prometheus (or a Thanos-managed Prometheus) will be used for the task.

K8trics will also have a UI as a client for communicating with the API server. The UI may use Grafana SDK for rendering dynamic charts.

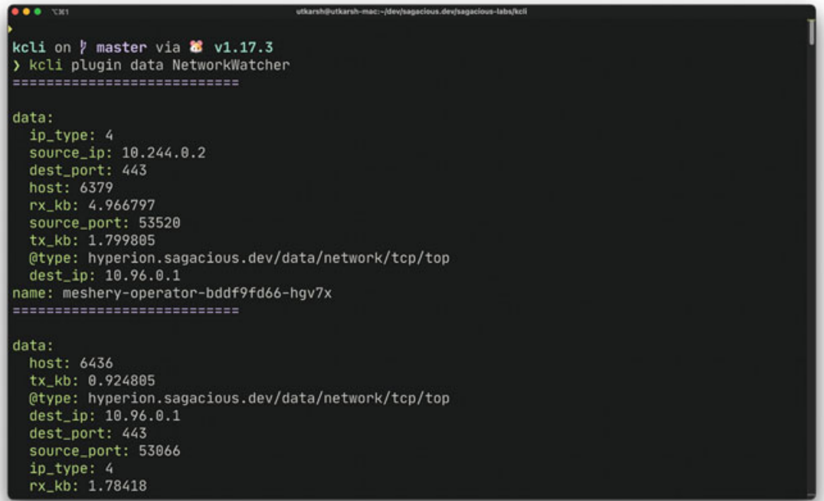
4 Evaluation



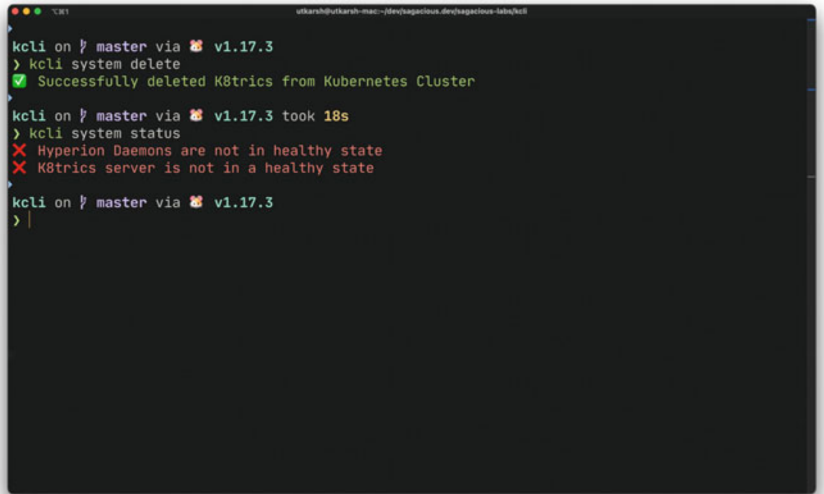
This is “kcli” (K8trics CLI), setting up K8trics in a remote Kubernetes Cluster and deploying Hyperion daemons in all of the available nodes and checking the health of the deployed components.



This is “kcli” adding a “NetworkWatcher” plugin to Hyperion which will help Hyperion to observe multiple network related metrics like amount of data being sent and received, the connection latency, services generating the traffic, etc.



This is “kcli” fetching data from K8trics API server which in turn is collecting metrics from all of the Hyperion instances.



This is "kcli" removing all the traces of K8trics API server and Hyperion Daemons running on all of the nodes/servers.

5 Conclusion and Future Scope

The need for visibility into application and infrastructure in distributed systems in an efficient way is becoming extremely important. Deep observability into applications and infrastructure has traditional implications of high resource usage and also comes with extreme limitations. eBPF is fairly new technology inside Linux Kernel, and K8trics is proof of concept of how eBPF can be extensively used to easily capture metrics. K8trics being in its early stage supports network metrics aggregation but intends to support sandboxing and network policy implementation in future.

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Designing Microstrip Patch Antenna for 5G Communication

R. S. Sabeenian, N. Vikram, S. Harini, and S. Arul Jebastin

Abstract Communication related to data transmission. These data transformation between devices involves different approaches like wireless, wired. The modern-day evolution of the communication between each person reaches its soaring heights. Network efficiency, flexibility, and speed are all enhanced by wireless technology. The tremendous usage of mobile handheld wireless devices simplifies the human needs and leads to the innovation of 5G which enables a new kind of network designed for universal connectivity of everyone and everything, including machines, objects, goods, and devices. As a result of fifth generation the dream of connective machines, devices and objects has become true. Here a 28 GHz of resonant frequency is used to create rectangular shaped patch antenna. The designed antenna is verified at the simulation level in ADS (Advanced Design System) 2019 simulation tool. Because of its high frequency, we are using Rogers RT Duroid 5880 as the substrate which is selected as the dielectric material for the patch antenna and it's dielectric constant is 2.2 εr. The used dielectric material height is 0.5 mm.

1 Introduction

Microstrip patch antennas are being extensively used in the field of research and even in many other applications because they can be directly printed onto the circuit board. Patch antennas are inexpensive and easy to fabricate. Because of its low-profile design, they require low cost [1]. The 5G network's data transmission are more accurate. People in the upcoming generation are so busy and they don't want to waste their time. The 5G network can fit their need by its main feature, low latency which can fulfill all their needs like high data rate because of its Gbps, live streaming, online classes etc., 5G networks are more capable for processing

R. S. Sabeenian (✉) · N. Vikram · S. Harini · S. Arul Jebastin
Sona College of Technology, Salem, India
e-mail: sabeenian@gmail.com

N. Vikram
e-mail: vikram.malliga@gmail.com

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the data, collecting the data or statistics collection and improvises the speed of the transmission real time analytical assisting IOT [2]. So, for achieving those things we are using millimeter wave. By this the generation capacity is also increased than the previous generation 4G. The rate of transmission is 100 times of the 4th generation [3]. For high-speed data rate which is better than the existing 4G communication sofa designing a microstrip patch antenna of rectangular shape which gives a high bandwidth, high data rate, low latency and also reduction in size of the antenna and offers high performance. Using 5G millimeter-wave bands resonating frequency of 28 GHz. The future 5G communication systems are expected to significantly boost communication capacity by exploiting enormous unlicensed bandwidth specifically in millimeter waves [4]. 5G network is predicted, that it has the ability to provide and support the significantly immense data rate, which in turn to yearly placement challenge on network requirements as well as in the antenna design. The antenna was designed at a desirable data rate and with useful capacity. Antennas main assumption is its frequency of operation in the 28 GHz range [3, 5–7]. This 28 GHz range frequency band is recommended for 5G system. Other important assumption for the antenna model includes small size, wideband with thereby enabling the use of the designed antenna in mobile terminals [8]. The miniature antennas were developed by reducing the size of mobile devices. This reduction in size of mobile devices doesn't affect the function of miniature antenna. These conditions ultimately lead to increase microstrip patch antennas in 20th century.

2 Proposed Method

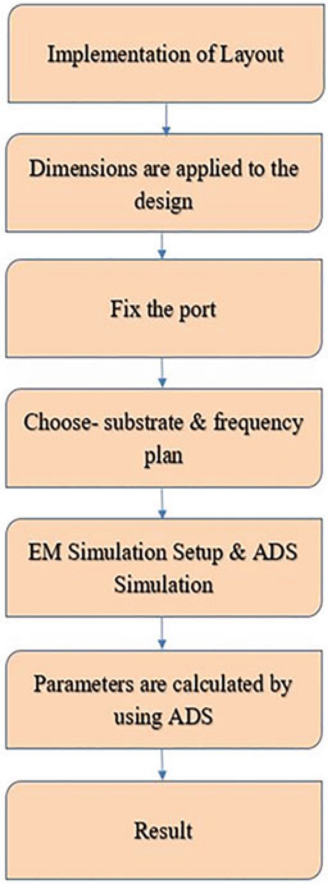
The diagrams shown below are created and simulated using Advanced Design System (ADS). While creating the outlook diagrams in ADS some basic measures are to be ensured that:

1. First the substrate material of the patch is selected as Roger RT Duroid 5880 dielectric.
2. Then the desired shaped (Rectangular) patch is to be drawn in the given layout.
3. Then feed line should be created to for transmission and port is to be assigned, the substrate material of the patch is selected as Roger RT Duroid 5880 dielectric.
4. After that proper material is to be assigned to the substrate as per requirements.
5. Then frequency plan is to be set for start and stop points.
6. Then finally EM simulation is to be done to check the required output (Fig. 1).

3 Antenna Design

The rectangular patch antennas are widely preferred geometrical shape. A dielectric material known as substrate, that separate the rectangular shaped microstrip patch

Fig. 1 Flow process



from ground plane. This rectangular patch design has linear polarization, it can cause a reduction in loss of antenna. The layout designs are said to have three major layers,

Substrate
Ground plane projection
Rectangular patch or feeding section

The above-mentioned rectangular patch design is made up of ground plane. The ground plane is basically rectangular shape of height 3.17 which is measured in millimeter (mm) [9]. The ground plane and the patch are conductors, thereby making it made up of various materials that have conducting capacity. The feeding system is feed by the microstrip line Centre. Then the microstrip line feed is given at the end of antenna. The microstrip line feed mentioned above makes the process of fabrication of antennas as simple and easy. The patch antennas are commonly linear polarization which helps to reduce the antenna losses [10]. The layout design is shown as Fig. 2, which is given.

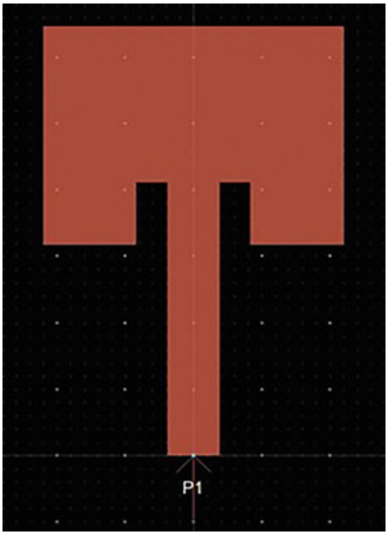


Fig. 2 Rectangular patch antenna layout

4 Substrate Specification

A dielectric material known as substrate, that splits the ground plane by dielectric material. Dielectric substrate is nothing but the insulator which prevents the conduction between the ground plane and the conductor layer. Here we're using Roger RT Duroid 5880 as the substrate [11]. The height of the substrate is 0.5 mm (Millimeter) and the ε r is 2.2 as strip on the substrate. The substrate of this rectangular patch is shown above in Fig. 3.

The rectangular patch requires the substrate Roger which lead the rectangular patch to resonate at the frequency 28 GHz. Other than Roger Substrate, any other substrate is used with same dielectric constant of Roger substrate, will not produce this much efficiency. The 3-Dimensional view is shown in the Fig. 4.

5 Simulation Results and Discusssion

The variants of the patch antenna geometry were implemented in the layout option of Advanced Design System (ADS) 2019 simulation software. The Stop and Start frequency of rectangular patch is put forward when the layout design and substrate

Fig. 3 Substrate of the rectangular patch

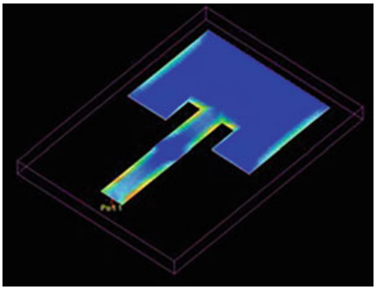


Fig. 4 Dimentional view of substrate

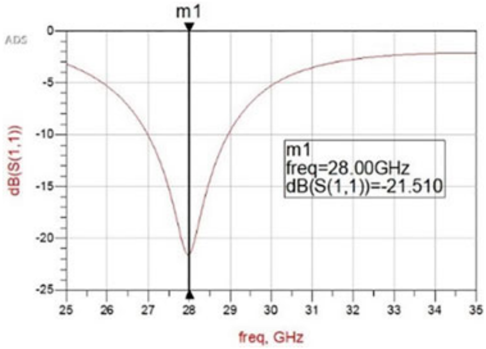


Fig. 5 Return loss of rectangular patch

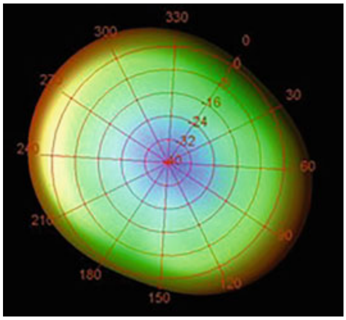


Fig. 6 Radiation pattern of rectangular patch cross section view

specification is given clearly [12, 13]. 25 GHz is considered the starting frequency and 35 GHz is considered the stopping frequency. By analyzing antenna, the antenna design can be simulated easily. Return loss performance of patch antenna is obtained by performing simulation over S- parameter. The return loss of patch was shown in Fig. 5.

The antenna is operated at a 28 GHz frequency, showing a low return loss of −21.51 dB. The mentioned patch design will support 5G communications to a certain extent. The antenna's radiation pattern is in the direction of high-power output, and it is projected on the map in ADS software. A 3Dimensional view of radiation pattern was obtained, and it is shown in Fig. 6 as shown.

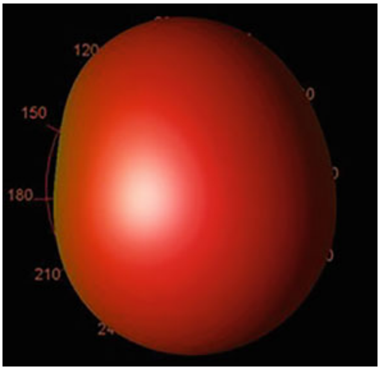


Fig. 7 Radiation pattern of rectangular patch top view

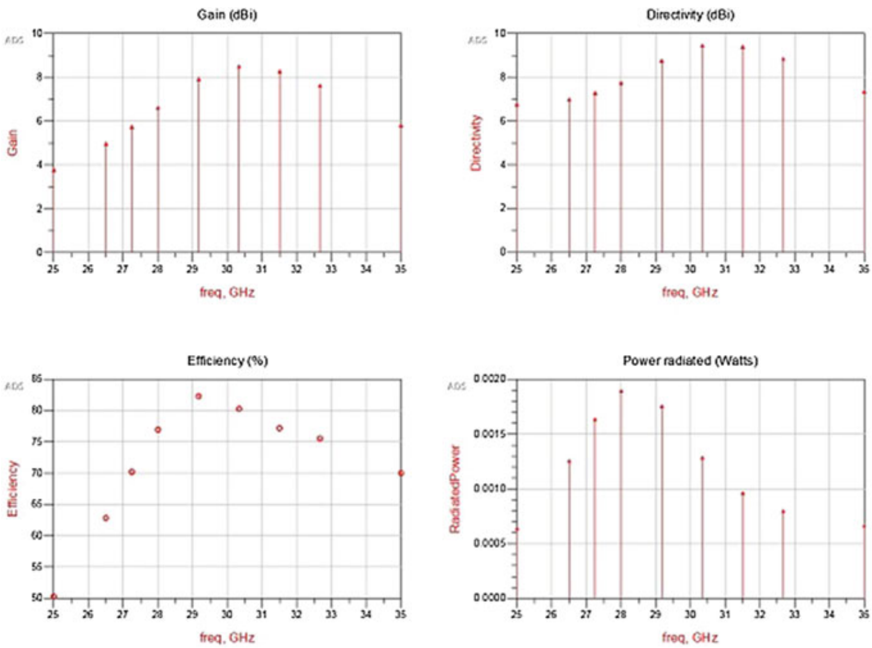


Fig. 8 Antenna parameters versus frequency

For a given rectangular patch, the radiation mode is at 28 GHz frequency, which is in the shape of a tomato, as shown in Fig. 7.

Other antenna parameters like inclination angle, radiation capacity, input power, output radiation power, maximum intensity, effective angles are analyzed with the help of ADS software as shown in the Figs. 8 and 9.

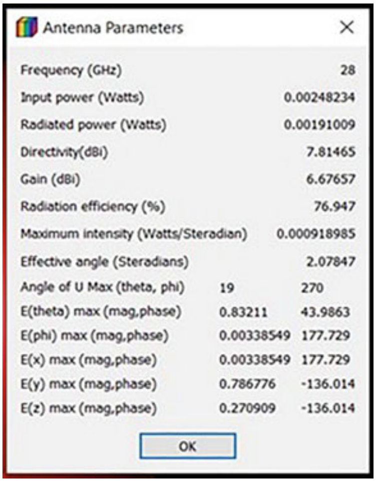


Fig. 9 Antenna parameters versus frequency

6 Conclusion

For 5G communication, a linear polarized rectangular patch antenna with 76.94 radiation frequency is designed when simulated on ADS tool. It was noted that there is a gain of 6.67 and of 7.81 dBi directivity in that antenna. After that, the designed antenna has a return loss of −21.5 db. After receiving the results, the design antenna is ensured to reach the list of good characteristics. This will make the antenna more sustain practically for the 5G communication. Our future work is planned to develop the proposed structure in the form of a printed circuit board and test the performance parameters of the antenna using a vector network analyzer.

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Advanced Speed Breaker System

N. Sasirekha, K. Kathiravan, J. Harirajkumar, and B. Indhuja

Abstract Advanced speed breaker is a system that helps to promote road education, contributes to respecting speed limits, benefiting road and drive safety, with the aim of preventing accidents and raising awareness among drivers of respecting speed limits, also compiling statistics and making possible measures impact and benefits. Advanced Speed Breaker could be a business safety system where dashing vehicles spark the speed swell and rises the speed bumps on top of the paved surface and giving the physical remainder to motorist to decelerate down the vehicle. If the speed of the on-going vehicles is inside the predetermine limit then the speed bumps keep flat on paved surface and vehicles passes over it well. This configuration detects the vehicles that circulate respecting the speed limit allowed in the area and lowers the device to ground level for them, but leaving it elevated for those who do not respect predetermine limit. Additional modifications can also be made to make emergency vehicles accessible.

1 Introduction

Advanced speed breaker is a system that helps to promote road education, contributes to respecting speed limits, benefiting road and drive safety, with the aim of preventing accidents and raising awareness among drivers of respecting speed limits, also compiling big data statistics how many cars, how many respect the speed limit, how many does not respect, traffic hours by day, month, year, software with space for plate reader and people's faces with photography or video and making possible measure impacts and benefits, taking care of, pedestrians, kids, drivers, security, education. The main concept of this work is to have an advanced speed breaker according to

N. Sasirekha (✉) · K. Kathiravan · J. Harirajkumar · B. Indhuja
Department of Electronics and Communication Engineering, Sona College of Technology (An Autonomous Institution), Salem, India
e-mail: sasirekha.n@sonatech.ac.in

J. Harirajkumar
e-mail: harirajkumar.j@sonatech.ac.in

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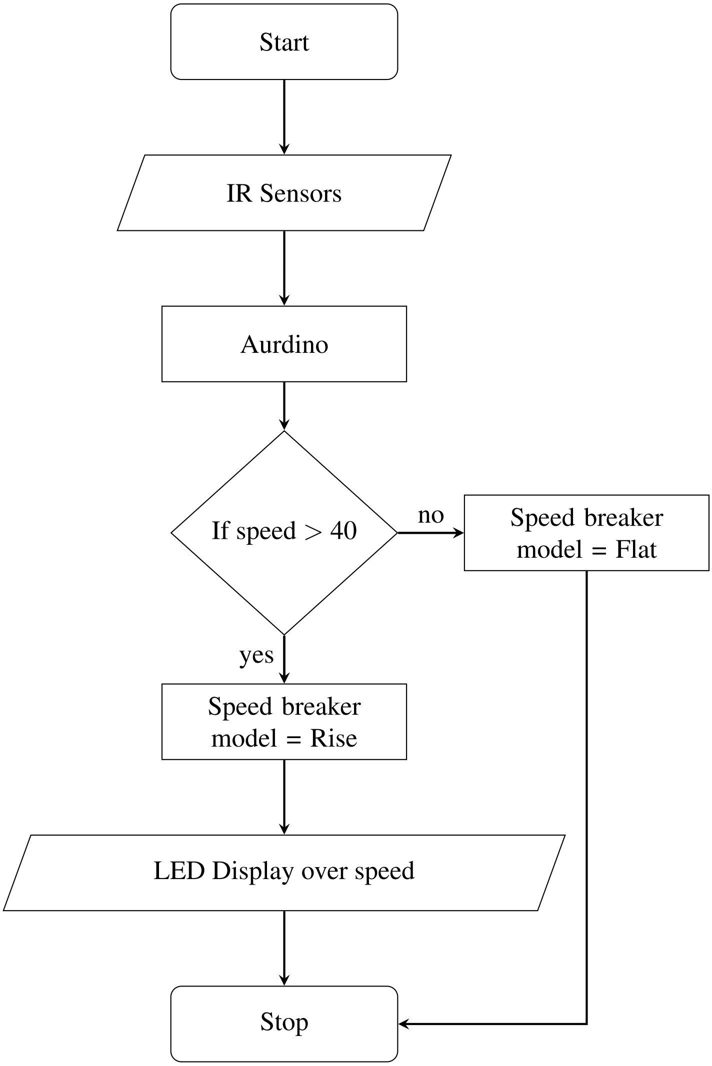
the requirements. Advanced Speed Breaker could be a business safety system where dashing vehicles spark the speed swell and rises the speed bumps on top of the paved surface and giving the physical remainder to motorist to decelerate down the vehicle. If the speed of the on-going vehicles is inside the predetermine limit then the speed bumps keep flat on paved surface and vehicles passes over it well. During this implementation we tend to square measure victimization associate iron created hemi-spherical speed swell which is able of rotating itself.

2 Existing Methodology

The speed has become an important factor in human life in the fast changing world. There are two viewpoints in the world of rapid speed, one is sustaining pace and the other is also maintaining safety media. There is a common practice of having concrete speed breakers on the road for safety purposes, to avoid road accidents. They are found solid all the time on the road in the case of traditional concrete speed breakers. Such types of speed breakers are very effective on the road but also cause a great change in vehicle performance at the same time. And why do not we have such a speed breaker that can lower the speed and keep the vehicle running. That is why, according to the specifications, there is a need for an automated breaker on time requests. Means when there is no need for the speed breaker on the road, it disappears from the road and the road becomes smooth, and when a need occurs then the breaker emerges from the ground on the road and starts working with slowing vehicle speed. This system allows detecting which vehicles are respecting the speed limit allowed in the area and lowering the device to ground level for them, but leaving it raised for those who do not respect said limit. This system causes the device to remain elevated for a sufficient time to cross the street even when the vehicle is respecting the permitted speed limit and thus make the pedestrian crossing safer. This application allows us to configure the device by day and time so that the device only remains elevated at the time of school entry and exit, that is, the rest of the day, on weekends and holidays, the device remains at ground level so as not to hinder mobility and reduce pollution. The existing system is construction based speed breaker is used. One speed breaker is broken again we want to reconstruct a speed breaker. This system used based on vibration on the road then it will activate a speed breaker. The drawbacks are Once the speed breaker is broken again we spend a money for a new speed breaker. Difficult to maintain this system.

3 Proposed Method

In our model, the Advanced Speed breaker system with IOT which will be remains paved surface and will be show up only if the on-going vehicle speed is above predetermining limits. The working of our project is initially the IR sensor detect the vehicle movements used to set the speed breaker and activating time and the speed breaker activated based on the IR sensor detect the vehicle movement, and it will be monitored.



3.1 Process of the System

The IR sensors are placed on a particular distance from the Advanced Speed-breaker. As vehicle passes, it detected by first IR sensor and then by second. The distance between each sensor is up to an expected value. The sensors are placed in such a way that each sensor detects the vehicle and calculates the speed i.e., if the distance between each sensor is 1 m, and the time taken to detect the vehicle between the two sensors is 0.06 s, the speed of the vehicle is 60 km/h. For the speed breaker to be activated, the vehicle speed must be above 40 km/h along with that, there will be an LED screen displaying, “over speed” Arduino board sends an indication to servo motor to rotate a hundred and eighty degree ensuing the speed hump to rise on top of the paved surface. If the vehicle moves between 40 km/h or less, the speed breaker would not be activated and remains flat. It creates an even traffic control among vehicles.

4 Methodology

The working of our project is initially the IR sensor detect; the vehicle movement is used to set the Advanced speed breaker and activating time and the Advanced speed breaker activated based on the IR sensor detect the vehicle movement, and it will be monitored. The IR sensors are installed before the Advanced Speed Breaker at appropriate distance. As vehicle passes, it detected by first IR sensor and then by second IR sensor.

$$\text{Speed} = \text{Distance}/\text{Time} \tag{1}$$

The distance between two IR sensors is known and from that we can calculate the speed of vehicle, by using the formula of speed. As shown in Eq. (1). A predetermine speed limit set into programmed of Arduino microcontroller as shown in Flow process. For the speed breaker to be activated, the vehicle speed must be above 40 km/h. along with that there will be an LED screen displaying, “over speed” Arduino board sends an indication to servo motor to rotate a hundred and eighty degree ensuing the speed hump to rise on top of the paved surface. If the vehicle moves between 40 km/h or less, the speed breaker would not be activated and remains flat. It creates an even traffic control among vehicles. The Smart Stop has five programming modes, depending on the zone or the use that you want to give it.

4.1 Speed Limit

This system allows detecting which vehicles are respecting the speed limit allowed in the area and lowering the device to ground level for them, but leaving it raised for those who do not respect said limit.

4.2 Pedestrian Crossing

This system causes the device to remain elevated for a sufficient time to cross the street even when the vehicle is respecting the permitted speed limit and thus make the pedestrian crossing safer.

4.3 School Zone

This application allows us to configure the device by day and time so that the device only remains elevated at the time of school entry and exit, that is, the rest of the day, on weekends and holidays, the device remains at ground level so as not to hinder mobility and reduce pollution. This system causes the device to remain elevated for a sufficient time to cross.

4.4 Total Stop

This configuration allows us to circulate with greater safety in areas where vehicles are required to make a total stop for a few seconds and continue their journey, such as in parking lots in shopping centers, entertainment centers, among others. The system detects when the vehicle reaches the crossing zone and stops in front of the device (stop) and after a few seconds the device lowers to the ground allowing the vehicle to continue its journey without having to go through any obstacle.

4.5 Respect the Pedestrian Line

The configuration allows us pedestrians to cross the road with greater safety since the device remains elevated while the vehicular traffic light is on red and lowers at ground level when the traffic light changes to green, thus contributing to education and road safety.

5 Results

This configuration detects the vehicles that circulate respecting the speed limit allowed in the area and lowers the device to ground level for them, but leaving it elevated for those who do not respect said limit. As shown in Table 1 Speed segments. The "Pedestrian Button Panel" module allows us the device to be kept elevated

Table 1 Speed segments

Sr. no	Vehicle type	Vehicle speed	Speed hump condition	Vehicle speed after crossing speed hump
1	Bike	70	Speed humps	40
2	Car	60	Speed humps	35
3	Truck	30	Remains flat	30

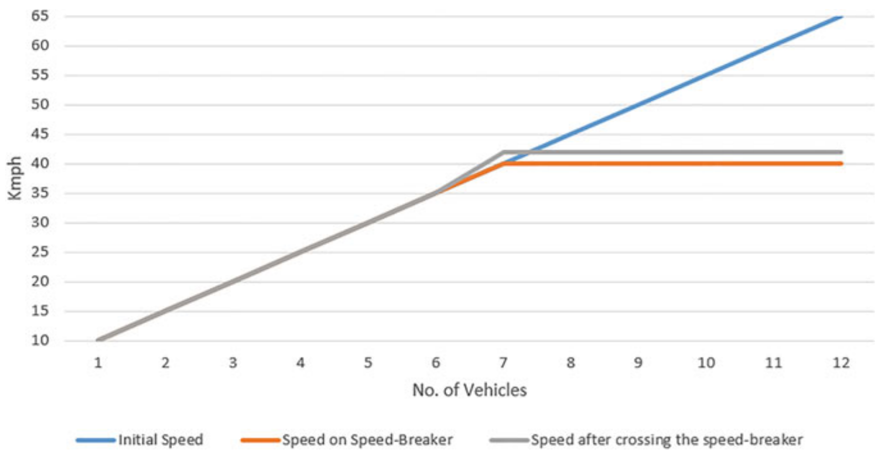


Fig. 1 Speed analysis

long enough to cross the road, offering more safety, even when vehicles are traveling within the permitted speed limit. Figure 1, Speed Analysis shows speed varying before and after crossing the speed breaker.

The graph shows three segments Initial speed, Speed on speed-breaker and speed after crossing the speed-breaker. Initial speed ranges from 10 to 65 kmph, it indicates number of vehicle crossing the speed breaker. Next speed on speed-breakers shows the speed level reduced to less than or equal to 40. Speed after crossing the speed breaker shows the reduced speed of the vehicles.

Vehicle speed $\geq$ 40, Remains flat
Vehicle speed $\leq$ 60, speed breaker humps

6 Conclusion

This paper bestowed a strategy for choosing optimum speed-breaker system. Advanced speed breaker is an innovation for the globe. Advanced speed breaker

Table 2 Comparison of different types of speed breakers

Mechanisms	Cost	Mechanism setup	Maintanaces	Efficiency	Design
Asphalt speed breaker	Cheap	Moderate	Less required	60	Easy to design
Advanced speed breaker	Moderate	Difficult	Monthly basis	85	Depand upon weight substaining capacity

could be a system that helps to market road education, contributes to respecting speed limits, benefiting road and drive safety, with the aim of preventing accidents and raising awareness among drivers of respecting speed limits, conjointly assembling statistics and creating potential live impacts and advantages. As shown in Table 2, comparison of different types of speed breakers. Advanced speed breaker a system that encourages road safety education. The advanced speed breaker system installation guarantees that law-abiding drivers are not penalized, preventing them from becoming enraged. As a result, when compared to traditional bumps, the system's installation would face little or minimal public opposition. The efficiency are better in advanced speed-breaker compared to conventional bumps the pre-emption technology eliminates worries about delays in emergency response times caused by bumps. The bump would induce fewer vehicles to brake and accelerate, lowering pollution produced by any other traffic calming device. It aims to solve various problems that currently present the stops as; hinder mobility, increase pollution and cause damage to health, economic impact by increasing fuel consumption, as well as vehicle deterioration due to tire, suspension and brake wear.

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Survey on Intrusion Detection System in IoT Network

Syed Ali Mehdi and Syed Zeeshan Hussain

Abstract Internet of Things (IoT) has emerged as a powerful communication and networking system for smart and automation processing. With the increasing usage of the Internet of Things in numerous critical activities, it is essential to ensure that the communication among these devices is safe and secure. The biggest threat to safe and secure communication is from cyberattacks. Cyberattacks have evolved and become more complex, henceforth posing increased challenges to the data integrity, communication security, and confidentiality of the data. With its success in detecting security vulnerabilities in a communication network, intrusion detection systems are best integrated for securing IoT-based devices. But the integration of an intrusion detection system in an IoT-based network is a challenging task. This paper investigates the state of the art of IoT and intrusion detection system, the technology in use, and the technology challenges by reviewing notable existing works. A systematic literature review of 25 sources comprising 22 research papers and articles covering the threat models, intrusion detection system key challenges in IoT, Proposed models, and implementation of models, reviews, and evaluations are reviewed. The findings explore the needs and the best ways of integrating artificial intelligence-based intrusion detection systems in IoT networks for ensuring security and safety of communication.

Keywords The intrusion detection system · Internet of Things (IoT) · Computer Security · Artificial Intelligence

S. A. Mehdi (✉) · S. Z. Hussain
Department of Computer Science, Jamia Millia Islamia, New Delhi, India
e-mail: alimehdi777@gmail.com

S. Z. Hussain
e-mail: szhussain@jmi.ac.in

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1 Introduction

Internet of Things (IoT) is the technology that makes communication and control among various devices connected in a network. IoT allows for distributed communication through devices like sensors and other communication devices along with data processing units. It enables autonomous decision-making and intelligent data processing and analysis. The biggest technology that helps IoT devices in establishing communication and data transfer are wireless communication and Cloud computing.

IoT usages have increased over the years, and today, they are in automation applications like health care services, industries, smart home applications, etc. These devices are in use in these critical areas and thus are more under the attacker's lists. Hackers aim to gain access to the network for financial gains and other gains. Security is thus of utmost importance for IoT-based devices as they are primarily used in automated applications. Thus, there is a need to have a reliable security mechanism, and an intrusion detection system is one such effective mechanism.

Intrusion detection is the process wherein the objective is to detect intruder actions. These intruder action's main objectives are to gain unauthorized access to the network, thereby interfering with data integrity or network security. The intrusion into the network can be carried out from inside the network, i.e, internal intruders or from outside the network, i.e, external intruders. Thus, the intrusion detection system (IDS) aims to identify the intruder's actions and trigger an alarm in the network for a quick response to the intruder's actions. A general IDS comprises of sensors, an analytical engine for processing and analyzing intruder patterns or actions and a reporting mechanism. The sensors of the IDS are placed in the network at various host positions. The task of a sensor is to collect the host data that includes packer headers, network service requests, file exchanges, statistics of traffic, etc. All this collected data is sent to the analytical engine that investigates the data and detects any intrusion. If in case any intrusion is detected, the reporting mechanisms send the report to the network admin and an alarm is triggered for the intrusion. Millions of money being spent securing the network, and the devices and IDS are such effective devices.

With the emphasis on IoT Security, intrusion detection systems have been proposed for the IoT environment. Before aiming to come up with efficient IDS for IoT, it is essential to understand IDS in the context of the IoT environment. Thus, there is a need to examine the current state of the art, the basic requirements of IDS in IoT, the best strategies, and the best ways to have efficient IDS for the IoT environment. This literature review aims to examine all these aspects by addressing the following questions:

RQ1: What key cyber threats are faced by IoT devices that require the need of IDS?

RQ2: What are the IDS systems used so far in IoT based environment? Can they be classified? If yes, on what basis?

RQ3: What are the critical challenges of IDS in the IoT environment? Can AI address these challenges?

2 Methodology

2.1 Search and Selection Strategy

The data for this literature work is obtained from various reputed sources in the form of research articles, literature reviews, case studies, web articles, and books in online printed form. The articles were extracted through search from search engines like Google, Google scholar, Sci-Hub, sciencedirect.com, and the university library. Apart from it, the other useful research material was obtained from reputed books and student thesis documents. The search relied on the query of the Intrusion detection system in IoT; it was then further refined with keywords like Artificial intelligence, security threats in IoT, challenges, etc.

2.2 Data Analysis

Quick abstract reviews and the article summary review were opted as the preliminary paper selection method. For theoretical frameworks, reviewed surveys, and case studies full paper or abstract. Only papers with implementation models, their challenges, and experimentations are selected. The review findings shall be listed in the table, and the analysis shall be done based on the listing to come up with a conclusion.

2.3 Quality Appraisal

The research paper and articles quality were highly dependable on the following factors:

- Relevance: Whether the information is relevant to the topic of research.
- Credibility: Whether the information in the paper, a book, or an article is supported with facts and figures.
- Transferability: Whether the information in paper or book can be generalized to other settings.

2.4 Result

Fifty-eight papers related to the topic were selected through abstract reviews from the year 2013 to 2020. These 58 papers were filtered out based on a full article review and topics related to IoT. This resulted in 25 relevant papers. When evaluation, research works, or surveys-based papers were searched, the search resulted in 22 papers and articles.

The rest papers were filtered because either they are proposals or literature surveys. Finally, only implementation models and frameworks are selected. This resulted in 10 papers with implementation models and 12 for related works.

3 Discussion

3.1 Types of Security Threats in IoT Based Environment

Numerous researches have classified the various threats present in the IoT network. The broad classifications are passive attacks and active attacks.

Passive attacks: The passive attacks are mainly hindering confidentiality and are very hard to detect. In these attacks, the attackers are hidden and affect the communication lines. These include eavesdropping, node tampering, node outage, analysis of traffic patterns, etc. [1].

Active attacks: These attacks not only affect confidently, but also have an impact on data integrity. The attacker in an active attack aims to gain access to the system through unauthorized means and affects the network's operations. Wireless sensor networks and IoT currently employ five different OSI models, namely: the physical layer, the data link layer, the network layer, the transport layer, and the application layer. Research has classified attacks based on each layer. The summary of these attacks is as follows:

- Denial of Service (DoS)—This security threat is known to deny or prevent authorized users to access the resources on a network. It does this by sending unwanted traffic. This attack can affect the network order by sending data packets or by simply flooding the packets in the network. Some IoT devices thus shall be denied service [2].
- Malware—In this attack, an executable code known as malware is used to disturb the IoT devices in the communication network. With this executable code, the access to the network is gained. [1].
- Sybil attack: The attacker sends fake identities to authorized nodes, and by doing so, these legitimate authorized nodes become disabled permanently from the network. This can lead the IoT devices to accept inaccurate reports and accept spam and thus lose privacy [3].
- Replay attacks: This attack reproduces the signal which is used for controlling any device. Different modulation methods are used to capture this signal and then collect the data for this signal. This signal is then again retransmitted to gain access to the system [3].
- Selective forwarding attack: The malicious nodes in the network behave like the normal nodes, and thus refuse to forward a packet selectively or drop the packet

selectively. By selective dropping or reject forwarding, the nodes do not come into the picture quickly [15].

- Sinkhole attack: In this attack, the malicious node advertises through broadcasting to its entire neighbor that it is the next hop for them. All nodes start sending packets to this sinkhole. It does not drop the packet and thus remains undetected by the intrusion detection system [2; 3].
- Wormhole attack: In this attack, the attacker can get the data packets on one side of the tunnel, and through this tunnel, it can send to another malicious user. These are the toughest attacks to detect and impact on localization, data fusion of the network [3].
- Blackhole attack: In this attack, the malicious user listens to the packet request with the help of routing protocols and then drops all the packets, thus stopping the packets near the black hole [15].
- Jamming attack: In this attack, the attacker monitors the operational frequency of the node signals from the receiver to the sender and vice versa. It captures it and then transmits a signal on the same frequency to hinder the receptor [1].

3.2 Classification of the Intrusion Detection System (IDS) for IoT

Numerous Intrusion detection mechanisms have been proposed in existing research. These intrusion detection systems are classified as statistical methods, knowledge-based, data-mining methods, and machine learning-based methods [26]. Statistical-based IDS techniques relies on the stochastic behavior of the captured network traffic. The statistical patterns give information on good actions and bad actions. The bad actions are marked, and intrusion is triggered [9]. On the other hand, knowledge-based techniques makes use of prior knowledge of the user behavior. These Knowledge-based Intrusion detection systems are known to encode the expert's knowledge of already known patterns of previous cyberattack and any sort of system vulnerabilities in the form of if—then database rules [16]. These IDS build a knowledge base from the knowledge gained from various kinds of attacks and the loopholes that exist in the network. When any action that is not recognized as normal behavior is detected, such action is not considered acceptable, and the alarm is triggered. The detection approach is based on measuring the distance based on the Gaussian function modified to function as a similarity function [26]. The approach uses the K-Means algorithm for clustering based on the distance measures over both the training and testing data [21]. The training and testing data are then converted to a single-dimensional feature vector through the distance measure and the k-means [21]. The existing research work concludes that the accuracy of such an intrusion detection system is good, and it generates very low false alarm rates [26]. But the limitation of the system is that, it is complicated to gather information on the known attacks and update the data with the new set of vulnerabilities [26]. It is essential to have a thorough analysis of all the vulnerabilities for the maintenance of the knowledge base of the intrusion detection system, which is a very time-consuming job.

Classification of IDS based on technique: Various studies have categorized intrusion detection systems for IoT based on their preferences. For example, based on their technique applied for intrusion detection, these systems are classified as follows:

- Signature-based intrusion detection system: In these IDS systems, the attacks are detected when the attack signature matches the internal database signature of any existing attack. When such an attack signature is found, then an alert is signaled. Numerous researches have found that these are more accurate and effective [8; 17; 21]. These are also easy to understand and use. The key challenge in this method is that the database should be updated regularly for enhancing efficiency [21].
- Anomaly-based intrusion detection system: These IDS are generally used to detect intrusion in the network and monitor the misuse in the network. The system categorizes the activities into normal and abnormal activities based on a threshold value [18]. Such IDs in IoT monitor the behavior of the node and compute its threshold. It then compares it with the defined threshold for the network, and any deviation from it is considered abnormal, thereby resulting in an anomaly [12; 18; 24].
- Specification-based intrusion detection system: These IDS are based on rules. The rules define the expected behavior of the network, the nodes, and the protocols [10; 13]. When any node behavior or communication differs from the specification, a trigger is raised. It differs from the anomaly-based system because the human user makes the rules. These IDs are more proneto more false-positive rates, due to human-based rules [10; 13].
- Hybrid intrusion detection system: These IDS employ the best ways of all three approaches to capture intrusion in a more effective manner.

Classification of IDS based on placement strategy: In another classification of an intrusion detection system, these systems are classified based on the placement of the IDS in the IoT network. These are classified as follows:

- Centralized IDS: In this placement strategy, the IDS is placed in the central component of the network, like a border router or any specific central host. The total traffic passes through this border router or the central host and can be analyzed for any intrusion activities.
- Distributed IDS: This is a placement strategy of IDS wherein the IDS are placed in every network entity. Thus, IDS are deployed in each node. The biggest challenge in using these kinds of IDS is that the IoT devices are resource constraints, and thus researchers have proposed lightweight IDS for the distrusted placement strategies.
- Hybrid IDS: In this placement strategy, the entire network is divided into clusters. For each cluster, the main node has the IDS to monitor the neighboring node traffic [20].

From the existing research work on intrusion detection systems in the IoT environment, the key findings are summarized in Tables 1 and 2.

Table 1 Summary of methodology and strategy of placement of IDS

Paper	Methodology	*Strategy of placement*
Kasinathan et al. [8]	IDS in IoT are built over IPv6 over a low-power personal area network (6LoWPAN) devices. The proposed IDS framework has a monitoring system and a detection engine integrated into the network framework developed within the EU FP7 project 'ebbits'	The IDS is placed centrally [8]
Raza et al. [20]	Real-time intrusions detection in IoT named SVELTE [20]	Not available
Ham et al. [4]	Made use of linear Support vector machine method for anomaly detection in android machines [4]	Not available
Lee et al. [11]	Lightweight intrusion detection model based on energy consumption analysis of nodes consumed in 6LowPAN. The sensor nodes with irregular energy consumptions are identified as malicious attackers [11]	Distributed
Oh et al. [17]	Makes use of a pattern matching engine that detects the signature of the intrusion and signals an alarm [17]	Distributed
Le et al. [10]	Routing protocol for low power network protocol based IDS [10]	Hybrid placement
Hodo et al. [5]	Made use of the artificial neural network, supervised learning for detecting DoS-based attacks [5]	Not available
Thanigaivelan et al. [24]	Each node monitors its neighbors at the data link layer. If in any node behvaiour is abnormal, the monitoring neighbor node will block the packets from this abnormally behaving node. It will then report the abnormality to the parent node [24]	Hybrid placement
Li et al. [12]	Makes use of AI for IDS. It is two-stage IDS with Software-Defined Network (SDN) to support [12]	Not available
Liu et al. [13]	Made use of principal component analysis algorithm for intrusion detection [13]	Not available
Sicato et al. [22]	Software-defined IDS for distributed cloud [22]	Centrally placed

Table 2 Summary of IDS technique, advantages, and Issues in IDS

Paper	IDS detection technique	Advantages	Issues
Kasinathan et al. [8]	Signature-based detection technique	Easy to use, stable and scalable [8]	Need further refinement for more attacks detection requires an updated database [8]
Raza et al. [20]	Hybrid IDS technique	Real-time applicability	Low rates of detection [20]
Ham et al. [4]	Anomaly-based	High precision and low false alarms [4]	Greater overhead time [4]
Lee et al. [11]	Anomaly-based	Lightweight, effective [11]	Requires high time for computation [11]
Oh et al. [17]	Signature-based	High accuracy rates and uses less memory [17]	It cannot detect in a real-time scenario and has the lesser capability of intrusion detection [17]
Lee et al. [10]	Specification-based	More effective	Requires more rules for being effective [10]
Hodo et al. [5]	Anomaly-based	Good accuracy with low false-positive values, Excellent energy efficiency [5]	Consumes more time for perfect result computation [5]
Thanigaivelan et al. [24]	Anomaly-based detection [24]	Uses network fingerprinting for network changes [25] topology, Effective	Requires high computing resources [24]
Li J. et al. [12]	Anomaly-based	Very good accuracy with low false rates [12]	More time consuming & needs more computational resources [12]
Liu et al. [13]	Specification-based	The detection rates are high, and the false alarms are low [13]	As the volume of data increases, efficiency decreases [13]
Sicato et al. [22]	Anomaly-based integrated with machine learning	SDN-based IDS makes use of IDS controller at Fog layer [22]	High risk to IoT application layer security

Table 1 summarizes the IDS methodology and the placement strategy of IDS in the IoT environment.

From Table 1, it is evident that the most preferable strategy for placing the intrusion detection system is central. The total traffic passes through the centrally placed IDS, and thus the entire system is monitored. The IDS technique, the advantages of each technique, and the challenges are summarized in Table 2.

From Table 2 the key findings are:

- IoT networks are resource constraint devices. Thus, there is a shortage of extensive databases for known attack detection, especially in signature-based detection methods. Thus, signature-based methods are less effective in an IoT-based environment [18].
- Most of the existing IoT-based IDS employ an Anomaly-based intrusion detection technique followed by a hybrid detection technique. It is mainly because the anomaly-based detection technique enables dynamic behavior intrusion detection. It is also capable of detecting unknown threats and vulnerabilities. The key challenge with such intrusion detection techniques is that these have high false-positive rates and require high time for processing and computation.
- Moreover, it has been found that the usage of the traditional Intrusion detection system techniques in the IoT-based network is challenging due to characteristics such as device-based resource constrain, challenges related to protocol stack, and other communication standards.

3.3 Challenges in IDS in IoT

From the analysis of the existing literature work, the key challenges of IDS in IoT-based environment are as follows.

In general, an intrusion detection system working on LAN-based network raises several intrusion triggers [19]. Thus, there are a large number of false-positive rates and a sometimes-large number of low priority alerts. In such a scenario network, the admin cannot compute these alerts manually to find out which false-positive attack is and what mitigation steps are needed. The same problems are a challenge in the IoT environment. This challenge becomes more complex because most IoT devices are used for automation and significantly less human interaction [26]. Therefore, there is a need to address this issue in IoT-based IDS systems. Thus, alert processing methods are needed. Furthermore, IoT-based devices cannot be flooded with many alerts and data due to resource constraints. Thus, these issues must be addressed.

- IoT-based networks are more used for automation devices and thus have less human intervention. Thus, IDS administration cannot have frequent human intervention in the IoT environment. Therefore, there is a need to have an automated IDS mechanism with minimal intervention from humans. Research works are on automated mitigation of threats paradigms for IoT. Such mechanisms are well-needed for IoT-based networks. This is where artificial intelligence has a promising role to play. Early works on Artificial intelligence-based Intrusion detection systems in a normal network as well as in IoT by [6; 7; 22; 23; 25] show the promising result that artificial intelligence and machine learning are the best technique for enhancing existing intrusion detection system efficiency.

- The needs of IoT are different as they require real-time monitoring of the data, require an automated system to detect anomalies, have different sets of protocols, etc. Thus, Midi et al. [14]. proposed Kalis, an intrusion detection system for IoT which was protocol independent. Kalis IDS relies on "network-based, hybrid signature/anomaly-based technology that has placement strategy of hybrid centralized/distributed and is capable of adapting to different environments." This system can be used as a standalone tool or as an external agent device. It is based on a knowledge-based system, and thus automatically detects the data based on the network features. Furthermore, Kalis was able to detect the type of prevention techniques, such as cryptographic functions deployed by the network. Thus, it happened to be an effective and efficient system. The system's detection rate was found to be 91% with 100% accuracy, 0.19% CPU usage, and 13,978.62 KB memory consumption. The system promised to be an effective tool for IoT-based intrusion detection [14].
- IoT networks are resource constraint devices. Thus, there is a shortage of extensive databases for known attack detection, especially in signature-based detection methods [23]. Thus, signature-based methods are less effective in an IoT-based environment [23]. This has to be addressed for signature-based IDS in IoT.
- The IoT devices are small, and have small resources, and thus, in such a scenario, anomaly-based detection methods are better than the other approaches [21; 23]. It is also found that this anomaly-based detection requires more computational needs, efforts, and time, and this emerges as a key challenge [23].
- The current security mechanism in IoT adapts the virtual local area network paradigm to secure the communication between two nodes and the IDS component [22; 23]. Moreover, completely securing the data communication lines in IoT network is not possible due to IoT characteristics. Any weak attack can be used to eavesdrop or passively monitor the communication lines and intrude on the network. Thus, there is a need to look at the IoT sensor and node communication [22; 23].
- Placement strategies of IDS in IoT are still a challenge and require further research.

4 Recommendations

IoT security requires two main aspects: the security architecture aspect and the security by design aspect. To achieve these aspects, the systems must have the following things:

- To have an automatic detection mechanism to enhance the incident response during any attack. Artificial Intelligence is a powerful tool that can make use of its learning algorithms to help in achieving automation.
- The automation algorithms should be self-learning and adaptable. This can be achieved with the help of artificial intelligence, and some of its adaptive self-learning algorithms are machine learning by neural networks, artificial immune systems, etc.

- There is a need to have faster and enhanced decision-making abilities. Moreover, to effectively mitigate the intrusion, there is a need to understand the attacker's behavior and the data behavior. These understandings can be done with the use of computational intelligence systems. Thus, it can be concluded that an effective automated intrusion detection system can be made with the help of artificial intelligence tools.

5 Conclusion

This review is a summary of the methods used for designing the intrusion detection system for the IoT. Preliminary findings from the literature review revealed that an intrusion detection system is highly essential for IoT devices to ensure safe and secure communication. Widely used IDS for IoT relies mostly on anomaly-based detection methods due to its effectiveness. Moreover, the anomaly-based detection method is efficient due to IoT devices being small, and with limited resources. It is found that the anomaly-based intrusion detection technique requires more computational technology, and this emerges as the key challenge in its usage. To overcome this challenge, automated IDS is the need of the hour. This, in turn, looks toward Artificial Intelligence as the game-changer. Artificial intelligence could be a powerful tool in designing an efficient intrusion detection system for IoT-based systems. Finally, the literature on the placement strategy of IDS in IoT and its effectiveness is limited. Henceforth, there is a need to address the placement strategy for IDS in the IoT environment for more reliable and secure IDS in near future.

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Assessing Student Engagement in Classroom Environment Using Computer Vision and Machine Learning Techniques: Case Study

Ganeshayya Shidaganti, Rithvik Shetty, Tharun Edara, Prashanth Srinivas, and Sai Chandu Tammineni

Abstract Today there are a wide variety of methods of teaching, but choosing the most efficient one for a particular group of students is an effortful task. The proposed system estimates the degree of student engagement by analyzing various facial features extracted from the video dataset, time of the day, and relative intelligence determined by a questionnaire given to each student. Our model encompasses the usage of both facial features and psychological factors to achieve the result. We classified the degree of student engagement into four levels—not engaged, partially engaged, engaged, and fully engaged, ranging from low to high, respectively. The performance of the model is better with Random Forest Classifier with an accuracy of 76%. In this paper, we majorly focus on improving the quality of education by enhancing student engagement throughout the course. Based on the results, the faculty can update their teaching methodology.

Keywords Student engagement · Machine learning · OpenFace · Educational data mining

1 Introduction

Educational data mining (EDM) is a field of study that is mainly focused on applying data mining, machine learning, and statistics to uncover patterns by the information generated in educational settings. These patterns are used to study and analyze the behavior of students at multiple hierarchy levels and generate insights that can be beneficial for improvements in the teaching methodologies.

Engagement in a classroom is a critical factor to improve the learning and teaching methodology of a classroom. Analyzing the engagement of students provides key insights about the teaching methodology and thus provides information regarding teaching aspects where improvements can be made. The engagement of students is

G. Shidaganti (✉) · R. Shetty · T. Edara · P. Srinivas · S. C. Tammineni
Department of Computer Science and Engineering, M. S. Ramaiah Institute of Technology (Affiliated to, Visvesvaraya Technological Unversity), Bangalore, India
e-mail: ganeshayyashidaganti@msrit.edu

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also directly affected by the teaching structure, thus by measuring the engagement, we can also identify the effectiveness of a teaching methodology [1]. Psychological factors make a pretty huge impact on the engagement of a student in the classroom and it mainly depends on the process of selection [2].

Although a lot of research is being done for analyzing the engagement of students in a classroom by using computer vision techniques, most of the research done so far doesn't account for psychological factors, but it has been proven that the cognitive behavior of students [3] can be clustered and thus can affect the overall engagement in the classroom as a whole. Hence, these can be the decisive factors for the engagement of a student in a classroom. Student engagement is more often linked with academic self-concept and sense of achievement [4], and in this work, we try to analyze the relation between facial features and other psychological factors like "Time of the day", "Attention to Detail", and "Interest" to the engagement of a student.

In this work, we are proposing a novel technique where we are using psychological factors as well as facial features to analyze the engagement. We are using a camera to capture the video of the students in the classroom non-intrusively. Also, a questionnaire is given to each student to analyze the psychological factors and relative intelligence of the student. We are extracting individual frames from this video by using an open-source tool called FFmpeg [5]. These frames are used to analyze facial features and postural data by using an open-source computer vision toolbox that works in real-time called OpenFace [6–11]. This data along with the results of the questionnaire are weighted and are classified by using machine learning algorithms to measure the engagement.

2 Related Work

First, the motivation to analyze the engagement of students was discussed in the previous section. In this section, we will discuss research done on student engagement analysis.

Several works have used non-intrusive methods involving computer vision techniques and machine learning algorithms. In 2017, Thomas and Jayagopi [12] proposed a system of predicting the engagement level based on facial expressions, head pose, and eye gaze to make a decision based on a supervised Machine Learning Model. They make use of OpenFace, which is an open-source facial analysis toolbox. They have selected features based on the intuition that students who are attentive have a tendency to look at the presentation and distracted students look away from it. OpenFace detects Action Units' intensity level and associates a binary value in case of presence/absence of Action Units. They extracted 30 such Action Units and eliminated redundant Action Units by running a correlation analysis between the engagement labels and features. Thus, the final number of Action Units were reduced to 27. $^2/_3$ rd of the results obtained were used for training a Supervised Machine Learning Model. They used various Algorithmic Models like Linear Support Vector Machine (SVM), Radial Basis Function (RBF) SVM, and Logistic Regression on the remaining ⅓ of the data to classify students as “Engaged” or “Not Engaged”.

The authors of [13] presented a system for detecting the levels of engagement of the students in an e-learning environment. This system only uses data provided by a webcam and works in real time. Data about the motion of the eyes, the head, and facial emotions were collected. This data was used to produce an index based on concentration with three levels of engagement: “very engaged”, “nominally engaged”, and “not engaged at all”. To produce this index in real time, Keras for analysis of the facial emotions, the Haar-cascade algorithm for tracking the eyes, and a Convolution Neural Network (CNN) were used. By analyzing the outputs from the analysis of the motions of the eyes and the head, and by analyzing facial emotions, the engagement level is classified into three levels: “very engaged”, “nominally engaged”, and “not engaged at all”.

The authors of Nomura et al. [14] are trying to predict student engagement from data such as students’ posture, upper body posture, and upper body pressure taken from a camera and pressure mat. This data is captured during an e-lecture. A pressure mat was used to capture pressure data and OpenPose, a human pose estimation library was used to capture posture data. From the data, 38 upper body pressure distribution features and 33 upper body features were extracted every minute, and by using this data, they predicted the student’s engagement by using a Support Vector Machine (SVM). The Support Vector Machine was trained with “engaged in lecture” and “not engaged in lecture” as the classes. For each person in the study, an SVM model was created based on the extracted features. The performance was measured by using a leave-one-minute-out cross-validation model. It was found that for the average of the proposed method, the method only with pose features and method only with pressure features was higher than the baseline model. Moreover, the accuracy of the model when the pressure distribution data and the posture data were combined becomes higher, compared to the separately used ones.

The authors of [15] proposed a hybrid system formed by the method of combining convolutional neural network (CNN) and logistic regression classifier (LRC) approaches. The main idea was to combine the benefits of the two approaches. The proposed system works in two steps of learning. At first, convolutional neural networks are used to detect and recognize features from images. Then, the features recognized by the convolutional neural network are used for classification by using a logistic regression method. This system benefits from the advantages of using convolutional neural networks such as extraction of features and robustness to distortions. On the other hand, a simplistic logistic regression method classifies the features extracted by the CNN with higher precision in lesser time.

Khorrami et al. [16], (2014) presented a system that monitors the attentiveness of the remote students in the online course by running the video-based three-dimensional face tracking algorithm on the client-side and based on various methods such as face tracking, head pose estimation, and gaze estimation. The system works on a multi-tier model of computer networking, where the client represents the students and the server represents the instructor. On the client-side, each student accesses subject material using the local systems which have the software designed to collect facial data like facial feature points and head pose direction using the webcam and send them to the server. The server then makes use of this data and keeps a record of all the information about the clients in the entire session. Using this data, the overall engagement of the student is calculated. The authors claim that the proposed monitoring system can predict students' engagement with an accuracy of about 75%. The proposed method can also be implemented in Massively Open Online Courses (MOOC).

In the work by Altuwairqi et al. [17], the researchers built their engagement level model and mapped them accordingly with various appropriate emotions by studying various studies done in this area of research previously. Then, they proposed an effective process and model to predict the final engagement level. The high-engagement class had enthusiasm, anger, and excitement. This class has either extreme positive or negative effects depending on the emotion. Hence, when the student belongs to this class, they might be in a high engagement class. Thus, the emotions which cause extreme positive or negative effects were considered a subclass of the high engagement class. The medium leveled engagement class contained content, happy, joyful, delightful, and sad emotions. This class is filled with pleasant emotions and unpleasant emotions. Hence, the student who has pleasant or unpleasant emotions might belong to the medium engagement class. So, pleasant and unpleasant emotions were mapped with a medium engagement class. The low engagement class has bored, relaxed, and tired emotions. This class is filled with a mild positive effect along with a mild negative effect. Hence, when the student displays these emotions they may be in a low engagement class. So, emotions in mild positive effect and mild negative effect were concluded to be in low engagement class. The efficiency of the Affective Model proposed is figured experimentally by a series of experiments conducted. At first, they calculated the Matching Score (MS) and Miss-matching Score (MisMS) for each engagement class. Then, they applied the detection process of improved engagement levels in severe cases. Finally, to detect strong emotions, they analyzed all emotions in each of the classes of engagement. The Matching Score was 71.2% for low engagement levels and higher for other emotions.

In this work, Kim [18] proposed an algorithm for present smart classrooms. It helps in providing feedback to the teacher by detecting the engagement of students in real time. It evaluates the psychological states of students by making use of thermal infrared imaging. This technique has been good for non-invasive evaluation and also due to contact-less evaluation of emotional states, psychophysiological responses, and vital signs. After defining the classroom environment as the area of interest (AOI), the data recorded from the difference in mean temperatures of the AOI was considered as an index to estimate the engagement levels of the students. From the infrared camera, the temperature data waveform is collected and converted to its root mean square (RMS) form. Then the final result is determined by using a derivative test, and based on the result, a color change is indicated on the mobile phone. Since this algorithm heavily relies on qualitative data, the result of this work provides the students' real-time engagement level as a quantitative index instead of qualitative indices.

As discussed, a lot of work to determine student engagement relies on computer vision techniques and machine learning algorithms. In this work, we are using facial features along with psychological data. We are applying machine learning techniques to this data to determine the engagement level. Details about data collection are discussed in the next section.

3 Data Collection

In this section, the specifics of data that has been used in the development of this model are being discussed, including the processes of data cleanup, data pre-processing, and data labeling in detail.

The dataset comprises videos shot and data from a questionnaire filled post-session to get psychological factors like the interest level of students and their relative intelligence by asking them to answer questions related to the lecture. The videos are of 8 min and were captured over a span of a week, totaling 6 videos and at different times like morning, afternoon, and evening. All the students in the videos belong to the age group 20–23 and are from different disciplines from the Ramaiah Institute of Technology. The video was recorded by placing the camera in front of the subjects during the lecture and was shot well enough to cover all of their faces to monitor their expressions throughout the lecture. For the content of the lecture, we taught various subjects including aptitude problems and some theoretical topics like the history of “C”. The recorded video is then used to extract the frames at an interval of 2 s, and using OpenFace, the features are extracted and converted to a Comma-separated values (CSV) file. The goal of this action is to extract the facial features while the student is watching the video and analyze the engagement level. Due to the COVID-19 pandemic, the process of learning was made completely online and it has become difficult to keep track of all the students. In this scenario, the data can be collected to monitor them and analyze their engagement.

The students were seated comfortably well within the field of view of the camera to capture all of their faces perfectly. The experiment was held once a day and continued for up to a week. The videos are recorded in 4 K clarity, at 30 fps. For training a supervised classifier, data labeling plays an important role. The ground truth is derived based on the Engaged and Not-engaged labels. The label is decided for each extracted frame. The frames were extracted at intervals of 2 s and each of those frames was labeled accordingly. When the duration of the interval is increased, there could be cases of both engaged and not engaged where the result could be ambiguous. This makes the process of decision-making difficult. A student may be identified and marked as engaged when their gaze and pose are toward the screen and distracted when their gaze is away from the screen.

The dataset gathered was analyzed, cleaned, and reduced before being sent for processing. Steps were taken to minimize noisy data and to handle failure cases. The original dataset consisted of 19,189 rows and 715 columns in the engaged label and 16,821 rows and 715 columns in the not engaged label. We have collected the features

Table 1 Shows the details of the transformation of the dataset

Rows x columns	Original dataset	Cleaned dataset	Selected dataset
Engaged	19,189 × 715	12,221 × 715	12,221 × 50
Not Engaged	16,821 × 715	9834 × 715	9834 × 50

having confidence less than 50 percent and removed the corresponding frames from the training set. After that, we have also removed the unwanted features from our training set, as part of data pre-processing. Now, on these training datasets, we have performed the feature selection using the ExtraTreeClassifier algorithm. It works by selecting the features which have a higher statistical correlation with the target attribute. After obtaining the scores corresponding to the features, we select the top 50 features from a total of 715 features. The resulting dataset consisted of 12,221 rows and 50 columns in the engaged label and 9834 rows and 50 columns in the not engaged label. The below table shows the details of the transformation of our dataset across the steps taken (Table 1).

4 Methodology

We now apply the class of Supervised Machine Learning algorithms to obtain the classifier model. The collected data from the set of students in the classroom is used as the testing dataset and it is tested using the classifier model. The classifier model then generates the degree of the engagement of that particular student, based on various aspects of the extracted facial features. Now, using this report, we further take up the score of the questionnaire, which is conducted at the end of the class. The time of the day, degree of student engagement (generated from the above step), and the score of the questionnaire provided to another classifier, which gives the overall engagement of the particular student. Based on the overall engagement, we finally classify the engagement score into 4 different levels, namely—Not Engaged, Partially Engaged, Engaged, and Fully Engaged, respectively (the score ranging from low to high). Figure 1 showcases the overall view of the process.

There are a few other characteristics like student interest in the topic being taught, student illness or wellness, teaching strategy, etc., which also affect student engagement. The addition of these features may lead to the improvement of the overall result of the proposed work. Another mainline improvement can be made by increasing the training dataset on a large scale which will result in better performance. As we have used an open-source software called OpenFace in the development of this model, the software can be altered according to the need of our work which can make the process simple and reliable.

We have collected and trained the model using the best quality data possible. The higher resolution of the captured videos will increase the performance of the

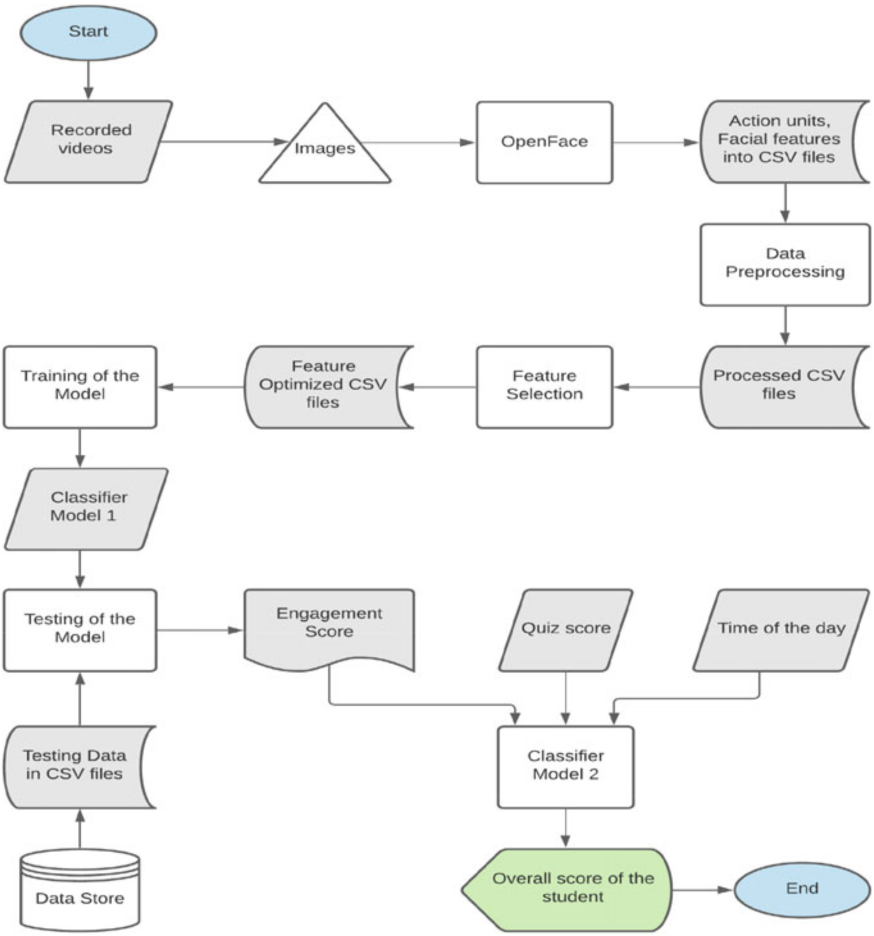


Fig. 1 Overall view of the process

model. We could also reduce the failure cases to the minimum possible count. The hypothetical questions that could arise in the future are:

- Can we improvise the performance and speed of the process while handling huge data?
- Can we include factors like student state of mind to estimate the engagement factor?
- Will we be able to categorize the students into top learners, average learners, and poor learners?

5 Implementation

This section emphasizes the details of the actual implementation of the classifier model in particular. The core part of the implementation comprises two classifiers that help in the evaluation of the processed data at various levels. So, we can classify them based on the level at which they perform the operations on the data.

- Classifier-1
- Classifier-2

The flow of data (i.e., the pre-processed data) takes place from Classifier-1 to Classifier-2.

5.1 Classifier-1

These classifiers are implemented using supervised machine learning algorithms. It plays a significant role in determining the engagement of the student by using facial features. These classifiers are trained on the top 50 features obtained by Extra-TreeClassifier which have the highest statistical correlation with the target attribute. The components involved are:

- **Pre-processed file:** This file is generated at the pre-processing step. It consists of characteristic features of various facial features under consideration.
- **Engagement Score:** This document contains information about the list of video frames, in which the student is engaged and not engaged, respectively.

5.2 Classifier-2

This takes the engagement score, time of the day, and quiz score as input and calculates the overall engagement of the student. The components involved are:

- **Quiz Score of student:** The quiz is taken at the end of the class. The questions are asked based on the topics covered in the lecture.
- **Time of the Day:** It takes 3 values—morning, afternoon, and evening, respectively.
- **Overall Score of student:** This is the final engagement score estimated, considering all the parameters.

6 Results and Analysis

6.1 Decision Tree

Figure 2 shows the Learning Curve of the Decision Tree, in which the cross-validation score is increasing as we increase the number of training examples.

Figure 3 shows the scalability of the model, in which we see the fitting time for the model is proportional to the size of training examples.

Figure 4 shows the performance of the model, in which we observe that the cross-validation score increases as a function of fitting time (measured in seconds).

Fig. 2 Learning curve for Decision tree

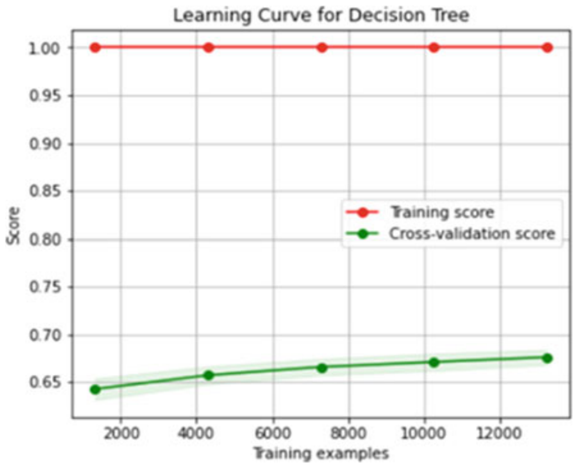
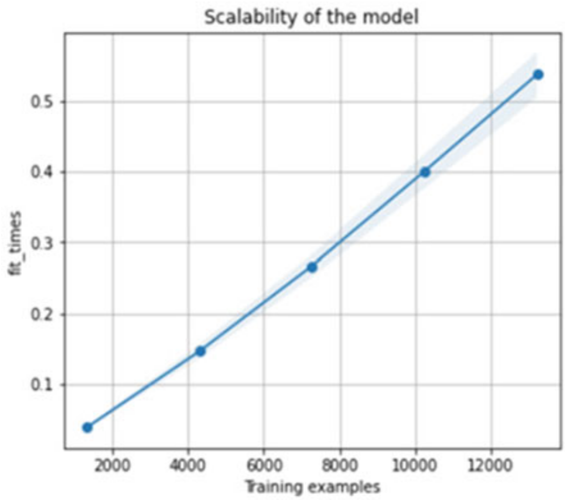


Fig. 3 Scalability graph of Decision Tree



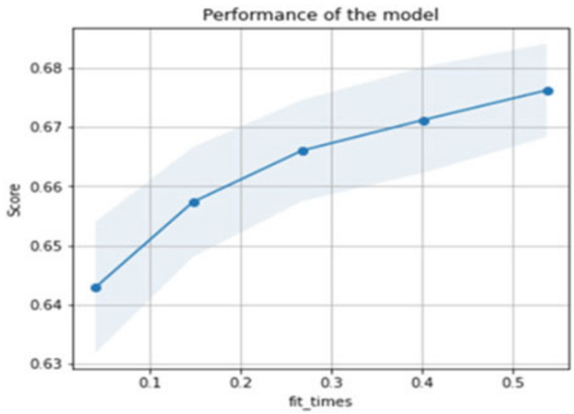


Fig. 4 Performance graph of decision Tree

6.2 Logistic Regression

Figure 5 shows the Learning Curve of Logistic Regression, in which the cross-validation score is increasing as we increase the number of training examples.

Figure 6 shows the scalability of the model, in which we see the fitting time for the model is proportional to the size of training examples.

Figure 7 shows the performance of the model, in which we observe that the cross-validation score increases as a function of fitting time (measured in seconds).

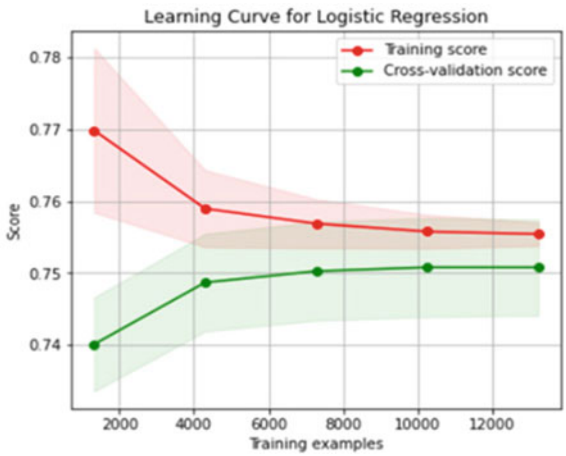


Fig. 5 Learning curve of logistic regression

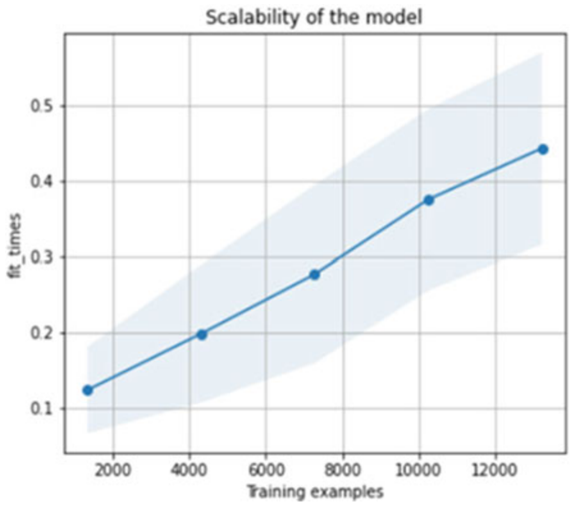


Fig. 6 Scalability of logistic regression

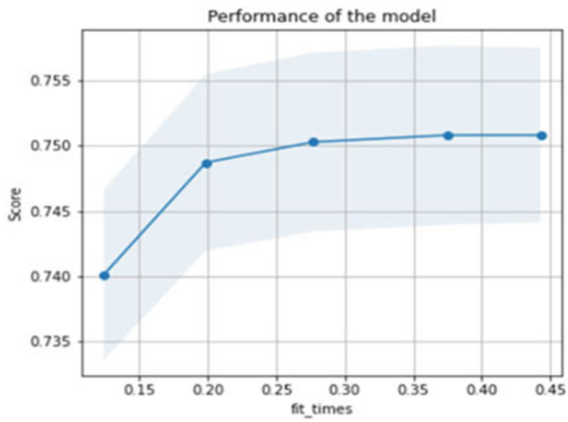


Fig. 7 Performance of logistic regression

6.3 *Random Forest Classifier*

Figure 8 shows the Learning Curve of Random Forest Classifier, in which the cross-validation score is increasing as we increase the number of training examples.

Figure 9 shows the scalability of the model, in which we see the fitting time for the model is proportional to the size of training examples.

Figure 10 shows the performance of the model, in which we observe that the cross-validation score increases as a function of fitting time (measured in seconds).

From Table 2, it is clear that the Random Forest classifier has higher accuracy and better F1 score, precision, and recall.

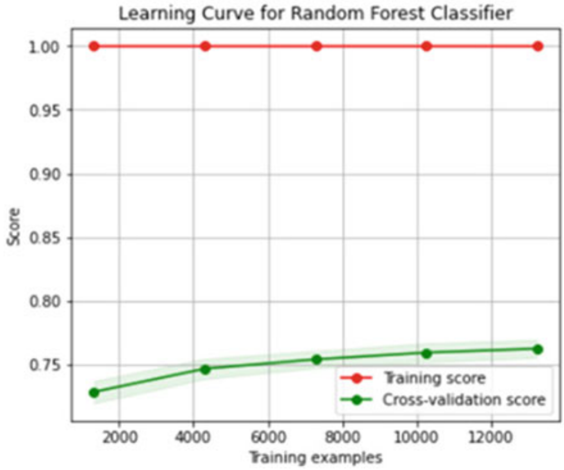


Fig. 8 Learning curve of random forest

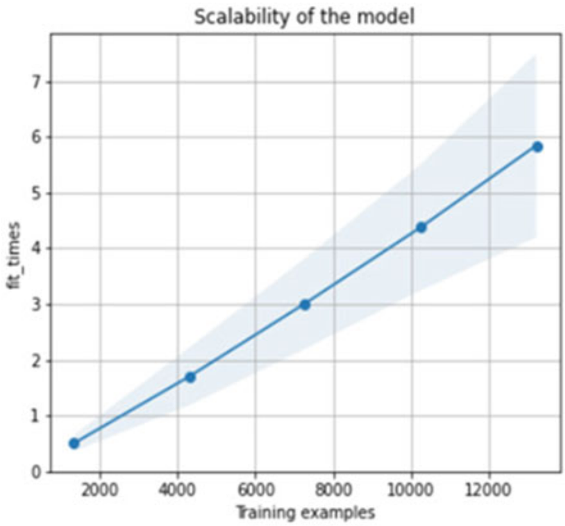


Fig. 9 Scalability of random forest

6.4 Results

The following section describes the engagement score generated by the classifiers.

At the end, the overall engagement score obtained is classified into the following four levels:

- [0,25]—Not Engaged
- (25,50]—Partially Engaged
- (50,75]—Engaged
- (75,100]—Fully Engaged

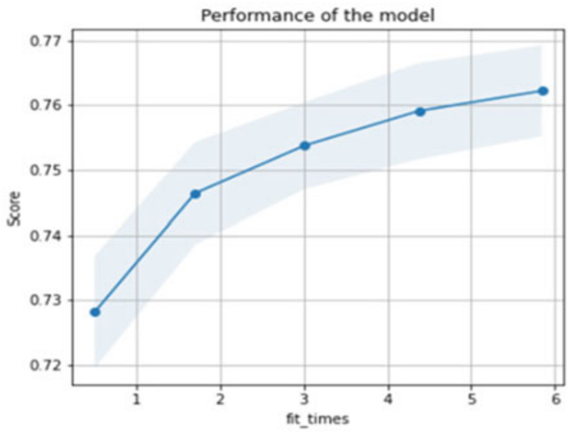


Fig. 10 Performance random forest

Table 2 shows the comparison of the accuracy metrics of 3 Classifiers

Classifier model	Precision	Recall	F1 Score	Accuracy
Decision tree	0.69	0.69	0.69	0.69
Logistic regression	0.76	0.75	0.75	0.76
Random forest	0.76	0.76	0.76	0.76

6.5 Failure Cases

An important aspect that needs to be taken care of is to figure out the cases where the classifier fails. While recording the lecture, there is a possibility of obtaining frames in which the students' faces might not be completely visible because of various reasons. We have solved the problem by utilizing the confidence attribute and making sure that those frames with confidence less than 50% are removed during the data pre-processing. Despite the above problem being handled well in many cases, it can still occasionally cause problems, as sometimes there is a possibility to cross the confidence threshold of 50% by a small margin. Although there is an error involved, this occurs very rarely.

7 Conclusion

Assessing Student Engagement in a classroom environment will lead to massive improvements in the teaching–learning process. The proposed model predicts the engagement of a student in the classroom environment into four categories. This model uses psychological factors and facial features to determine the engagement. With this, we can further improve techniques of "Research-Based Teaching" to help the teacher understand the classroom behavior. The main focus of the research was to accurately monitor the behavioral and cognitive engagement of a student and the results obtained were quite good. This model gives about 76% in terms of accuracy and F1 score, respectively. This model can be further improved by increasing the sample size of the data and by utilizing psychological factors which have a higher correlation toward engagement.

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Performance Enhancement of Motor Imagery EEG Signals Using Feature Extraction and Classification with Time Domain Statistical Parameters of Brain–Computer Interface

P. S. Thanigaivelu, S. S. Sridhar, and S. Fouziya Sulthana

Abstract According to a current evolving real paradigm in neuroscience innovation, humans may use brain impulses to interact with, effect, or transform their environment. People may use the growing brain–computer interface (BCI) technology to control, communicate, and monitor their objects by utilizing or interacting with assistive devices. BCI technology will surely rely on improved signal capture and clear validation of actual research and delivery models in the future, which will be connected to the dependability issue. For the BCI system to work better, an appropriate signal processing approach must be used that makes it easier to collect physiological data and a higher classifier suitable for the specificity of the system. We offer a concise overview of several signal processing strategies for improving BCI focus. A supervised classification method is utilized to improve the support vector machine in order to recognize and categorize EEG data. The EEG data's temporal domain properties are retrieved and input as feature vectors into the SVM, which are subsequently utilized for classification and identification. The algorithm's exploration capabilities and convergence time have both improved, as shown by statistical analysis of the data. The SVM parameters are then optimized using this information. The approaches for feature extraction and classification are covered in this study. This outcome represents a 2–5% improvement over the previous technique. EEG (Electroencephalography) is a complex bio-electrical signal. Researchers may uncover useful physiological information if they do a thorough examination of this data. The challenges that BCI data processing designers face are discussed here, along with some drawings of possible existing and prospective solutions. We create ways to extract and identify specific traits from the standpoint of BCI systems, and we conclude with a thorough conclusion and interpretation.

P. S. Thanigaivelu (✉) · S. S. Sridhar · S. Fouziya Sulthana
SRMIST, Kattankulathur, Chennai 603 203, Tamilnadu, India
e-mail: tp4069@srmist.edu.in

S. S. Sridhar
e-mail: sridhars@srmist.edu.in

S. Fouziya Sulthana
e-mail: fouziyas@srmist.edu.in

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Acronyms

SVM	Support Vector Machine
EEG	Electroencephalography
BCI	Brain-Computer Interface
ML	Machine Learning
SP	Signal Processing
ECoG	Electrocorticography
MEG	Magnetoencephalography
fMRI	functional magnetic resonance imaging
fNIR	functional near-infrared imaging
ERPs	Event-related potentials
In	Inion
Ns	Nasion
Ref	Reference
Gnd	Ground
DWT	Discrete Wavelet Transform
PSD	Power Spectral Density
RMS	Root Mean Square
STFT	Short Time Fourier Transform
ASP	Asymmetric Spatial Pattern
SSA	Stationary Subspace Analysis
CSP	Common Spatial Patterns
ANN	Artificial Neural Network
k-NN	k-Nearest Neighbor
PCA	Principal Component Analysis
AR	Auto regressive Model
ICA	Independent Component Analysis
CMRR	common-mode rejection ratio
SNR	signal-to-noise ratio

1 Introduction

The BCI receives, analyzes, and translates brain signals into instructions that are sent from a computer-based system to an external device and then used to perform the required action. BCIs (Brain-Computer Interfaces) are becoming more popular. Any kind of EEG input might possibly be used to monitor the BCI device. Brain activity, as measured by electrodes placed on a person's scalp or on the surface of their cerebral cortex, has received a lot of attention recently. Electrical impulses are considerably disrupted during their passage via the skull, scalp, and Dura in scalp recordings, which is the most significant drawback. As a result, important data may be lost. The brain signal tracking methods for monitoring brain and device

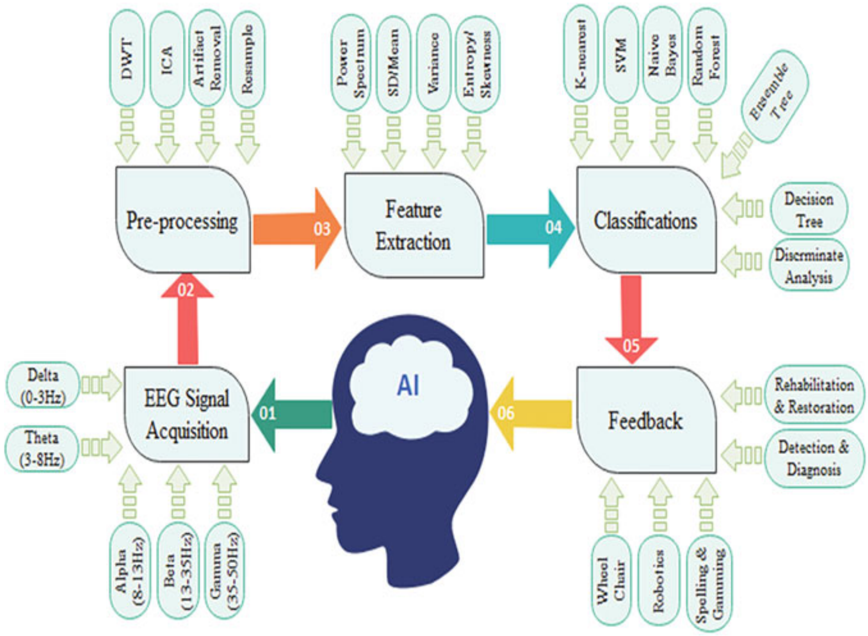

Fig. 1 Block diagram of BCI

interface devices include electrical and magnetic signals such as electrode clusters within Intracortical, Electroencephalography (EEG), Electrocorticography (ECG), and Magnetoencephalography (MEG), as well as metabolic signals such as functional magnetic resonance imaging (fMRI) and functional near-infrared imaging (fNIR). The BCI framework consists of four sequential components: (1) signal acquisition, (2) extraction of features, (3) localization of- features, and (4) performance of devices (Fig. 1).

1.1 Utilization of Signals

The analysis of brain signals is the basic method of perception from the acquisition of signals. In order to eliminate electrical noise or other unnecessary signal disturbance, the signals are amplified to thresholds sufficient for computer transmission and subject to filtering. Then it digitizes and transfers the signals to a device.

1.2 Feature Extraction

Feature extraction is a technique for separating and representing certain signal characteristics from relevant data in a compact manner that may be translated into output instructions. Time-triggered EEG reaction attenuation and response duration's, strength within distinct EEG bandwidths, and activating frequencies of particular cerebral mantle activation frequencies are the most frequently derived signal characteristics in contemporary BCI systems. To guarantee accurate analysis of brain signal characteristics, environmental artifacts, and anatomical objects such as electrical activity generated by skeletal muscle signals are removed or disregarded.

1.3 Interpretation of Features

The signal patterns were then supplied to the conversion algorithm in the function, which transformed the characteristics into directives for the output device. The conversion algorithm should be flexible enough to ensure that the user's reasonable selection of function values covers the entire range of device control, allowing it to support and respond to unexpected or encountered changes in signal features.

1.4 Device Output

The function's translation algorithm, which includes modules such as robotic arm operation, letter selection, cursor movement, wheelchair operation, and so on, controls the external device. When the user receives feedback as a result of the system's implementation, the control loop is broken. When the BCI could be used to monitor and control the operations of the output device, the user interface was deemed to be good. Simultaneously, this bright future can only be achieved if BCI scientists and engineers keep a close eye on and handle issues in three key areas: signal gathering hardware, BCI measurement and dissemination, and reliability. The objective of achieving exceptional results will prove to be the most difficult scenario in all situations.

2 Brain Signals and Features

Two criteria are required for the effective development of contemporary communication medium–straight from the brain to the processing system. The usage of an appropriate sensor that can correctly compute brain signal characteristics that may communicate the consumer's intent is the first need. When it comes to a uni-

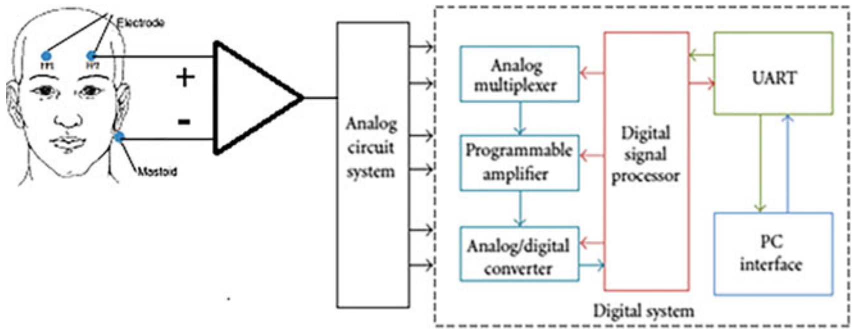

Fig. 2 Internal function of the BCI device

versal language, the second prerequisite is to create and implement a set of brain signal properties (e.g., period or wavelength measurements at specified regions) that may be used to communicate with the machine. The lexicon of BCI correspondence cannot be completely random for different reasons. Furthermore, the brain will be physiologically incapable of producing the language's objects. In spite of the fact that the brain is capable of constructing these things, it may not be able to utilize them to communicate meaning. Furthermore, there is no scientific foundation for referring to BCI communication in terms of brain signals. Furthermore, practical issues including risk, profit, and cost would inevitably impact any therapeutically effective BCI. Because of these limitations, it's uncertain whether brain stimulation and sensor technology (EEG, ECoG, or extremely linear recordings) would be most beneficial. Simultaneously, scientific evidence may provide light on which brain impulses should be used for BCI communication. Deep learning is a subset of machine learning (Fig. 2).

Event-related potentials (ERPs) may be advantageous for BCI processing in contrast to the brain responses generated by motor activity or sensory processing. A P300 is normally triggered when four objectives are fulfilled. Following that, a sequence of conventional stimulus events must be shown. Second, a classification rule must be used, which splits the pattern of activity into multiple categories. Finally, it is the patient's obligation to take advantage of the law. Fourth, a new set of activities should be offered every now and again. In a number of research utilizing empirical techniques that encompass these four criteria, the capacity of P300 is often used as a core notion for the BCI approach. This section provides information about the fundamental ideas of brain signal processing and many sorts of signal objects seen after detailing the most-often utilized brain waves for BCI activity. Various properties of metal electrodes inserted on the scalp (EEG) or on the cerebral cortex are used to detect brain signals (ECoG). Electrical impulse potentials in the hippocampus, which are a reflection of neuron activity, are detected with this kind of electrode. These signals must first be amplified to see their tiny amplitude.

Any biosignal amplifier searches for voltage differences (variations) between reference electrodes. The second electrode in most BCI systems is the same, resulting in “unitary” rather than “bipolar” readings. Data from both electrodes is usually combined and applied to a single “reference” electrode (Ref). The amplifiers need the addition of a “ground” electrode, often referred to as Gnd, in order to improve signal efficiency. The 10–20 global approach is the most used naming and placement strategy for EEG applications. Using an iterative subdivision of the scalp arc, it is developed from Inion (In), Nasion (Ns), and Right and Left Pre-Auricular locations on the skull (PAL and PAR, respectively). The intersection of the lateral (PAL-PAR) and longitudinal (Ns-In) diagonals forms the vertex. A total of 19 electrodes were used in the 10–20 system at one time. As a result, the standard has been expanded to include over 70 electrodes. T7, P7, T8, and P8 were the original names for the T3, T5, T4, and T6 electrodes in this improved version. On occasion, a reference electrode is put on one of the electrodes in these locations. More often, the lobe of the ear, or mastoid (the projection of the bone behind the ear), is employed. Researchers have usually seen five kinds of electrical rhythms or brain functions throughout the cortex at the same time. Delta (0–4 Hz), theta (4–7 Hz), alpha (8–13 Hz), beta (13–30 Hz), and gamma (13–30 Hz) are the waves in sequence from lowest to the highest frequency (30–63 Hz). These waves work together to execute mental tasks accurately and thoroughly [1]. Each brain functions, on the other hand, has a distinct function. While doing a certain activity, a distinct brain wave will be prominent at any one moment, and this will depend on the person’s current state of awareness.

The following is a detailed description of each beneficial brain wave: (i) Delta waves are associated with the deepest phases of pleasure as well as medical relaxation and sleep restoration. (ii) Sleep and daydreaming are associated with theta waves. They are linked to us because they are aware of and experience strong, basic emotions. (iii) Alpha waves provide a “frequency bridge” between our conscious (beta) and intuitive (theta) minds. They have a reputation for assisting us in slowing down and bringing emotions of better ease and contentment. (iv)Beta waves are low-amplitude, and slightly elevated brain waves that are frequently found in dreams. When a person is thinking, listening, reading, estimating, or pondering about anything, they generate them. (v) Gamma waves are necessary for learning, information processing, and memory. Gamma waves are a subject that researchers are continuously striving to learn more about. They investigated the link between contemplation and gamma waves.

An acquisition of EEG data, noise reduction and subband separation, feature collection, and classification are all part of the suggested solution. The EEG signals, on the other hand, additionally contain vibrations. An unfavorable signal has polluted the attraction signal. To obtain valuable information from raw signals, the noise must be eliminated. The amplification and filtering of raw data is the initial stage in studying EEG signals. The EEG signal is non-stationary, and the multi-resolution DWT decomposition method is frequently used to remove noise from non-stationary signals. The extraction of features is a technique for exposing the input signal’s hidden characteristics. To put it another way, a collection of characteristics might be considered an input signal. In addition, the initial input signal represents a single behavior or pattern in this function set. The variance of the unit and the average value of each signal are calculated. Each machine learning algorithm has certain goal functions associated with it. Because the range of raw data values varies more than normal, these objective functions sometimes cannot operate effectively without optimization. A lot of classifiers use the Euclidean distance between points as a way to figure out which ones belong to each other. If one of the traits or attributes has a probability distribution, the distance will be estimate during that feature. As a result, the bandwidths of all characteristics may be normalized such that each contributed significantly about proportionally to the ultimate distance. The resulting characteristics are often subjected to normalization.

A bandpass filter was used to eliminate EEG data in each of the frequency bands for each of the EEG segments. Second-order Butterworth filters were chosen because they have significant transition band features at low coefficient orders, making them useful. PSD was used to extract frequency domain characteristics from a time-series signal. PSD is defined as the Fourier transformation of the time series' autocorrelation sequence in this study. The x(t) input signals and Fourier transform X(f) is defined as

$$X(f) = \int_{-\infty}^{+\infty} x(t)e^{-j2\pi ft}dt; -\infty < f > +\infty, \tag{1}$$

where X(f) represents the signal information, and x(t) is the inverse of X(f):

$$x(t) = \int_{-\infty}^{+\infty} X(f)e^{j2\pi ft}dt; -\infty < f > +\infty \ . \tag{2}$$

Peak Frequency, which indicates the frequency of the PSD's greatest Peak, has been shown to have a strong discriminating capacity in many tests, is one of the features that has been found to have strong discriminatory power. "The frequency at which something occurs once in a while," according to the official definition of "peak frequency".

$$f_{max} = arg(\frac{f_s}{N} max_{i=0}^{N-1} P(i)) \ . \tag{3}$$

The number of samples is denoted by N, whereas the frequency of the sample is represented by fs. The median frequency, on the other hand, is a valuable function in EEG analysis since it is used to assess the signal's average frequency. The median frequency should be reported as

$$f_{med} = i_m \frac{f_s}{N} \ , \tag{4}$$

$$\sum_{i=0}^{i=i_m} P(i) = \sum_{i=i_m}^{i=N-1} P(i) \ . \tag{5}$$

The median pattern is the place on the frequency power spectrum where the sum of the dots on either side is equal. In this work, RMS is also used to evaluate signal strength for EEG frequency bands. It must be described as and include a measurement of the changing quantity's size.

$$RMS = \sqrt{\frac{1}{N}\sum_{i=0}^{N-1} x(i)^2}\ . \tag{6}$$

If the root of the mean of the squares for all samples in the signal can be calculated, then the signal described by the time series X(i) can be identified. Sample entropy may be used to assess the signal's complexity, which is recognized to be a significant function. In other words, the sample entropy quantifies the EEG signal's variation. It has the following definition:

$$SampEnp = \sum_{i=1}^{N}(X_i * log(X_i^2))\ , \tag{7}$$

where N is the time series' length and Xi is the EEG signal's sample ith. Signal energy is another essential factor to consider when estimating EEG signal strength in different frequency bands. This is defined as the total of the samples' squared magnitudes:

$$E = \sum_{k=1}^{N} x_k^2\ . \tag{8}$$

Skewness and kurtosis are useful for providing information about the distribution of the time series' amplitude. In other words, it refers to the distribution's shape. Skewness is a term that has been used to denote

$$s = \frac{E(X-\mu)^3}{(\sigma)^3}\ , \tag{9}$$

where (x) is the expected value of some variable x, σ is the standard deviation, and μ the mean of the signal. Kurtosis is classified as

$$k = \frac{E(X-\mu)^4}{(\sigma)^4}\ . \tag{10}$$

The technique below may be used to determine the mean correlation coefficient, it analyzes how strong a correlation between the two variable is

$$\Gamma_{xy} = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sum(x-\bar{x})^2(y-\bar{y})^2}\ . \tag{11}$$

Another area of research would be the evaluation of different parameter modification settings. Advanced artificial neural network designs, as well as more complex classification techniques and methodologies, will be explored. Future research will focus on continuous long-term EEG recordings for one person over several hours (rather than 60 s chunks). This will include identifying different types of seizure activity and determining how well classifiers can distinguish between them. Vapnik and Cortes created the Support Vector Machine to address a two-group classification problem. EEG signal classification, cancer detection, bioinformatics, seizure prediction, facial recognition, and speech difficulties are just a few of the uses for SVM. The Support Machine is often used to discriminate between normal and epileptic activity in continuous EEG recordings. Both seizure and non-seizure behavior yield feature vectors. The RBF kernel function may be used as a classifier to produce optimum decision boundaries. Extracted features may be generated using empirical mode transformation, which splits the Brain signals into magnitude and phase-modulated elements. The component's size and average probability are calculated and sent into the SVM as input. To categorize seizure and non-seizure behavior, a least-square classification algorithm with a radial basis kernel function might be used. The Discrete Wavelet Transform may be used to divide EEG data into different frequency bands. SVM can be trained to categorize seizure and non-seizure activity using features like entropy, energy, and standard deviation. Many mental activities, such as thinking to move one's left or right hand, execute mathematical operations, and think to a music, may be classified using Support Vector Machine classification. Features are extracted from preprocessed signals using the Power Spectrum method, which is subsequently utilized as SVM training data. For testing reasons, a single channel might be used to classify. During the feature selection phase, SVM is also taken into consideration. SVM with Gaussian Kernel is used to pick neonatal features. The SVM classifier extracts several characteristics, such as mean and standard deviation. Training data determines the optimal hyperplane for new-born data. With the right testing and training, EEG signals might be utilized to identify brain tumors. Adaptive filtering is used to eliminate EEG signal artifacts, and spectral techniques are used to identify distinct spectral bands of frequencies. These features are given into the SVM classifier to categorize tumors. Emotion detection from EEG waves may be classified using SVM. EEG signal categorization has traditionally relied on time-domain characteristics as a reliable indication. After time-domain analysis has preprocessed the data, two time-domain characteristics, Root Mean Square (RMS) and Integral EEG (IEEG), are retrieved as eigenvalues using the methods below

$$IEEG = \frac{1}{N}\sum_{i=1}^{N}|X_i| \,, \tag{12}$$

$$RMS = \sqrt{\frac{\sum_{i=1}^{N} X_i^2}{N-1}} \,. \tag{13}$$

C3, C4, and Cz channels are used to collect EEG signals. After feature extraction, each sample is merged into a six-dimensional vector called a feature vector. By improving SVM parameters, the modified squirrel approach is employed to improve classification accuracy. To eliminate exceptions in the results, we run the program five times to compare the final classification accuracy under various optimization strategies.

Various authors employ different feature extraction and classification strategies. Ahmadi et al. [2] proposed a low-cost categorization strategy based on temporal and frequency domain data. The Short Time Fourier Transform (STFT) and Wavelet transform are used to extract features after preprocessing and filtering. Huang et al. [3], who devised a feature extraction approach, addressed the problem of EEG-based emotion identification. Asymmetric Spatial Pattern (ASP) is a method for obtaining a pair of spatial filters, one for each of the two sources. They used real-world data to demonstrate that the proposed technique works for two sorts of EEG-based emotion identification issues: valence recognition (positive vs negative) and arousal detection (strong vs. calm). Using high-dimensional EEG data, Von Bünau et al. [4] the fundamental stationary and non-stationary brain resources were discovered using Stationary Subspace Analysis (SSA), and a time series analysis approach. With the help of CSP, they were able to tell the difference between the movement patterns of their left and right hands with 70% of the time. Sannelli et al. [5] recommended co-adaptive calibration is improved using the Common Spatial Patterns Patches (CSPP) approach. CSPP is a series of localized spatial filters that have been fine-tuned using CSP analysis on phenomenon data. Fan et al. [6] proposed a system for monitoring drivers' states using EEG to identify pedestrian unexpected occurrences as an example of emergency situations. To recognize an emergency scenario, the LDA classifier was used using EEG potentials as input data, and its threshold was calculated using the power spectrum of EEG potentials (ROC). The outcomes of three healthy people's trials showed that the detection model can identify an emergency scenario with 70% accuracy in one second (shorter than a driver's response time), indicating that emergency situations may be recognized to monitor the driver's emotional condition using EEG. Aggarwal et al. [7], presented on EEG-based BCI for motor imaging tasks, which included a detailed review of key feature extraction approaches. Islam et al. articles [8] EEG datasets are created by imagining different vibrations in various directions while keeping one eye open. To identify this EEG data, several feature extraction methods such as k-Nearest Neighbor (k-NN), Artificial Neural Network (ANN) were applied and Support Vector Machine (SVM). Rajya Lakshmi et al. [9] described it at each level of the brain–computer interface, data processing techniques such as Principal Component Analysis (PCA), Auto Regressive Model (AR), Wavelet Transform (WT), Wavelet Packet Decomposition (WPD), and Independent Component Analysis (ICA), were investigated. In their study report, VaciusJusas et al. [10], researchers looked at Fast Fourier Transform, channel variance, band power, and time-domain features. Murugappan et al. [11] Hjorth mobility statistics such as minimum and maximum values, means, and SD are used to determine alertness or drowsiness Shoeibi et al. [12] proposed a spectrogram-based approach for extracting characteristics from EEG data. STFT was first used for EEG in order to get time-frequency representations. We must utilize several feature extraction algorithms since the spectrum of EEG signals fluctuates throughout time, making them non-stationary as shown by Manjula et al. [13]. Kanoga et al. [14] proposed a key issue in the field of EEG signal processing research is to investigate an eye blink artifact elimination technique from single-channel electroencephalographic (EEG) recordings. To explore the characteristic of EEG features more thoroughly, high removal performance is still required. Even yet, failing to allow for environmental behavior limits may result in technological/scientific artifacts that are commonly jumbled with EEG data and make signal processing challenging in a variety of ways by successfully masking as EEG characteristics.

3 Result and Discussion

These EEG data sets were gathered from a group of healthy individuals. A separate data file was created for each person who participated in many sessions over a period of time. These are some of the two or three motor imaging tasks in the emotion-based BCI paradigm visualizing the movement of the right hand (RH), left hand (LH), and both feet (F). The EEG waves were band-passed at a sampling frequency of 256Hz between 2Hz and 40Hz, with a notch filter at 50Hz, and a bandpass filter between 0.1Hz and 100Hz at 250Hz. Volts (V) are the units of measurement for the signals. All of the statistical models are stored on the MATLAB format (*.mat) platform. Regarding this discrepancy, the results of our trials were not significantly worse than those reported in earlier investigations utilizing multi- or single-channel approaches. The findings suggest that collecting more data, even if it contains information tangential to the potential noises, might be beneficial (Figs. 3, 4, 5 and Tables 1, 2).

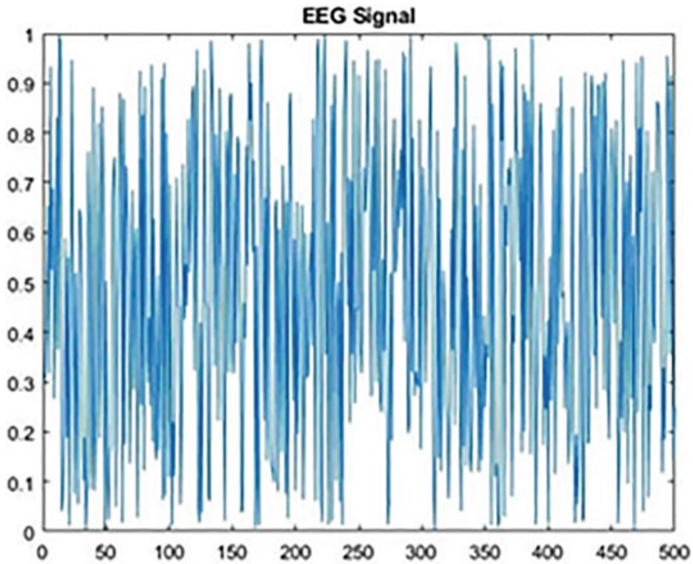

Fig. 3 Input raw EEG data

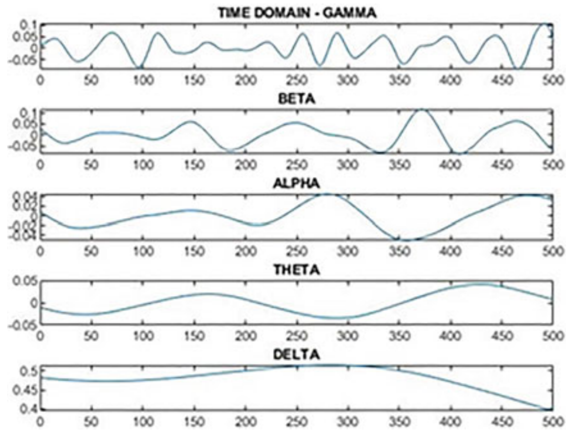

Fig. 4 Classifications of different EEG signals

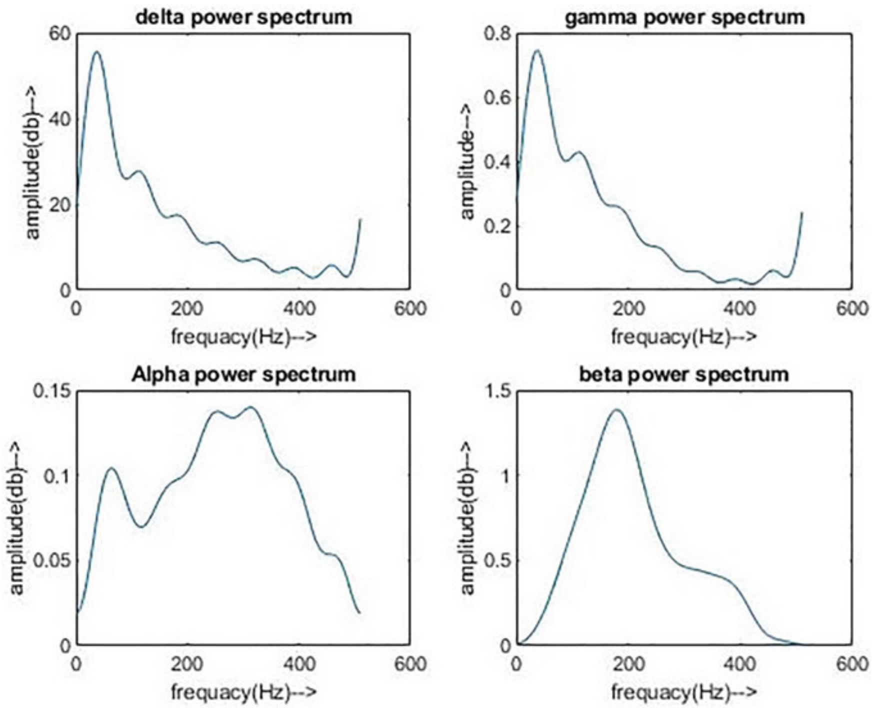

Fig. 5 Power spectrum of each EEG signals

Table 1 Analysis of different feature selection methods for each EEG signals

Feature selection algorithm	Alpha	Beta	Delta	Gamma
Ration of band Power	0.3582	0.0009	1.1249	1.5135
Band power	2.6058e-07	1.2087e-06	0.0722	5.2835e-07
Hjorth activity	0.0254	0.454	0.0093	0.0418
Hjorth mobility	6.5419e-04	0.0020	8.5795e-04	0.0017
Hjorth complexity	−9.9168e-04	1.7974e-04	0.4824	0.0027
Skewness	0.0722	0.1787	−1.1097	−0.0560
Kurtosis	2.2912	2.6701	3.7844	2.4993
First difference	7.3081e-04	0.0026	3.4502e-04	0.0047
Normalized first difference	0.0286	0.0576	0.0118	0.1119
Second difference	0.0015	0.0052	6.8932e-04	0.0093
Normalized second difference	0.0571	0.1151	0.0235	0.2227
Mean curve length	7.2934e-04	0.0026	3.4433e-04	0.0047
Mean energy	6.5291e-04	0.0020	0.2321	0.0017
Mean teager energy	1.5424e-06	2.0598e-05	7.5186e-07	6.7055e-05
Log root sum of Sequential variation	−1.7122	−1.1382	−2.0154	−0.8891
Tsallis entropy	0.9954	0.9947	0.9980	0.9950
Shannon entropy	8.0651	7.9674	8.9554	8.0626
Log energy entropy	−4.2941e+03	−3.7734e+03	−734.0927	−3.7180e+03
Renyi entropy	7.7709	7.5474	8.9461	7.6493
Arithmetic mean	−1.8050e-04	1.7470e-04	0.4809	0.0021
Standard deviation	0.0256	0.0450	0.0293	0.0418
Variance	6.5419e-04	0.0020	8.5795e-04	0.0017
Median value	9.9168e-04	1.7974e-04	0.4824	0.0027
Auto-regressive model	−3.6947 5.1019 −3.1193 0.7121	−3.6158 4.8981 −2.9462 0.6641	−3.8548 5.5646 −3.5649 0.8551	−3.4741 4.5703 −2.7041 0.6100
Maximum value	0.0458	0.1168	0.5153	0.1076
Minimum value	−0.0507	−0.0870	0.3941	−0.0929
Average power spectrum	0.1818	1.0402	31.8632	0.4308

Table 2 Analysis of different classification methods for each EEG signals

Classification algorithms	Parameter settings		Parameter settings		Parameter settings	
	opts.tf = 2;		opts.tf = 1;		opts.tf = 3;	
	opts.kfold = 10;		opts.ho = 0.3;		opts.fun = 'r';	
	opts.k = 5;		opts.nSplit = 50;			
	Accuracy (%)	PT (s)	Accuracy (%)	PT (s)	Accuracy (%)	PT (s)
K-nearest neighbor	97.4	2.45	96.66	0.10	97.2	3.29
Multi-class SVM	97.6	2.15	98.66	0.12	98.2	38.26
Decision Tree	96.2	0.35	95.33	0.02	98.2	38.26
Discriminate						
Analysis classifier	83	1.39	–	–	–	–
Naive bayes	82.6	1.15	20	0.18	0	44.03
Random forest	98.2	2.27	97.33	0.10	97.8	46.92
Ensemble tree	97.4	6.55	98	0.59	97.8	251.84

4 Conclusion

Given that EEG signals from the brain are often quite tiny, it is critical when constructing an EEG preamplifier that it has a high common-mode rejection ratio (CMRR) and signal-to-noise ratio (SNR). This means that noise interference should be kept to a minimum while waveform distortion, offset, and other issues should be avoided. Simultaneously, the digital technique is used to give an inherently amplification and filtering characteristics for various EEG frequency bands. In order to use MATLAB to show brainwaves, the frequency band from the analogue circuit must be filtered via the filtering circuit and then converted to the proper frequency band using the digital filter design. Finally, the classification accuracy of this approach is 98.66%. When the results of combining SVM with other optimization approaches are compared, the strategy excels and outperforms the others. When compared to the findings of previous studies utilizing the same data set, the classification accuracy attained in this study is likewise highly competitive. As illustrated in the tables and figures of result data, SVM surpasses a variety of regularly used optimization strategies. We want to use this model for multi-classification signal identification in the future. Signal pretreatment has a considerable influence on classification outcomes, according to the data. This paper's signal processing approach is lacking since it focuses only on the classification model's performance. We'll concentrate on feature extraction and feature selection in the upcoming investigation. Simultaneously, the model created in this work is linked to further improve classification accuracy. We'll look into additional topics in order to expand the index. In the near future, scientists will concentrate on multimodality-based BCI for physiological signals such as EEG, body temperature, galvanic skin response, a respiration rate, and blood pressure.

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Performance Stagnation of Meteorological Data of Kashmir

Sameer Kaul, Majid Zaman, Sheikh Amir Fayaz, and Muheet Ahmed Butt

Abstract Rainfall prediction is the highest research priority in flood-prone areas across the world. This work assesses the abilities of the Decision Tree (DT), Distributed Decision Tree (DDT), Naïve Bayes (NB), Random Forest (RF), Support Vector Machine (SVM), K Nearest Neighbour (KNN), and Fuzzy Logic Decision Tree (FDTs) machine learning algorithms for the rainfall prediction across the Kashmir province of the Union Territory of Jammu & Kashmir. On application of Machine learning algorithms on geographical datasets gave performance accuracy varying from (78.61–81.53)%. Further again machine learning algorithms were reapplied on the dataset without season variable yet again performance ranged in between (77.5–81)%. Vigorous analysis has established that these machine learning models are robust and our study has established that the dataset reaches performance stagnation and thus resulting in performance capping. The stagnation is irrespective of the choice of algorithm and the performance shall not improvise beyond a specific value irrespective of the choice of the machine learning algorithm.

Keywords Decision tree · Geographical data · Random forest · Naïve Bayes · Distribute decision tree

1 Introduction

Climate projections suggest that impacts are likely to be varied and heterogeneous in India. Some regions will experience more intense rainfall and flood risks, while others will encounter sparser rainfall and droughts including a spatial shift in the pattern of rainfall. Different machine learning (ML) techniques are used for the accurate prediction based on historical and geographical data. For this, we can use

S. Kaul · S. A. Fayaz · M. A. Butt
Department of Computer Sciences, University of Kashmir, Srinagar, India

M. Zaman (✉)
Directorate of IT & SS, University of Kashmir, Srinagar, India
e-mail: zamanmajid@gmail.com

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many regression and classification techniques to check the overall accuracy and performance. Since a lot of work has been done in weather forecasting and different machine learning techniques produce different accuracies, so it is vital to choose the best algorithm that produces good accuracy and performance and model it as per the requirements [1].

1.1 Decision Trees (DT)

In the late 1970's J. Ross Quinlan developed a decision tree algorithm known as ID3, he later developed a successor of ID3 known as C4.5, and this continues to be the benchmark algorithm till date. In the mid-1980's Classification and Regression Tree (CART) algorithm was proposed by L. Breiman and others, CART describes the generation of a binary tree. ID3, C4.5 and CART construct decision trees using the recursive divide and conquer method. The implementation of a decision tree requires a training dataset (tuples with labels), which is recursively partitioned into smaller subsets till no further partitions are required or are possible.

A decision tree is a tree like structure, which has the root node, internal node(s), branch(s) and leaf node(s). The top most node is the root node and it is also the starting point of the decision tree, while an internal node represents a test/condition on the given attribute; each branch coming out of the node represents a possible outcome of the test/condition while as leaf node is the final outcome and holds the class label [1, 2].

The creation of a decision tree classifier is void of any dominion knowledge understanding, and thus are suitable for empirical knowledge discovery. A decision tree can be implemented on multidimensional data. Decision trees are easy to understand and implement and their representation is natural to human understanding. The decision tree is supervised learning and has learning and classification steps which are simple to implement and exhibit fast performance. The accuracy of the classifier is data specific and thus varies from model to model however in general decision tree classifiers have shown good accuracy. Attribute selection measures are central to the design and implementation of a decision tree; attribute selection is the process of selecting attributes that best partitions the data into distinct classes [3, 4]. The resultant decision tree may have branches that reflect noise or outliers in the training data set. The methodology of identifying and removing such branches is known as pruning, the purpose of such removal/s is an improvisation of accuracy [5, 6].

1.2 Random Forest (RF)

Random forest is considered as the most popular supervised machine learning algorithm which is capable of implementing both classification and regression tasks. It is an ensemble method that is used to train the different decision trees in a parallel manner with bootstrapping which is followed by aggregation. This process is called as Bagging in which a number of different decision trees are trained in different subsets and for the final decision it aggregates the individual decisions from the different individual decision trees and consequently, it shows good generalization.

The major advantage of using random forests over the decision tree approach is that it can handle the missing values and maintains the accuracy for missing data. It also handles the large set of data with higher dimensionalities without over-fitting the model. i.e. it inclines to outrange most of the other classification methods with respect to the accuracy without over-fitting [7, 8].

Furthermore, there are various other machine learning techniques, which are used for the prediction purposes including model trees, KNN [9], SVM, Fuzzy etc.

2 State of Knowledge

It has been always a challenging task to predict the accurate weather forecasting for every researcher. There is a lot of literature on rainfall prediction which works on the historical data and predicts the outcome for the future [10–15]. Researchers have used many machine learning techniques [16–21] for the prediction purposes which consist of various data mining algorithms like supervised and unsupervised approaches. Some of the Machine learning algorithms which are used for the prediction of rainfall are Decision Trees [22, 23], SVM [24], Random Forest [25] and KNN.

Wang et al. [24] proposed a study in China, on water level prediction of rainwater pipe networks using the SVM approach. It was observed that the approach (SVM) hold better performance and accuracy measure.

Ji et al. [26] proposed a machine learning approach in which SVM was used for the forecasting of floods. The flood stage data used in this approach was from the Bangladesh region. In this study, SVM helps in identifying the useful training exemplars for the available training set. It results in the SVM being uniquely solvable as it doesn't suffer the limitations as in ANN and they also concluded that the SVM is easy to implement and easy to use. Based on the previous geographical data, Aswini et al. [27] proposed a statistical technique to predict the rainfall. The algorithms used in the implementation were Naïve Bayes, KNN, Decision Trees, Fuzzy Logic and Neural Network. The experimental results showed that the Decision trees and KNN are performing better results in terms of accuracy. The decision tree algorithm has been implemented by Petre [28], over historical- meteorological from the year 2002–2005 and the results were suitable as compared to other techniques. Ozan et al. [29], proposed a distributed representation [29] in which multiple paths are combined that can be crossed at the same time using multiple layer perceptron. In this study distributed decision trees and budding trees were compared and the results depict that in classification and regression techniques distributed decision trees perform much better than in the case of budding trees. This study also concludes with that the distributed trees can be considered as alternative layers of perceptrons for deep learning by implementing the hierarchical distributed representation of the input at the various levels.

Since, we have only quoted some of the basic researches, as there is an enormous amount of research available based on traditional machine learning algorithms in rainfall forecasting [30–34]. Some of the latest papers published on rainfall prediction included various algorithms like logistics model trees, M5 model trees, Gradient boosting approaches and so on. The accuracy measure still remains somewhat the same as the basic traditional algorithms.

3 Methodology and Data Preparation

In this paper, we have used nine parameters in the dataset including humidity at 12 AM (humid12) and 3 PM (humid3), Maximum Temperature (tmax), Minimum Temperature (tmin), Station ID (station_id), date (dt), month (mnth), year and the rainfall (rfall) as the target parameter.

These parameters are present in two comma separated files which consist of around 12,000 instances (Fig. 1) of humidity values measured at two time intervals every day at 12 AM and 3 PM and 6000 instances of the rest of the above defined parameters every day (Fig. 2). This data was collected from the year 2012–2017 for all the three stations.

Fig. 1 Instances of relative humidity at different time interval

Station_id	Year	Mnth	Hr	Dt	Relative humidity	
					Humid12	Humid3
42026	2012	2	3	5	100	100
42026	2012	2	4	8	96	100
42027	2013	6	5	9	86	96
42044	2016	4	6	7	100	94
42027	2014	3	2	8	94	86
42044	2012	6	1	9	100	96
42026	2012	2	3	5	100	100
42026	2012	2	4	8	96	100
42027	2013	6	5	9	86	96
42027	2017	6	1	8	100	100

Fig. 2 Instances of various attributes

Station_id	Year	Mnth	Dt	tmax	tmin	rfall
42026	2012	2	5	5.5	-8	0
42026	2012	2	8	5.4	-7.6	0
42027	2013	6	9	4.2	-8.1	0
42044	2016	4	7	4	-9.1	1.1
42027	2014	3	8	-1	-10.5	17.2
42044	2012	6	9	-2	-8.6	6.8
42026	2012	2	5	2.5	-4.3	0
42026	2012	2	8	-7.8	-17.6	16
42027	2013	6	9	-3	-6.3	16.5
42027	2017	6	8	1.6	-4.5	2.6

The two files are then integrated into a single file where all the missing values were removed and all the inconsistencies were resolved and cleaned. The below snapshot (Fig. 3) shows the integrated file in which all the necessary attributes are merged for all the three stations of the Kashmir province.

Thus the same continuous dataset has been discretized [2] using the GINI index and was used for the implementation purposes. The snapshot of the final processed and labelled data is shown below (Fig. 4).

The conversion of the continuous attributes to discrete is based on the below table (Table 1) [2]. (Table 2).

Station_id	Year	Mnth	Dt	tmax	tmin	rfall	Humid3	Humid12
42026	2012	2	5	5.5	-8	0	100	100
42026	2012	2	8	5.4	-7.6	0	100	100
42027	2013	6	9	4.2	-8.1	0	96	90
42044	2016	4	7	4	-9.1	1.1	86	96
42027	2014	3	8	-1	-10.5	17.2	97	100
42044	2012	6	9	-2	-8.6	6.8	96	98
42026	2012	2	5	2.5	-4.3	0	87	100
42026	2012	2	8	-7.8	-17.6	16	100	88
42027	2013	6	9	-3	-6.3	16.5	95	93
42027	2017	6	8	1.6	-4.5	2.6	94	100

Fig. 3 Integrated data

Fig. 4 Processed and labelled data

Season	tmax	tmin	Humid3	Humid12	rfall
Summer	H2	L1	U1	T1	N
Summer	H2	L2	U2	T2	N
Winter	H1	L2	U1	T1	N
Autumn	H2	L2	U2	T1	Y
Spring	H1	L1	U2	T2	Y
Autumn	H1	L1	U2	T1	N
Autumn	H1	L2	U2	T2	N
Spring	H2	L1	U1	T2	Y
Winter	H2	L1	U1	T2	Y
Winter	H1	L2	U2	T1	Y

Table 1 Best possible splits using GINI index [2]

Attribute	GINI index	Class one	Class two
Tmax	8.05	8.05 < = is H1	>8.05 is H2
Tmin	−0.35	−0.35 < = is L1	> −0.35 is L2
Humid12	69.5	69.5 < = is T1	>69.5 is T2
Humid3	89.5	89.5 < = is U1	>89.5 is U2

Table 2 Splitting Months into season [2]

Month Name	Month No	Season
Dec, Jan, Feb	12,1,2	Winter
Mar, Apr, May	3,4,5	Spring
Jun, July, Aug	6,7,8	Summer
Sep, Oct, Nov	9,10,11	Autumn

4 Results: Experimental Evaluation and Performance Comparison

All the experiments have been performed in python on the two different sets of combinations of data and the results were analyzed separately. In one set of data, the attribute season has been skipped and the performance was calculated using each algorithm individually and the same approach was used when the attribute season was included in the data. The overall results and other performance parameters were calculated and are shown in the below tables (Tables 3 and 4) respectively.

The above two tables shows a snapshot of results which includes accuracy, precision, recall values and many other calculations. It was observed that the accuracy ranges between 77 and 82% approximately in all the algorithms that were implemented.

Table 3 Prediction performance of various techniques with season as one of the parameter

Algorithm	Decision tree	SVM	Naïve Bayes	KNN	Fuzzy
Model	30–70	30–70	30–70	30–70	30–70
Test	1786	1786	1786	1786	1786
Training	4165	4165	4165	4165	4165
Correctly classified	1459	1439	1404	1436	1377
Wrong classified	327	347	382	350	345
Accuracy	0.8153	0.8057	0.7861	0.804	0.80
Error	0.1847	0.1943	0.2139	0.196	0.20
Precision	0.823	0.844	0.822	0.861	0.857
Recall	0.9460	0.89	0.892	0.863	0.863
Cohen kappa	0.502	0.509	0.447	0.524	0.507
F-measure	0.88	0.867	0.856	0.862	0.86
Specifity	0.5020	0.89	0.892	0.863	0.863
Sensitivity	0.5020	0.89	0.892	0.863	0.863

Table 4 Prediction performance of various techniques without season

Algorithm	Decision tree	SVM	Naïve Bayes	K-Nearest neighbor	Fuzzy
Model	30–70	30–70	30–70	30–70	30–70
Test	1786	1786	1786	1786	1786
Training	4165	4165	4165	4165	4165
Correctly classified	1431	1448	1370	1410	1332
Wrong classified	355	338	416	376	381
Accuracy	0.8012	0.8107	0.7670	0.7894	0.7775
Error	0.1987	0.1892	0.2329	0.2105	0.2224
Precision	0.812	0.845	0.818	0.848	0.841
Recall	0.938	0.897	0.864	0.857	0.846
Cohen kappa	0.456	0.519	0.411	0.485	0.458
F-measure	0.87	0.871	0.84	0.853	0.844
Specifity	0.938	0.897	0.864	0.857	0.846
Sensitivity	0.938	0.897	0.864	0.857	0.846

5 Discussion

On comparing these above implemented algorithms for the prediction of rainfall, SVM and Decision tree performs well in either of the cases (with Fig. 5 and without season data Fig. 6) because these models were able to predict the maximum portion of the data with top F-measure, precision, recall and sensitivity values. Other methods are also very efficient methods but they need a large portion of training data to train in order to predict a very small portion of test data.

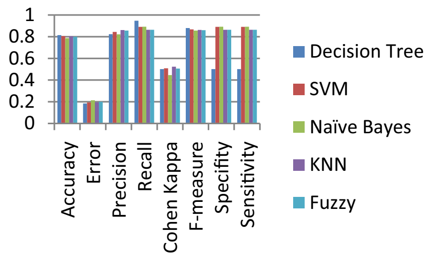

Fig. 5 Comparative graph of classifiers for predicting rainfall when season was taken as one of the parameter of the data

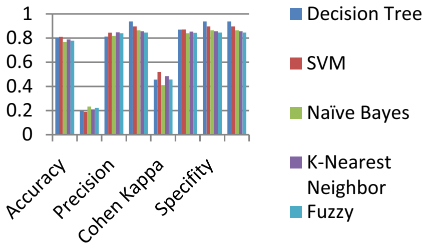

Fig. 6 Comparative graph of classifiers for predicting rainfall without season as one of the parameter of the data

6 Conclusion

The choice of machine learning algorithm does not necessitate improvisation in the performance, the performance capping is inherent in the dataset and the choice of the algorithm may result only in a marginal degree of variation in the performance. Thus, data quality and variable identification plays important role in improvising the overall accuracy of the model.

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Intrusion Detection System Using Deep Learning Approaches: A Survey

Kantagba Edmond, Parma Nand, and Pankaj Sharma

Abstract In recent years, there has been an urge for development in network technologies and that has contributed to an increase in cyber-attacks that are threats and challenges to the protection of network resources. In contribution to the protection of the network, artificial intelligence has been shown to be an efficient and better technique used in recent years for better detection of network attacks. In the paper, we propose an overview of deep learning techniques which are applied in intrusion detection systems. A summary of different deep learning techniques and their applications in intrusion detection systems are proposed with the various problems encountered by network security. We also give a brief summary of the benchmark datasets used in the deep learning techniques and provide a comparison of the performance of the different techniques. Finally, we propose suggestions to improve the performance of those deep learning in the attack detection.

Keywords Cyber-attacks · Artificial intelligence · Intrusion detection system · Deep learning

1 Introduction

There is a large growth in internet usage due to its numerous benefits to users and organisations in the aspect of sharing resources and other activities. This large usage of the internet has led to an increase in cyber-attack targeting those networks and personal data over the internet. Attackers are always finding a new way to overcome

K. Edmond (✉) · P. Nand · P. Sharma
Sharda University, Greater Noida, Uttar Pradesh, India
e-mail: 2020826402.edmond@pg.sharda.ac.in

P. Nand
e-mail: parma.nand@sharda.ac.in

P. Sharma
e-mail: pankaj.sharma1@sharda.ac.in

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the detection and protection systems. So, it is important that individuals and institutions such as financial, governmental and educational institutions have to always deploy new ways and techniques to protect their data and resources against intelligent attacks. Ingenious has been employed in cyber-attacks to make detection difficult with standard detection systems such as intrusion detection systems that are no more efficient and unable sometimes to detect unknown and new attacks.

The intrusion detection system has attracted various researchers to work in this field over the past years and they employed several machine learning techniques especially deep learning techniques to improve IDS performances in intrusion detection systems. The traditional intrusion detection systems had some limitations such as low performance in detecting unknown and new attacks and also the confusion in classifying normal traffic as malicious. So, the use of machine learning techniques has really helped solve some of those limitations [1]. Machine learning by its ability to simulate human brain network structure has made a great breakthrough and these approaches are classified as deep learning methods to solve complex problems efficiently.

The advantages and benefits of deep learning methods have led various authors to use these methods to propose intelligent intrusion decision systems. Therefore, several researchers have proposed models using those methods in order to increase the efficiency of IDS. In this paper, we used different papers that are used as the foundation to our paper and there is a lot of literature that helped us in this paper like [2, 3]. This paper provides an explanation and summary of the application of deep learning in attacks detections and gives a comparative statistic on the performance of each method studied in this paper.

In this paper, we provide a summary of security issues in the network and then categorise the previous methods used in solving those problems. Then, the progress of the deep learning methods in attack detection and cybersecurity, in general, are introduced and in the process of solving issues related to the traditional machine learning techniques such as false reduction rate. Furthermore, a performance comparison analysis of the different deep learning algorithms with the various benchmark dataset is proposed in this paper. Finally, we summarize the different difficulties to be solved in future work to help enhance the performance of the deep learning techniques.

Section 2 gives an overview of the concepts of attack detection and Sect. 3 provides a classification of deep learning techniques used in IDS in unsupervised and supervised methods. Section 4 focuses on the datasets used and analyses the performance comparisons of the various deep learning methods. Section 5 is the last part in which we make the discussion and summary on the basis of the current foundations.

2 Overview of Attack Detection

It is necessary to briefly discuss attack detection in general as background knowledge before getting into intrusion detection using deep learning techniques. An attack is an attempt to get unauthorised access or to bypass the security mechanism or policies of a system or group of the system forming a network. The security experts or personnel are always finding means and ways to protect and avoid their resources being compromised and one of the mechanisms usually employed is the intrusion detection system.

The intrusion detection system is the process of tracking activities including network traffic, and examining them for any signal of intrusions [4]. The dramatic advances in the era particularly in wireless verbal exchange systems are leading to an increase in threats and assaults focused on greater wi-fi communications structures because of the openness of wi-fi channels [4]. The dramatic advances in technology especially in wireless communication systems are leading to an increase in threats and attacks targeting more wireless communications systems due to the openness of wireless channels. There are three different ways in which intrusion detection systems can detect a sign of intrusion which are signature-based, anomaly-based detection and stateful protocol analysis. A signature-based detection, analyse traffic by comparing patterns or strings of the traffic with the ones already present in its database to differentiate malicious traffic and normal. So, it can define that signature-based detects already known attacks. Anomaly-based detection works in monitoring the behaviour of the network or system and if there is a deviation from known or normal behaviour such as monitoring regular activities and network connections failure or the unexpected failure of the system or overwhelming uses of network resources. In this age of machine learning, IDS are developed using machine learning algorithms, especially deep learning methods, to detect various attacks such as abnormal packet attacks, flooding, spoofing and distributed denial of service.

There has been an urgent development in machine learning this recent year, and the deep learning approach with its ability to solve complex problems has gotten more attention in the detection system. Deep learning structures simulate interconnecting neurons of human brains by using artificial neural networks, which gives them the ability to solve problems that are complex to standard algorithms [5]. Several applications of deep learning structure in intrusion detection have been proposed and shown a good achievement of this structure. Due to its great potential, deep learning is widely used in cybersecurity and specific areas of applications are phishing, malware, spam detection and analysis of traffic [6]. Shone et al. [3] came up with a network intrusion detection system which uses deep learning, helpful in network traffic analysis with an asymmetrical deep autoencoder. Vinayakumar et al. [7] used the LSTM set of rules and designed an IDS approach which allows the semantics of every name and courting at the community with an integration technique for an anomaly intrusion detection machine.

3 Attack Detection Using Deep Learning Methods

Deep learning consists of different methods, each one of which helps accomplish specific problems in their ways with varied performances. The deep learning methods can be categorised into two main types such as unsupervised learning and supervised learning. The quantity of information that is manually provided by manually labelled samples to the supervised, and the supervised methods results in high accuracy compared to the unsupervised learning methods which have less knowledge from labelled samples [8]. However, in complex attacks, manually labelling data leads to time consumption and there are situations such as the inherent complexity of real-world virtual web attacks. So, in this case, unsupervised methods take advantage of supervised methods because they can perform without prior knowledge [1].

a. **Review of Unsupervised Learning in intrusion Detection**

- Autoencoder Based Methods

Called an information compression set of rules, Autoencoder in his function compresses the input facts into feature area illustration and then, reconstructs the representation into the output. For the reason that autoencoder is taken into consideration to be a representing mastering algorithm. It is broadly used in dimension reduction and used to symbolize ordinary behaviour which offers the advantage of dynamically representing unknown assaults in the class with its compressed characteristic space.

Yu et al. [9] have proposed a NIDS using Stacking Dilated Convolutional Autoencoders, made of representation learning and self-taught to extract informative features from authentic traffic data. Firstly, the authentic network traffic is transformed into a numeric vector which is a training dataset through the pre-processing module. Afterwards, this model learns from unlabelled samples in the unsupervised training stage. The hierarchical structure of the feature representation and the feature description ability is improved using a backpropagation algorithm and a few labels.

Furthermore, a ‘Non-Symmetric Deep Auto-Encoder model’ has been proposed by Shone et al. [3] which was constructed using the encoder phase which is a shift from the encoder-decoder architecture. With the adequate studying shape given, the model computational time can be reduced and a decrease can be noticed in the overheads, all this with less impact on efficiency and accuracy. The evaluation of their model has been carried out using KDD Cup99 and NSL-KDD datasets which showed good results compared to others.

IEEE Staff [10] introduced an intrusion detection “Deep Auto-encoder (DAEs)” that reveals essential feature representations present inside the imbalanced training data which then provides a model for abnormal and normal behaviours detection. In order to avoid overfitting, the model was trained using unsupervised learning and at the top of the model for representing the desired outputs, they made use of SoftMax. The KDD Cup99 dataset is used to implement their model and has shown high accuracy.

Autoencoder with the structure of information compression and feature generation when used in feature extraction bring the advantages of automatic and dynamic feature construction. So, autoencoder performs well with high accuracy with predefined attacks present in datasets but for better performance in undefined attacks, self-learning has been suggested by researchers.

- Deep belief network-Based Methods

The deep belief network is a deep neural network made up of stacked layers of Boltzmann Limited (RBM) machines designed to solve a problem related to slow learning of standard neural networks in training deep layered networks and sometimes with poor parameter selection get stuck [11]. A Boltzmann Limited machine is a useful algorithm for reducing size, partitioning, retransmission, shared filtering, learning features and title modelling [13].

Ad-hoc network intrusion detection got more attention recently and Tan et al. [13] proposed an intrusion detection based on DBN specific to the ad-hoc network by making use of the variety of available feature samples for the purpose of training their model in order to detect normal and abnormal traffic in the network. This DBN model is then used to detect interferences in the network traffic in which sequence is compared to the known abnormal behaviour characteristics of the network and if there are similarities between the new sequence and the already abnormal sequence then the model classifies as an attack or malicious acts [13].

Afterwards, Tan et al. [13] introduced an intrusion detection system based on DBN for Ad-hoc networks due to its behavioural characteristics. Their model contains 6 modules which helped their model achieve high accuracy up to 97.6% and in those modules, there is a data fetching module which is wireless monitoring nodes and a data integration module used to integrate useful data for redundancy removal. In order to train the model, a DBN training module is used and a DBN intrusion module is employed and then the results are given by the response module.

IEEE Computational Intelligence Society, International Neural Network Society, Institute of Electrical and Electronics Engineers, and B. C. [14] in their research proposed a DBN model which deals with large raw data by adjusting the different parameters such as the numbers of hidden layers. In adjusting parameters, they find that a four-layer DBN model is the best parameter that can achieve better performance using the KDDCup 99 dataset.

b. **Review of Supervised Learning in intrusion Detection**

- Deep neural network Methods

A deep Neural Network is a form of machine learning in which the system makes use of more than one layer of nodes to acquire high-level functions in input facts. The multi-layer feature of DNN helps to produce complex functions with a few parameters that help to extract the feature and learn to represent it. DNN is usually made of an input layer then follows the hidden layer and an output layer.

el Kamili and Institute of Electrical and Electronics Engineers [15] Introduced a DNN model for intrusion detection for flow-based anomaly as a solution to the network security problem. They built their model which contains an input layer as the starting layer and used three hidden layers and then completed their model with an output layer. They implemented their model using the NSL-KDD dataset to evaluate their model which has proven that the DNN model detects a zero-day attack.

Peng et al. [16] suggest a network access method, which makes use of a deep neural network to extract data features from network monitors and differentiate intrusion by using a neural BP network. As the result of their model in an experiment using a benchmark dataset KDD Cup99 has shown a good accuracy of 95.45% which compared to conventional machine learning has significant improvements and performs well.

In order to detect android malware, "Enhanced Reader" [17] proposed an android malware detection model using DNN known as HashTran-DNN. The main idea is to use space-saving hash functions to modify samples to reduce, if not eliminate, the impact of the opposing interference. They used an autoencoder to duplicate DNNs and recreate sample hash presentations. The figures below show the HasTran-Dan architecture and also the training and testing phases in their research (Fig. 1).

- Convolutional Neural Network Methods in intrusion detection

A convolutional neural network is a deep learning technique that can identify and then classify various specified features from images. CNN uses a mult-ilayer perceptron variant design which requires less or minimal pre-processing and this method is made of three main layers. In the first layer, there is the convolutional layer which extracts the various features and then comes the pooling layer that reduces the dimension of the output from the previous layer and in order to finalise the CNN process the last layer known as the fully connected layer, contains the weights and bias which helps adjust and connect all the neurons from past layers.

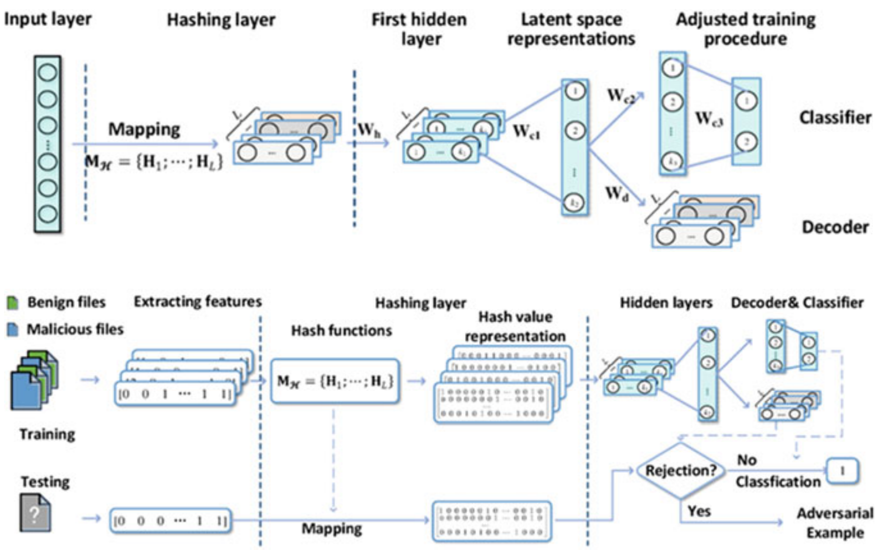


Fig. 1 **a** HasTran-Dan architecture proposed by "Enhanced Reader" [17]. **b** Training and testing phases in the HashTran-DNN proposed by "Enhanced Reader" [17]

The convolutional neural network has been employed in intrusion detection mechanisms which has shown much progress and enhanced their performance. Wang et al. [18] introduce a novel IDS that implements the CNN architecture, which consists of a data pre-processing module, and a training module to train their model with a testing module to help evaluate their system. Their model was built on the basis of the Linux platform and implemented using the NSL-KDD dataset. The results provided in the experiment show that their model can detect intrusion with high accuracy and elevated detection rate.

Wu and Guo [2] in the construction of their hierarchical convolutional neural network (LuNet), have considered that in network traffic data there is a presence of local and temporary features. LuNet is constructed with a succession of several convolutional layers in combination with recurrent sub-nets. The learning of data is done at each layer of the convolutional neural network and as the learning progresses, the data also gets detailed. The model has been implemented using two different datasets NSL-KDD and UNSW-NB15 which result in a very high detection rate with both datasets.

Deep learning being able to extract features automatically from a large dataset and also to share weight, Wu et al. [19] in their perspectives on improving the imbalanced traffic detection accuracy, have come up with a model of massive NIDS using the convolutional neural network. They suggested a method for setting the coefficients of the cost of each class's workload based on the number of training samples which resulted in better performances of the model. In the below figure they have given the architecture of their CNN of the model (Fig. 2).

Saxe and Berlin [20] proposed eXpose neural network which uses a convolutional neural network, in which the authentic short strings are taken as input and features are extracted in contribution to detect attack indicators. In this model, they used features which are extracted and classified using character-level embeddings. Since there was an issue with manual feature extraction, eXpose showed that it can overcome that issue in intrusion detection systems. The combination of supervised training with the embedded convolutions layers embeddings has allowed their model to benefit from implicit feature set extraction which is optimised for classifications.

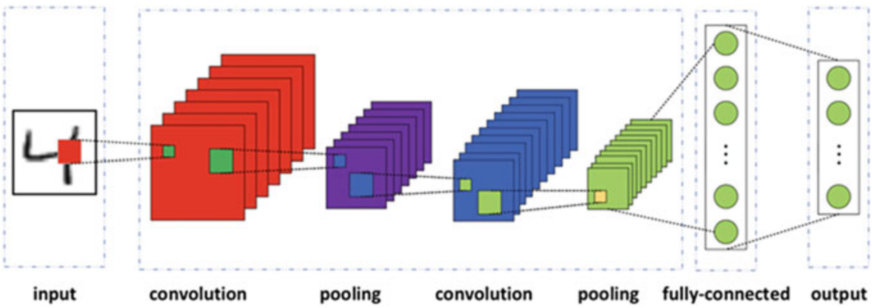


Fig. 2 The convolution neural network architecture proposed by Wu et al. [19]

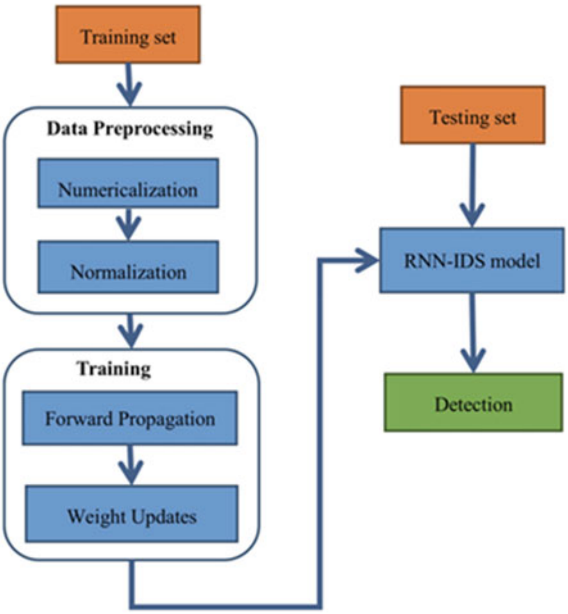
- Recurrent Neural Network-Based Methods

The ability of remembrance of previous layer information to impact the present layer input, made the Recurrent neural network to acquire more attention from various researchers in the construction intrusion detection system. So, when dealing with time-series information RNN is a good technique to use and its logic is like human cognition which is memory capability. With such functions and advantages, it's obvious that researchers have worked and proposed intrusion detection systems using RNN.

Yin et al. [21] came up with an intrusion detection system based on RNN in which multiclass and binary classification is used to evaluate their model. Their model profit from the remembering capability of the RNN to outperform compared to the CNN based model. The NSL-KDD dataset used for the experiment shows high accuracy achievement and that their model is best suited for class modelling and that its performance exceeds the standard machine learning methods. Figure 3 is the block diagram of their model.

Long short-term Memory (LSTM) is capable of recalling values during the processes and it is a type of recurrent neural network that has been used to develop IDS. In the classification and prediction of known and unknown attacks, LSTM is a suitable method and that is why Institute of Electrical and Electronics Engineers [22] proposed an intrusion detection system by applying LSTM-RNN. In this model, the design of a four-memory block network contains two cells each which results in high performance compared to previously proposed work.

Fig. 3 A flowchart of proposed RNN-IDS by Yin et al. [21]



ICT Platform Society [23] have used the LSTM in their proposed model for intrusion detection due to the advantage that is provided by the LSTM which is the resolution of the long-term dependency issue. The implementation of their model LSTM-RNN is done using KDD Cup99 dataset which showed great performance and compared to the model in Institute of Electrical and Electronics Engineers [22] this present model has high accuracy. At the end of the experiments with this model the size of the hidden layer was 80 and the learning rate was 0.01

Agarap [24] introduced a novel network classification system for finding attacks using a different GRU LSTM which uses the SoftMax function in the final layer (final output layer) of the model. As it is known that there are losses of information in the processes of the model the authors decided to use cross-entropy which helps calculate those losses. In order to improve their model, they made use of a linear support vector support (SVM) in replacement to the SoftMax function of the proposed GRU model and it resulted in high achievement compared to the original model and this is due to faster integration and better segmentation.

4 Comparisons and Analysis

The implementation of the various deep learning techniques is best achieved with two public datasets in the intrusion detection fields which are KDDCup 99 dataset and NSL-KDD.

- **KDDCup 99 dataset**

This dataset has been used before the other dataset was created and KDDCup 99 was generated from data originating from DARPA'98 IDS evaluation. The main issue in this dataset is the redundancy of training and testing data but that does not prevent its wide usage in the cybersecurity field. There are five categories of labels in the KDDCup 99 dataset, normal, DoS, which is an attack that prevents flooding the victim's network, making him unable to access his services, Probe, which is malicious surveillance to get user credentials for harming actions and the final two which are R2L remote to local refers to an attacker trying to get root privilege from offsite login to a local computer and the U2R user to root which a low privilege user trying to get administrative privileges. The Table 1 shows the various features and their descriptions.

- **NSL-KDD dataset**

As the KDD Cup 99 was having redundancy issues, the NSL-KDD was developed to solve those issues and has become one of the most used datasets in recent years. It isn't the handiest disposal of redundant information from the education and checking out but additionally sets the variety of data for each education and checking out that help to obtain greater accuracy in detection. NSL-KDD and KDD Cup 99 datasets

Table 1 KDD cup 99 features

No	Variable name	Type	No	Variable name	Type
1	Duration	Continuous	22	Is_guest_login	Discrete
2	Service	Discrete	23	count	Continuous
3	flag	Discrete	24	Srv_count	Continuous
4	Src_bytes	Discrete	25	Serror_rate	Continuous
5	Src_bytes	Continuous	26	Srv_serror_rate	Continuous
6	Dst_bytes	Continuous	27	Rerror	Continuous
7	land	Discrete	28	Srv_rerror	Continuous
8	Wrong_fragment	Continuous	29	Same_srv_rate	Continuous
9	urgent	Continuous	30	Diff_srv_rate	Continuous
10	hot	Continuous	31	Srv_diff_host_rate	Continuous
11	Num_failed_logins	Continuous	32	Dst_host_count	Continuous
12	Logged_in	Discrete	33	Dst_host_srv_coun	Continuous
13	Num_conpromised	Continuous	34	Dst_host_diff_srv_rate	Continuous
14	Root_shell	Continuous	35	Dst_host_diff_srv_rate	Continuous
15	Su_attempted	Continuous	36	Dst_host_same_src_port_rate	Continuous
16	Num_root	Continuous	37	Dst_host_srv_diff_host_rate	Continuous
17	Num_file_creations	Continuous	38	Dst_host_serror_rate	Continuous
18	Num_shells	Continuous	39	Dst_host_srv_serror_rate	Continuous
19	Num_access_files	Continuous	40	Dst_host_rerror_rate	Continuous
20	Num_outbound_cmd	Continuous	41	Dst_host_srv_rerror_rate	Continuous
21	Is_host_login	Continuous	42	Normal or attack	Discrete

are comparable in shape, with 4 assault sorts as cited before but the former is divided into KDDTest+ and KDDTrain+ which are shown in Table 2.

- **Evaluation metrics**

In the process of evaluating the performance of the deep learning technique and making analysis, various evaluation metrics are being used and the most used metrics are accuracy, precision, memory or recall, and F1-score. When the ACC displays a fraction of the predetermined amount of data in all data, the precision calculates the fraction of the predetermined for real attack prediction, recall indicates the truth

Table 2 NSL-KDD training and test data

Class	KDDTrain+	KDDTest+
DoS	45,927	74,588
Probe	11,656	2421
R2L	665	2754
U2R	52	200

positive predictions and the F1-score measures precision and recall and represents the balance of performance in both accuracy and memory.

5 Performance Comparison and Analysis of Various Deep Learning Techniques

As seen in section three above, various deep learning techniques have been used in construction detection systems which reveals the performance of each technique that has been evaluated using different metrics. Table 3 is a summary of the performances of the deep learning techniques evaluated using accuracy, precision, false positive rate and F1-score metrics. Though there are some unavailable metrics data, Table 3 still allows us to make a rough comparison amongst the different learning techniques.

We can note that the performance between different stages of attack detection methods varies. From Table 3, DBN, LSTM, CNN, and AE are achieving the adoption process through a downward spiral. At the same time, the hybrid methods are not compatible, because their functionality is closely related to the ensemble classifiers. DBN is the best in overall performance, because of its multi-layer natural properties in dealing with unlabelled data. LSTM can also gain higher overall performance than CNN by using temporary equipment for more accurate modelling.

We notice that RBMs and AEs are both widely used for intrusion detection systems due to the ability of both methods such as the ability to pretrain unlabelled data and adjust with less labelled data. In table three, we have seen the various performances of the different techniques of deep learning that the best performance has been achieved with the KDD Cup 99 dataset, i.e., 99.97% obtained by Sara et al. [22] with less data employed and with the NSL-KDD dataset provide lesser performance than the KDD Cup99 Niyaz et al. [25], therefore just show that NSL-KDD dataset is much realistic with less redundancy than the KDD Cup 99.

As observed in above section III, we can notice that the modified AEs perform better than the standard AEs and this is because with standard AEs there is a high risk of important information losses during compression which is not the case with improved AEs. The improved AEs has the ability to capture important information including additional design much more clearly and better than the previous AEs. Similarly, LSTM and GRU methods with their features in gate architecture and memory cells surpass RNN-based methods. In fact, such ingenious designs offer the opportunity to preserve long-term knowledge, thus better modelling for long-term relationships.

The remembrance functionality of the RNN keeps remembering the last moments by using the output of the previous layer as the input of the present layer, this functionality enhances the classification accuracy.

Table 3 Summary of the performances of the different deep learning techniques with the various datasets

Authors	DL technique	Dataset	Accuracy (%)	Precision (%)	Recall (%)	F1-Score
Xu et al. [6]	AE	CTU-UNB	98.40	98.44	98.40	0.9841
Shone et al. [3]	AE	KDD CUP'99	97.85	99.99	97.85	0.9747
Shone et al. [7]	AE	NSL-KDD	85.42	100	85.42	0.8408
Niyaz et al. [25]	Sparse AE	NSL-KDD	98.30	–	–	0.990
IEEE Staff [10]	AE	10% KDDCup 99	94.71	94.53	94.42	–
Morabito et al.[12]	DBN	NS2 simulation	90.27	96.4	–	–
Tan et al. [13]	DBN	KDDCup 99	97.60	–	–	–
IEEE Computational Intelligence Society, International Neural Network Society, Institute of Electrical and Electronics Engineers, and B. C. [14]	DBN	Simulation dataset	96.60	–	–	–
el Kamili and Institute of Electrical and Electronics Engineers [15]	DNN	NSL-KDD	74.67	83	75	0.74
Tang et al.	DNN	NSL-KDD	91.70	83.00	–	–
Peng et al. [16]	DNN	KDDCup 99	95.45	–	–	–
Han et al. [17]	DNN	Android malware	91.71	–	–	–
Vinayakumar et al. [7]	DNN	KDDCup 99	93.00	99.00	–	–
Wu and Guo [2]	CNN	NSL-KDD	85.35	97.43	–	–
Wu et al. [19]	CNN	NSL-KDD	80.10	–	–	–
Berlin and Saxe [20]	CNN	TensorFlow	92.00	–	–	–
Wang and Yang	CNN	KDDCup 99	95.36	95.55	–	0.930
Yin et al. [21]	RNN	NSL-KDD	83.28	–	–	–
Institute of Electrical and Electronics Engineers [22]	RNN-LSTM	KDDCup 99	99.97	99.5	99.5	–
ICT Platform Society [23]	RNN-LSTM	KDDCup 99	96.93	98.80	–	–
Agarap [24]	RNN-GRU	TensorFlow	84.15	–	–	–

6 Summary

Deep learning to process data makes use of a succession of layers which contribute to the promising results achieved by the unsupervised feature learning and pattern recognition. The improvement in performance of the intrusion detection using deep learning methods shows that deep learning techniques are important to network security in attack detection. Therefore, we made a classification of recent applications of deep learning techniques and their results in this paper.

There has been fundamental progress during the last few years in the studies concerning the application deeply and getting to know techniques in attack detection and features have shown super performances. But we can deny that there are still some limitations to those techniques. One of the major issues is the challenge to adapt deep learning methods like real-time classifiers of attack detection. Another problem is that in experiments that are more data involved, the results of the separation will be better, but many attack detection problems are lacking sufficient data. From the above analysis, we believe that this all-encompassing view is to the benefit of those who have ideas to improve the effectiveness of accurate detection.

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A Novel Similarity Measure for Context-Based Search Engine

Pooja Mudgil, Pooja Gupta, Iti Mathur, and Nisheeth Joshi

Abstract Analyzing the multiple relevant documents returned in reply to an end-user request by an information retrieval system is challenging. It is very time-consuming and less efficient to find analogous web pages without applying the clustering. Clustering of web pages arranges a large number of web documents into relevant small clustered groups. In this paper, a novel similitude degree computation technique is proposed to provide the web documents related to the context in which multiple related web documents are the members of the same cluster. The clustering module results in web documents' arrangement with their associated topic and corresponding computed similitude or similarity score. This provides the user clusters containing equivalent web documents related to the issue of desire. This context-based grouping of web documents reduces the time taken for searching relevant data and improves the results in response to a user request. Moreover, the comparison and analysis of the proposed technique are done with different existing similarity measures on the basis of performance metrics purity and entropy. It has shown the proposed scheme provides better results to the user.

Keywords Web documents · Clustering · Information retrieval · Cosine similarity measure · Jaccard coefficient

P. Mudgil (✉) · I. Mathur · N. Joshi
Department of Computer Science and Engineering, Banasthali University, Radha Kishnpura, Rajasthan, India
e-mail: engineer.pooja90@gmail.com

N. Joshi
e-mail: jnisheeth@banasthali.in

P. Gupta
Department of Computer Science and Engineering, Maharaja Agrasen Institute of Technology, Delhi, India

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1 Introduction

Web documents are a large corpus of documents available throughout the internet. Text Retrieval is a process of finding web documents, usually in a text from a large corpus of documents. Search Engines [1] are used to extract the relevant document according to a user query. It is challenging to give significant records against numerous corpus of web pages. So this becomes very important to find the similarity of different web pages to provide the best results to the user.

The similarity of web documents can be computed using the clustering of web pages. So clustering of web documents is done to cater better results to a user. A lot of relevant techniques [2] used to search the relevancy among the documents include Cosine Similarity Measure [3], Dice Coefficient [4], Euclidean Distance, and Jaccard Coefficient.

The most Common matching measure used for the similarity of web pages is Cosine Similarity Measure [5]. It is based on the term frequency and inverse document frequency [6] of keywords. Term Frequency means the recurrence of a term within the web page, and Inverse Document Frequency means the repeated occurrence of web pages in the corpus that contains that term.

Euclidean Distance [7, 8] is another matching technique amongst two web pages. It means the square root of the total sum of all the squared distances among related data objects. The lesser the Euclidean distance between the two web documents, the more the two web documents are similar. The other Similarity measure is Dice Coefficient [9]. It is computed by considering twice the number of terms common to both the documents to the sum of total terms of each web document. Jaccard coefficient [10] is also applicable to find a matching of the web pages. This is based on the quantum of similar words from both the web pages to the total of words from the pair of web documents.

In a basic Search Engine [11], Web Documents are searched against the query in which the related web documents are scattered. It is very time-consuming to search the related web documents without clustering documents and repeating the same process. Thus the efficiency of results produced also becomes insufficient. In a proposed context-based Search Engine, clustering of web documents is done to cater to a user's better results. It follows the heterogeneous grouping in which in a cluster, more than one class member can occur. Thus the time required to search the web documents decreased, and the efficiency of results produced improved inversely.

Clustering [12] of web pages is an essential way of organizing many web pages into the relevant small clustered web pages. So clustering gathers similar objects in a group. In response to a query fed by the user, the crawler will try to match the whole cluster so that the complete cluster is given back to the end-user according to the documents' significance.

The proposed Similarity-based approach used the approach of clustering of web documents. This technique relies on the frequency of keywords in the web document. The fewer frequency keywords are not considered in our approach. The results show better Precision, Recall, Purity, and entropy as compared to other Similarity Measures.

2 Related Work

Grangier and Bengio [13] used the concept of hyperlinks for extracting the similarity between the web documents. They considered the approach hyperlinks documents are more closed to each other than those of unlinked documents. They used the technique of measuring similarity functions for linked documents by using the Gradient Descent Strategy. Similarity function uses the vector space model of documents comprising term frequency of documents, inverse document frequency, and averaging of the length of documents. Based on this, the similarity between other linked or not linked documents is measured using similarity parameters. But many times, this approach is not so useful when a document contains hyperlinks to advertisements or unrelated data.

Huang [14] used the concept of partition-based clustering of web documents in which an algorithm of K-means searches for the centroid of the cluster. He has used the traditional clustering approach for finding the relation between the web documents. He has worked on seven data sets for finding the similarity of documents. He has manually assigned the labels to each document, which is a very tedious task. The less number of times of occurrence of a word in a document is not taken into account. The above technique used for computing the similarity of web documents does not provide exemplary performance in the Euclidian Distance Similarity Measure.

Clustering of web pages based on fuzzy logic [15] follows the Fuzzy Sets model of documents using the Similarity Function and then used the merge function for merging clusters based on the threshold function. Fuzzy set representation is evaluated using several occurrences of words from a web page to the occurrence of other terms in the same web page of a finite set. Then the Similarity function is computed using Intersection and Union of Fuzzy Cluster Sets. The above approach provides too many small clusters.

Another author [16] used the hybrid technique of computing the relatedness of documents. Their first approach extracted the most frequent terms from the web document and fed it into the ontology to derive more related words. The Jaccard coefficient is then applied for measuring relationships by counting all the related keywords to the aggregate terms in the document. In the second approach, they applied the similarity based on semantics between the web documents using the Wordnet Ontology and Wikipedia Corpus. They applied POS tagging to web documents for finding nouns, verbs, and adverbs. These words are passed to the Wordnet Ontology for finding synsets of related words, and finally, relatedness amongst the documents is calculated using Wikipedia corpus.

Sadas and Jha [17] applied the News ontology for text clustering of the news article documents. They have constructed the News Ontology for finding concepts and relationships of the terms associated with news domains. Then processed keywords from the web documents are used with the news ontology. They have clustered similar news article data based on the topic of the web document. Then the identical news articles are displayed to the user. But they have not used any standard similarity measure for calculating relationships among the web pages.

Relatedness among two documents is computed using Cosine Similarity [2], which follows the preprocessing of web documents followed by weighting the term using the term frequency of the keyword and evaluating the cosine similarity between the two web documents. But they have only calculated the relevance of two documents using Cosine Similarity Measure, and other Similarity measures like Jaccard Coefficient or Dice Coefficient are not considered.

LDA Model is used for topic modelling [18]. Its aim was to group the documents related to a similar topic or find out a particular document in a corpus that can serve a query related to a specific topic. So, they searched and found topic models, i.e. LDA [19, 20], which come under clustering in Information Retrieval.

The drawbacks of the model are the numbers of topics is fixed i.e. say ‘k’ classification categories but the topic vocabulary is not defined earlier. It’s done using Gibbs Sampling, which is a very complex process. So we proposed a technique that if a document is taken as a topic and all other documents in the corpus are to be analyzed against this topic, then the better clustering of web documents will be done, and better results are produced. Section 3 will discuss the proposed framework for clustering of web documents. Section 4 provides the outcomes of the proposed work. The next Section depicts Performance Measures. The last section describes the Comparison of the Proposed Relevancy technique and other relevancy techniques.

3 A Framework for Clustering of Web Documents

The proposed system is developed for clustering of web documents and applying various similarity measures for evaluating the relatedness between the documents. Here similarity of web pages depends upon clustering for web pages based on the particular topic of the document. The architecture of the proposed approach shown in Fig. 1 is subdivided into two categories Back-End Approach and Front-End Approach as follows:

- **Back-End Approach**: Firstly Initial Seed URLs are fed by the crawler to the Worldwide Web to retrieve the web documents. These web documents are then stored in the repository in which a unique identifier is provided to each web document for further processing. Then the Clustering Module extracts the web documents from the repository and forms the clusters of web documents in which every cluster is related to one topic. Then these clusters maintain the index in the form of a list of documents, their related topic, and score of similarity score

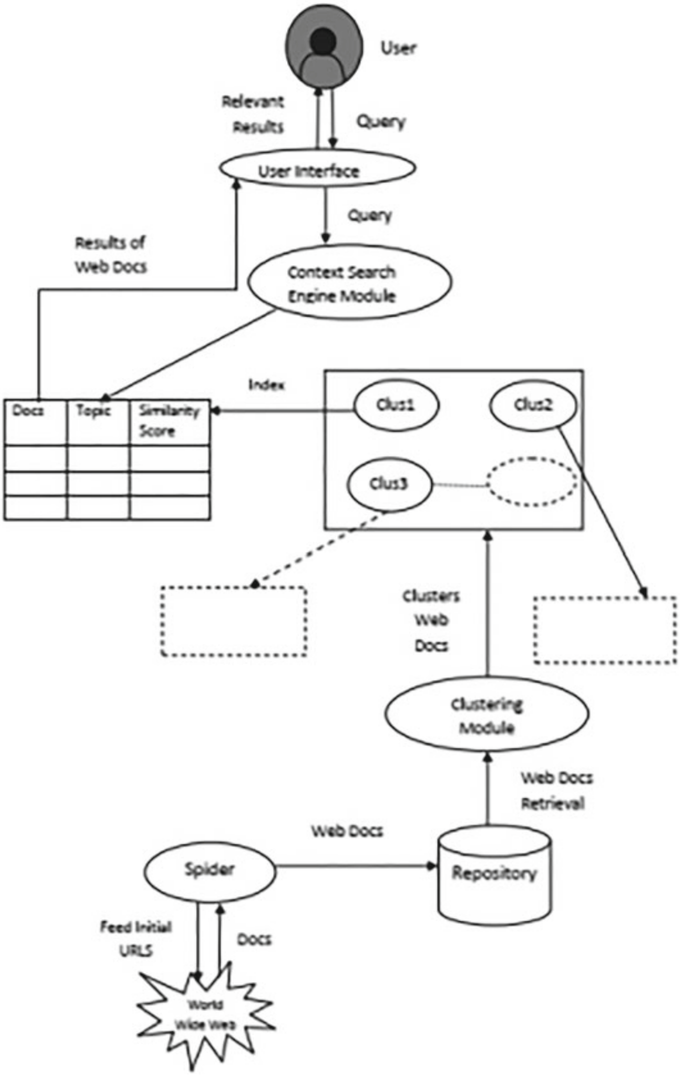

Fig. 1 Architecture framework

- **Front-End Approach**: In the Front-End Approach, the user fires query through the end User Interface with the help of the list of keywords. This query containing keywords is provided to the Context Search Engine Module, which computes the question and retrieves the outcomes from Index containing similar web documents. These results are given back to the User Interface, so the user gets the desired relevant results in the form of web documents.

3.1 Clustering Module

The Clustering Module is afterwards composed of the Keyword Extractor Module, Similarity Score Computation Module and the repository of Clustered Web Documents. Figure 2 describes the diagrammatic flow of the Clustering Module. The number of web documents under consideration is fed to the clustering module. Keyword Extractor is an open-source tool that provides a list of keywords and their term frequency. The clustering module computes the keyword and their term frequency of web documents with the help of a keyword extractor tool and computes the fraction score or similarity score between web documents which is explained in the next section Similarity Score Computation Module. Then the clustered web documents are stored in the repository.

Similarity Score Computational Model

The Similarity Score Computational Module describes the overall process of finding the relevance between the web documents that are demonstrated below.

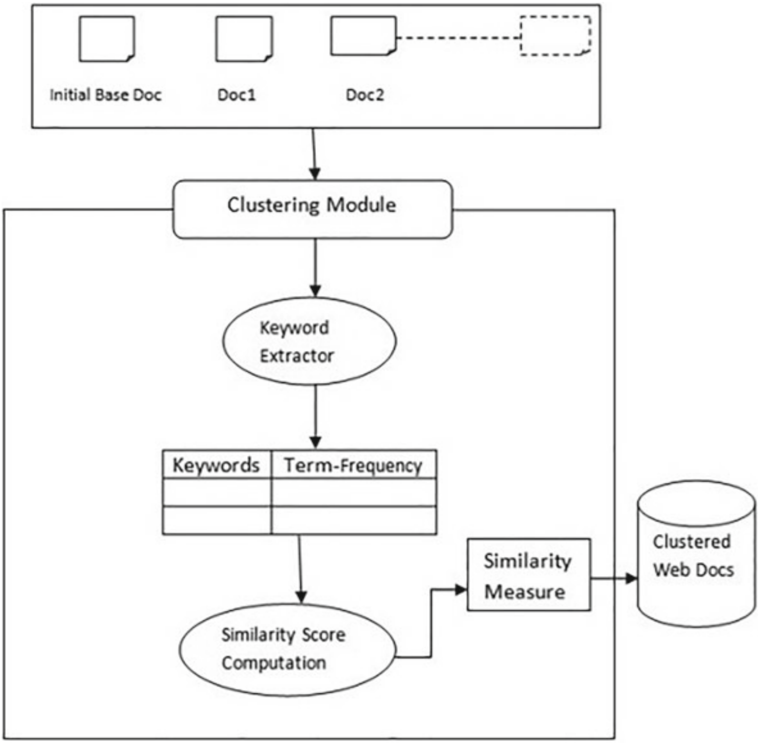

Fig. 2 Computational flow of clustering module

Step 1: Firstly preprocessing of web documents is done by removing the Stop words from the downloaded documents. Stop words are the unnecessary words that does not contribute to the sense of the web document. Then Stemming of web documents is done to find the root keyword of the document using the Porter Stemming Algorithm [21, 22].

Step 2: Pick a document as the topic. Choose di as one document vector, and depending upon the frequency in the base document, we will consider the keywords in the document under consideration.

Step 3: Select only the high-frequency distinct keywords and this becomes the vocabulary of the topic1. It considers keywords with frequency > 3.

Step 4: Then find out the similarity between another document in the corpus and this initial vocabulary.

Step 5: For all the document vectors, Compute Fraction or Similarity Score, given in "Eq. (1)", SK_j:

$$SK_j = \sum_{D_j=1}^{n} \frac{NK_i \cap NK_j}{NK_i * NK_j - 2(NK_i \cap NK_j)} \tag{1}$$

where, NKi: total number of keywords in base document.

NKj: total number of keywords in tested similarity document.

NKi ∩ NKj: common keywords in both of the documents.

In the denominator, 2(common) keywords are being subtracted as these common keywords are counted twice as they are present in m1 as well as in m^2, so subtracted that fraction while computing the similarity coefficient.

Step 6: For Clustering of web Documents, normalization is done. Normalization is applied for the same min–max of the computed Fraction Score and the formula of evaluation is shown in "Eq. (2)".

Normalized Fraction,

$$Nor(f_i) = f_i - \frac{F_{min}}{F_{max} - F_{min}} \tag{2}$$

where, F_{min}: lowest value for variable F.

F_{max}: highest value for the variable F.

If F_{max} is equal to the F_{min}, then Nor (fi) = 0.5.

Step 7: Then pick the other documents as the base topic as the second iteration starts and so on the similarities between the web documents are found.

4 Experimental Results

Above discussed algorithm is implemented using Java and tested on a set of web documents. The web documents are randomly downloaded from Google API on various topics and stored in a database. Then these web documents are analyzed and clustered by applying the proposed algorithm. The results thus obtained are then analyzed manually with the help of experts in the field. It shows that the most similar results are extracted from the proposed approach. We hypothesize that the relativity for web documents and clustering for web pages concludes better results than the traditional similarity approach. Then to test the hypothesis, two sets of experiments were performed as given below.

Objective of Experiment Set 1:
Similarity Compute:

1. To generate the list of documents for Computation of Relevance between documents related to each topic.
2. To calculate Matching or Fraction Score for base web document with respect to other web documents. Then iterate the process by taking another document as based document.

Objective of Experiment Set 2:
Allocation of Document in Clusters:

1. To evaluate the Normalization of Fraction Score for scaling the values.
2. A single web document can be a part of two almost similar topics. So we need to assign the document to clusters depending upon the Normalized Similarity Score of web documents.

4.1 Similarity Score Computation of Web Documents

The similarity between a based document and other web documents is computed using the Eq. 1. The results are stored in various heads (columns) such as Fraction and Normalized Fraction, where Fraction shows the similarity score and Normalized Fraction gives the score after applying normalization so that values can come under a similar scale for the ease of comparison.

The experiment conducted for finding the clustered web documents is summarized in Table 1. The first column contains the base document and other Documents between which similarity is to be computed. The second column shows the Similarity fraction of the base document and other web documents and the third column represents the Normalized Fraction for the Similarity Fraction Score.

On a similar basis in a second iteration, we considered the other random document as a base document and repeat the clustering process with all other web documents present in a corpus. For Instance, the results shown in Table 2 are displaying the

Table 1 Fractioned score and normalization fraction of base web document

Base document & similarity document	Fraction	Normalized fraction
Base document & Doc1	0.049	0.339
Base document & Doc2	0.0470	0.32
Base document & Doc3	0.0379	0.259
Base document & Doc4	0.035	0.239
Base document & Doc5	0.035	0.239
Base document & Doc6	0.0331	0.226
Base document & Doc7	0.032	0.219
Base document & Doc8	0.0312	0.213
Base document & Doc9	0.024	0.164
Base document & Doc10	0.0470	0.32
Base document & Doc11	0.0234	0.160
Base document & Doc12	0.0217	0.148

Table 2 Fractioned score and normalization fraction of iterative web document

Base document & similarity document	Fraction	Normalized fraction
Doc21 & Doc1	0.067	0.394118
Doc21 & Doc2	0.061	0.352884
Doc21 & Doc3	0.044	0.25884
Doc21 & Doc4	0.009	0.052941
Doc21 & Doc5	0.094	0.552941
Doc21 & Doc6	0.047	0.276471
Doc21 & Doc7	0.034	0.20000
Doc21 & Doc8	0.091	0.535294
Doc21 & Doc9	0.019	0.111765
Doc21 & Doc10	0.061	0.352884
Doc21 & Doc11	0.0277	0.162941
Doc21 & Doc12	0.032	0.188235

clustering scores when m21 is considered as a base document. When manual analysis of these documents is done it has been observed that the document ‘m’ is related to the topic Computer Mouse and m21 is related to the topic Academic.

4.2 Performance Metrics

The execution of the proposed system is checked by the following measures: Precision, Recall, and F-measure. Precision [23, 24] means the fraction of quantity of accurately produced similar documents of one cluster with the total sum of web documents of a sample space. Recall means the fraction of quantity of correctly predicted similar web documents of one group with sum total of similar web documents for one group. So the formula for Precision and Recall is shown below in "Eqs. 3 and 4:

$$\text{Precision (i, j)} = \frac{S_{ij}}{S_j} \tag{3}$$

where, S_{ij}: Sum total of entities of set i that are in group j.

S_j: Sum total of entities in group j

$$\text{Recall (i, j)} = \frac{S_{ij}}{S_i} \tag{4}$$

where, S_{ij}: Sum total of entities of set i that are in group j.

S_i: Sum total of entities in group i.

F-measure [25] is used to find the robustness of the proposed model. It means harmonic average with respect to Precision and Recall of the proposed system shown in "Eq. (5)".

$$\text{F} - \text{measure}, \text{F}_{\text{i,j}} = \frac{2 * \text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}} \tag{5}$$

The outcomes of above discussed metrics of clustered web documents are shown below in Table 3.

Now to calculate the Overall F- Measure $F1_{i,j}$, we are using the equation "Eq. (6)" given below:

Table 3 Performance metric outcomes for clustered web documents

Precision (i, j)	Recall (i, j)	F-measure$_{i,j}$
0.6111	0.9166	0.7375
0.8888	0.2285	0.3634
1	0.0857	0.1578
1	0.2307	0.3749
1	0.2285	0.3719
0.9090	0.7692	0.8332

$$\mathrm{F1}_{(i,j)} = \sum_{\mathrm{i,j}=1}^{\mathrm{n}} (\frac{\mathrm{M_i}}{\mathrm{M_j}} * F_{i,j}) \tag{6}$$

where, M_i: sum total of related web documents in group.

M_j: sum total of web documents for a group.

So from Table 3, the overall F-Measure of clustered web documents computed is 0.9182.

4.3 *Existing Similarity Measures*

There are many similarity measures for computing the similarity of web documents. So mostly applied matching measures are cosine similarity and Jaccard coefficient. Cosine Similarity [26] of web documents used the concept that each web document may be presented in the vector space containing the vocabulary of a web document. This similarity measure does not consider the size of a web document. It provides the angle between the two web documents. The less the value of the angle, the more is the cosine angle between the web documents, that is, more the similarity between the web documents. The formula for measuring the Cosine Similarity is given below in "Eq. (7)":

$$\mathrm{Cosine}\left(\mathrm{d_i}, \mathrm{d_j}\right) = \frac{\sum_{\mathrm{i,j}=1}^{\mathrm{n}} \mathrm{d_i}.\mathrm{d_j}}{\sum \mathrm{d_i}. \sum \mathrm{d_j}} \tag{7}$$

where, $d_i.d_j$: documents of two vectors.

n: total number of documents.

Here numerator provides the summation of the product of the frequency of one keyword in one document with the frequency of the same keyword in other documents. The denominator provides the product between the summation of the square root sum of all common keywords in one document and the summation of the square root sum of all common keywords in another document. Jaccard Coefficient [27] provides a fraction of the intersection of objects and a combination of objects.

Jaccard Distance provides dissimilarity between the web documents. The formula for measuring the Jaccard Coefficient (JC) [28] and Jaccard Distance [29] shown in "Eqs. 8 and 9" is given below:

$$\mathrm{JC}\left(\mathrm{d_i}, \mathrm{d_j}\right) = \Sigma_\mathrm{i} \mathrm{d_i}.\mathrm{d_j} / \Sigma_\mathrm{i} ||\mathrm{d_i}||^2 + \Sigma_\mathrm{i} ||\mathrm{d}||^2 - \Sigma_\mathrm{i} \mathrm{d_i} \times \mathrm{d_j} \tag{8}$$

The value of the Jaccard coefficient (d_i, d_j) ranges from 0 to 1. When the terms of the two documents are similar, that is, di = dj then the value of the Jaccard Coefficient is 1 otherwise 0.

$$\text{Jaccard Distance} = 1 - \text{Jaccard Coefficient} \tag{9}$$

Table 4 Cosine similarity measure, jaccard coefficient and jaccard distance outcomes

Base document and similarity document	Cosine similarity measure	Jaccard coefficient	Jaccard Distance
Base document & Doc1	0.072304704	0.036308868	0.963691
Base document & Doc2	0.313795528	0.076312296	0.923688
Base document & Doc3	0.151514579	0.036807638	0.963192
Base document & Doc4	0.575900969	0.075732824	0.924267
Base document & Doc5	0.180346021	0.050421905	0.949578
Base document & Doc6	0.074427985	0.021870778	0.978129
Base document & Doc7	0.166270318	0.038811491	0.961189
Base document & Doc8	0.217440318	0.05290096	0.947099
Base document & Doc9	0.663339482	0.126331082	0.873669
Base document & Doc10	0.313795528	0.076312296	0.923688
Base document & Doc11	0.131740459	0.02124607	0.978754
Base document & Doc12	0.174156581	0.031006878	0.968993

For the purpose of comparison of our proposed method with the Similarity measures, we have computed the above results of the base document with the other documents through standard matching measures. Table 4 depicts the results of the cosine matching measure, Jaccard coefficient and Jaccard distance between base web documents and other similarity Documents.

5 Comparison of Proposed Relevancy Technique and Existing Relevancy Technique

The proposed relevancy technique imparts the similarity between the two documents by clustering the web documents related to the particular topic. The existing similarity measures like cosine similarity and Jaccard coefficient do not focus on the contextual relevance between web documents related to a particular topic. So, we compared the existing similarity measure and the proposed similarity measures in association with their Purity and Entropy. Purity [30] tells the degree to which documents of a given cluster belong to the same domain. Entropy [31] defines the division of categories over a given cluster. It measures the level of association amongst group labels and class labels. Purity [32] of a given cluster Ci of size ni is provided as follows in "Eq. (10)":

$$P(C_i) = \frac{1}{n_i} * \max_h(n_i^h) \tag{10}$$

where, n_i^h: sum total of documents from the cluster Cibelong to the group h.

$\max_h(n_i^h)$: Sum total of documents classified from dominant group in cluster $C_{i.}$

So Overall Purity, P is computed as follows in "Eq. (11)":

$$P = \sum_{i=1}^{k}\left(\frac{n_i}{n} * P(C_i)\right) \tag{11}$$

Entropy, Ej for a given cluster [33] is computed below in "Eq. (12)":

$$E_j = \sum_i P_{ij} \log_2(P_{ij}) \tag{12}$$

where, j: cluster.

i: class.

P_{ij}: possibility that an element of cluster j associate to class i.

Overall Entropy, E [34] for all the clusters is computed as follows:

$$E = \sum_{j=1}^{m} \frac{n_j}{n} * E_j \tag{13}$$

where, n_j: size of cluster j.

m: sum total of clusters.

n: sum total of documents.

Tables 5 and 6 shows the comparison of Clustered Web Documents based on Purity and Entropy Metrics.

Table 5 and Fig. 3 represent the comparison of the proposed model with two different techniques such as Purity based on Cosine Similarity Measure and based on Jaccard Coefficient. From the analysis, we observed that the proposed model achieved far better purity results based on the 10 clusters and in the below section, we also compare based on the entropy values.

Table 5 Purity results

Clusters	Purity based on proposed similarity measure	Purity based on cosine similarity measure	Purity based on Jaccard coefficient
Cluster 1	0.61111	0.6428	0.9285
Cluster 2	0.88889	0.9090	0.6153
Cluster 3	1	0.8	0.5833
Cluster 4	0.9090	0.6	0.625
Cluster 5	1	0.5	0.714
Cluster 6	1	0.75	0.6

Table 6 Entropy results

Clusters	Purity based on proposed similarity measure	Purity based on cosine similarity measure	Purity based on Jaccard coefficient
Cluster 1	0.96416	0.94029	0.3678
Cluster 2	0.50	0.4395	0.96128
Cluster 3	0	0.72193	0.9798
Cluster 4	0.4395	0.97095	0.9543
Cluster 5	0	1	0.8631
Cluster 6	0	0.81125	0.97095

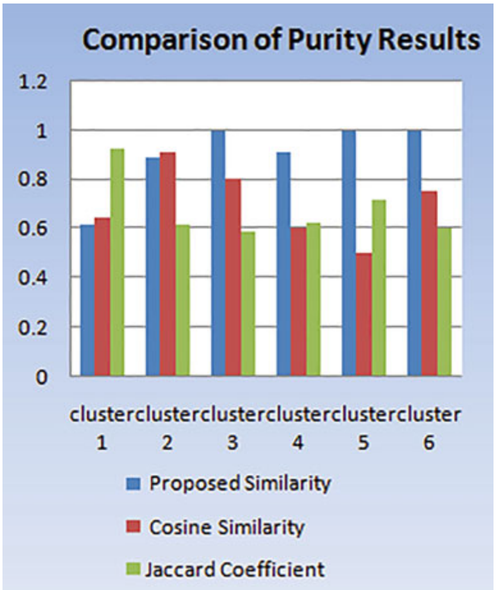

Fig. 3 Comparison of purity results

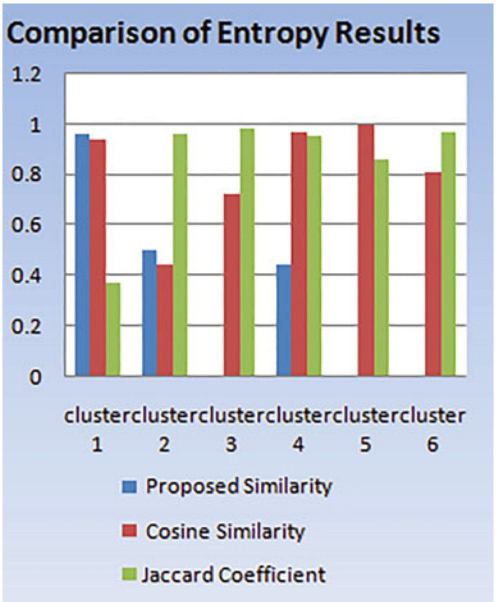

Fig. 4 Comparison of entropy results

Achieved entropy values comparison is shown in the above Table 6 and Fig. 4 for the proposed model with two different techniques such as entropy based on Cosine Similarity Measure and based on Jaccard Coefficient. From the analysis, we observed that the proposed model achieved far better entropy results based on the 10 clusters and in the below section, we also compare the different similarity measures based on the Overall Purity and entropy values shown in Table 7.

The Column Chart of Overall Purity and Overall Entropy is illustrated below in Fig. 5.

It is clear with respect to the above matching techniques that the proposed technique shows overall high Purity. Entropy provides a small disorder in clustering. So lower the Entropy better the clustering of web documents which means the proposed relevancy technique provides the improved results.

Table 7 Overall purity and entropy results

Similarity measure	Overall purity	Overall entropy
Cosine similarity measure	0.716	0.79605
Jaccard coefficient	0.68255	0.79831
Proposed similarity measure	0.8495	0.4445

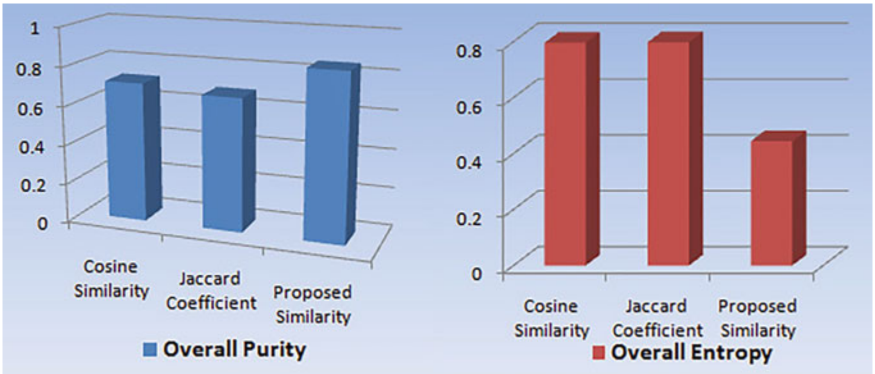

Fig. 5 3D Column Chart representing the Purity and Entropy values of Cosine Similarity, Jaccard Distance and Proposed Similarity Measure

6 Conclusion

The size of the World Wide Web is increasing extensively. Thus it has become a challenge to provide the relevant results to the user. Moreover, the result should be in the context of the query that the user has passed to the information retrieval system. Thus the requirement of technique is identified that arrange the documents in order of context of the words present in that document. The proposed Similarity Measure exploits the observation that terms are usually not uniformly occupied in a document, and hence not every term is equally important for clustering purposes. Terms with very low frequency are treated as unimportant (outlier) and removed. The proposed algorithm is an incremental method as it does not require the whole dataset in advance and only scans the dataset once. The documents are arranged in order of their computed similarity score associated with their corresponding context. Thus it has made the search fast and efficient by providing more related documents in one place in response to a user query. Moreover, a comparison with other existing similarity measures on the basis of standard performance metrics purity and entropy has clearly shown that the proposed similarity measure results with more precision.

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A Survey on the Security Issues of Industrial Control System Infrastructure Using Different Protocols

Ankita Sharma and Vishal Bharti

Abstract Control and monitoring of essential infrastructures like nuclear plants, power generation and distribution plants, oil and gas, and many more facilities are handled by industrial control systems (ICS). The real-time response, high-performance computing compatibility as well as security. There are a number of protocols in place to assure the safety and security of the operations in question. ICS protocols phasing so many problems due to their high demand in real time. ICS has adopted Internet-based technologies and most communication protocols have been rewritten to work over IP as a result of the increased access to the Internet world for business purposes. In contrast to typical IT systems, the ICS components and communication protocols were vulnerable to cyber-attacks because of their openness. In order to make it easier to analyze the danger of ICS protocol cyber-attacks. We propose the taxonomy model to identify the attacks on different protocols of ICS based on the security pillar, attack type, and different protocols used in the devices. This paper help researchers and industrialist understand the attacks and issues on the different protocol.

Keywords Industrial control protocol · Security issues · Protocols · Cyber-attack

1 Introduction

Cyber-physical systems are made up of both cyber and physical components. The term "cyber" refers to computer and communication devices. Natural and man-made things are both considered physical elements. Sensors and actuators, for example [1]. Systems for computing and communication. A cyber-physical system is one that is interconnected with the physical environment system. S. Shyam Sunder gave a standard on March 13, 2012. "Cyber-physical systems" is defined as "hybrid networked cyber-physical systems". co-designed physical elements and engineering physical elements to generate adaptive and for improved performance, predictive

A. Sharma (✉) · V. Bharti
Chandigarh University, Punjab, India
e-mail: ankita.ceh@gmail.com

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systems are used. Measures of performance include the following: safety and security, dependability, agility and stability, efficiency, and effectiveness [3]. Industrial control systems (ICSs) are commonly found in critical infrastructures and industrial sectors, such as nuclear and thermal power plants, water treatment facilities, power generation, heavy industry, and distribution systems [8]. ICS is a broad term that encompasses a wide range of control systems, including supervisory control and data acquisition (SCADA) systems, distributed control systems (DCS), and other control system configurations like programmable logic controllers (PLC). A typical ICS is made up of a variety of control loops, human–machine interfaces (HMIs), and remote diagnostics and maintenance tools, all of which are developed utilizing a variety of network protocols. SCADA systems collect data from and issue commands to geographically remote field stations to monitor and control various industrial control system components [4]. SCADA and DCS systems are frequently linked to work in tandem. Despite the fact that a DCS controls the operation of the industrial facility, the DCS must communicate with the SCADA system in order to coordinate production output with transmission and distribution demands.

CPS systems, despite their many benefits, are vulnerable to a variety of cyber and/or physical security risks, attacks, and obstacles. Because of its heterogeneous character, reliance on sensitive and private information, and large-scale implementation [5]. As a result, purposeful or unintentional exposures of these systems might have disastrous consequences, necessitating the implementation of rigorous security measures. However, most of the researchers focus on the cyber-attacks on different domains of CPS and ICS infrastructure attacks. This paper helps researchers and industrialists to understand the cyber-attacks and issues in Protocols of ICS infrastructure.

Aside from the introduction, this paper is divided into four main sections as follows. Section 2 presents some literature survey and background about ICS including their layers, components, models, and protocols on each layer. Section 3 discusses and details the key ICS protocol attacks and issues in security pillars and explains some real-case ICS Protocol attacks. Section 3.2 presents the solutions of ICS protocol security. Section 4 presents the conclusion of this work.

2 Background

This section is divided into parts, Sect. 2.1 describes the related work, and Sect. 2.2 will describe the ICS background with their architecture and main components as well as protocols of each layer.

2.1 Literature Survey

Several recent research works addressed the various security aspects of CPS: [1–9], IoT storage issues [10] and Operating System vulnerabilities [8, 9, 11], IoT storage issues [10] and Operating System vulnerabilities [8, 9, 11], IoT storage issues [10] and Operating System vulnerabilities [11]; and several security and privacy solutions using crypto. However, none of the previous works provided a comprehensive view of CPS security in terms of threats, vulnerabilities, and attacks based on the domain of interest (cyber, physical, or hybrid). As a result, this article provides a comprehensive analysis of current cyber, physical, and hybrid assaults, as well as security solutions, both cryptographic and non-cryptographic. 2 Furthermore, CPS forensics is presented for the first time as a necessary component of investigating the causes of CPS-related crimes and attacks. According to a research by Makrakis et al. [14], threats to CI are on the rise as a result of the proliferation of commodity tools and techniques that can aid in either the early or late stages of an assault. Furthermore, our survey reveals that current flaws in the design and implementation of various OT-specific network protocols might easily allow adversaries to have a decisive impact on physical processes. This research aids us in understanding the vulnerabilities in OT. Hu et al. [15] proposes a new taxonomy of intrusion detection systems for industrial control systems based on various methodologies, including protocol analysis, traffic mining, and control process analysis. In addition, we examine the benefits and drawbacks of several types of intrusion detection systems, as well as highlight some future advancements in intrusion detection systems for industrial control systems, which do not focus on protocol difficulties. The structure and components of a typical ICS system are presented by Geng et al. [16]. After that, it simply examined the technological characteristics, system framework, and benefits and drawbacks of four different types of conventional ICS testbeds. Finally, it outlined ICS testbed application scenarios and highlighted several testbed construction issues. Knowles et al. [17] discusses the most up-to-date methods and studies for assessing and controlling this risk. A lack of security metrics particular to industrial control systems has been noted as a hindrance to using these techniques. As a result, a research agenda for future industrial control system security metrics is given; however, they do not assist us in understanding the protocol risk element. Yaacoub et al. [18] gives an overview of the major aspects of CPS, as well as the related applications, technologies, and standards. Furthermore, CPS security vulnerabilities, threats, and attacks are examined, as well as major difficulties and challenges. In addition, existing security methods are given and examined, with their primary weaknesses identified. Finally, based on the lessons learned throughout this exhaustive assessment, various ideas and recommendations are made, however, there is no protocol definition or detailed attacks on the system.

2.2 *ICS Layers and Components*

Industrial Control Systems is abbreviated as ICS. ICS is a generic word that refers to a variety of control systems and their associated equipment that are used to control and monitor industrial operations. For the purposes of running and supporting critical infrastructure, ICS combines hardware, software, and network communication. ICS systems collect data from remote sensors and give commands to the machinery, instructing it to conduct the proper actions.

ICS systems, for example, may use data from remote sensors to determine whether a piece of machinery is overheating. If it is, it may issue shutdown commands to the machinery. As a result, ICS systems ensure that industrial operations function smoothly and provide an easy means for operators to remotely monitor, control, and manage industrial processes.

Components of ICS: ICS is a generic word that refers to a variety of control systems and their associated equipment that are used to control and monitor industrial operations. For the purposes of running and supporting critical infrastructure, ICS combines hardware, software, and network communication. ICS systems collect data from remote sensors and give commands to the machinery, instructing it to conduct the proper actions. ICS systems, for example, may use data from remote sensors to determine whether a piece of machinery is overheating. If it is, it may issue shutdown commands to the machinery. The mapping of all layers with components is shown in Fig. 1.

SCADA: SCADA isn't a solution that can provide you a complete control. Instead, its skills are geared at giving supervisory control. Scattered throughout the building are SCADA devices (mainly PLCs or other commercial hardware modules), which communicate with each other. An HMI (Human Machine Interface) is typically integrated with SCADA systems to provide centralized monitoring and control of

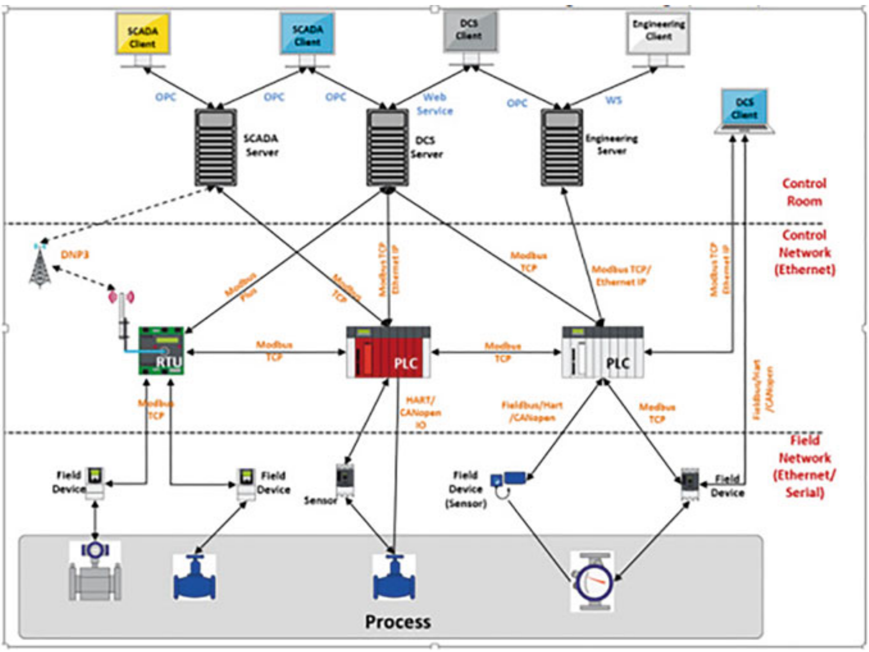

Fig. 1 Communication protocol in ICS infrastructure

various process inputs and outputs. SCADA's primary function is to provide long-distance supervision and control. Water treatment, pipelines, and electric power all use it.

DCS: This is a solution for controlling several manufacturing systems from a single location. A setpoint is communicated to the controller in a DCS, which can tell valves or even an actuator how to function so that the desired set point is maintained.

IT and OT: Enterprises benefit from improved integration and visibility of their supply chain, which includes essential assets, logistics, plans, and operational procedures, thanks to the convergence of IT and OT. Having a clear picture of the supply chain can help businesses stay competitive. On the other hand, the convergence of OT and IT makes it easier for cybercriminals to obtain entry into all these two aspects. OT infrastructure is at best inadequately safeguarded against cyber threats in many enterprises.

PLC: A PLC serves the same purpose as Remote Terminal Units in SCADA (RTU). PLCs are utilized as local controllers in DCS as part of a supervisory control scheme.

RTU: An RTU is a field device controlled by a microprocessor that receives commands and sends data back to the MTU.

HMI: A graphical user interface (GUI) program that allows the human operator to interact with the controller hardware. It can also show device status and history data gathered by the ICS environment's devices.

Control Server: The DCS or PLC supervisory control software is hosted on a control server, which connects with lower level control devices.

3 Results

The following section is divided into three research questions We are finding the questions from literature survey as follows.

3.1 What Are Different Protocols Using in Various Applications?

From the different papers, we found that very few researchers find out which protocol is majorly used in different IoT devices. Table 1 helps the reader understand which protocol is used by the different devices. Like RS232 [21], RS-485 [17] is used in different devices, such as in industry 4.0, SCADA, and in all the different devices, but this protocol is not useful in the smart home. Similarly, Modbus and DNP3 are used in almost every device because they help us communicate with different devices. Hart is mainly used in different automation systems. ICCP/TASE 2.0 is widely used

Table 1 Different devices using ICS protocol

Protocol	Layer	Device							
		Smart home	Oil refinery	Smart grid	Water management	Medical devices	Scada	Smart cars	Smart supply
RS232 [21]	Serial communication		✓	✓		✓	✓	✓	
RS-485 [17]			✓	✓	✓	✓	✓	✓	
Modbus [19]	Tcp/ip	✓	✓	✓	✓	✓	✓	✓	✓
DNP3 [20]		✓	✓	✓	✓	✓	✓	✓	✓
Hart	Physical layer		✓	✓	✓	✓	✓		
TASE 2.0	Tcp/ip/layer 7		✓	✓	✓	✓	✓		
ICCP			✓	✓	✓	✓	✓		
CIP [22]	Data link layer		✓	✓	✓	✓	✓		
Profibus	Serial communication		✓	✓	✓	✓	✓		
Profinet	Serial communication		✓	✓	✓	✓	✓		
Foundation fieldbus [22]	Data link layer		✓	✓	✓	✓	✓		
Bacnet			✓	✓	✓	✓	✓		

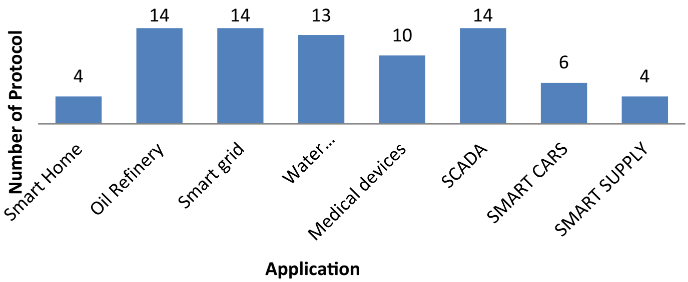

Fig. 2 Application using various ICS protocol

for wireless communication between different devices at two or more centers. The Foundation Fieldbus is intended for nuclear power plants and is equipped with a high-speed Ethernet interface. We show that DNP and communication protocols are widely used in many applications in Fig. 2.

3.2 *What Are the Different ICS Protocols Having Issues in Security Pillar?*

Each of the systems in an ICS must be accessible to a wide range of people. The ICS faces a hurdle in authenticating and authorizing these users. As employees are recruited, terminated, and their roles change, managing these user accounts can be a challenge. As an example, managing the increasing number of systems and users is becoming increasingly complex. The process of authenticating a user's or system's identification is known as authentication. Acknowledgment Authentication rules are applied to authenticated users to govern the process of providing them access privileges. Table 2 describes which protocol provides confidentiality, integrity, and availability. Access control mechanisms are used to ensure that only authorized individuals can access a certain resource. Both systems (e.g., HMIs, field devices, remote substations, LANs, etc.) can be controlled by the authentication process. We analyze Fig. 3 based on how many protocols are mapped with the security pillars.

3.3 *How Many Different Paper Studies on ICS Protocol Attacks?*

The latest industrial control system (ICS) threats and assaults have made headlines around the world. Trendlines can be traced back to the 2015 Ukraine power outage, which was followed by an attack on safety systems at a Saudi Arabian oil and gas site in 2017 [31]. Attacks are becoming more sophisticated, but they avoid using

Table 2 Mapping of protocols with CIA security pillar

Protocol	Description	Security pillar (CIA)		
		Confidential/authentication	Integrity	Availability
RS232 [21]	Low speed and shortest distance and allow only one transmitter			✓
RS-485 [21]	High speed over long distance and allow full duplex			✓
Modbus [19]	Serial communication protocol		✓	
DNP3 [20]	Distributed Network protocol, it's a three-layer protocol		–	✓
Hart [29]	Highway addressable remote transducer is open source for analog and digital protocol	✓	✓	
TASE 2.0 [30]	Inter-control center protocol is TASE 2.0.it is desgined for WAN	✓	✓	–
ICCP [28]	Inter-control center protocol is TASE 2.0.it is desgined for WAN		✓	
CIP [22]	Common Industrial Protocol, it is widely used in industry		✓	✓
Profibus	It is serial protocol			✓
Profinet	It is a advance version of profibus			✓
Foundation fieldbus [22]	Refining and replace the analog connection	✓	✓	
Bacnet	Building automation and control		✓	✓

malware and techniques that are obvious signs of advanced adversary activity; and second, only at the final stages of intrusions is complex malware introduced to codify ICS-specific knowledge so that nearly any computer network operations operator can perform complex commands. As we know, ICS attacks are becoming more popular, so Table 3 will help industrialists and researchers to make protocols more secure from

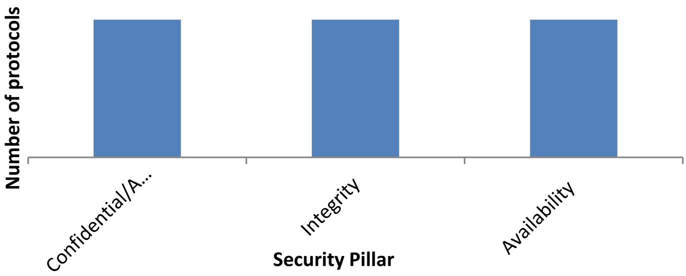

Fig. 3 Security issues in protocol

such types of attacks. From this analysis in Fig. 4, we identify that DNP, Modbus, and application layer protocols are phasing out so many attacks rather than network-layer protocols.

4 Conclusion

A bifurcated approach that incorporates commodity, "living off the land" techniques for the majority of actions on target with target-specific malware deployed only in the final stages of an attack has replaced ICS-focused attacks that previously relied almost exclusively on custom toolkits and software. ICS security is always a concern, not withstanding the recent rise in the use of big data analytics and cloud computing. Even though cloud platforms will assist ICSs and eventually the industry as a whole; yet, the lack of effective security in novel multi-cloud platforms may lead to a large cost associated with security breaches in real-time industrial platforms. Zero-day attacks and rootkits have made it extremely difficult to prevent and detect attacks at the ICS component level because of their high level of sophistication. A novel approach is needed to protect process control systems against intrusion detection technologies. Machine learning approaches have shown to be extremely helpful in this regard. We examined the most commonly used industrial control protocols in this article. There are many different protocols for industrial control systems, and we covered all of them. By applying this taxonomy, cyberattacks on industrial control systems (ICS) and control protocols can be classified. The results of this taxonomy will be used in the future to conduct a risk assessment on ICS prior to design and to specify the security countermeasure by including security requirements and services in the ICS Design stages. These security issues help researchers to understand that there are many issues and attacks done on the protocols. Our next project will be to redesign the protocols so that they incorporate security services for integrity and authentication. Ultimately, researchers and industrialists need to think about the standardized design of the protocols' services.

Table 3 shows a variety of ICS protocol attacks

Protocol	Attack's									
	Lack of encryption/authentication	DOS	XML injection	SQL injection	FDIA	CRC Check	Spoofing attack	Session hijacking	WAN Attacks	Man in the middle attack
RS232 [22]										
RS-485 [23]										
Modbus [24]	✓									
DNP3 [25]	✓			✓		✓				
Hart [26]	✓		✓				✓			
TASE 2.0 [27]	✓						✓	✓		
ICCP [27]										✓
CIP [30]										
Profibus[31]										
Profinet [32]										
Foundation fieldbus [34]										
Bacnet [33]									✓	

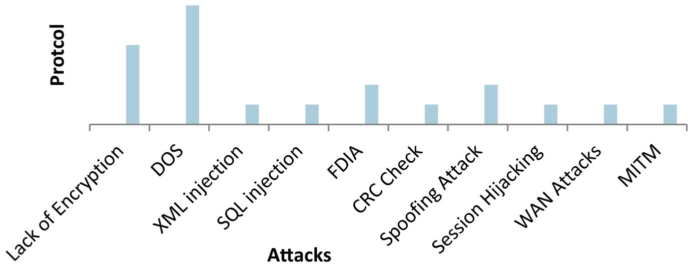

Fig. 4 Attacks on ICS protocol

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Comprehensive Prediction Model for Player Selection in FIFA Manager Mode

Usha Divakarla, K. Chandrasekaran, K. Hemanth Kumar Reddy, and Manjula Gururaj

Abstract Game is one of the most entertaining shows for today's all generation peoples, particularly Football in most part of countries of the world. Football as a sport is only growing more and more popular every day. It is currently the world's most-watched sport and has the highest viewership audience. As a result, a whole industry has arisen around this sport with one important part of it being FIFA. The amount of budget allocated and the number of persons involved in a Football game directly or indirectly can affect the financial budget of a person to a federation's finance. In such cases, player selection for a finalist from the federation is the most crucial task. Every year different approaches were investigated for player selections, but none of them was regarded as the best approach for team selection. Thus, there is a need for a standard approach for finding out the perfect players for their teams with the exact qualities that they demand. In response, we have developed a machine learning model that predicts players who could replace a current existing player in a team. Along with that, we have also incorporated Data Analytics that helps us decide which factors would be more important than others. The proposed prediction model is implemented and the results of our machine learning (SAGA-ML) tool are applied to Electronics Arts' FIFA Soccer game.

U. Divakarla (✉) · K. Hemanth Kumar Reddy · M. Gururaj
NMAM Institute of Technology, Nitte, Karkala, Karnataka, India
e-mail: ushachavali@gmail.com

K. Hemanth Kumar Reddy
e-mail: khemant.reddy@nitte.edu.in

M. Gururaj
e-mail: dr.manjulagururajh@nitte.edu

K. Chandrasekaran
National Institute of Technology Karnataka, Surathkal, Karnataka, India
e-mail: kch@nitk.edu.in

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1 Introduction

FIFA, also known as FIFA Football or FIFA Soccer, is a series of association football video games or football simulators, released annually by Electronic Arts under the EA Sports label. The Guardian called the series "the slickest, most polished and by far the most popular football game around". In the game, users build a team using the huge roster of 8000 players using which they either play or simulate matches online or offline. The players can be transferred between teams so that each club can build its team depending on what kind of players they require. For example, a small team would prefer young players who have a low overall rating and high potential as they would be cheap and would be a good investment when they get older [1]. A bigger team would prefer players that are of moderate age and have good experience and also high potential ratings. Players develop their current overall to higher or lower values depending on their performance and potential which vary with many factors [2]. There are various factors that affect the maximum potential a player can reach such as but not limited to age, country and position. We will use these factors to create a model that helps suggest players depending on the user's requirements. We are going to see how these factors are related to each other and how we can use these constraints to find out the required player for signing for a particular team with a particular demand.

We are going to do in-depth exploratory data analysis on the player ratings in FIFA 19. By doing so, we would be able to say which features are highly correlated with a player's overall rating with respect to player position and its overall value. Further analysis would help tell how the differences between a player's current rating and their potential rating can be understood and used to the user's advantage. Furthermore, we can find out which players have the highest potential and till when can they sustain it, so that we can estimate how many years they can play for the club hence adding to the players' value. Thus, the exploration of data will help us find out if there is someone with the same skills/potential, can they be found for a bargain? The final outcome would involve producing a list of players who would be the best fit for a particular position. To complete this, however, we will also have to age cost of the player that we are buying. This filter is used at the end and then the list is displayed. It is an extremely integral component of the future of the whole FIFA career mode game and the process of scouting of players in the game as well as real life as it explores deeply into all the possible contributing factors of player's rating and value in a very modern and advanced way. A number of prediction approaches are proposed in the literature in this context, whereas this article presents a comprehensive prediction model that used a data analytics approach for finding the player features that impact the game outcome and a machine learning approach to predict the list of players best suited for a team with all specified constraints.

The rest of the paper is organized as follows. Section 2 presents the detailed literature study, and details nut shell of the prediction model is presented in Sect. 3. The implemented details of the proposed model are presented in Sect. 4, the model efficacy is presented in Sect. 4 and the work is concluded with a future direction in Sect. 5.

2 Literature Review

In [3], Tiffany D Do et al., presented a prediction model to predict the ranked-based game outcomes using a Deep neural network-based approach and were able to predict them with 75.1% accuracy. The proposed model used for League of Legends and matchmaking uses individual player's skill information. Whereas in [4], R Ani et al., proposed a machine learning-based prediction algorithm to predict the winner of a League of Legends of a multiplayer online battle arena game. The proposed model is able to extract the significant features that impact the game outcome. İn [5]. Chen Z et al., proposed a prediction approach that predicts the player's level of skill sets in multiplayer online battle arena games. The proposed model decomposes the skills of players that impact the game outcomes. The proposed models are focused on predicting the players' skills that impact the game outcome of online games, and offline games are quite different than the online like the surrounding environment, location, timing and other parameters too. Due to the above differences, offline game behavior is quite different than online games. Apart from prediction for online games, there are techniques proposed for predicting offline games using different optimizing techniques and other approaches. In [6], Kanren et al., proposed optimization-based comprehensive learning to bid framework that optimizes the three parameters as a joint optimization problem, and the authors proposed a bidding machine that predict and regularly update itself using offline and online mode.

The machine learning-driven portfolio optimization methodology mainly uses virtual bidding in electricity market and was proposed by Wu et al. [7]. In the electric city market, there will be lots of risks and price fluctuations present. To have the maximum profit, there are many standalone proprietary trading algorithms that may be built by the firms. The market clearing algorithm's inter-hour dependencies are used to build a recurrent neural network-based Locational Marginal Price (LMP) spread forecast model. The LMP spread sensitivity with respect to net virtual bids is addressed as a homogenous function using the suggested constrained gradient boosting tree.

The bidding has extended to the advertising department to predict the bidding in the advertising for the winning price in the DSP (Demand-Side Platform) [8]. This is done by using the proper bidding value in the RTB (Real-Time Bidding) auction. By using the machine learning and statistical methodology, the train is done to predict the winning price. The fact that a DSP's winning price is sometimes suppressed, especially for previously rejected bids, is a serious challenge. To solve it, the authors employed a censored regression model, which is commonly used in survival analysis and econometrics, to fit the censored bidding data. The censored regression assumption, on the other hand, does not hold true for the genuine RTB data. As a result, the authors proposed a mixed model that includes linear regression on bids with observable winning prices and censored regression on bids with censored winning prices, both of which are weighted by the DSP's winning rate. According to the results of the experiments, the proposed mixture model outperforms linear regression in terms of prediction accuracy in general.

The shill bidding is based on the fusion-based model proposed by Park et al. [9]. This proposed model is divided into two sections, 70% training and 30% validation. The first module consists of two machine learning algorithms called Support vector machine (SVM) and Artificial neural network (ANN) that were trained in parallel on the same dataset and predicted bidding fraud. These models' predictions are fed into the fuzzy-based fussed module, which determines the actual output based on SVM and ANN predictions. It forecasts whether or not a bid has been tampered with. Continue bidding if the behaviour is normal; otherwise, cancel the bid and block the user. The proposed fussed machine learning approach has a prediction accuracy of 99.63%. The proposed fussed machine learning methodology produces more appealing outcomes than state-of-the-art published methods, according to simulation findings. Bidding tool used is versatile and it was proposed with the new algorithms in the area of civil and constructions.

The systematic tool helps for decision making for bidding to construction, maintenance, engineering and startup operations. Technical Risk Extraction and Design Parameter Extraction were created using machine learning and AI algorithms to extract and analyse hazards in the project's technical specifications as proposed by Thomas et al. [10]. Technical Risk Extraction and Design Parameter Extraction are the two digital modules based on machine learning and AI algorithms, and logistic regression was designed to extract and analyse hazards in the project's technical specifications [11]. Even heuristic approaches can improve the performance [12]. Technical risk keywords in bidding technical specifications are collected, lexiconized and then extracted using phrase matcher technology and a machine learning natural language processing technique, in the Technical Risk Extraction module. The Design Parameter Extraction module compares the gathered engineering standards' as such standard design parameters with the plant owner's technical requirements on the bid, allowing a contractor's engineers to find and negotiate differences. The design risk extraction accuracy of the system module has a relative advantage of 50% or more, compared to the risk extraction accuracy of manual evaluation by engineers, as a result of the pilot test done to validate the performance and validity of the two modules. Furthermore, the automatic extraction and analysis of system modules are 80 times faster than the engineer's human analysis time, reducing project loss due to design risk analysis errors or omissions during the project bidding stage with a predetermined deadline.

3 Comprehensive Prediction Model

The comprehensive prediction model consists of two major submodules namely the data analytics module which is incorporated to find the best features of the players

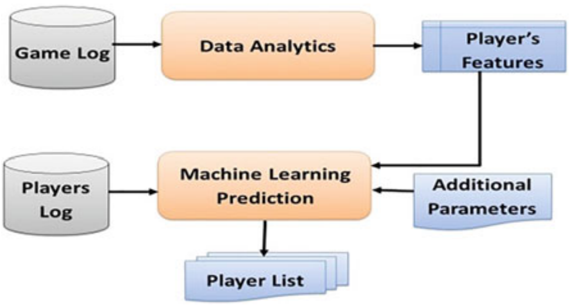

Fig. 1 Overall architecture comprehensive prediction model

that impact the game outcome, whereas the second submodule is a machine learning approach which is incorporated to predict the best players from the set of available players. Figure 1 depicts the overall components level diagram of the comprehensive prediction model. The following subsections present the details of these submodules.

3.1 Architecture of the Proposed Model

As we all know that football is a complex game and selecting the best player for the team is the toughest task. Our proposed model helps in selecting the best player for the team. Figure 1 represents the architecture of the proposed model. The model consists of components like Game Log, Player Log, Data Analysis, Machine learning Prediction, Player features, Additional parameter and player list.

The game log contains details of the game like rules, number of teams, number of players and all the details with regard to the game. Player log contains details like player name, age, performance, etc. Using the details of the game log set of teams and players is analysed by the data analysis which also considers the players' features requirements stored in player features. By combining the details from the player feature and data analysis, a machine learning algorithm will predict the tentative players list who can become the positive players for the respective teams.

3.2 Primary Data Analysis Approach

To start with, the dataset was used from Kaggle which contains about eighty nine columns, each displaying a different parameter of the player, such as Nationality, Overall, Shooting and Position. It also contains a total of 8226 players with unique photographs for each. Given so much data, we require some beginning data exploratory analysis to help us decide which factors might be contributing more towards a player's capability to fit into another team and perform there. This beginning analysis can also help us by allowing us to check the accuracy of our model after we complete it. As we know, football is quite a complex game [3] and you cannot exactly say which player would be able to perform better at a specific team or game [4]. There could be many other factors such as homesickness or language barriers. However, we will be focusing more on the technical side, that is, how he might be helping his other teammates or how much he might improve. To decide which factors might be the most important in contributing, we first studied the relations between various important parameters.

3.3 Machine Learning Approach

Machine learning is the scientific study of algorithms and statistical models that computer systems use to effectively perform a specific task without using explicit instructions, relying on patterns and inference instead. It is seen as a subset of artificial intelligence. Pattern classification tasks can be grouped into two main sub-categories: Supervised and unsupervised learning. In supervised learning, the class labels in the dataset, which are used to build the classification model, are known. For example, a dataset for spam filtering would contain spam messages as well as normal messages. In a supervised learning problem, we would know which message in the training set is spam or ham, and we'd use this information to train our model in order to classify new unseen messages. Our model is able to predict a player that would be the best fit to replace another player that the team had before. The output is a list of players who are closest in skill and talent. Also, it automatically tries to place younger players with higher potential towards the top of the list. Since there is a high presence of outliers in our data, we have used the k-NN (K-Nearest Neighbours) algorithm to help us design our model. In recognizing patterns, the k-nearest neighbours algorithm (k-NN) is a non-parametric method that can be used for both classification and regression. In both cases, the input consists of the k closest training examples in the feature space. In our model, k-NN is used for classification. In k-NN classification, the output is a denotation to a class. An object is classified by the neighbours that are present near it, with the object being assigned to the class most present among its k-nearest neighbours (k is a positive integer, typically small). If $k = 1$, then the object is simply assigned to the class of that single nearest neighbour. In our model, we scale down all the factors into different subplots, using the StandardScaler function. We then compare which players are having close values, and then depending on the nearest neighbours, we decide which players are similar to one another. In our model, we have taken the value of k as 6 and chosen the method "Ball-tree" to help plot the points on the graph.

Although, we cannot actually predict if a player might function properly due to other reasons such as player-coach relationship, adapting to new location and league, skill-wise they should be the best fit.

4 Implementation

Based on our knowledge of football, the most important parameters to buy a new player were decided as his age and potential. If he was a younger player with a higher potential, then he would be a better buy. In order to analyse this, we plotted graphs for each age group to map the overall and potential changes. We found that the overall and potential of a player is usually met at the age of twenty-nine, and they usually reach their peak around that age and after that do not improve much. We also mapped all of these factors by position and realized that usually it is defenders that end up playing for a longer time and are able to keep their overall stability for quite sometime towards the end. All these observations were accomplished with the help of Pandas.

Once the tables were designed, we created the graphs using Matplotlib, which is another Python library for plotting graphs. The teams that the players played for also mattered because we calculated the average ages of all the teams and realized that some teams used older players while others would have a line-up with younger squads. We also analysed the top teams in the game to find how they managed their players and realized that the top clubs usually had players who were at their peak or those who were just hitting the right stride. The top international teams, however, had players of different age groups since the players would only come together every four years for an event like the World Cup. However, the World Cup winners generally had players who were the top for their respective clubs.

5 Result Discussion

Multiple graphs and histograms were developed based on the collected database, which would help in understanding the different relationships between age, position the player is playing, overall rating, potential increase, nationality and football clubs.

The age and potential growth relationship curve is represented in Fig. 2. The age is plotted in the x-axis and players' rating at that age is plotted on the y-axis. It shows us that most players tend to increase their rating till the age of 30. After that, the rating remains stable for sometime. and by the time they are of the age 34, their ratings start to decline as shown in the graph below.

This means that it is advisable to buy a player before they turn 30, because after 30 they don't improve much and it would be more valuable to invest in younger players. This also shows that 30 is the peak age of performance of any player; therefore, if a player is at 30 it is less likely that their ratings would go up.

Figure 3 represents the relationship between a player's overall and their potential rating. This has been designed for the top 20 players with the highest potential. With this graph, we can infer which players will be a good buy just by looking at the overall and potential. However, this graph is not good enough since it does not show us the age and other important details. Along the y-axis, we have plotted the names

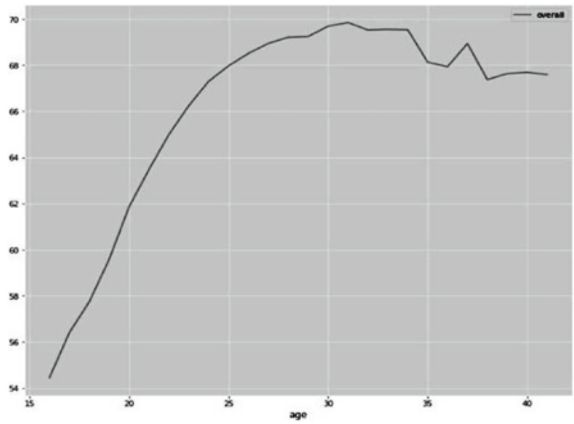

Fig. 2 Graph of the age and potential growth relationship curve

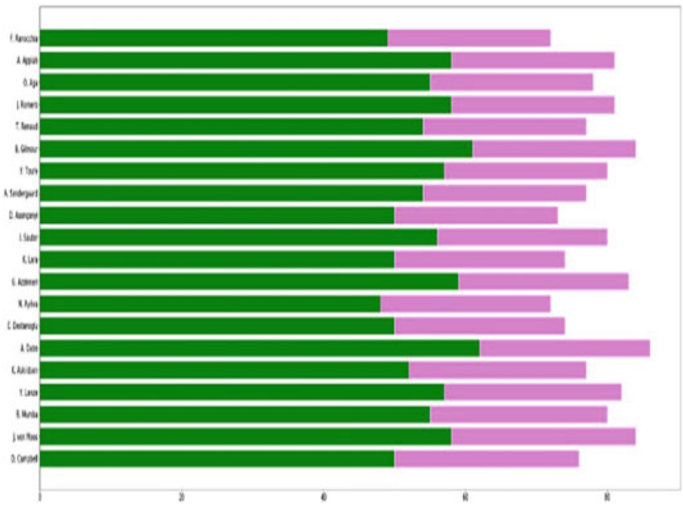

Fig. 3 Graph of relationship between a player's overall and their potential rating

of the players and the x-axis ranges from 0 to 100. The green bar shows the overall and the pink bar shows the potential.

Figure 4 represents the average ages and average overalls of the top 20 clubs. We can clearly see that most of the best teams have players of the age around 24 as well as players rated around 90. This shows that it is good to invest in 24-year-old players and make them play often as they can have better development and thus are a better investment.

As for the verification of our results, when we compared the results of our model to that of the vector simulator, we found that our model only works for the top

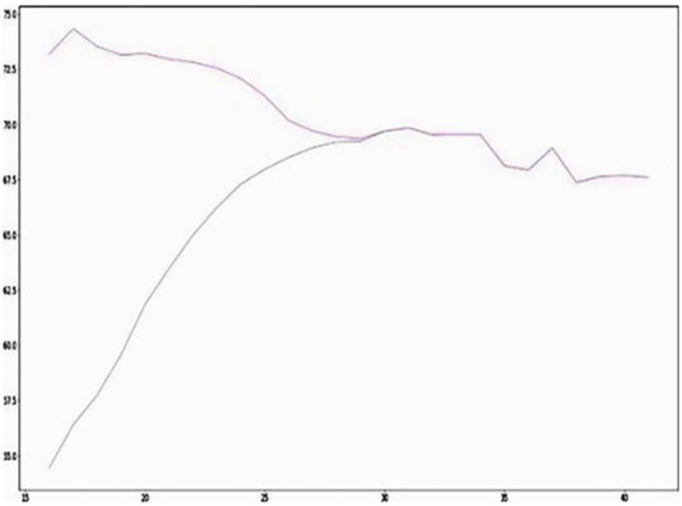

Fig. 4 Histogram showing the average ages and average overalls of the top 20 clubs

few players but later branches out. As compared to other models or similar works, we do not have the exact numerical value of accuracy that can be used. A factor that contributes to this is the fact that we cannot divide our data into different sets. However, we believe that our model does give a general sense of which player a user could choose as a replacement for a current player that he owns. The predicted values come from the dataset itself and even through our own knowledge of football, we can acknowledge that the results make a lot of sense.

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