Lecture Notes in Networks and Systems 615

M. Shamim Kaiser
Juanying Xie
Vijay Singh Rathore *Editors*

Information and Communication Technology for Competitive Strategies (ICTCS 2022)

Intelligent Strategies for ICT

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Lecture Notes in Networks and Systems

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Preface

Seventh International Conference on Information and Communication Technology for Competitive Strategies (ICTCS-2022) targets state of the art as well as emerging topics pertaining to information and communication technologies (ICTs) and effective strategies for its implementation for engineering and intelligent applications.

The conference is anticipated to attract a large number of high-quality submissions, stimulate the cutting-edge research discussions among many academic pioneering researchers, scientists, industrial engineers, students from all around the world and provide a forum to researcher; propose new technologies, share their experiences and discuss future solutions for design infrastructure for ICT; provide a common platform for academic pioneering researchers, scientists, engineers and students to share their views and achievements; and enrich technocrats and academicians by presenting their innovative and constructive ideas; focus on innovative issues at international level by bringing together the experts from different countries.

The conference was held during December 9 and 10, 2022, physically at The Fern Residency, Chandigarh, India, and digitally on Zoom organized by Global Knowledge Research Foundation.

Research submissions in various advanced technology areas were received, and after a rigorous peer-review process with the help of program committee members and external reviewer, 143 papers were accepted with an acceptance rate of 16%. All 143 papers of the conference are accommodated in 2 volumes, also papers in the book comprise authors from 13 countries.

This event success was possible only with the help and support of our team and organizations. With immense pleasure and honor, we would like to express our sincere thanks to the authors for their remarkable contributions, all the Technical Program Committee members for their time and expertise in reviewing the papers within a very tight schedule and the publisher Springer for their professional help.

We are overwhelmed by our distinguished scholars and appreciate them for accepting our invitation to join us through the virtual platform and deliver keynote speeches and technical session chairs for analyzing the research work presented by the researchers. Most importantly, we are also grateful to our local support team for their hard work for the conference. This series has already been made a continuous series which will be hosted at different location every year.

Dhaka, Bangladesh	M. Shamim Kaiser
Xi'an, China	Juanying Xie
Jaipur, India	Vijay Singh Rathore

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About the Editors

Dr. M. Shamim Kaiser is currently working as a professor at the Institute of Information Technology of Jahangirnagar University, Savar Dhaka-1342, Bangladesh. He received his Bachelor's and Master's degrees in Applied Physics Electronics and Communication Engineering from the University of Dhaka, Bangladesh, in 2002 and 2004, respectively, and the Ph.D. degree in Telecommunication Engineering from the Asian Institute of Technology (AIT), Pathumthani Thailand, in 2010. His current research interests include data analytics, machine learning, wireless network and signal processing, cognitive radio network, big data and cybersecurity, and renewable energy. He has authored more than 100 papers in different peer-reviewed journals and conferences. He is an associate editor of the *IEEE Access Journal* guest editor of *Brain Informatics Journal* and *Cognitive Computation Journal*. Dr. Kaiser is a life member of Bangladesh Electronic Society; Bangladesh Physical Society. He is also a senior member of IEEE, USA, and IEICE Japan, and an active volunteer of the IEEE Bangladesh Section. He is the founding chapter chair of the IEEE Bangladesh Section Computer Society Chapter.

Dr. Juanying Xie is currently a professor with Shaanxi Normal University, Xi'an, China. She has been a full professor at the School of Computer Science of Shaanxi Normal University in PR China. Her research interests include machine learning, data mining, and biomedical data analysis. She has published around 50 research papers and published 2 monograph books. She has been an associate editor of Health Information Science and Systems. She has been a program committee member of several international conferences, such as the International conference on Health Information Science, etc. She been a senior member of China Computer Federation (CCF), and a member of Chinese Association for Artificial Intelligence (CAAI), and a member of Artificial Intelligence and Pattern Recognition Committee of CCF and a member of Machine Learning Committee of CAAI etc. She been a peer reviewer for many journals, such as *Information Sciences* and *IEEE Transactions on Cybernetics*.

She was awarded her Ph.D. in signal and information processing from Xidian University. She cooperated with Prof. Xiaohui Liu at Brunel University in UK from 2010 to 2011 in machine learning and gene selection research. She received an engineering master degree in the application technology of computers at Xidian University and a bachelor degree of science in computer science at Shanxi Normal University.

Dr. Vijay Singh Rathore is presently working as Professor-CSE and Director—OutReach Jaipur Engineering College and Research Centre, Jaipur (India), and Membership Chair, ACM Jaipur Chapter, and Past Chairman, CSI Jaipur Chapter. Having Teaching Experience of 20+ Years, 5 Patents published, 20 PhD Supervised, Published 94 Research Papers and 10 Books and associated as Editor and Reviewer in some reputed Journals, Received 20+ National and International Awards of Repute. His core research areas include Internet Security, Cloud Computing, Big Data, and IoT. He has organized and participated 25+ National and International Conferences of repute.

His foreign visits for various academic activities (Delegate/Invited/Keynote Speaker/Session Chair/Guest) include USA, UK, Canada, France, Netherlands, Singapore, Thailand, Vietnam, Nepal etc. He had been member of Indian Higher Education Delegation and visited 20+ leading universities at Canada (May, 2019), UK (July, 2017), and USA (August, 2018) supported by AICTE and GR foundation. Other Delegation visits include University of Amsterdam (2016), Nanyang Technological University, Singapore (2018), University of Lincoln, QMUL, Brunel University, Oxford Brookes University (2020) for discussions on academic and research collaborations.

He is an active academician and always welcoming and forming innovative ideas in the various dimensions of education and research for the better development of the society.

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Attainment of Program Outcomes in Outcome-Based Education: A Case Study with Operating Systems Course

H. M. Anitha, V. Shubha Rao, and P. Jayarekha

Abstract Teaching in engineering domain is a great challenge. Many innovative teaching methodologies have been inculcated in various courses of engineering education. Operating system (OS) is a core course of information technology and plays a vital role in various domains of IT industry. Effective teaching of OS course with appropriate pedagogical approach leads to deeper understanding of concepts and helps the student to gain thorough knowledge in the domain. Recently, outcome-based education (OBE) methodologies have established broad attention. The learning phase outcome proves the student's learning ability and demonstrates the knowledge gained. The impact of OBE is explored systematically using evaluation and assessment tools. This technique brings a very good impact on student's learning ability and enhances fundamental knowledge. The approaches discussed are problem-based learning and technical presentation on recent research trends in OS. These methods were identified and applied to develop a better perspective toward technical paper reading and implementation of a small module with in. The methodology aided students to comprehend the course better and built strong communication skills, also enhancing interpersonal skills. In this paper, OS course teaching methodology is proposed and implemented. Results clearly show that students have learned the course with at most interest toward gaining comprehensive knowledge.

Keywords Problem-based learning · Teaching learning process · Flipped classroom · Peer learning · Activity-based learning

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1 Introduction

Operating system is the core course in Department of Information Science and Engineering at BMS College of Engineering. BMS College of Engineering is one of the oldest and first private institutions in our country. It is the first institution to be National Board of Accreditation (NBA) accredited under tier 1 in Karnataka. BMSCE is an autonomous institute under Visvesvarya Technological University (VTU). Outcome-based education (OBE) is inculcated in engineering education. BMSCE adheres to the OBE pattern. OBE focuses on student-oriented learning with a measure in terms of outcomes. Outcomes are mainly level of student's development with attributes such as skills, knowledge and attitude. The progress of graduate is measured through OBE model with program education objectives (PEOs), program outcomes (POs) and course outcomes (COs). Program outcomes (POs) are the designed by the program in line with graduate attributes as per National Board of Accreditation. There are twelve Pos, and among these twelve, eight POs are attained with operating system course. In this paper, using operating systems, course case study outcomes are reviewed and attainments are discussed.

OS concepts play a vital role in the life of an engineer. OS course is included in the second-year engineering curriculum. Operating system is a course involving topics such as scheduling algorithms, process synchronization, multiprogramming, memory management, file management and deadlocks. Traditional way of teaching operating system courses to students is challenging because of the theoretical concepts such as multithreading, process concepts, paging, swapping and kernel modules. Many approaches have been used by teachers, but there is no generic approach which is followed in engineering for operating system course.

The major challenge in the engineering education is to delegate the effective and application-level teaching to prepare the students to work in the current dynamically changing industry requirements. Effective teaching can be measured with student's deep understanding and analysis of the course. In order to impart the quality in education, the traditional and formal way of teaching may not be sufficient. Hence, it is required to adapt changes in the teaching methodology in engineering institutes. Monotonous teaching might result in lesser student participation in the classroom activities and knowledge reception might be less. By incorporating the pedagogical approaches, the student involvement can be enhanced.

Due to dynamic changes happening in the current life, operating systems have importance in many areas such as flight simulation, modern devices such as television, mobile devices, kitchen appliances and many more. The student will be learning the features of operating systems in a more general way not sticking to any particular operating system. The course explores different types of OS such as windows, Linux, Mac OS and Solaris. Seminar on recent research trends in operating systems is an approach where students can explore latest happenings on the topics in line with theory concepts. Problem identified during the research analysis is implemented using suitable programming language and documentation is submitted. In this paper, the implemented approaches such as problem-based learning, activity-based learning and seminar on recent trends in operating systems are discussed in detail and justified with outcomes. All these three pedagogical approaches were evaluated by the course teacher with two reviews. The two reviews are facilitated by the course instructor. Rest of the paper is organized as follows: Sect. 2 presents the literature review, Sect. 3 describes background, Sect. 4 starts discussing the course delivery approach, Sect. 5 observation and inferences and Sect. 6 concludes paper.

2 Literature Review

A software tool which is interactive could help the students to learn Linux OS. Garmpis et al. [1] noticed that difficulties are reduced using the tool. There are advantages of the software tool such as convenience in usage for desktop files from any part of the world. No manual installation is required as automatic updates are provided and secured from different attacks. Teaching the course with a regular theoretical approach is followed in most of the courses. Teaching with analogies has several benefits such as real-world connection, student's knowledge in the subject gained earlier and student's visualization process will be enhanced. In [2], Patil et al. have proposed the teaching with analogies for the operating system course. The process followed toward this approach is an introduction to the topic, finding the students familiarity with the analogy, correcting the wrong assumptions made by the students and appropriate conclusion is derived. Analogy for various topics of OS is discussed in the class. The topics considered for discussion are fragmentation, paging, segmentation and demand paging. Analogies provided are train reservation, contents of the book and search engine. An innovative teaching methodology [3] has been incorporated to teach high performance computing by providing software tools such as simulators, resources for active learning in the class to develop skills. Students were facilitated to use the OPNET simulator in the first level. In second level, students were asked to configure several simulations with respect to the parallel computing and architectures. Authors observed that students were enriched with more knowledge in the course. By this technique, improvement of marks as well as confidence in the student with the course is achieved. Interactive learning is a requirement in the current teaching scenario for the students. They learn many things with virtual environments. Simulation and game-based techniques were implemented in [4]. This type of learning is incorporated in the curriculum. Students have learnt the concepts visually in a better way. It has shown the positive result in many engineering and management courses. Different scenarios are understood by students using simulation tools. Critical problems are solved using game-based activity. An interdisciplinary teaching learning approach is incorporated in [5]. The course is introduced by inculcating concepts of operating systems from computer science and embedded systems, electronics discipline. It is found that students were enriched with complete knowledge on the course. They were able to solve problems, implement projects and present papers in conferences and journals. This course contributed toward the outcome-based education.

3 Background

Traditional Teaching

Traditional teaching revolves around building the theoretical concepts and gives minimal importance to the practical applications. Traditional operating systems course is taught with theory concepts involving blackboard and PowerPoint presentation teaching. Students participate passively in the class with less interest toward course. Students here lack analysis ability with real-world application and hands-on perspectives. Normally, evaluation in traditional method is written mode of exams where students acquire theoretical contents from the textbook and reproduce in the exam. Traditional teaching process is shown in the Fig. 1.

Demits of Traditional Teaching Methods

- Teacher's responsibility is more in order to organize the class and deliver the material.
- Teacher has a great responsibility of controlling the class and make sure that students have understood the topic clearly.
- Information is disseminated using blackboard by the teacher toward students which is one sided and students make a note of the topics.
- This technique mainly involves students to clear and pass the examination.

Teaching using Pedagogical Approaches

Teaching using pedagogical approaches has taken an important milestone the higher education. The students learning of the course with these approaches have shown a positive result. The competency level of the teachers enhanced using these approaches. The formal and traditional teaching is more teacher centric and does not involve the students actively in the class. In providing the quality education to the students, pedagogical approaches contribution is more. Strong foundation and deep understanding of topics is achieved by the use of these approaches. Students' participation in teaching learning process and development of cognitive skills such as application and analysis of the topics is achieved with much higher rate. There is tradeoff between the traditional teaching and teaching with pedagogical approaches.

The advantages are listed below

- Students develop the understanding of the concepts deeply with active participation in the classroom activities.
- Teacher's competency level is increased to a greater extent.

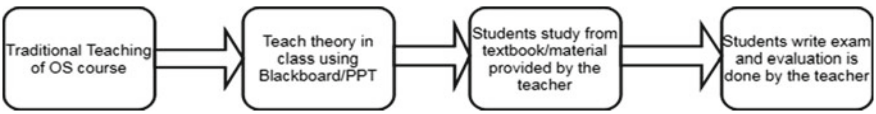

Fig. 1 Traditional teaching process

- Student's holistic development will be the attained.
- Students are more responsible and develop soft skills, collaboration with peers is achieved.

Pedagogical Approaches

The activities planned in engineering domain will pave the way for economic advancement in a longer run. Hence, it is the responsibility of the engineering colleges to provide the qualified and skilled professionals to the industry to improvise economy. Pedagogical approaches help in contribution toward this contribution. Students who are comfortable with teaching methods used by the course instructor will tend to learn the course in a better and useful way. Students will be able to do analyses and apply the concepts in exams. Every pedagogical approach has its own benefits with students learning and performance in the evaluations conducted by the course instructor.

Many pedagogical approaches are followed in the engineering education. It is not advised to implement a same approach for different courses. Each course has its own requirements and criteria to impart the knowledge among the students. Some of the most commonly [6] used approaches are discussed below.

(1) Individual participation of students is encouraged through cooperative learning technique. This technique allows students to think, pair and share the concepts. This method encourages students to think critically the internal process, organize, retain ideas and communicate effectively the notions related to the subject.

    Think: Independent thinking to form new ideas based on questions posed.
    Pair: Discussion held in pair groups to share thoughts.
    Share: Sharing of ideas among paired groups.

(2) Cooperative learning technique enables effectiveness in highlighting student's skill in Individual assessment, team recognition, teamwork and presentation of content. Students form small groups and work together under the teacher's guidance to learn a particular topic. This technique will aid the students to apply the concept learnt and develop the interpersonal skill. This approach will give all the students equal opportunity to work, self-responsibility and interaction among themselves.

(3) Flipped classroom [7] is a pedagogical, student-centric, active approach. In its spirit, students prepare for classes by watching videos, emphasizing them have a deeper knowledge and develop higher-order thinking skills. Students are allowed to discuss concepts on the basis of what they have learned from videos. The in-class learning activities include inquiry-based learning, active learning and peer learning.

(4) Peer learning encompasses a broad sweep of activities. Students of same class form groups to assist each other in understanding the course contents. It is a two-way reciprocal activity mutually helping students to share ideas, knowledge and experiences among them. This approach gives students learn the topic efficiently than traditional learning approach. Peer learning offers more opportunity for

students to practice and understand on their own responsibility. Identifying the peers in the classroom is very important and teacher will facilitate for the process of peer learning.

(5) Problem-based learning is an approach [8, 9] where students are assigned with a problem and asked to analyze the solution. It is student-oriented pedagogy and faculty facilitates the process of approach. As per the understanding of the student, faculty conducts reviews and evaluates. This approach pushes the student toward the critical thinking, deep analysis and develop independent quality. There are benefits of this approach such as develop interpersonal skills, critical thinking, working in teams and self-learning ability.

(6) Activity-based learning [10] is a pedagogical approach where students learn at their own speed and teacher facilitates. Students are assigned some activities in the class hour such as minute paper, pick a topic and speak and group quiz. In this approach, student builds confidence, and communication skills are also improved.

4 Course Delivery Plan

Course is designed by framing the committee involving academicians, industry people and aluminous. The course will be kept for review by the Board of Studies (BoS) members and is the final stage of course approval. After this, course is included in the curriculum. Course outcomes are the ones which are attained after completion. Course outcomes are prepared and mapped with program objectives. Program outcomes are the learning results, which are specific skills attained by the student pertaining to the program.

The course outcomes (CO) focused to achieve for the operating system course are shown in Table 1

Course assessment method followed with 80% of continuous internal evaluation and 20% alternate assessment. Three CIEs were conducted out of which two best was selected.

Teaching Learning Process

Teaching learning process (TLP) includes several components to involve the students toward learning course. With this, TLP faculty impart knowledge to the students

Table 1 Course outcomes

CO1	Understanding basic concepts
CO2	Applying concepts to solve the problems related to process management, synchronization and deadlocks
CO3	Analyzing different algorithms of operating systems
CO4	Develop solutions for problems using different algorithms

Table 2 TLP of operating system

Lecture	Tutorial	Alternate assessment tool	
		Research analysis	Problem-based learning
• Three hours per week is conducted • Methods are PowerPoint presentation, blackboard, think pair share	• Two hours are conducted per week • Unix Shell commands to explore OS • TeachSim [11]-Simulator used to demonstrate the OS concepts • Activity-based learning is carried out with group quiz and worksheets were given to students for numerical problems like deadlocks, CPU scheduling and memory management algorithm	• Students were informed to form a team of 4 • Students were asked to choose ten papers published in IEEE, Springer, ACM and Elsevier and explore to find the research gap • Publications not before 2015	• Once the research gap findings are completed, students provide a solution

effectively. Here, TLP comprises of lecture, tutorial, research analysis and problem-based learning (Table 2).

Outcome-based education [12, 13] gives weightage on what student is able to achieve at the end of the program with assessment methods designed by the faculty to attain.

The program outcomes [14] which are attained with the operating system course using the pedagogical approaches are PO1: Engineering knowledge, PO2: Problem analysis, PO3: Design/Develop the solutions, PO5: Modern tool usage, PO9: Individual and teamwork, PO10: Communication, PO11: Project management and finance, PO12: Lifelong learning depicted.

- Lecture: In TLP, the lecture is very important part. Along with regular teaching, classroom activities included the verbal quiz about scheduling algorithms, application of OS in the industries to enhance the effectiveness of teaching learning process.
- Tutorial: Every week, a tutorial was included as a part of TLP. Related to OS, practical concepts were taught in the tutorial. Worksheets are distributed in the class for the students. They are asked to frame the group of three or four students. They are assigned with different set of worksheets to solve the problems of OS concepts. They are given time of 20 min to solve the worksheets. Students discuss the given exercise in the worksheet and find the solutions. Course instructor walks

around in the classroom to find out if any students has any doubts. This kind of approach helped to inculcate the good communication skills, cooperative learning and teamwork. Students were given an insight of real working of OS concepts in OS simulator (TeachSim) and were asked to explore. Some of the sample problems are:

1. Page Replacement Algorithm

   Given page reference string: 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6
   Compare the number of page faults for LRU, FIFO and Optimal page replacement algorithm.
2. A system uses 3-page frames for storing process pages in main memory. It uses the first in first out (FIFO) page replacement policy. Assume that all the page frames are initially empty. What is the total number of page faults that will occur while processing the page reference string given below?
   4, 7, 6, 1, 7, 6, 1, 2, 7, 2
   Also calculate the hit ratio and miss ratio.

- Alternate Assessment Tool: As a part of AAT, the students will do research analysis and problem-based learning carried out in two reviews.

Alternate Assessment Tool

Research Analysis: Students in a team of 3–4 will deliver seminar on the topics assigned by the faculty and are asked to conduct exhaustive survey and present their idea. The evaluation was based on the rubrics by the faculty.

Problem-Based Learning: The student completes the research analysis, and the problem is found. They solve the problem and implement with programming language of their choice. Some of the problems implemented by students are crontab scheduler, I/O operations using system calls, multithreaded sorting, etc.

Research analysis and problem-based learning are part of alternate assessment tool (AAT), and weightage is 20% of the continuous internal evaluation.

Two reviews are conducted to assess the student shown in the Fig. 2.

The rubrics for evaluation are described below

Evaluation parameters of first review are:

- Students refer research papers relevant to operating systems course with a maximum of ten recent papers and minimum of three papers.

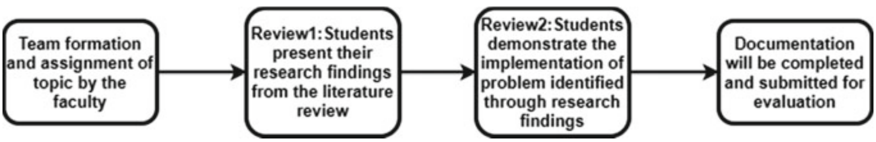

Fig. 2 Alternative assessment tool diagram

- Students have thorough understanding, analyses and derive the appropriate conclusions.
- Each batch of students will be given 15 min for presentation.
- All the research findings have to be well documented in a report format.

Evaluation parameters of second review are:

- Students should have thorough understanding and analysis of the research findings of review1.
- Implementation will be done using modern tools such as C++, Java, Python, etc.
- The mini project implemented should run correctly without any errors and pass all the test cases.
- Code documentation should be clearly summarized in a report format.

Here in the analysis of results, it clearly depicts the involvement of students toward learning. Faculty is facilitating the reviews, and students are actively participating in pedagogical approach followed in this course.

5 Observations and Inferences

Feedback from the Students

Students were asked to rate the phases of the reviews. Total participation across three sections was 100 students. The review questionnaires were shared through the online google form and there were good responses from the student community. They did support the new learning approach. Though a few students felt, the reviews were a little cumbersome to cope with other courses.

Review1 questionnaires are as follows:

A. Rate your level of understanding toward the research topic
B. Were you able to understand how to perform research analysis?
C. Was your work sufficient and needful toward building knowledge?
D. Was the time given to analyze sufficient?
E. Rate your learning from your teammate.

Review1 showed a positive response shown in Fig. 3. The understanding level of research papers was as expected. Some students found difficulty in searching the research papers for the topics. The topics like shared memory, deadlocks and page replacement were found scarce. At times, students felt the papers were very highly informative and were finding difficulty in understanding the research methodology followed. Students were from third semester and hence had less understanding on topics like fuzzy logic, machine learning and artificial intelligence. But they found the mathematics involved in the papers to be very easily understood. They were able to coordinate and make a good team to present their ideas. Few students faced the audience for the first time and hence had stage fear; communication was deliberately bad. But the teammates picked up the presentation till conclusion. Hence, the review

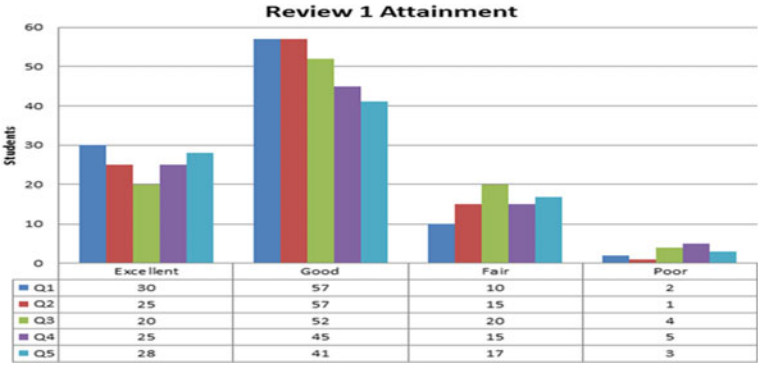

Fig. 3 Review 1 attainment

1 attainment had better and excellent responses and mere number of poor and fair responses. Review 1 maps to the program outcomes PO9: Individual and teamwork, PO10: Communication, PO11: Project management and finance, PO12: Lifelong learning.

Review2 questionnaires are as follows:

A. Were you able to analyze the problem statement?
B. Rate your problem-solving abilities
C. Were your coding skills improvised?
D. Were you able to derive conclusions from the solutions obtained?
E. Were you able to convey/present the ideas?
F. Rate your teamwork and contribution.

Students were able to decipher the problem statement found in the research analysis done in review 1. With the suitable discussions and suggestions from the mentors, they were able to implement the problem (solve problem or implement concept). They used programming languages like C, C++, Python and Java to demonstrate the solutions. Some students were unable to understand the requirements and constraints to solve the problem, while some had good approaches. There was a lot of exchange of programming ideas among the teammates, hence strong teams were built. Few students were incompetent to conclude the presentation in a fine manner, while others did a good job. Review maps to the program outcomes PO3: Design/Develop the solutions, PO5: Modern Tool usage, PO10: Communication, PO11: Project management and Finance, PO12: Lifelong learning. The review 2 analysis is shown in the Fig. 4.

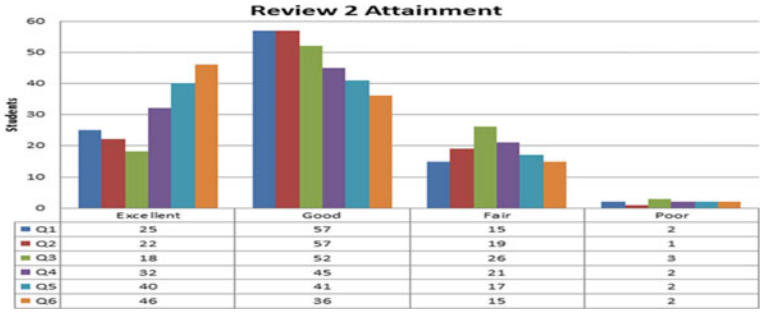

Fig. 4 Review 2 attainment

6 Conclusion

Problem-based learning and presentation of research a approached has instilled a good platform for students to look through a course in a better mode. Usually, textbooks learning and regular teaching do not promote challenges. To make concepts understand in a better way, this approach helps memory retention. They are more actively participating than idol observers or listeners. The methodology helped the students to understand the course better, thus leading to good results in semester end exams compared to earlier batches. Students built strong communication skills; also, interpersonal skills were enhanced. With the results shown, it clearly suggests that students have attained and learned the course with at most interest toward gaining thorough knowledge. In this paper, pedagogical approaches have aided the accomplishment of outcome-based education. The results clearly depict approaches applied in the learning of OS course has helped to attain POs such as PO1, PO2, PO3, PO5, PO9, PO10, PO11 and PO12.

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Classification of Iris Image Features Using Supervised and Unsupervised Learning

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Abstract The human iris is a very stable and distinct biometric feature that may be used to identify and/or authenticate any person in today's society. In recent years, it has attracted the interest of researchers. Iris biometry is a technique for recognising people in a natural and intuitive way. Many applications, such as airports, ATMs, and UID, employ an iris recognition technology. Four parts make up a standard iris recognition system. The first module utilised to collect images is image acquisition. Preprocessing is the second module, which consists of three steps: image localisation, normalisation, and enhancement. Feature extraction and matching are the following two modules. The feature extraction module extracts the most noticeable features from frames, while the matching module accomplishes the desired result by comparing and recognising individual objects. Classification of iris image features using supervised and unsupervised learning is the theme of the proposed research article.

Keywords Supervised learning · Unsupervised learning · Iris biometric

1 Introduction

Biometrics have significantly enhanced individual identification and verification, and they are crucial to ensuring the safety of individuals, nations, and the entire world [1]. Since it is stable throughout time and particular to each person, the iris is one of the most significant biological characteristics in biometry [2]. It is not necessary to make physical contact while using the iris picture capturing and evaluation technique [3]. Figure 1a depicts the human eye's iris and other features.

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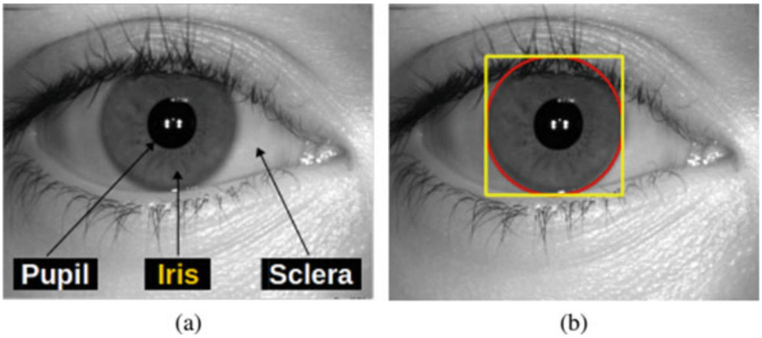


Fig. 1 **a** Periocular area's basic structural elements and **b** manual localisation of the iris using a bounding box

In identification, authentication, and identity systems, the position of the iris is frequently the first step [4], and as a result, it can have a direct impact on performance [5, 6]. It would be interesting to learn how the iris localisation stage affects such systems in this aspect. To do this, we advise benchmarking/assessing baseline strategies that might be applied to iris localisation. We begin by looking at some of the theories advanced in the literature.

The approach developed by Daugman, which suggests an integro-differential operator to detect the circular borders seen in the images, is the first and arguably most well-known method for iris localisation. By maximising the partial derivative with respect to radius, this operator maximises the optimal location while taking into account the iris' circular form [6].

A helpful method for iris localisation that makes use of border detection and the Hough transform was also covered by the author.

Spatial subsampling is done after low pass Gaussian filters are used to isolate the iris. Then, a set of criteria and the Hough transform are used to choose the sections that most closely resemble a circle [5]. The Daugman algorithm has a version that is presented by Tisse et al. To determine the pupil centre, this technique uses a gradient decomposition and a Hough transform. The iris margins are then located using the integro-differential operator. It benefits from removing errors brought on by specular reflection [7]. The inner and outer iris outlines were determined using two methods. The operator Daugman suggested is used to find the inner iris contour. The next step is to locate three dots that stand in for a triangle's vertices and are positioned around a circumference that mimics the iris' outer border. Although this method does not perform more accurately than the Daugman method, it fully exploits local texture variance and does not use any optimisation methods. The computational expense can be decreased as a result [8]. The author described a method for identifying irises that relies on the gradient analysis methodology to identify circular boundaries in the sites of interest of succeeding arcs. The quantified majority operator QMAOWA was used to generate a representative value for each consecutive arc. The iris boundary can be located by obtaining the arc with the highest representative value. With quicker processing times, the authors were able to produce results that were comparable to those of the Daugman technique [9, 10].

The first step of ZhuYu and Cui's method is the removal of the eyelashes using a dual-threshold technique, which is superior than current iris detection techniques. The facula is then eliminated via an erosion process. The Hough transform and least-squares approach are then used to determine the precise position [11]. A method for iris localisation that uses Vector Field Convolution (VFC) to foretell the iris's initial position was put out by Zhou et al. [12]. This preliminary estimate, as opposed to circle fitting, greatly improves location accuracy and reduces computational costs by moving the pupil placement closer to the real border. To arrive at the outcome, Daugman's algorithm [6] is utilised. Zhang et al.'s approach [13] uses a momentum-based level set technique [14, 15] to calculate the pupil border. The Daugman method was then used to locate the iris. Time is saved and Daugman's method produces better results when the beginning contour for momentum-based levels is determined using the least average grey level method. This enhancement happens as a result of the initial contour, like the Zhou et al. [12] approach, frequently being close to the actual iris inner border. Su et al.'s [16] recommendation for an iterative search method and regional property for iris location. The pupil area is calculated using the regional property of the iris image, and the iris inner edge is fitted by iteratively comparing, sorting, and fitting the pupil edge points. An iterative searching technique is utilised to finish the outside edge placement based on the retrieved pupil centre and radius. Numerous papers in the literature have shown how to perform iris localisation by computing a circle that delimits it (as shown in red in Fig. 1b), since iris normalisation is necessary in many applications. After normalisation, which entails converting the iris' circular region from Cartesian space to a polar coordinate system, the iris is seen as a rectangle. The altered image is typically used to extract representations and attributes for use in subsequent processes [17–24].

2 Methodology

2.1 Supervised Learning

Labelled data sets are used in machine learning techniques like supervised learning. To enable precise data identification or outcome projection, these data sets are used to "train" or "supervise" algorithms. It will be possible for the model to evaluate its accuracy and advance over time by using labelled inputs and outputs. Classification and regression are the two sorts of issues that can arise in supervised learning for data mining.

2.1.1 Classification

When solving classification problems, such as distinguishing between apples and oranges, an algorithm is utilised to properly divide test data into various groups. In contrast, supervised learning algorithms may be used in the real world to categorise spam and put it in a different folder from your inbox. Examples of classification methods include decision trees, support vector machines, random forests, and linear classifiers.

2.1.2 Regression

A supervised learning technique called regression makes use of an algorithm to ascertain the relationship between dependent and independent variables. Regression models can be used to predict data from a variety of data sources, such expected sales revenue for a particular company. Logistic regression, polynomial regression, and linear regression are three widely used regression techniques.

2.2 Unsupervised Learning

Unsupervised learning analyses and groups unlabelled data sets using machine learning algorithms. Without the assistance of humans, these algorithms analyse data to find unnoticed patterns (thus the term "unsupervised").

Applications for unsupervised learning models include dimensionality reduction, association, and clustering.

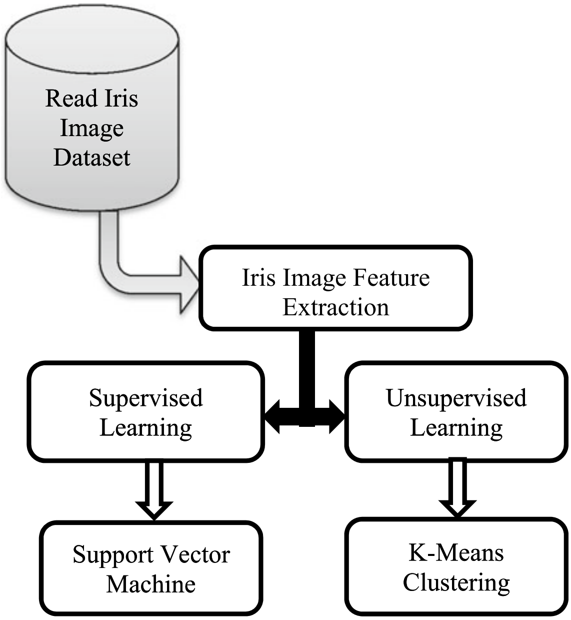
2.2.1 Clustering

Using the data mining technique of clustering unlabelled data based on their similarities or differences, the K value indicates the size and level of the grouping in K-means clustering algorithms, which separate similar data points into groups. Among other aspects, this technique is helpful for market segmentation and image compression.

2.2.2 Association

Association is a different kind of unsupervised learning method that makes use of a number of rules to identify relationships between variables in a data set.

Fig. 2 Workflow of proposed algorithm



2.2.3 Dimensionality

When a data set contains an excessive number of attributes, dimensionality reduction is a learning technique that is applied (or dimensions). It reduces the quantity of data inputs to a tolerable number while maintaining data integrity. When autoencoders clean up visual data to create better-looking images, for example, this technique is frequently utilised during the data preparation step.

Figure 2 shows the workflow classification of iris image features using supervised and unsupervised learning.

In proposed algorithm, read the iris image from database (IIT Delhi, UBIRIS and UPOL). Afterwards perform feature extraction techniques using image processing operations. After extraction of feature, apply supervised and unsupervised learning for classification of iris features.

3 Result

Iris images are usually colour images that have been converted to grayscale. Then, the feature extraction algorithm is used to detect inner iris and then extract features from iris using digital image processing techniques that are numerical characterisation of the underlying biometrics. Figure 3 shows the iris detection output.

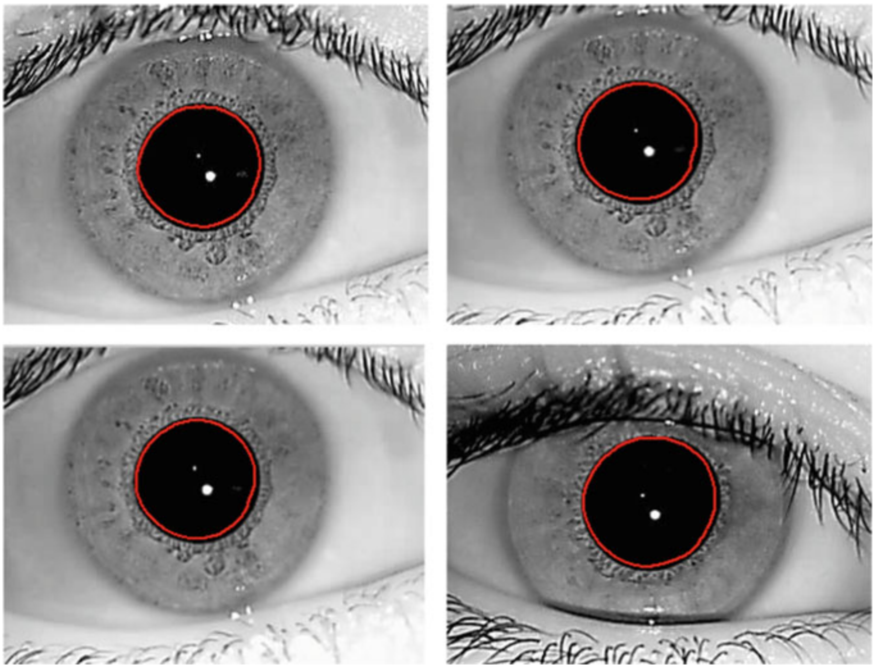


Fig. 3 Iris localisation using image processing techniques

Apply supervised and unsupervised categorisation after locating the iris. For categorising features, support vector machines and K-means clustering are used.

Support vector machine is a linear model for classification and regression problems. It is helpful for a variety of applications and can handle both linear and nonlinear issues. The basic principle behind SVM is that it constructs a line or hyperplane that divides data into classes (Fig. 4).

Unsupervised learning is employed when we have unlabelled data, or data without clearly defined categories or groupings. K-means clustering is one such method. This method seeks to locate K groups in the data, where K is the total number of groups (Fig. 5).

4 Conclusion

Iris recognition uses mathematical pattern recognition algorithms to analyse video footage of one or both of a person's irises. These algorithms contain complex patterns that are recognisable, steady, and easy to spot from a distance. In proposed research work, feature extraction algorithm is used to detect inner iris and then extract features

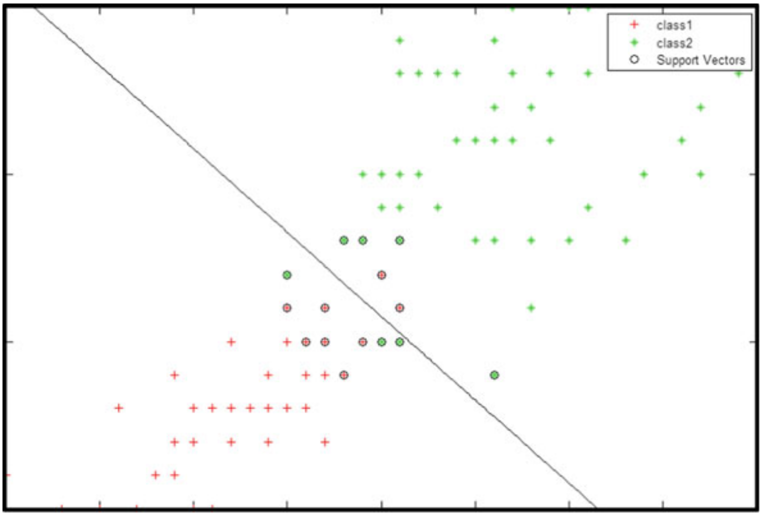


Fig. 4 Support vector machine

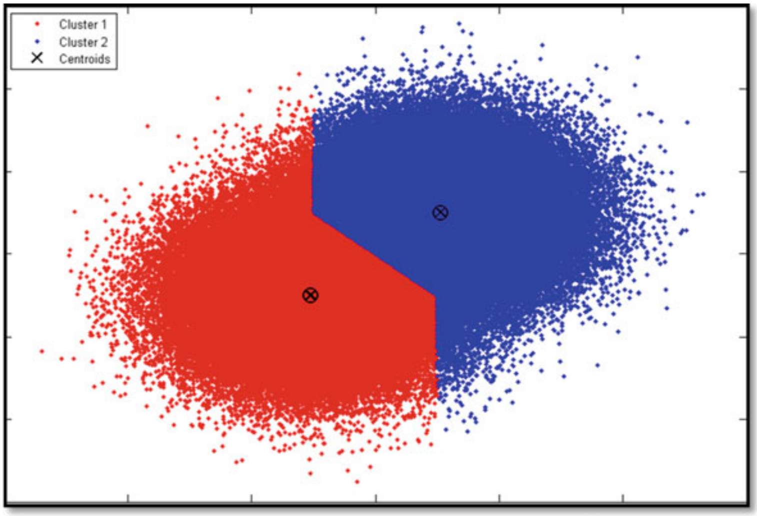


Fig. 5 *K*-means clustering

from iris using digital image processing techniques that are numerical characterisation of the underlying biometrics. Finally, apply supervised and unsupervised approach for classification of iris features.

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Privacy Preserved Effective Bill Collection System Using Blockchain

L. Pooja and J. Madhuri

Abstract Electronic invoices are generated using blockchain technology. Additionally, it has the potential to fundamentally alter how invoices are produced, transactions are validated, and payments are executed. These distributed ledgers continue to be the most well known and are regarded as the cornerstone of cryptocurrencies. They are composed of blocks, and each block contains a transactional record. On a decentralized blockchain network, a document that is accessible and editable by multiple users simultaneously keeps account of who made changes and when. It is impermeable and translucent. The proposed system is used for enforced bill collection system ensuring user privacy using the smart contract. Since every transaction is visible to both parties and every record or block is linked together and encrypted, there is no need for a middleman. It will be possible for users to make automatic payments to a service provider's digital wallet by using an invoicing system built on the blockchain. Transactions can be easily tracked and monitored, and thanks to blockchain technology, a complete history of all transactions can be downloaded. This study suggests using smart contracts and accountable ring signatures to secure blockchain transactions.

Keywords Ring structure · ECDSA · Smart contract

1 Introduction

A distributed ledger system called blockchain employs point-to-point encryption. Due to statistical methods like sociological mining and data mining as well as the open and public blockchain ledger, user privacy is now critically at stake. As a result, privacy protection is the current area of emphasis for blockchain technology research.

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Ring signature technology is an encryption technique that is frequently utilized in the privacy protection sector. In order to achieve blockchain privacy, this study develops a ring signature-based security architecture. Using the ring signature on the elliptic curve, this method created a privacy data storage protocol for data security and user identity privacy in blockchain applications.

Smart Contract: Smart contracts use computer programs and computational infrastructure to carry out the terms and conditions of a specific agreement. They work as programs that execute and enforce themselves. The decentralized applications known as smart contracts enhance the functionality of the underlying blockchain network. The centralized third party is not required in the execution of peer to peer smart contracts. Hence, all the services are offered devoid of the centralized infrastructure. The transactions are handled automatically when certain conditions are satisfied. The following points describe the key traits of smart contracts based on blockchain:

(1) Elimination of Third Party and Making Autonomous Execution:

The main advantage of smart contracts related to blockchain is decentralization. It is possible to do away with the need for reliable middlemen like brokers, agents, or service providers when a particular system is integrated with blockchain-based smart contracts. If a reliable third party is eliminated, centralized institutions will have less control over transactions and the costs related to them.

(2) Immutability

Distributed ledgers use digital signatures to verify the veracity of the transaction records. Additionally, before being recorded in the ledger, each transaction was examined and approved. The unchangeable approved transactions make up the constantly growing ledger since the smart contract code is tamper evident, the modified smart contracts cannot be executed. Smart contracts, on the other hand, can be altered if necessary with the approval of blockchain network nodes.

(3) Transparency

Transparency is one of the primary distinguishing traits that smart contracts have gained from the blockchain. There are two main ways that the smart contract is transparent. First of all, the code stated in smart contracts is visible to both the general public and any intervening parties. Second, the collection of transactions that make up the blocks is likewise accessible to the general public. As a result, the intermediaries of the blockchain network can trust in its logic and transactions.

2 Related Works

(Gür et al. [1]) In this work, a blockchain-based and energy-efficient IoT energy tracking system is proposed. The confidentiality of the personal data was this study's key concern. A method that allows users to store their own private information on their own devices and only share it when necessary is suggested. The rate of inaccurate human measurements can be decreased by automating all energy tracking processes using smart contracts. The transaction's validators will be displayed by certificate authorities. Hlaing and Nyuang [2] recommended a system in order to lower the power consumption of smart contracts; a cloud-hosted database powered by Firebase is used in an electrical billing system based on Ethereum blockchain. In this system, Firebase is used not only to store user data but also as an authentication channel. Feng et al. [3] proposed an valuation on as a basic piece of Vehicle-to-Grid (V2G) organizations. The power for the electrical vehicles is acquired from the different EVs within the framework. This work introduced a blockchain-based payment method that protects privacy and certainly meets the criteria of privacy safeguard in V2G networks. Guan et al. [4] proposed an assessment on smart urban area development in light of the Internet of Things (IoT) has reached a new level with the approach of the Industry 4.0 period.

Alsharif [5] presents an high level metering network that allow the service providers to assess the energy usage of users for efficient load balancing and energy management. Xu and Xue [6] provided the report on how remote monitoring of health information to carry out wise medical services by integrating Internet of Things (IoT) significantly. Wu et al. [7] represented the study on evaluation on the cipher text strategy and its significant role in information exchange. Lu et al. [8] proposed to cancel the group membership using dynamic accumulator mechanism and to create a novel group signature technique for satisfying the privacy of membership requirement. XIAOFANG Li et al. [9] proposed a system which incorporates ring signature technology, which can guarantee user data privacy in a shared and transparent blockchain ecosystem. Im et al. [10] provided patient-centric access control for electronic medical records in order privacy. The hybrid technique combines the benefits of the private–public key technique with blockchain technology and also integrates other lightweight cryptographic primitives. Guan et al. [11] In order to protect users' privacy in smart grid, a privacy-preserving and effective data aggregation system based on blockchain is being developed.

Existing Privacy-Preserving Techniques and Drawbacks

As of now, different procedures have been proposed to resolve the issue of protection to users' personal data. Perusing the connected work, we sum up the connected procedures by adding viewpoint centers around safeguarding clients' personalities, and different puts accentuation on safeguarding client's information. In the existing system, the user privacy concern is not been taken seriously. Some of the methods that are taken to store the user information is like cloud storage, firebase, and many more, but these are the traditional methods of storing the information and can be duplicated by the third party.

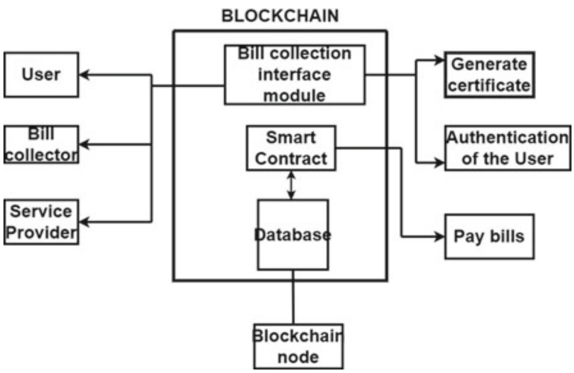
Blockchain can be a long haul, feasible, and best arrangement since it can give a decentralized stage to get capacity of these papers. So blockchain is promising advance to protect the privacy concerns of the users and safeguard the information of the bill documentation sent by the bill authority [12]. It can also be used to verify whether the bill is sent by the bill authority or not. Hence, the proposed methodology protects the user information in the blockchain network and also authenticates the bill generation.

3 Proposed System

In this work, we propose a privacy-preserving effective bill collection system using blockchain. The significant feature of the system keeps track of service fees paid by the customers. The proposed system is shown in Fig. 1. Smart contracts are used in the proposed system as a way to automatically connect the service providers and the customers on the blockchain. The group signature system is used by the service provider to offer services when a user submits a deposit. If the user pays the service fee, which indicates that they accept the bill collector's invoice, the deposit is automatically returned to them; if not, the deposit is delivered to the bill collector. The outline of the suggested privacy-preserving forced bill collecting method is presented in this section. Users, service providers, and bill collectors are the three components that make up the system. A certificate with a ring signature is verified by the service provider, who also renders a service. Service providers don't have any personal information. Users who have utilized the service are identified by the bill collector, who then sends them charges. The bill collector can automatically identify the payment defaulters, and the service fee can be deducted from the deposit made through the smart contact if the customer refuses to pay the bill after the reminders. Users who do not use the service are presumably not subject to any unauthorized charges by the bill collector because services provided are recorded without errors. Since the user profile is private whenever there is a transaction, ring signatures are used in order to maintain anonymity. Furthermore, we want to make it clear that when a charge must be paid through a smart contract, anonymity is not something we take into account.

Security Requirements: The security requirements of the proposed system are as follows:

Fig. 1 Proposed system



- User Anonymity: The only person who can identify a user from a certificate is the bill collector.
- Certificate Unforgeability: A certificate cannot be altered or falsified.
- Collection Correctness: The bill collector accurately collects all costs from a user even if they ignore a payment request.

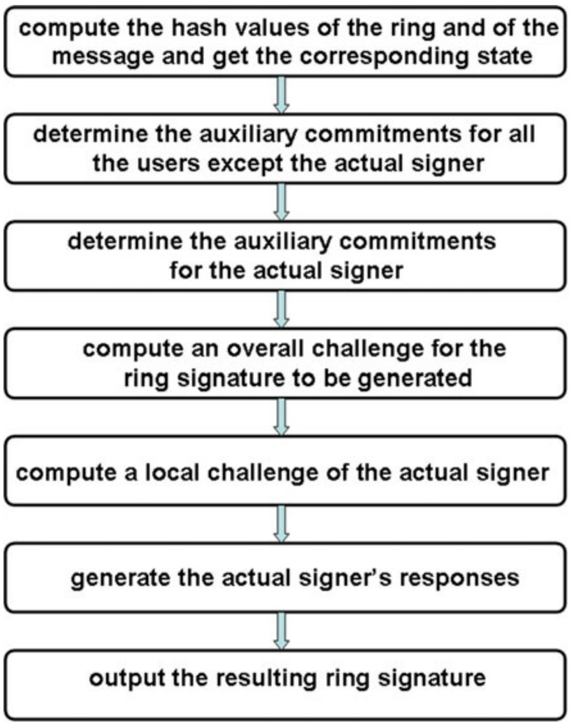
Ring Structure

A ring signature is a sort of digital signature used in cryptography that can be executed by any user within a group of users who are all in possession of the same key. A message bearing a ring signature is thus approved by someone from a specific group of people. It should be computationally impossible to ascertain which of the group members' keys was used to form the signature, which is one of the security features of a ring signature (Fig. 2).

Smart Contract

Since the terms of the contract between the buyer and seller are directly encoded into the contract's lines of code, a smart contract is a self-executing contract. A decentralized blockchain network hosts the contracts and underlying code. The code regulates transactions, making them traceable and irreversible. Smart contracts allow for the

Fig. 2 Ring signature



formation of trustworthy transactions and agreements between dispersed, anonymous individuals without the need for a centralized authority, a legal framework, or an external enforcement mechanism. Blockchain technology was initially used to create the digital currency bitcoin, but it has since grown to serve a variety of purposes. Elliptical Curve Digital Signature Algorithm (ECDSA) is proposed in smart contracts.

Elliptic Curve Digital Signature Algorithm (ECDSA)

One of the more difficult public key cryptography encryption methods is the ECDSA. Elliptic curve cryptography produces keys that are often smaller than those produced by digital signing techniques. Public key cryptography based on elliptic curves over finite fields' algebraic structure is known as elliptic curve cryptography.

Along with ECDSA's complexity, this makes switching to it look like a more enticing option every year. More modern protocols prefer ECDSA over RSA for actions involving public key cryptography as a result of these benefits.

Key Generation Using ECIES (Elliptic Curve Integrated Encryption Scheme)

ECIES Encryption

- The input consists of the public key in hex (at the first line, uncompressed, 128 hex digits) + plaintext message for encryption (at the second line).
- The output is the hex-encoded encrypted message. It may hold the ECC ciphertext public key + the ciphertext + MAC code + the symmetric key algorithm parameters, but this depends very much on the underlying algorithms and implementation.

ECIES Decryption

- The input consists of the private key in hex (at the first line, 64 hex digits) + encrypted message for decryption (at the second line).
- The output is the decrypted plaintext message (Fig. 3).

4 Algorithm Design

The Algorithm Design for Various Implemented Modules are as Follows:

User Signup and Adding Deposit.

Steps to perform Signup activity for user and Adding Deposit.

Step 1: Step 1: Add credentials to signup
Step 2: Step 2: Block created in the server
Step 3: Step 3: Security Deposit added to smart contract.

Block Creation using SHA1

- SHA-1 hash is a cryptographic algorithm that authenticates messages sent between the client and server during the TLS handshake.

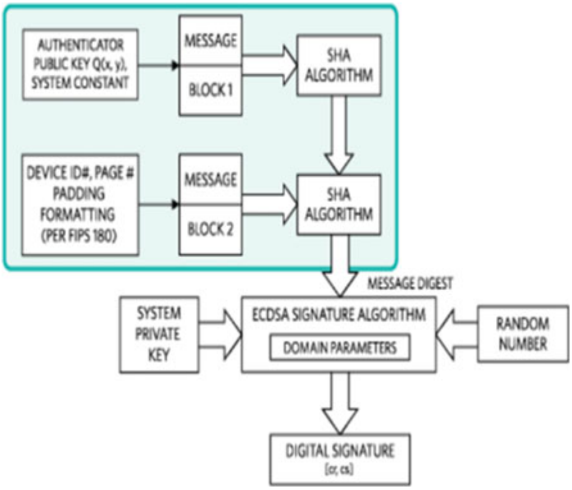


Fig. 3 Elliptic curve digital signature algorithm

- Message is “padded” with a 1 and as many 0’s as necessary to bring the message length to 64 bits fewer than an even multiple of 512.
- 64 bits are appended to the end of the padded message. These bits hold the binary format of 64 bits indicating the length of the original message.
- Prepare Processing Functions.
- Prepare Processing Constants.
- Initialize Buffers SHA1 requires 160 bits.
- Processing Message in 512-bit blocks. This is the main task of SHA1 algorithm which loops through the padded and appended message in 512-bit blocks.

Deposit Amount Added to Smart Contract

- Smart contracts are blockchain-based algorithms that execute when certain criteria are met.
- They are often used to automate the implementation of an agreement so that all parties can be certain of the conclusion right away, without the need for an intermediary or additional delay.

Bill Collector Sending the Invoice

- Step 1: The bill amount is added by the service provider.
- Step 2: This bill amount invoice is generated by the bill collector and sent to user.
- Step 3: User can authenticate this invoice using ESCDA to verify whether the invoice is sent by the bill and this invoice can be seen by user.

Elliptic Curve Digital Signature Algorithm (ECDSA)

- ECDSA is more effective at accomplishing the same task than any other digital signing signature.
- In order to achieve the same level of security as any other digital signature technique, ECDSA uses smaller keys.
- ECDSA certificates, a form of electronic document used to authenticate the certificate owner, are produced using ECDSA.

5 Functionality of Our System

1. Decentralization: We need a decentralized structure to ensure strength and adaptability, as well as to eliminate many-to-one traffic streams. We can also eliminate the weak link or problems with data postponement by using such decentralized systems. We are using an overlay decentralized network in our model.
2. Versatility: Proof of work (PoW) is a computationally intensive method of adding new blocks of transactions to a cryptocurrency's blockchain. Similar to a small-scale network, a large-scale network has many hubs, and blockchain scales inefficiently as the number of hubs increases. Within our layer organization, we reject the notion of PoW. Instead, we distributed the hubs throughout several bunches. Our model is reliant on the system's additional security features, such as its responsible ring structure, elliptical shape of digital signatures, and others.
3. Information Storage: Data can be saved by using blockchain to store massive amounts of information. Blockchain doesn't save any of its data in a single place. Instead, the blockchain is distributed and copied by a network of computers. Every time a new block is uploaded to the blockchain, every computer in the network updates its blockchain.
4. Secrecy of Clients: Information should be anonymized across the company because user information may contain personal data and transaction information may be recorded. We are using a lightweight ring construction for secrecy [2]. Any member of the group of users who have keys can participate in ring structure. By doing this, privacy and anonymity will be preserved.

6 Results

The proposed method is done using smart contracts built on the blockchain and protects user privacy by using the elliptic curve digital signature algorithm. The conventional approach to evaluating the outcome bills are sent using a third-party website, which violates the privacy of the user. Using a blockchain-based platform for selling renewable energy helps to ensure the security of the transactions and the privacy of the users. Blockchain is the primary platform technology used to securely and immutably store transaction data. The showed that, without losing system effectiveness, ECDSA resolves the privacy leak issue in blockchain-based payment system.

The transactions that are happening over the blockchain are increasing everyday. Hence the proposed system provides the opportunity to safeguard user privacy and enable fraud detection in the bill payment system.

The amount of computational work necessary to carry out an action is measured in Ethereum by the concept of gas. In Ethereum, gas refers to the unit of measurement used to quantify the amount of computational work required to execute a transaction or a smart contract on the Ethereum network. Every operation or transaction that is executed on the Ethereum network requires a certain amount of gas to be completed, and the user must pay for this gas with Ether (ETH), the native cryptocurrency of the Ethereum network. The deployer of the smart contract must state how much ETH that they are willing to spend per unit of gas at the time of deployment so that gas-relevant transactions can be investigated. A transaction is mined more quickly when the gas price is higher because miners are more motivated to mine. The cost of a transaction is often calculated as the amount of gas used times the price of gas. Figure 4 illustrates the costs associated with contract creation and function execution based on market value at the time the contract was deployed (Jan 8, 2022).

The accuracy of the bill payment transactions are listed in Table 1.This indicates the computation power of proposed method is more compared to traditional method. The user privacy can be preserved using the ECDSA, and the computation cost is also reduced.

Fig. 4 The transaction happening using Ethereum using smart contract

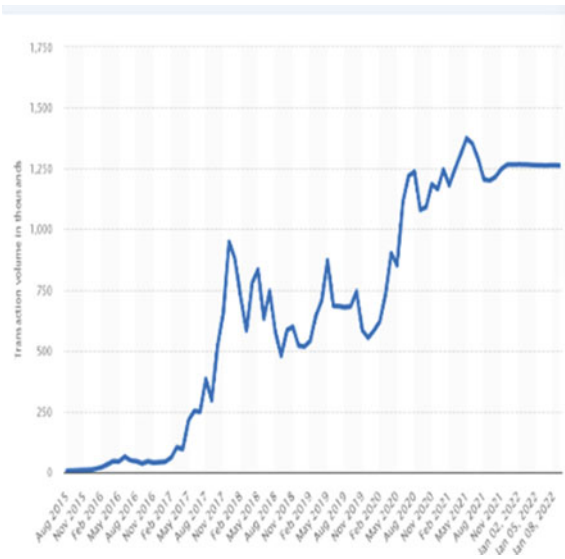


Table 1 Table indicates the accuracy while paying the bill using smart contract

No. of user	Accuracy of paying the bill traditional method (%)	Accuracy of paying the bill blockchain method (%)
5	60.34	95.65
100	57.56	95.76
500	57.56	95.85

7 Conclusion

This work proposed a security protecting upheld billing collection framework that upholds a usefulness for traceability of bill payment defaulters and enables deducting of the bill amount from the deposit amount paid from clients. The proposed framework depends on the utilization of responsible ring signature and smart contacts with ECDSA. In our future work, we aim to enhance our framework's security by incorporating measures such as providing enrollment security through the use of a unique group signature scheme. Additionally, we plan to develop a billing system that ensures users' anonymity while collecting service fees. This could be achieved through the use of anonymous cryptocurrency such as Monero or Zcash.

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Speech Emotion Recognition Using Convolutional Neural Networks on Spectrograms and Mel-frequency Cepstral Coefficients Images

Sambhavi Mukherjee, Shikha Mundra, and Ankit Mundra

Abstract A Speech Emotion Recognition (SER) system is a collection of methods for processing and classifying voice inputs to recognize emotions. This type of system could be beneficial in several sectors, including interactive voice-based assistants and caller-agent conversation analysis. We want to reveal underlying emotions in the recorded speech by analyzing the acoustic features of audio data. The majority of Emotion Recognition research has concentrated on the use of speech descriptors such as mel-frequency cepstral coefficients (MFCC), Linear Prediction Coefficient (LPC), energy, spectral flux, spectral centroid, spectral roll-off, and zero-crossing rate, followed by the application of machine learning classifiers such as SVM, Nave Bayes, and others, or an ensemble of a few such classifiers. In other research papers, the speech recognition problem was turned into an image recognition problem, and then convolutional neural network (CNN) architectures were used, only evaluating MFCC images of audio signals. In our technique, we gathered spectrogram images from audio samples to train our CNN architecture. Spectrograms are graphical representations of the signal strength, or 'loudness,' of a signal across time at various frequencies contained in a waveform. We also compared the results with the CNN model applied to this dataset's MFCC images. When compared to our spectrogram CNN model, the MFCC image CNN model improved by 3.75% (accuracy 82.5%). https://github.com/sambhavi10/Speech-Emotion-Recognition.

Keywords Emotion recognition · Mel-frequency cepstral coefficients (MFCC) · Spectrogram

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1 Introduction

One of the most natural ways for humans to express themselves is through speech. We rely on it so much that we notice its use in other channels of communication, such as emails and text messages, where we commonly use emoticons to express our emotions. Emotion detection and analysis are vital in the digital age of distant communication since emotions are so important in communication. Emotions are difficult to discern since they are subjective. There is no universally accepted method for quantifying or categorizing them.

Humans are emotional beings, and they express themselves using speech. The same sentence can have different meanings when spoken with different tones. Speeches can be sarcastic, which have meanings that contradict the linguistic meaning. If our computers were only trained on simple Natural Language, they would often misinterpret what's being said [1]. Thus, it becomes crucial to understand the emotional intent of the speaker, along with the content. Emotion detection has wide-ranging applications like teaching, security, medicine, and entertainment. It could be integrated with conversational AI such as Alexa or Siri, for the AI agent to be able to identify actual human sentiments and emotions [2]. This will prove to be a huge step in making our computers more 'human-like.' In this work, we have focused on popular signal features known as mel-frequency cepstral coefficients (MFCC).

Mel-frequency cepstral coefficients (MFCC) is a well-known feature for speech signals. The several applications of it in speech processing are speech recognition, speaker recognition, speech synthesis, speech coding, etc. The research paper [3] has used this feature, and it is described as a limited group of features (often 10–20) that represent the general shape of a spectral envelope clearly [4].

2 Related Work

In the modern world, voice recognition functions must be done by robots just as naturally as they are by humans. As a result, a significant portion of research has been conducted where the goal of SER was re-defined as an image classification problem and then accomplished using a pre-trained model [5]. We have read research where notable features were retrieved from voice data using MFCC. In addition to spectral (roll-off, flux, centroid, bandwidth), energy (root-mean-square energy), raw signal (zero-crossing rate), pitch (fundamental frequency), and chroma features, papers [5, 6] discuss the usage of MFCC features.

Several freely available speech datasets were used in the URDU dataset, including SAVEE, EMODB, and EMONO [5]. The EMODB dataset with seven emotion classes was utilized in the paper [7]. The RAVDESS dataset is used in papers [6, 8]. Reference [6] made use of the TESS dataset.

Researchers used both machine learning techniques, their ensembles, and deep learning models such as CNN models, semi-CNN models, and transfer learning models in their categorization method.

In [5] a comparison of decision tree (J48), random forest (RF), and sequential minimal optimization (SMO), machine learning techniques were presented, as well as an ensemble of these machine learning algorithms using majority voting. Paper [7] used MATLAB 2019a programming software and an HP Z440 Workstation with an Intel Xeon CPU, 2.1 GHz, and 128 GB RAM to deploy a transfer learning model called AlexNet to perform the task of SER. The researchers demonstrated the use of autoencoders for dimensionality reduction, followed by Support Vector Machines (SVM), decision tree classifiers, and convolutional neural networks (CNN), AlexNet, and ResNet50. The use of a deep transfer learning model to train and recognize emotions was demonstrated in the paper [8].

3 Proposed Methodology

To complete the SER goal, the focus of this paper is on merging the original speech attributes and employing images generated from speech signals.

Our model's design is mostly composed of two modules:

(1) SER utilizing audio features experimented using machine learning models.
(2) CNN models based on spectrogram and MFCC images.

We have converted the MFCC signal to images and used CNN to extract relevant features from MFCC images and spectrogram images. In addition, to compare its performance we have used audio features and classification using several machine learning models, including logistic regression, Random Forests, Naïve Bayes, and Support Vector Machine, which have been contrasted hhhh to one another.

Using CNN to analyze MFCC and spectrogram images produced accuracy levels of 82.5% and 86.25%, respectively.

Our main work has been focused on the following points:

- Using the Librosa package [9], extract feature vectors from audio (.wav) files. Applying feature extraction approaches to audio data namely extracting MFCC features from audio signals and extracting features from images. Then, to perform emotion classification on them, employ supervised machine learning algorithms and convolutional neural network architectures.
- To extract the spectrograms from the audio recordings and feed them into a convolutional neural network architecture to forecast the right output classes for the test dataset.
- To extract MFCC features from audio files and use them with a CNN architecture to predict the labels for test images.

- Compare the performance of the proposed MFCC image and spectrogram feature extraction method with existing audio features in terms of AUC score and accuracy.

4 Data Preprocessing

The initial step is to pre-process the audio files so that they may be used with machine learning methods. Librosa, a Python speech recognition package, was used to read the audio files for 2.5 s using a resample type of Kaiser fast, a sampling rate of 44,100 Hz, and an offset of 0.5 s. Following that, the 'feature. mfcc' technique of Librosa was used to transform the signals into feature vectors of 216 dimensions by employing the sample rates and time series collected from the signals. Mel-frequency cepstral coefficients (MFCC) are among the most commonly used speech and emotion identification features.

We experimented with numerous divides for the train and test datasets, and 80:20 proved to be the best possible split for this dataset. After doing a train–test split, our dataset is ready to be fed to machine learning algorithms, which will provide predictions. The spectrogram images for CNN architectures are extracted using the Open-Soundscape library's spectrogram module. Open-Soundscape [10] is a utility library for analyzing bioacoustic data. This produced graphics of 224 by 224 pixels for the audio files. The MFCC pictures were extracted using the Librosa Library and a 2-s speech signal for each audio file. Our CNN architectures may now use these images for image categorization.

5 Classifiers

For extraction and classification of the most relevant feature, we have experimented with machine learning and deep learning methods as described in below sections.

5.1 Machine Learning Classifiers

Our dataset is known as the Urdu dataset, and it comprises four output emotion types. In such supervised learning situations, machine learning algorithms are frequently extremely useful. Supervised learning is a sort of machine learning in which machines are trained with well-labeled training data and then predict the output [5]. Labeled data shows that some input data has already been assigned an output. As a result, our problem is a multi-class classification problem that has been solved with classifiers such as logistic regression, Support Vector classifier, Random Forest classifier, and Nave Bayes Classifier [11]. Our dataset is known as the Urdu dataset, and it comprises four output emotion types as explained in Sect. 6.

5.2 *Deep Learning Classifiers (CNN)*

CNN is a neural network-based architecture popular in image categorization. This is critical for the task of SER using photos. It is useful for feature extraction and classification since it can pass values to the next layer while preserving spatial information and may be used in noisy images. The overall architecture of CNN is comprised of several layers that function as input, hidden, and output layers. The hidden layers are composed of feature maps, a fully connected layer containing convolutional neural networks, and pooling layers. The convolutional layer and the pooling layer collect essential properties from the input data, and the extracted value is mapped to the feature map [12, 13]. In this process, the characteristics of the MFCC and spectrogram images can be extracted, and then the fully connected layer focuses on the features extracted to perform classification.

6 Dataset Description

For our SER job, we used publicly available URDU data [14]. The URDU dataset is made up of emotional utterances from Urdu talk shows. It has 400 phrases that depict four fundamental emotions: angry, pleased, neutral, and emotional. There is a total of 38 speakers (27 male and 11 female). This information was collected from YouTube content. Speakers are selected at random. The nomenclature used to label the files in the dataset includes information on the speaker, gender, file number for that speaker, and overall numbering of the file in a certain emotion. The files have been renamed so that the first letter indicates the emotion: *S* for Sad, *H* for Happy, *A* for Angry, and *N* for Neutral, followed by a number to represent the file order. The dataset is divided into four emotion categories: angry, happy, neutral, and sad. Each lesson included 100 audio files with the .wav extension. We experimented with other splits for training the models, such as 75:25 and 80:20. The latter proved to be the preferable option, so we chose 80:20 for training and testing. As a result, the training dataset contained 320 speech files, and the remaining 80 speech files were used to test the performance of our models. Our dataset is also available on GitHub. (Link: https://github.com/siddiquelatif/URDU-Dataset).

Table 1 CNN architecture for the spectrogram model and the MFCC model

Layer	Output shape
Rescaling	(None, 180, 180, 3)
Conv2D	(None, 178, 178, 32)
MaxPooling2D	(None, 89, 89, 32)
Conv2D	(None, 87, 87, 32)
MaxPooling2D	(None, 43, 43, 32)
Conv2D	(None, 41, 41, 32)
MaxPooling2D	(None, 20, 20, 32)
Flatten	(None, 12,800)
Dense	(None, 128)
Dense	(None, 4)

7 Experimental Setup and Hyperparameter

To facilitate comparability, the machine learning models chosen were trained on identical training and testing datasets. Sklearn, a popular Python machine learning toolkit [15], was used to create these models. The model achieved a test accuracy of 48.75% by employing the hyperparameters solver = 'saga,' penalty = 'l2,' and max iter = 80 in logistic regression. The accuracy of SVM was 56.25%. Nave Bayes, on the other hand, provided an accuracy of 58.75%. The Random Forest model obtained an accuracy of 60% on the test dataset after tweaking the hyperparameters: n estimators = 120, criteria = 'entropy.'

Apart from machine learning algorithms, convolutional neural networks are also applied to the generated MFCC and spectrogram images. The CNN model using MFCC was able to achieve a test accuracy of 82.5%, and the CNN model using spectrogram images was able to achieve a test accuracy of 86.25%. Table 1 shows the CNN architecture used.

8 Experimental Results and Conclusion

The classification metric used for contrasting the models is accuracy, AUC score, and area under AUC-ROC curve. Table 2 shows the AUC scores, and it is observed that CNN using spectrogram, and MFCC image has performed significantly better than traditional audio features. We have also plotted the AUC-ROC curve for the ML model with audio features and CNN with MFCC image and spectrogram image as shown in Fig. 1.

Table 3 depicts a comparative examination of the models based on accuracy. From Table 3, it has been observed that logistic regression with MFCC has performed lowest and CNN with spectrogram has performed best among all.

Table 2 AUC scores in tabular form

Model	AUC score
Logistic regression	0.7229
Random forest	0.8183
SVM	0.7821
Naïve Bayes	0.7558
CNN using MFCC	0.8416
CNN using spectrogram	**0.8499**

Best score is highlighted in bold

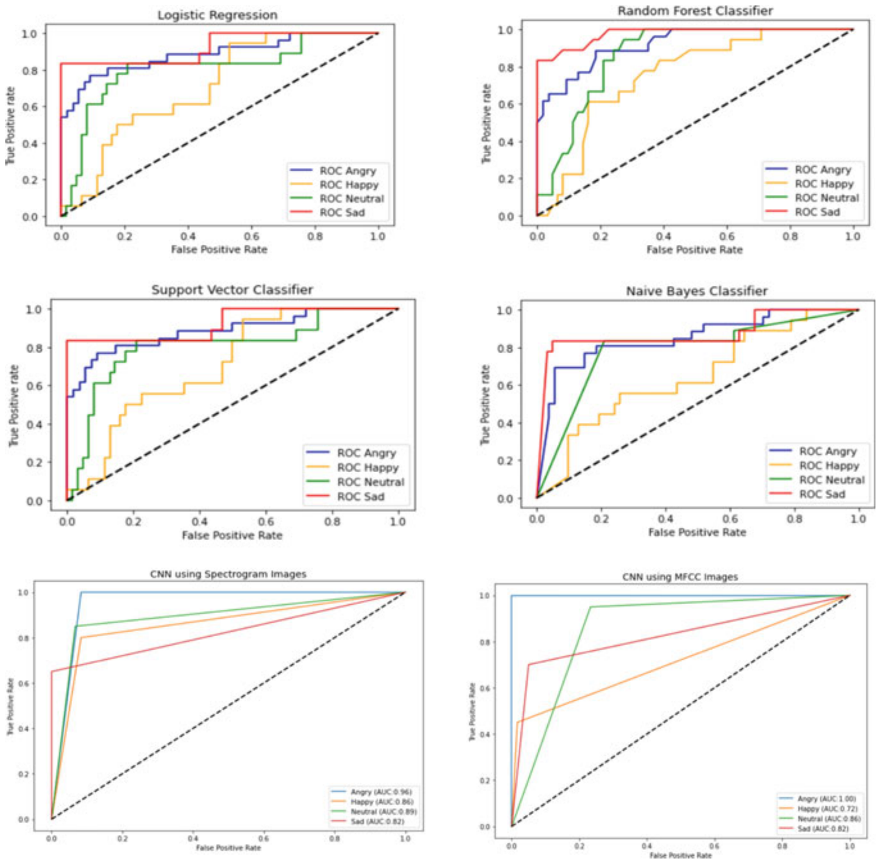

Fig. 1 AUC-ROC curves for all models

Table 3 Comparative performance in terms of accuracy (%)

Models	Test accuracy
Logistic regression	48.75
Random forest	60
SVM	56.25
Naïve Bayes	58.75
CNN using MFCC	82.5
CNN using spectrogram	**86.25**

Best score is highlighted in bold

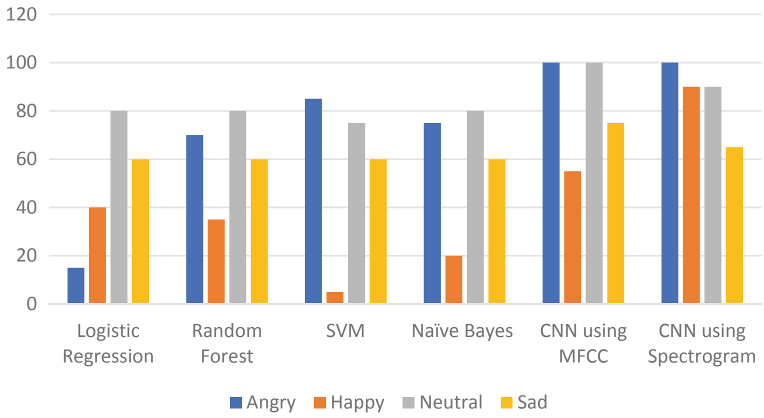

Fig. 2 Class-wise accuracies represented as bar plots

This research aims to compare machine learning and deep learning models in executing the SER task. As shown in Fig. 2, we made comparisons between various machine learning and deep learning models. Logistic regression (48.75%), Naïve Bayes (58.75%), SVM (56.25%), and Random Forests have the highest accuracies (60%). Following that, we used CNN on MFCC images to achieve an accuracy of 82.5% and on spectrogram images to achieve an accuracy of 86.25%. Here, we observed that image-based features can play a crucial role in the extraction of emotion from the speech signal. In the future, spectrogram image features can be combined with text-based features [16] to enhance the performance and improve the robustness of the model.

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Automatic Recognition and Categorization of Tomato Leaf Syndrome of Diseases Using Deep Learning Algorithms

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Abstract Several studies have evaluated leaf image data and protected plants from diseases using machine learning classifiers. To classify the leaves in an image, the majority of the suggested classifiers take hand-crafted features from the image and train and test them on limited datasets. Contrary to the state of the art, we used a sizable dataset for this investigation. 14,529 images of tomato leaves with ten different infections are included in this dataset. We have introduced Inception V3 and ResNet-50 as learning algorithms to train our classifier. These techniques are transfer learning, which is utilized for deep learning, and each step in this technique is better than the previous one. We have employed visualization techniques to comprehend symptoms and pinpoint the locations of diseased leaf sections to examine the proposed deep model. The acquired results are promising because they outperform significantly with an accuracy rate of 85.52% and 95.41% for the Inception V3 model and in ResNet-50 accordingly, and they can be utilized by farmers as a useful tool to preserve tomatoes from infection.

Keywords Deep learning · Transfer learning · Inception V3 architecture · Resnet-50 architecture

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1 Introduction

The tomato is a frequently produced eating vegetable and a nutrient-rich plant [1]. According to the statistics, plenty of (160 million tons) of tomatoes are consumed per annum throughout the world [2]. The tomato is thought to be a significant factor in the decline of poverty and a source of income for agricultural households [3]. Tomatoes are one of the crops with the highest nutritional density; tomatoes have an immense impact on the farming economy through production and farming. The tomato offers medicinal properties that prevent diseases including hepatitis, hypertension, and gingival bleeding in addition to being nutrient dense [1].

Leaf disease detection by hand requires a team of experts and continuous observation. A huge farm incurs higher costs. Therefore, image processing procedures can be utilized without human intervention to identify diseases in leaves as opposed to conventional approaches, saving time, money, and effort. Quickly detecting diseases in leaves boost crop productivity. Through using image processing techniques like segmentation, detection, and categorization, disease-affected plants can be identified early on, improving agricultural output and quality. Many farmers are deficient in the means or knowledge necessary to connect with specialists, which increases the cost, duration, and accuracy of the process. In this instance, crop observation results showed that the suggested method was more beneficial.

The disease is unavoidable, and detecting them plays an important role by using modern technologies knowledge. Wrongly identifying plant disease will cause a huge amount of lost time, loss of cash, and labor, and these will cause poor quality of product and value. Labor-intensive detection of ailment mechanism well but it requires more time than automatic detection by technology. Sometimes manual detection may result in the wrong detection which leads the cultivators in the wrong direction. The farmers of developing countries have large farming land, and farmers cannot monitor every single plant each day. So, they are unaware of non-native diseases. It is time-consuming and costly to check the plants. So, by utilizing the development of technology, we can monitor the condition of leaf disease, and by using image processing techniques, we can detect tomato plant disease.

The features of a disease can be promptly and precisely diagnosed using image processing technology. Using this technique, disease prevention strategies can be implemented quickly, and efforts to prevent the spread of new illnesses can be made. People used to be able to distinguish between different diseases based on their personal experiences, but the procedure is laborious and limited. Technologies for machine learning and image processing are rapidly developing and being used increasingly often across a variety of industries, including agriculture.

2 Literature Work

For the purpose of identifying plant diseases, it is common practice to pull out the texture, nature, dye, and other distinctiveness of disease spots using traditional computer vision methods. As a result of its reliance on a team of specialists with in-depth knowledge of agricultural ailments, this method's identification effectiveness is low. Due to the rapid advancement of artificial intelligence technology, several academics have recently done extensive studies on deep learning expertise to get better the precision of plant infection identification [4]. The vast majority of strategies for analyzing plant diseases now in use are based on disease categorization [5].

The transfer learning system was used by Selvaraj et al. [6] to retrain three CNN architectures. Deep transfer learning was utilized to create networks employing learned disease recognition models in order to make accurate predictions.

Fuentes et al. [7] proposed deep learning to detect pests, diseases, and infections in tomato plant images acquired at different camera resolutions. Multiple CNN [8, 9] object detectors and deep learning meta-architectures were used. To get better training accurateness and lessen false positives, we used data extension and limited and worldwide class annotation. The entire training and testing process was conducted using a sizable dataset on tomato disease. From the complex settings, the system successfully identified nine distinct pests and diseases.

A deep learning-based method was projected by Yong [10], Fuentes and Yoon [7] to recognize pests and infections in tomato vegetation. The system's three crucial parts are an integration unit, a secondary investigative unit (CNN filter bank), and a key analytical unit (bounding box creator). The main unit creates a set of boundary boxes that include scores for every instance of a given class and coordinates that specify the target for each image and class category. For each class, the secondary CNN classifiers operate separately.

AlexNet and VGG16 net, a suggested pre-trained deep learning manner, were created by Rangarajan et al. [11]. The evaluation was carried out using 13,262 picture samples, with the number of pictures, mini-batch sizes, weights, and bias learning rate changed. The results are 97.29% and 97.49% using VGG16 and AlexNet, respectively. The finest accuracy was acquired with 373 pictures, but the accuracy of the final product fell after fine-tuning the bias learning rate for 30 image rates, then waxed. With an increase in the learning rate, accuracy decreased in the VGG16 net scenario.

To discover and recognize the disease in tomato leaves, Tm et al. [12] employed a light form of convolution neural network model called LeNet. The neural network approach was found to be feasible even in poor conditions, as indicated by the average accuracy of 94–95%.

Devi and Sudha [13] evaluated the effectiveness of K-nearest neighbor (KNN) and multi-class support vector machine (SVM), and they also provided a neural network-based classification of potato leaf disease using the GLCM technique to extract color and texture features. The method has a 92% precision rate.

A deep convolution neural network is used by Ashqar and Abu-Naser [14] to recognize five diseases from a dataset of 9000 images of tomatoes diseased and in good physical shape states. The author employed a Smartphone-assisted plant infection diagnosis procedure on the expanding image datasets.

Kakade and Ahire [15], authors, performed image attainment, image pre-processing, extraction of features, and categorization of neural networks for detecting the disease that is created by bacteria, fungi, viruses, etc. The accuracy of the model is 92.94%.

Moshou et al. [16] developed a straightforward and reasonably priced optical system based on canopy reflections in a number of wavebands for remote disease diagnosis. Early wheat plants were examined to determine how the healthy and afflicted plants differed in their spectral reflections.

Experimental results from Agarwal et al. [17] demonstrate the superiority of the projected model over pre-trained models such as VGG16, Inception V3, and MobileNet. The suggested model has a standard precision of 91.2% for the nine disease classes and one in good physical shape class, ranging from 76 to 100% for each class.

3 Methodology

This research implemented data about tomato leaves from the PlantVillage dataset [18, 19], which includes pictures of tomato leaves. Ten classes of healthy leaves and a variety of infected leaves were tested. ResNet-50 and InceptionV3 are two pre-trained networks that are used for classification.

3.1 Dataset Preparation

This dataset contains images of different types of crops and plants. Among them, 14,529 images are of tomato leaves which are categorized into ten classes. Nine classes are unhealthy, and one class is healthy. Each of the images downloaded is in RGB form and is stored in JPG format. Numerous illnesses are found in tomatoes. The images of a variety of classes are shown in Fig. 1.

The entire dataset for the test was split into training, testing, and validation data in an 80:10:10 ratio. There are 13,256 unhealthy leaf images and 1273 healthy images in the dataset. The sub-class of unhealthy leaf images is given in Table 1.

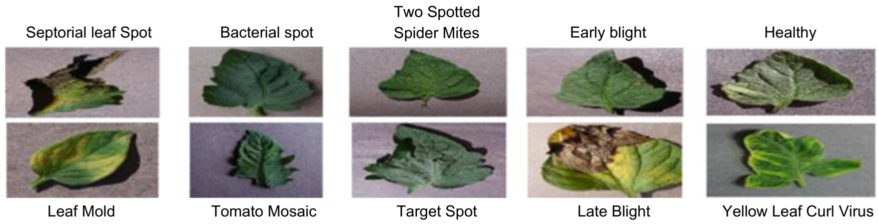

Fig. 1 Tomato healthy and diseased leaf images from PlantVillage dataset

Table 1 Sub-class of unhealthy leaf images

Fungi	Bacteria	Mold	Virus	Mite
Early blight (800)	Bacterial spot (1702)	Late blight (1527)	Tomato mosaic virus (299)	Two-spotted spider mite (1341)
Leaf mold (761)			Tomato yellow leaf curl virus (4286)	
Septoria leaf spot (1417)				
Target spot (1123)				

3.2 *Dataset Preparation*

There are restrictions on the input image size for each CNN network. As a result, the images were downsized to 224 × 224 for ResNet-50 and 299 × 299 for Inception V3. The dataset's mean and standard deviation were utilized to regularize the photos using Z-score normalization.

3.3 *Experiments*

We examined two pre-trained CNN models that had been initially programmed to classify pictures of tomato leaves. To determine if thin and deep networks are appropriate for this application, one of the pre-trained networks is shallow: ResNet-50, and the another is deep: Inception V3. Table 2 displays the experiment's parameters.

Table 2 Review of the parameter for experiments in classification

Parameters for classification model	Values
Batch size	32
Learning rate	0.0001
Epochs	10
Loss function	Sparse Categorical Cross-Entropy
Optimizer	RMS Propagation

3.4 Transfer Learning

Transfer learning is carried out using deep transfer learning, which heavily relies on these pre-trained models. Deep learning techniques involve tweaking pre-trained models and utilizing them as feature extractors. For computer visions, pre-trained deep neural networks include ResNet-50 [20], VGG-19 [21], Inception V3 [22], MobileNet [23], and others (see Fig. 2). Transfer learning can be implemented by taking away the final predicting layer from the pre-trained model and substituting it with the predicted layer.

Designing Inception V3. CNNs use Inception Modules as a means to cut down on computational costs. A neural network must be properly designed since it processes a huge variety of images with widely varying conspicuous sections, sometimes referred to as the highlighted image content. An input is convolution using not one, but three separate size filters (Fig. 3) in the most condensed form of an inception module (1 × 1, 3 × 3, 5 × 5). Max pooling is also used. The outputs are then concatenated and forwarded to the following layer. The CNN is set up so that all of its convolutions are performed at the same level, which causes the network to grow in width rather than depth.

The deep learning model known as Inception V3 is built on convolutional neural networks. It serves as an image classification tool. There are 42 layers in all. The following are the main changes made to the Inception V3 model (Fig. 4):

1. The first step is factorization into smaller convolutions.
2. Asymmetric convolutions via spatial factorization.

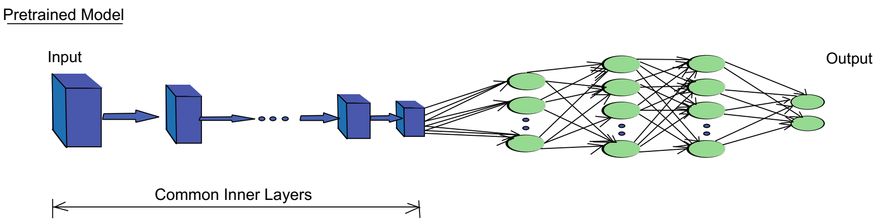

Fig. 2 Pre-trained model architecture

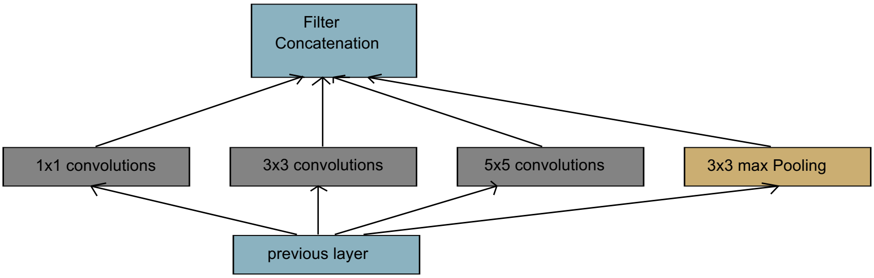

Fig. 3 Three separate size filters in an inception module

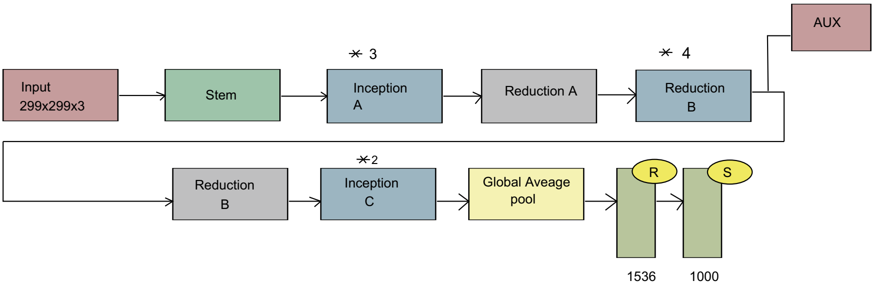

Fig. 4 Inception V3 model outline

3. The usefulness of auxiliary classifiers.
4. Effective reduction of grid size.

The outline of the Inception V3 model is given below:

Designing ResNet-50 network. Deep neural networks are complicated to train for the vanishing gradient problem because the gradient is back-propagated to prior layers and may get smaller with repetition. As the network's production quickly declines, it becomes deeper.

By first implementing the skip connection, ResNet-50 is represented by the following code:

X shortcut = X assigns X's starting value to a variable. Apply batch norm operations and convolution to X X = Add () ([X, X shortcut]) SKIP Connection.

The pass-over connection is employed earlier than the RELU produces the greatest results. Similar to the fully convolution network (FCN) and U-Net, ResNet-50 uses skip connections to pass information from one layer to the subsequently. The ResNet-50 model (Fig. 5) consists of three convolution layers and five phases. There are 23 million learned variables in this model.

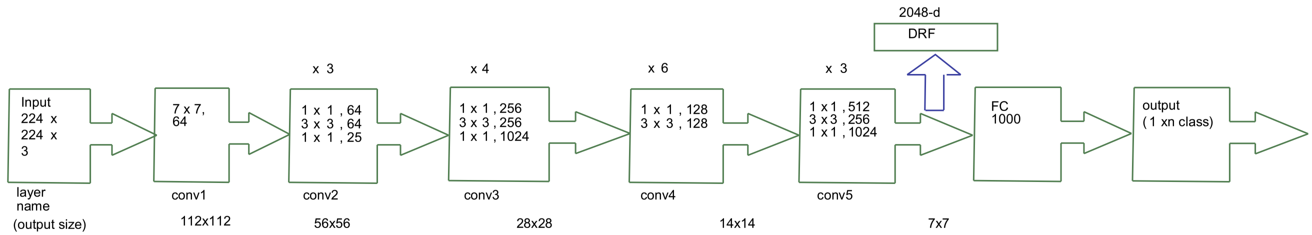

Fig. 5 ResNet-50 model outline

Table 3 Confusion matrix

	Actually positive	Actually negative
Predictive positive	True positive	False positive
Predictive negative	True negative	False negative

4 Performance Matrix

The accuracy, precision, recall, and $F1$-score trials are used to assess the model's performance. To avoid being duped by the confusion matrix, we applied the aforementioned evaluation criteria [24].

4.1 *Confusion Matrix*

It is a table that gives prediction information of various objects using a classification algorithm (Table 3).

4.2 *Accuracy and Loss*

Scientifically, it represents the proportion of the calculation of true positives and true negatives out of all the calculations.

$$\text{Accuracy Score} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{FN} + \text{TN} + \text{FP}}$$

Loss is a number that indicates how bad the model's prediction was on an individual example.

4.3 *Precision, Recall, and F1-Score*

$$\text{Precision: Precision Score} = \frac{\text{TP}}{\text{FP} + \text{TP}}$$

$$\text{Recall: Recall Score} = \frac{\text{TP}}{\text{FN} + \text{TP}}$$

$$F\text{-1 Score: } F1 \text{ Score} = \frac{2 \times \text{Precision Score} \times \text{Recall Score}}{\text{Precision Score} + \text{Recall Score}}$$

Accuracy, precision, and recall [25] are the performance metrics that were observed in this area of the simulation findings. Additionally, it highlights the convolution layers of the techniques and the confusion matrices of various datasets.

5 Result Analysis

This section depicts how various networks performed in the various experiments. Table 4 in this study displays the performance comparison for two various transfer According to Table 4, every tested pre-trained model does a fantastic job of classifying photos of healthy and infected tomato leaves in ten-class scenarios.

ResNet-50 performed better than the Inception V3 model on tomato leaf images for the ten class challenges. The accuracy of ResNet-50 is 96% which is around 8% higher than Inception V3. In addition, in the case of precision, recall, and $F1$-score, the ResNet-50 is better than Inception V3 model.

Google Colab, the entire experiment was carried out. In the following subsection, the outcome of the suggested strategy is discussed along with examples using various test epochs and learning rates.

Although learning rates were 0.0001, this study used epoch 10 for comparison. Figure 6 compares training accuracy and validation accuracy for Inception V3 and training accuracy and validation accuracy for ResNet-50.

With a training step of ten epochs and a learning rate of 0.0001, the accuracy rate for ResNet-50 is 95.62%, and for Inception V3, it is 87.38%. Therefore, based on the research method, it is plausible to assume that more iteration will lead to improved data accuracy. But as the training phase gets longer, there are more epochs.

On the flip side, Fig. 7 compares training loss and validation loss for Inception V3 and training loss with validation loss for ResNet-50.

Table 4 Summary of the performance

Model	Accuracy	Precision	Recall	$F1$-score
Inception V3	0.8798	0.91	0.89	0.87
ResNet-50	0.9562	0.97	0.94	0.93

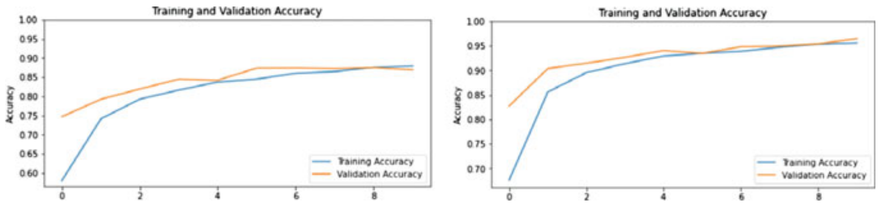

Fig. 6 Training accuracy versus validation accuracy in inception and ResNet-50

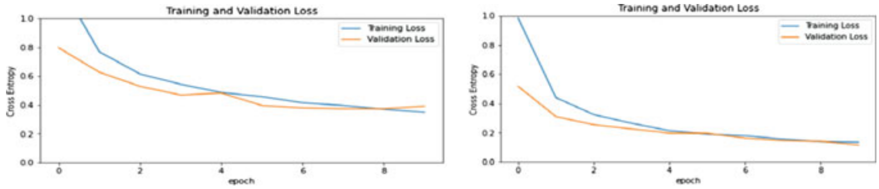

Fig. 7 Training loss versus validation loss in Inception V3 and ResNet-50

The training loss is decreasing over time for Inception V3 which is much higher than ResNet-50. The learning rate and epoch both affect the accuracy rate: The calculation is more accurate the more significant the epoch value.

6 Conclusion

Machine learning and image processing technologies require a minimum number of unhealthy image samples. For diagnosing plant diseases, it is far superior to conventional manual diagnostic and recognition techniques. One of the most popular artificial intelligence techniques is deep learning. Computer vision uses a variety of deep learning techniques. The paper discussed a deep learning model for identifying and categorizing leaf diseases on tomato plants. It also took into account physical characteristics of the plant, such as color, texture, and leaf margins. Standard profound learning models with variations were introduced in this article. Analysis of the data revealed that ResNet-50 model performed better than Inception V3. Our long-term goal is to increase the gathering of distinctive data and gather a significant amount of information on various plant diseases. In the future, we'll use new technology to increase accuracy.

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Fake News Detection Approach Based on Logistic Regression in Machine Learning

M. Sudhakar and K. P. Kaliyamurthie

Abstract Today, social media is allowing everyone to spread information without any cost, and only a few people will do the small investigation and fewer filters than before. Political events are one of the increases in the popularity and spread of fake news. The increasing of fake news is the major problem of today and will negatively impact the world. To avoid this type of bogus information spreading worldwide, we can use artificial intelligence and machine learning. Recently, deep learning techniques used complex natural language processing also to providing the solution for counterfeit news detection. Facebook is using AI techniques to filter the fake news stories from the user feeds. Now it is possible using the Naïve Bayes classifier to differentiate between fake news and real news.

Keywords Fake news · CNN · RNN · Misinformation · Rumors · Logistic regression · Naïve Bayes

1 Introduction

The adaption of social media gives way to spread information in the world wide. This has never been witnessed before in people life. The news media improved from newspaper to online news platforms such as Blogs, Twitter, and Facebook. Using this platform, the user will get the latest information or news at their fingertips. These social media are powerful and valuable to the people to share their ideas and debate issues such as education, health, and political issues. The negative people use the same platform to share fake information or news to gain money, creating biased opinions, changing people mindsets, etc. The machine can solve the fake news problem better than humans. For detecting, keep tracking and taking statistical machines are better than humans. Some sources as considered as a piece of factual information, and some popular information providers such as Wikipedia are prone to fake news [1]. The biggest threat to the people is fake news, and this one can cause

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democracy, commerce, and journalism worldwide. One of the recent fake news is about the spread of the coronavirus nature, origin, and behavior over the Internet. The people will read that the content is worse than the real news (Figs. 1 and 2).

More than 70% of US news consumers are concerned about the fake news. This information is collected by Deloitte Media Trends Study 2021 (Fig. 3).

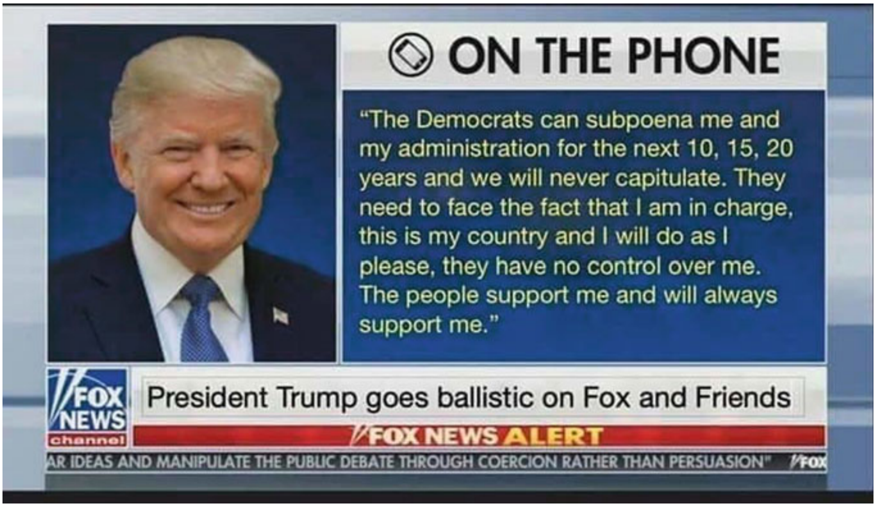

Fig. 1 Fake news on Trump. *Source*: Google

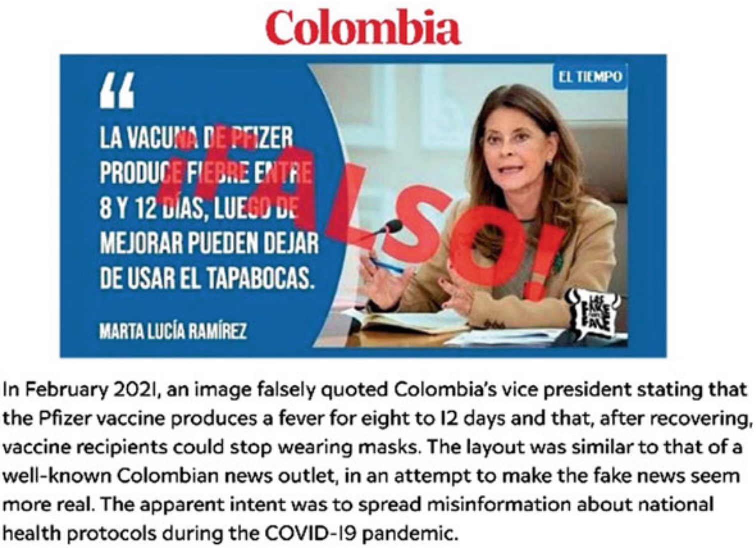

Fig. 2 False quote from VP of Colombia. *Source*: Google

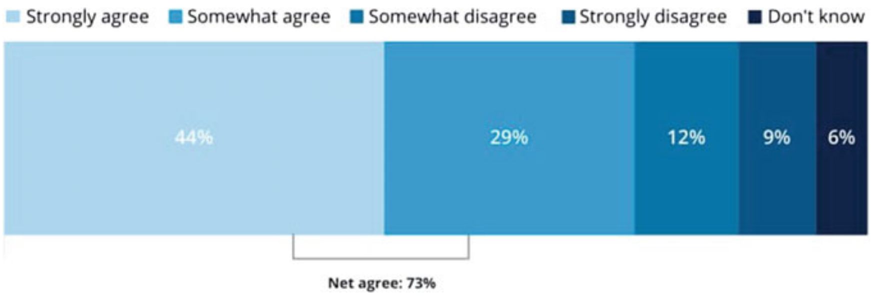

Fig. 3 Concerned about fake news in 2021 (US). *Source*: Google

2 Literature Review

The author Mykhailo Granik used the Naive Bayes Classifier algorithm to identify the fake news. This method was implemented to identify the fake news from the Facebook posts using their dataset. They collected three extensive dataset from the Facebook pages and the same three data selected from the political news from the newspaper. This one provided approximately 74% of accuracy of fake news. This one will cause 4.9% only.

The author Himank Gupta has collected 400,000 datasets from spam tweets and 250,000 datasets from non-spam tweets. He used Botmaker to process the more number of datasets, and it produced 91.65% of accuracy, approximately 18% solution from the existing one.

The next author Marco L. Della Vedova research on the fake new detection will produce the accuracy of 78.8%. He collected the data from the various social media platform such as Messenger, Tweets, and real world applications. He implemented content-based approach method and social-based system. In this research, he got the accuracy of fake news which is 81.7%.

Cody Buntain used to detect the fake news from tweets, and he used two types of fake news detection automated. He collected datasets from Creadbank and Pheme for assessment purpose. He applied this method into the fake news dataset of Buzzfeeds. He collected forwarded conversations from tweets and identify the threads.

Shivam B. Parikh aims to detect the fake news based on the text-based analysis. He explored a deep into the news story in the different content type to readers. In his research, he had a different types of research challenges, and this one takes a lead to future research.

3 Objective of Research

Political events are one of the most considerable fake news circulations worldwide. People in the world it is tough to identifying whether the information is fake or real.

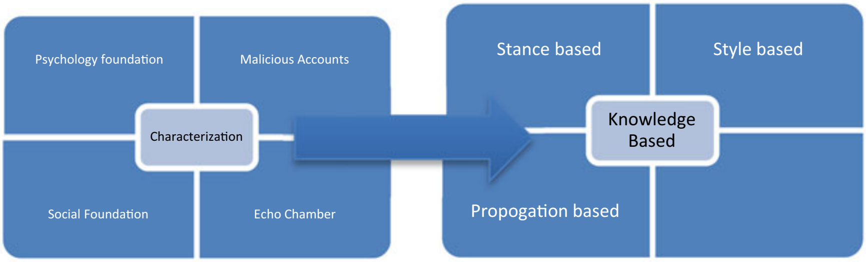

Fig. 4 Types of fake news detection approaches *Source*: Google

Machine learning will help to see the phony news using language patterns. We used different machine learning models and language patterns to differentiate the real news and fake news.

4 Fake News Detection Types and Approaches

Two methods are used in this approach: characterization and the second is detection (Fig. 4).

5 Dataset Descriptions

The fake news dataset and real news dataset were collected from Kaggle. The file types are CSV. The total number of news is 44,898. Here, 21,417 news is considered real news, and 23,481 news is considered a piece of fake news. First, we must import all the necessary library files and then read the CSV files.

No.	Title	Target
0	Donald Trump out embarrassing new year	Fake
1	Drunk bragging Trump staffer started Russian	Fake
2	Sheriff David Clarke becomes an internet joke	Fake
3	Trump is so obsessed he even has Obama name	Fake
4	Pope Francis just called out Donald Trump Drunk	Fake

Table 1 Classification report

	Precision	Fact	Score $f1$	Support
Counterfeit	0.99	0.99	0.99	4740
True	0.98	0.99	0.99	4240
Perfection			0.99	8980
Numerous mean	0.99	0.99	0.99	8980
Weighted mean	0.99	0.99	0.99	8940

Table 2 Confusion matrix

4674	66
45	4195

5.1 *Logistic Regression Model*

First, we will use an evaluation matrix to classify the news (Tables 1 and 2).

The result of logistic regression will provide 98.76% of accuracy.

5.2 *Naïve Bayes Model*

Next, we will use the Naïve Bayes model to classify the news (Tables 3 and 4).

The result of the Naïve Bayes classifier will provide 93.56% of accuracy.

Table 3 Classification report

	Precision	Fact	$F1$-score	Support
Counterfeit	0.93	0.95	0.94	4740
True	0.94	0.92	0.93	4240
Perfection			0.94	8980
Numerous mean	0.94	0.93	0.94	8980
Weighted mean	0.94	0.94	0.94	8940

Table 4 Confusion matrix

4486	254
324	3916

6 Conclusion

In this paper, we used two methods to be used for the fake news detection problem. This problem is very important in our real life. Logistics regression will provide 98.76% accuracy, and Naïve Bayes will provide 93.56% of accuracy. After the classification, we conclude logistic regression will provide better classification of real news and fake news.

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A Survey on Deep Learning Methods for Addressing COVID-19 Issues

Aanal Raval and Arpita Maheriya

Abstract Due to the unprecedented COVID-19 breakout and its flare-up of mutations, catastrophic effects are seen on subsistence and the continuation of the human race. This disease chiefly infects and damages the lungs, leading to respiratory illness. Although admitting that its survival rate is high, which leans on an individual's immunity, it's creating an imbalance in the biotic ecosystem. In its diagnosis, the generally test used is reverse transcription-polymerase chain reaction (RT-PCR), relying more on timing of sample collection and type, repository, handling, and processing, resulting in inaccuracy. So in these scenarios, deep learning techniques prove to be a boon. DL can assist the medical care sector to develop preventive and curative medicines, concerning issues regarding pinpointing its risk, predicting its timely spread and mutations, prediction of its effects on mental health, medical imaging and scanning, diagnosing and monitoring patients, forecasting successfulness of developed treatment and misinformation spread detection as well as even for the development of drugs. Amidst different numerous technologies available, deep learning models, a subfield of machine learning, have shown prominent and notable results in these tasks. This paper aims to unearth and analyze the DL methods to create application models that solve similar issues, which in succession will provide an easy as well as an appropriately governed analysis and research work. So outcomes of these analyses can provide service to the healthcare sector and administrative authorities to tackle its problems and can pave a path about what tactics should be implemented to put brakes on the outbreak and eventually terminate it.

Keywords Machine learning · Artificial intelligence · Deep learning · Coronavirus prognosis · Predict COVID-19 · AI/ML use in COVID control

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1 Introduction

Countless people have been affected and troubled by coronavirus pandemic. As of now, demise of numerous people has been observed in its various stages and apart from it more and more are getting affected every day. If symptoms aren't diagnosed early or if physical symptoms aren't seen, it can keep on spreading creating a chain. So its timely detection at an early stage becomes inevitable. Although diagnostic techniques like RTPCR, antigen, and antibody testing are widely used, these techniques have recorded issues like false negatives, false positives, and uncertainty in the correlation of antibody levels, respectively. Apart this process can be interrupted or can become time consuming due to its increasing demands and limited number of kits. So globally, for diagnosis of coronavirus and speeding up the related process, there was a need of searching some alternative methodologies. This is the main reason why DL models are used in radiographic techniques like X-ray, CT scan, and many more, as these are accurate and more sensitive in the detection of COVID-19 viruses (Fig. 1). Apart from diagnosis, it has numerous applications including drug development, monitoring, and predicting outbreaks. Another notable use seems to be the prediction of the most suitable method among available medical diagnoses.

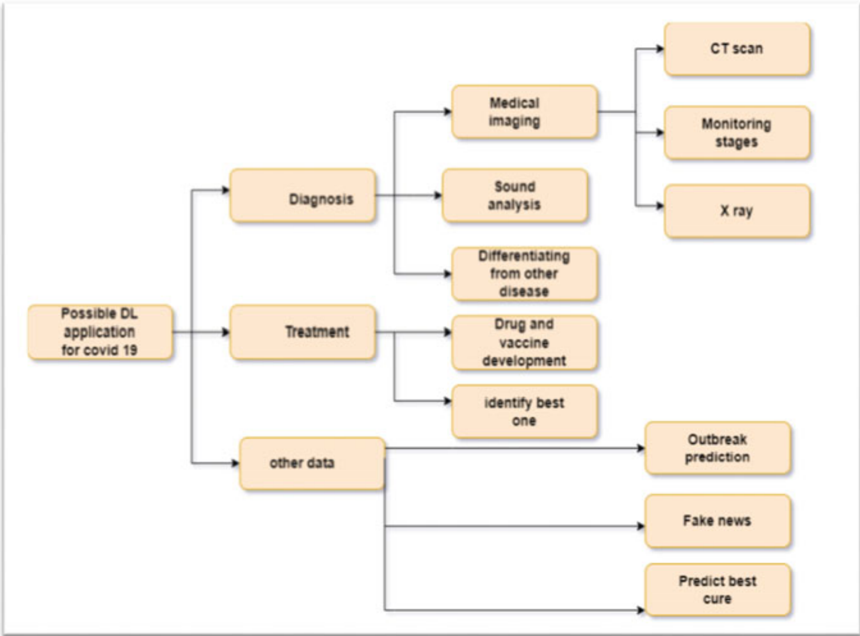

Fig. 1 Possible DL applications for COVID issue

2 Diagnosis

Diagnosis of COVID using deep learning can include detection, tracking of the virus with techniques like medical imaging, analyzing respiratory sound, and especially its differentiation from other diseases becomes important.

2.1 Detection and Tracking of Virus Through Image

The responsibility of imaging in requirements for detecting and tracking viruses has blossomed appreciably, due to its eminent and outstanding results. Predominating methods are lung-CT, PET-CT, and chest X-ray. These all techniques are accounted as accurate, rapid, and proven techniques for diagnosis of COVID-19 as compared to reverse transcription-polymerase chain reaction. It can churn out a variety of results in image detection and recognition of infected organs with its classification, thus assisting radiologists in tasks of surveillance and prognosis. So it will be viable to govern the individual improvement in illness, which in turn will aid in making medical decisions.

This section provides information of various technologies and methodologies applied for diagnosis in medical imaging tasks of detecting virus like CT scan and chest X-rays.

CT images: Ref. [1] describes the use of DL for lung ultrasonography (LUS) indicating disease seriousness at the video frame and pixel level. Frames are segmented from videos indicating the pathological artifacts. The frame-based score gives a prediction of disease with localization of pathological patterns, with the combination of CNN and STN, considering Soft Ordinal Regression (SORD) as loss function. The video-based score then labels each frame from the former output with the high predictable score based on frame predictor, takes the maximum result scorer of each frame, averages frame level predictions on the video, and outputs the score with the maximal average. This method achieves $F1$ score of 71.4% for frame-level predictions and for video-level predictions; $F1$ score, precision and recall are of 61%, 70% and 60% respectively. Segmentation is capable of displaying healthy markers and background, with various stages of coronavirus disease biomarkers at a pixel level, with an accuracy of 96%. The authors in [2] discusses the use of EfficientNet with 19 million parameters, 16—Batch size, image size of 348 $\times$ 348, and Adam as an optimizer, on 351 COVID 19 and 395 non-COVID 19 images, achieving accuracy and $F1$ score of 90%. This paper uses three types of learning rate: Stable rate of learning rate is 0.0001, cyclic learning rate: oscillate back and forth between two bounds when training, slowly increasing the learning rate after every batch update, and learning rate reduced on plateau: in which model learning rate decreases when model performance stops improving. The authors in [3] mentions the use of a combination of Inflated 3D ConvNet and 3D Residual network 50, which makes use of spatiotemporal information. I3D (Inflated Inception) starts with three convolutional layers thereafter applying a Maximum Pooling layer of stride (1, 2, 2), then two inception blocks, again a maxpool layer with five inception blocks. This result is fed to Maximum Pooling of stride 2 having a pair of inception modules. At last, average pooling has been done passing on the results to the convolution layer following the FC layer. For 3D ResNet, the first is a convolutional layer with stride 64, followed by six convolutional layers. Then eight are of stride 128, 12 are with stride of 256, following six convolution modules. Finally, average pooling is carried out followed by a 400d fully connected layer. So both these are used to train FC, whose output in terms of probability is fed to softmax layer, which finally classifies the suspect as positive or negative, claiming highest accuracy of 0.86 and $F1$ score of 0.85. Ref. [4] gives a DL model incorporating different types of layers with the basic convolutional layer with dropout layers, performing with an accuracy of 96% and sensitivity of 97%.

Apart from the above, various DL model like Visual Geometry Group (VGG) network, 2D CNN, CapsNet, GoogLeNet, DenseNet, XceptionNet, AlexNet, SqueezeNet, Inception-ResNet, NasNetmobile, EfficientNet, ShuffleNet, Generative Adversarial Networks (GAN), and MobileNet [5]. The gap in instances to train with a huge count of parameters is the matter of concern in CNN for which dropout ratio along with batch normalization accelerate the learning process. For better learning in AlexNet, response normalization locally along with dropout has been deployed. Now VGGNet is made up of a stack of ReLU function utilizing convolutional layers. Concerning classification purposes, softmax activation function has been used at the ending layers of the model VGG-E, showing its variants as with 11, 16, and 19 layers. In GoogleNet, kernels are of various sizes, due to which different receptive fields are generated. Another variant of it is a gradient injection, which aims to overcome the gradient vanishing. With the use of varying number of layers like 34, 50, 101, 152, and 1202, this task can be performed. One variant of ResNet is RexNet in which the outputs of different paths are merged by adding them together. Inception-ResNet v2 uses the architecture of Inception-ResNet v1 with inception v4 as stem [6]. Inception-ResNet v4 was evolved using the exploitation of reduction blocks. CapsNet was created to operate on inverse graphics by determining an object's location and then finding its instantiation. NasNet has two modules: RNN for finding normal and reduced convolution cells on sample dataset and then stacking its multiple copies, second is ScheduledDropPath for regularization. ShuffleNet consists of a convolution layer, followed by two pooling layers, then stacking of ShuffleNet units whose structure consists of three stages, and finally, a fully connected layer. EfficientNet was developed to vanquish the problem of bottleneck in MBConv.

Apart from the above models, GAN, FCN (for capturing of local map, FC layers are replaced with convolutions), SegNet (combination Encoder network by removing FC layers and decoder such that with each downsampling layer in encoding section, the upsampling layer is positioned to convert low to original resolution), U-Net (Like SegNet but with skip connections between upsampling and downsampling layers), Res2Net (1 * 1 convolution, feature map divided to subsets, 3 * 3 convolution and then concatenation through 1 * 1 filter as well as control parameters as scale dimension), LSTM, GRU, and autoencoders have also been deployed for application. Ref.

[7] designed a model CTnet-10 for COVID diagnosis being 82.1% accurate. Ref. [8] used transfer learning for initialization of parameters and pre-training of three CNNs: GoogleNet, ResNet, and AlexNet (for feature extraction), and then obtained classifier using voting [9]. Utilized fine tuning of 15 different models: NasNetLarge, Efficient-Nets (B0-B5), InceptionV3, NasNetMobile, SeResnet 50, ResNet-50, ResNext50, Xception, Inception_resnet_v2 and DenseNet121, after which voting and transfer learning was applied for recognition task.

Chest X-ray: Ref. [10] explores the use of CNN, VGG-16, VGG-19, and Inception v3 showing VGG-19 outperforming all with an accuracy of 95%. Ref. [11] too deployed CNN but considering factors like survival rate, common age ratio, and sex ratio from the infected, with an accuracy of 91.67%. Ref. [12] introduced a shallow classifier multi-stage residual network, MSRCovXNet, with Residual network-18 as a feature extractor. Optimization done by fusing of low- and high-level feature map like two feature enhancement modules or commonly written as low-fidelity models and high-fidelity models. LFMs have more local information and HFMs have more semantic information. For more potency, a single-stage FEM-MSFEM and a multi-stage FEM-MSFEM were built to boost the representation of semantic feature of the LLFMs and for the representation of local feature of the HLFMs, as insequence. This achieved an accuracy of 82.2% in COVIDGR dataset. In [13], first severity scores were calculated 0, 1, 2 for bottom, medial, plus higher zones accompanying an extreme result as 12. Then, to the zone of lungs having no radiographic locations, score having 0 was assigned, to ground-glass opacity zone score '1' was given as well as score '2' was for consolidated opacity zone no matter either with air bronchograms or even without it. Thereafter, a histogram of gradients and grey intensity feature families was computed. Calculation for statistical measures like skewness, kurtosis, median and standard deviation was done for every radiomic feature. Then on the same radiomic features, training and cross validation of models like Linear Discriminant Analysis (LDA), Quadratic Discriminant Analysis (QDA), and Random Forest (RF) were done for task of estimating requirements of ventilation and predicting mortality. For the same purpose, they deployed DL models like CNN. Every classifying observation made use of ResNet-50 already trained on ImageNet. It followed the task of (Class Activation Maps) CAMs generation before moving to global average pooling of ResNet-50, utilizing outputs of network. The purpose of CAM is to visualize attention module for estimations as well as making validations for appropriate regions which the network already determined, with t-SNE to visualize features, by converting to 2D.

Other models like VGG-16, AlexNet, GoogleNet, ResNet 18, GAN, U-net, Resnet-50, SqueezeNet, DenseNet 151, MLP with LSTM, MobileNet, and Inception net have also been deployed [14]. In [15], CSNN, a Neural Network with Convolutionary Siamese was created in order to output a notch of COVID-19 which presents the severity of patients' pulmonary X-ray. Ref. [16] deployed eight different pre-trained models of CNN such as GoogleNet, Residual network-50, AlexNet, Visual Geometric Groups-16, Residual Network-34, SqueezeNet, and Inception-V, for COVID infection detection in early stage, showing state of art results of

ResNet-34 with accuracy of 98.3%. Ref. [17] proposed a model with DarkNet acting as classifier for YOLO for the task of binary as well as multiclass classification with accuracy of 98.08% and 87%, respectively. Ref. [18] proposed Xception-based model Coronet for four class classification with overall accuracy of 89.6%. Ref. [19] deployed lightweight model COVIDNet giving accuracy of 93.3%.

2.2 Detection and Tracking of Virus Through Sound Analysis

In this field of analysis, indicators for diagnosis are detection of heartbeat, digestion, breathing, moaning, or any other vibrational sounds [14]. Ref. [20] uses the mentioned equation for data preprocessing that transforms the cough data collected to Mel scale 'me':

$$\mathrm{me} = \log 10(1 + \mathrm{fr}/700) * 2595$$

Here, me specify measured pitch scale by listeners to be same in distance from one another. Ref. [21] introduces Computer Audition (CA) to determine cough based on indications like dry or wet cough and breathing, a speech of flu-infected, sleepiness, or in pain. Using these data, they recommend diagnosis and treatment for COVID. Ref. [22] suggested a model of bidirectional GRU with attention module. This model is good in categorization of six different respiratory types, namely biots, central-apnea, bradypnea, eupnea, Cheyne–Stokes, and tachypnea. A device called FluSense was developed, based on ANN which can identify flu-like diseases. It included a microphone array, thermal camera, and neural computing engine. This device when used Pearson's Correlation coefficient yielded an accuracy of 95% [23, 24].

2.3 Detection and Tracking of Virus Through Non-invasive Estimation and Differentiating from Other Disease

References [14, 25] mentioned the use of smartphones to detect information of patients. The system included sensors that can detect a person's voice and body temperature by biometric (finger) recognition. These data were forwarded to an AI-based cloud server for analysis. Similar methods can be applied for contact tracking to maintain social distance.

As this virus targets the lungs, it becomes essential to cautiously differentiate it from other similar diseases. Ref. [26] deployed with convolutional neural network (CNN) architecture such as AlexNet, Residual Networks-18 and Residual Networks 50, Visual Geometry Group, MobileNet-version2, and Densely Connected Convolutional Networks-121 for this purpose. ResNet-18 among all proved to be foremost in differentiating coronavirus disease from pneumonia and pleural effusion, as well as mass of lungs. Ref. [27] used ResNet-18 for the same task. Ref. [28] proposed a model InstaCovNet-19, with stacking of deep CNN which included different re-trained models like Xception, MobileNet, ResNet101, NASNet, and InceptionV3 to handle small training data for differentiating COVID from pneumonia with accuracy of 99.08%.

3 Drug Development and Vaccine Discovery with Its Success, Behavior, and Recommendation

DL methods can assist in vaccine discovery by detecting the viral protein structure revealing the spread, communication, and propagation of vaccine components. Apart from this, DL can provide summaries of research documents quickly [29, 30]. Google DeepMind proposed AlphaFold, which predicts the evolution and generation of 3D proteins using their genetic sequences. Ref. [31] studied Extreme Learning Machine (ELM) with ANN model to forecast the drugs based on their performance. Ref. [32] used Knowledge Graph Embeddings-based method GFCNet (network of graph feature collection) considering both the neighbors and the feature of attributes to deal with the missing and complex relations of COVID data. For this task of drug estimation, COVID-19 drug KG dataset was used.

4 Prediction of Outbreak, Identify Best Treatment, and Fake News Detection

Prediction of an outbreak: Ref. [31] discussed the models like ANN, RNN, LSTM, GRU, Gated Recurrent Unit Recurrent neural networks (GRURNN), and Clockwork Recurrent neural networks (CWRNN). This task can be achieved by considering clinical and geographical data. Other parameters can be age, sex, location, province, date symptoms started, date of admitted to hospital, confirmation day, and intensity of sign.

Identify best treatment: Ref. [31] discussed the use of the Long Short-Term Memory Networks for sequence of training for classify best treatment available with high precision. The inputs discussed for this task are electrocardiography, history of chronic medical illness (for training process), and phases of COVID infection (mild, moderate, or advanced).

Fake news detection: For this task, combinations of DNN models like dense RNN, dense CNN, and attention layers are applied with natural language inference. Reinforcement has also been applied for the same task. Ref. [33] inspected evolutionary classification algorithms like Genetic Algorithm, Salp Swarm Algorithm, and Particle Swarm Optimization (GA, SSA, and PSO). Besides, for this task, ML classification algorithms seem to be more effective [34].

5 Challenges

Generally, DL techniques, especially task of medical imaging, are based on requirement of macro-scale data. Due to speedy flare-up of COVID and its mutations, inadequacy and restriction can be seen on availability of datasets. Dealing with samples of training data is tedious and time-consuming task as it needs DL knowledge as well as medical expertise. Spread of fake reporting, rumors, still needs to be detected precisely and accurately. Besides, due to presence of noise in dataset can result in biased outcomes affecting the performance analysis of predictions. Along with noise removal, secure data collection and protecting it during task becomes an important issue. The importance of valid information here too comes to play. Data can be ambiguous and incorrect when collected in large volumes from various sources. Tackling of unbalanced datasets becomes inevitable in case of medical imaging because of its time consumption during training. Another challenge occurs at time of collection of patients' data like their results. Another major issue is the limitation in awareness of crisscrossing of ML/DL and medical fields. Apart from all these, although work has been seen in its differentiation with other diseases, yet it needs to be made precise. Nature of data too determines behavior of different models. Figures 2 and 3 show pros and cons of offline and online data showing its importance and challenges of the respective.

For easy manipulation and to guarantee availability, data must be transferred to cloud. When the role of cloud comes in, privacy and security issues too steps in. Here are mentioned some of the problems (Fig. 4):

Whistleblowers: Protection of data against the working insiders who can leak or share records for personal interests.

Preserving private information: Information about insurance companies as well as prescriptions to patients can be mitigated which can result in economical losses.

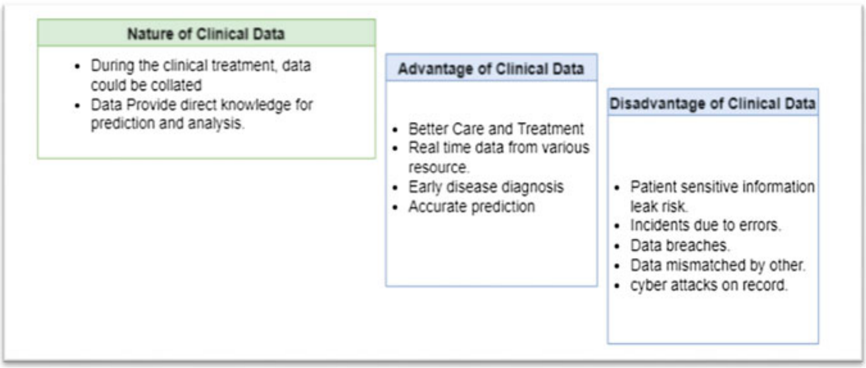

Fig. 2 Nature, advantages, and disadvantages of clinical data

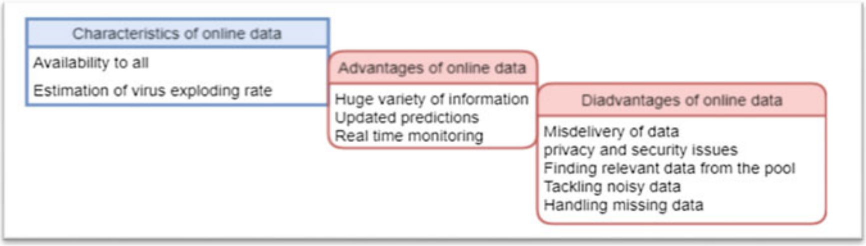

Fig. 3 Characteristics, pros and cons of online data

Collection of Patient's attributes: For some typical analysis, some patient attributes are needed. Getting access to these along with the consent is a quite difficult task.

Storage, tackling and proper retrieval of data: For the chore of storing voluminous data, assuring it to be noise free, handling its missing values, ensuring its validity, retrieval of proper data at proper time as well as keeping it up to date with its constant monitoring becomes quite monotonous task especially when viruses mutate post-haste within short time.

Consistent, Valid and up to date data: Ensuring that for particular task, needed, appropriate, updated, and unleaked data is available without noise.

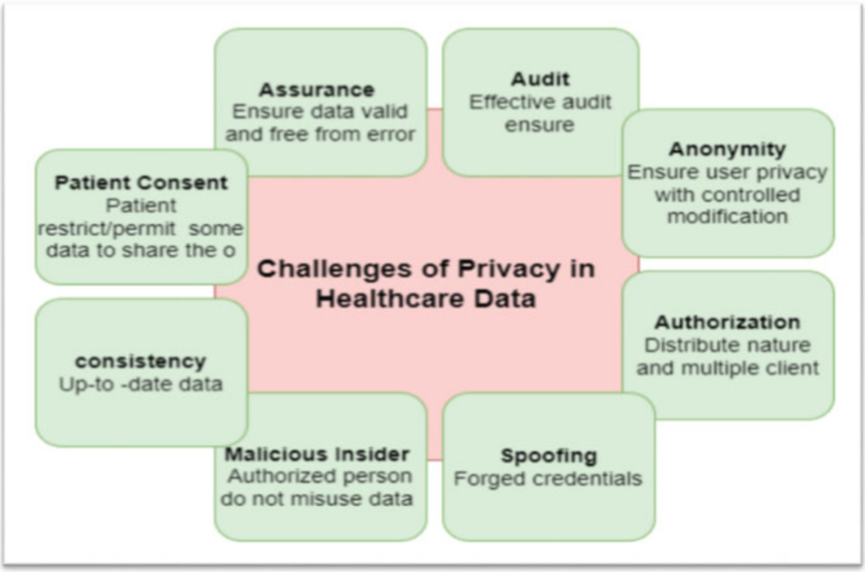

Fig. 4 Challenges of privacy in healthcare data

6 Research Scope and Motivation

Worldwide the corona virus outbreaks affect the lifestyle of human beings. This paper has provided with a summarized view of available tools, technologies, datasets, and applications based on advanced data-driven technologies that will be immensely useful to AI researchers for further work in this field. Along with it, this work describes techniques based on DL, which helps in early treatment of COVID-19 patients. Technologies are now becoming part of our daily routine; especially artificial intelligence and its application helps us to combat coronavirus outbreaks. Deep learning is foremost used to achieve promising results to fight with deadly diagnoses such as COVID-19. Deep learning methods can assist in knowledge of the severity of infection. To eschew the spread of the parasite as well as to aid the treatment, DL can serve with measurement estimations of non-invasive quantifiers. DL can simplify and rationalize task of analysis genetics and protein structures. Analysis of these structures estimating various combinations can help in state-of-the-art predictions of drug and vaccine synthesis. Also the fact that can be summarized is using DL models, any recrudescence, outbreaks, nature and characteristics of infection transmission with its effects can be found. Besides, monitoring and tracking of infected in public places can also control the spread to a noticeable extent.

7 Future Directions

In case of differentiating COVID symptoms from other diseases, deployment of automatic classification for CT scans and X-ray can be effective. Similarly, automation can be utilized to break the chain of transmission, by preventing potential of virus spread. Another scope includes video analysis and diagnosis. While consideration of drug development, future vaccines structures for mutations can be analyzed and developed, identifying behavior of composition along with its reactions on humans. Tracking of persons' physical contacts with patient too can predict and serve in controlling probability of spreading disease. Besides at various stages of infection, constant expert monitoring can help to make precise decisions in complex situations. Apart decision of selection of appropriate data and equipment along with tackling heterogeneities in data can be solved using DL.

8 Conclusion

DL has been applied for building various solutions to trouble caused by COVID including detection and diagnosis, predicting virus spread, monitoring drug development and testing etc. The explored methodologies and conceptual frameworks during analysis of applications and uses of DL for dealing with COVID issues are studied in this survey. Here, we inspected the DL-based methods for diagnosis and treatment along with best method identification in second and third sections, respectively. Third section provides analysis of outbreak prediction and identification of fake news regarding COVID. Here, we analyzed the involvement of AI in treatment, diagnosis, contact tracking, drug development, and vaccine discovery, as well as detection of fake news with existing algorithms in it and methods providing state of art results among existing. Assisting in voluminous data analysis and optimization, DL techniques can set and train machines more accurately and efficiently to tackle with COVID issues. Thus, DL has supported a lot and contributed to solutions against COVID-19. This can pave directions toward the development of completely automated decision support system for medical experts regarding research in diagnosis. Concluding the contribution of DL for addressing COVID issues, it provides a powerful recommendation and motivates novel researches in the field.

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An Application for Privacy-Preserving Contact Tracing and Public Risk Assessment Using Blockchain for Covid-19 Pandemic

K. R. Shreya and D. R. Nagamani

Abstract Many nations are debating on the ways to revert to the new regular state of living as the count of reported infections and victims of the novel COVID-19 outbreak drops with each day gradually. One option examined is the use of contact tracking to bring the spreading of the illness reducing and preventing another round of transmission. Contact tracing still has security and privacy difficulties, regardless of the fact that there are multiple solutions, which makes widespread usage challenging. On the basis of that, a unique approach for contact traceability is introduced, utilizing Blockchain like its foundation. User confidentiality may be protected as well as a comprehensive view of the public for all verified instances can be made available to individuals and governmental entities through connecting distributed ledger alongside contacts tracking apps. By calculating the danger of COVID-19 exposure to the wider populace and disclosing it in a ledger, it also explores how open places may assist in contact tracking. With the use of an Android app, the system can detect the position, and this position is kept on the ledger. These places can efficiently notify possible contamination concerns whilst still ensuring the data's confidentiality and reliability. Finally, findings were made when numeric figures are presented in various settings.

Keywords COVID-19 · Blockchain · Contact tracing

1 Introduction

The severe acute respiratory syndrome coronavirus-2 epidemic, also known as SARS COVID-19, affected the entire globe in 2020, putting multitudes of individuals under quarantined, isolation, and total lockup. Public agencies are debating ways to adjust to the newfound reality as the amount of cases begins to gradually fall. They propose keeping social distance, using masks in busy areas, and tracking contacts among individuals to prevent the virus from spreading once more. A conventional

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contact tracking is a procedure wherein medical professionals assist an individual to remember each individual they had intimate contact with while they might be infected. This is performed with the intention of reaching out to those who have been contacted and notifying them as swiftly as feasible in trying to end the virus's transmission and lower its reproductive rate.

Conventional contacts tracking reliability and effectiveness are constrained, though, because it depends on storage. Latest research also demonstrates that the medical facilities in place today really aren't equipped to do contact tracking on the size needed by the COVID-19 outbreak. For instance, in the US, an extra 50,000 workers will have to be recruited and educated, while US $3.6B in financing will be required. Various contact tracking methods are been created and tried all around the globe in response to this matter. Instances of how the COVID-19 outbreak was handled include South Korea and Singapore, in which the virus's transmission was stopped through employing a testing, track, and confine technique employing bluetooth connectivity. Apple and Google are also working together to create a bluetooth-based software where individuals are given unique identifiers based on their location. In order to protect individual privacy, this does not require the person's identification. The National Health Service of UK offers alternative option, although it has come under fire from the population for the kind of info it collects including how much it is kept on file. There are several approaches to digitized contact tracking (DCT), including the usage of web portal which link up individual contact details to medical records or the usage of the global positioning system (GPS) in conjunction using Wi-Fi to track people' locations. Thus, the app notifies the user's Smartphone anytime they get in touch with an affected individual.

2 Related Work

Lai et al. in article [1] talk on how Singapore, a nation with a large population, planned for the COVID-19 outbreak through implementing online target tracking methods. These methods included secure entrance, a cloud-enabled visitor registration scheme, as well as TraceTogether, a Smartphone app which works through exchanging unnamed signifiers among nearby Smartphone using Bluetooth connectivity.

The earliest countrywide deployment of a bluetooth-enabled interface monitoring system was TraceTogether. On same lines as DCT, J. Bay et al. developed alternative technology named BlueTrace [2]. It is a confidentiality framework that facilitates interaction monitoring by tracking Bluetooth interactions across connected gadgets whilst safeguarding the subscribers' private or sensitive details.

They established a BC-based EPIC procedure named BeepTrace [3], where they implement a ledger joining the subscribers as well as approved solvers to just not concern about the customer identifying and placement info, offering so much safe and secure environment and also extensive durable battery time and global accessibility. Additionally, it keeps the electronic interaction tracking organized.

This research demonstrates how well the Korean establishment responded to COVID-19 at workplace as well as in communal locations in paper [4]. The basis to Korea's best effective primary approach in combating the epidemic was the strict standards of adhering to social distance and immediate identification in crowded locations. Despite recurring breakouts in unsupervised workplaces including bars and nightclubs, especially shift work, the nation has so far managed to flatter the graph of disease incidence without suffering any significant casualties. The crucial confidentiality issues in online interactions tracking for the COVID-19 epidemic are resolved by this BC dependent system.

It serves as an example as to how relational databases and online equipment supported interaction tracking. A national contact tracking prototype known as TRACE was created by the Taiwan Center for Disease Control in 2017 [5]. This had knowledge related toward other database systems, is being employed to track contacts' wellness and assisted in maintaining interaction via daily exploratory research and associated key metrics. Employing TRACE strategy, both symptomless and or before infections might be stopped.

The research shows the way the US dealt with the COVID-19 epidemic in article [6], whereby they needed to carry out vigorously, manually performed contact monitoring. A group of undergraduates in medicine, nurses, and healthcare were assembled under the direction of physicians and public health officials. The trainees used phones to approach the sick individual, assisted in tracking down those they had interaction with, and ensured that they properly adhered to the quarantined and isolating rules. This averted the discovery of symptomless as well as or before individuals. Nevertheless, they encountered significant difficulties which might hinder the COVID-19 effectiveness in managing via contact tracking.

3 Algorithms

3.1 AES

Due to the growing usage of the web for the transmission of confidential documents mostly on a professional and private level, online protection has emerged a cause of worry. Information security requires cryptography to protect information against unauthorized entry. The encrypting key's magnitude determines the robustness. The very same key is utilized in both encoding and decoding in the symmetrical crypto algorithm known as Advanced Encryption System (AES). The working of AES Algorithm is given in Fig. 1.

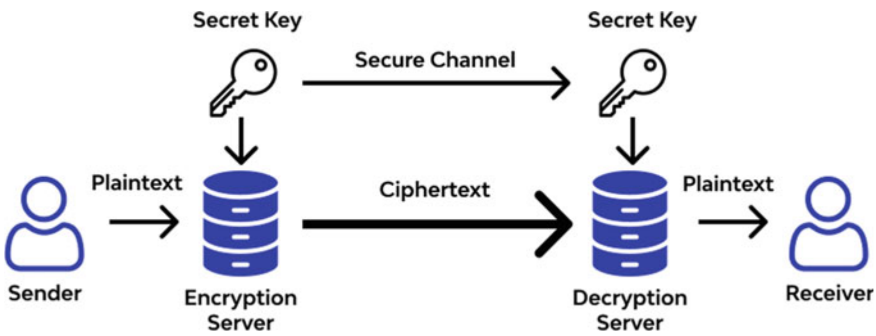


Fig. 1 AES working

3.2 MD5

The MD5 hash technique (message-digest algorithm) is a one-way crypto mechanism which intakes a message of any size and produces a fixed-length digestion result which could be employed to verify the validity of the actual text.

In hash information and certification documents, MD5 is employed as shown in Fig. 2. Each item of information generates distinct hashes which is completely indistinguishable to any other bit of info. Due to the reliance on the hashes which is produced from the information, the subsequent signature is also singular. The idea underlying such hashed techniques is that they're utilized to produce a brand-new digital message known as a hash or digest. In the suggested method, the blockbody is created employing the MD5 hashing, in which the root hash would be produced.

3.3 Block Updation Required Check

Algorithm 1: Block Updation Required Check

Input: User ID, Location Co-ordinates

Output: Block Updation Needed or Not Needed

User: Patient (Android App Timer Event)

```
if N minutes are over from last block updation
    Send User ID, Location Co-ordinate to Web server
    Fetch Pervious Location Co-ordinate for User ID
    Calculate Euclidian distance for both Co-ordinates
    If the distance is less then threshold then exit
    Send Block Updation needed message
else
    wait and check
```

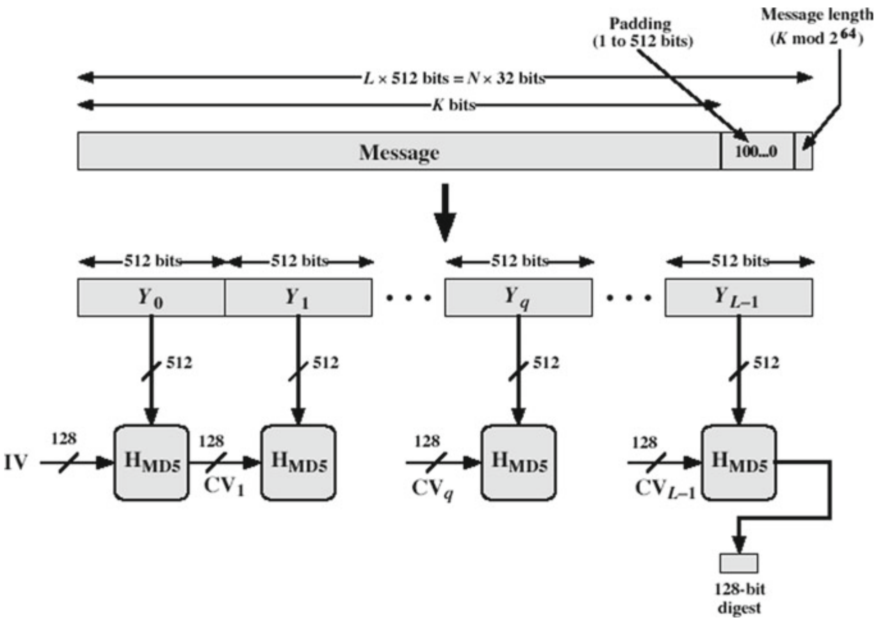


Fig. 2 MD5 working

3.4 Blockchain Block Integrity Check Algorithm

Block Integrity Check Algorithm

Input: Block Number

Output: Block Integrity Detail

User: Admin

if Block number is present then

- Identify the Block location
- Extract the block
- Read the Hash Code (1)
- From Previous Block read Hash Code (2)
- If Hash Code(1) = Hash Code (2) then Integrity Check PASS
  Else Integrity Check FAIL

else

- Display block number does not exist

4 Technologies

4.1 Blockchain Technology

In a blockchain, data is gathered in sets called blocks, each of which contains a bunch of data. Each block contains specific storing capabilities, but once occupied, they are sealed and connected to the block that came before them to create the information trail called as the blockchain (BC). Every additional piece of data which comes after the recently inserted block is combined into a brand-new block, which is then joined to the network when it is full. Block is kept inside the private cloud service Drivehq.

4.2 GPS

The networks of satellite transmitting navigational information and then a cluster of base units and mission controlling stations is employed for surveillance and management make up the global positioning system (GPS), a space-based radio navigational framework. Using the COVID-19 patients' GPS coordinates such as the longitude and latitude, the application employs GPS in the proposed method to trace contacts.

4.3 Euclidean Distance

The separation across two points is known as the Euclidean distance. In other terms, the distance of the line segment across two positions in a Euclidean area. It is also referred to as the Pythagorean distance since the Euclidean distance can be calculated employing coordinates as well as the Pythagoras method.

5 Proposed System

With the help of an Android mobile app, it is possible to locate COVID-19 patients' contacts in this platform, and the geolocation information is recorded in the BC.

Figure 3 depicts the suggested system design. Data of the Android app will be collected by the web app. After obtaining the information, it will retrieve the position information then fetch the longitude and latitude of the preceding transaction. The Euclidian distance across two geographic places would be determined. The records must be saved in a BC, if the Euclidian distance exceeds the threshold.

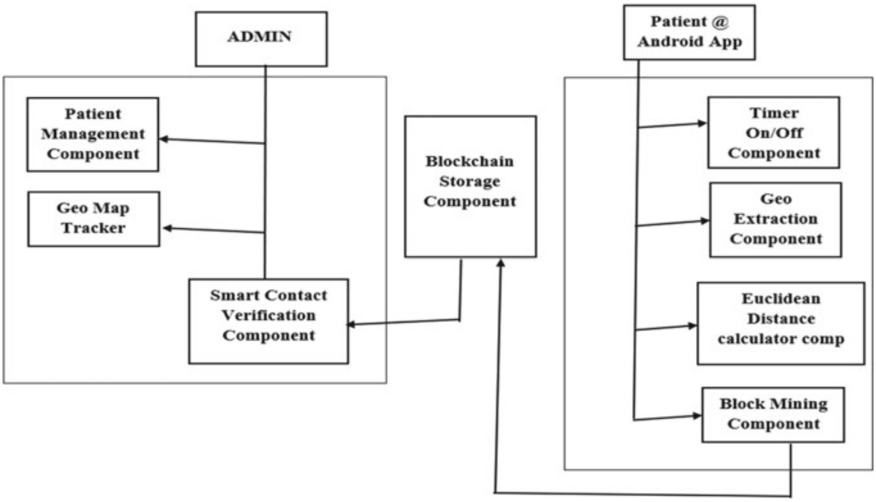
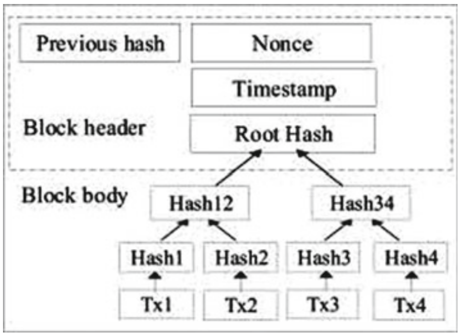


Fig. 3 System architecture

Depending on the choice selected, the mining operation on the BC would be activated. Block formation on the BC is done through mining. The AES method would be employed to encode the blockbody information. The MD5 method is used to build the root-hash and construct the blockbody. After obtaining the Previous Root-Hash, the Block Header is created by appending the Former Hashcode, Present Root-Hash, Timestamp, and nonce (i.e., a random number) as shown in Fig. 4. Join the Blockbody and BlockHeader utilizing the compressing method to create the Block having a Block ID. All of this data is kept in a database, after which the blocks are moved to BC.

The monitoring of contact lists and case enquiry are handled by the app. The app generates a geolocation listing for users depending on real-time data from an android app in the event that users made nearby contacts or were in the exact shared environment at same instance. The app is also in charge of asking the BC to look for

Fig. 4 Blockchain process



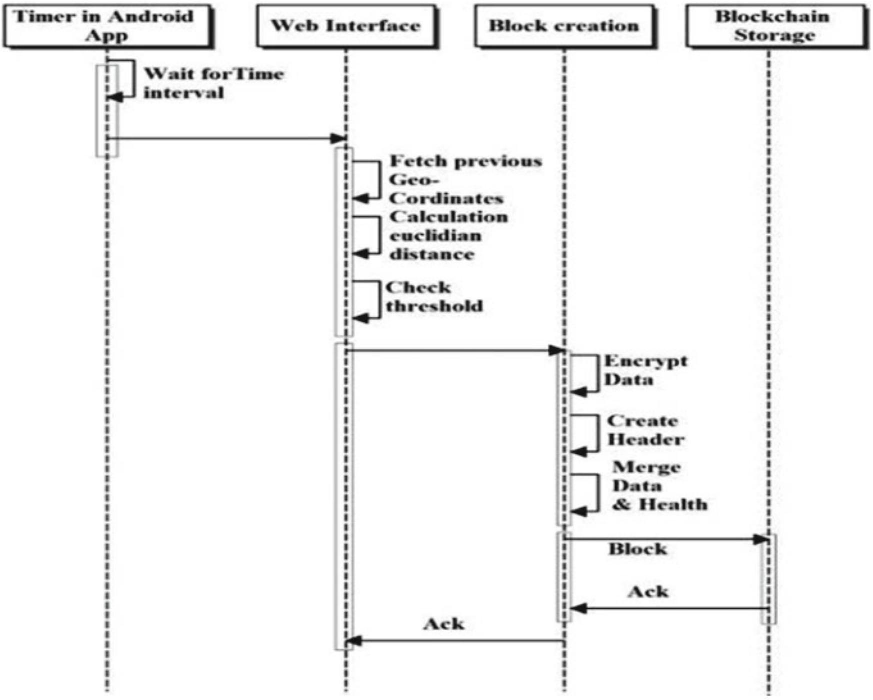


Fig. 5 Sequence diagram for GPS coordinates

possible connections among the manually recorded positive patients and also those logged in the BC.

All COVID-19 patients are expected to download this Android app onto their phones. A timer system will start after this software is launched. The timer system will retrieve the cell device's GPS coordinates and submit it, including the patient ID, time stamp, latitude, and longitude, to the web app. The timer system can only be started and stopped by authorized users as shown in Fig. 5.

6 Result and Analysis

This system is deployed and tested in the web application and Android along with the blockchain technology, it attains all the required specifications. The user modules are functioning properly in both Android app and web app.

Figure 6 shows the file encryption and decryption time comparison in the vertical bar graph. The horizontal axis represents the file size in KB, and vertical axis represents the time. Here, the decrypting time of the file is less as compared to time taken for file encryption.

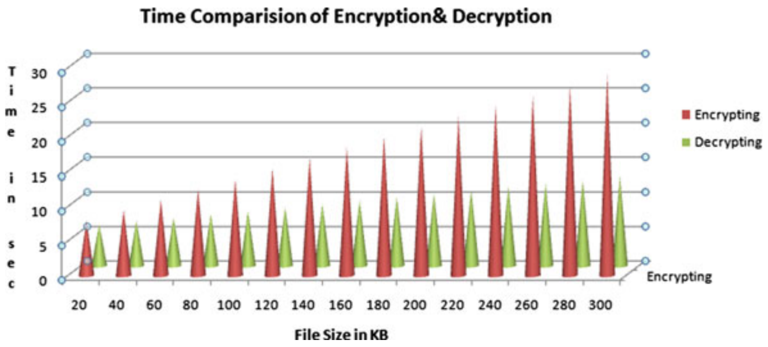


Fig. 6 Bar graph for file encryption and decryption

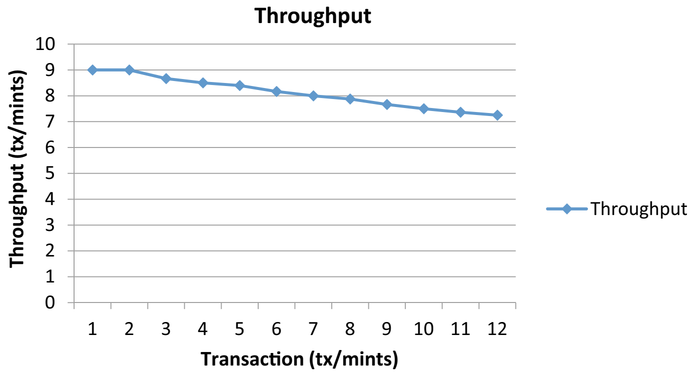


Fig. 7 Throughput for transaction data

Throughput is the amount of data which passes through the system. Figure 7 shows the throughput for transaction data. The horizontal axis depicts the transaction, and the vertical axis depicts the transaction. As the transaction increases, the throughput decreases simultaneously.

The time elapsed between a user's activity during data transaction and the response they receive from a web application is referred to as latency. Figure 8 shows the latency for user activity on the web application; here, latency is increasing as the transaction increases.

7 Conclusion

In this system, developed an Android app and a Web app-based contact tracing solution. Have demonstrated the numerous privacy concerns associated with contract tracking and have given a unique blockchain-based architecture to address these

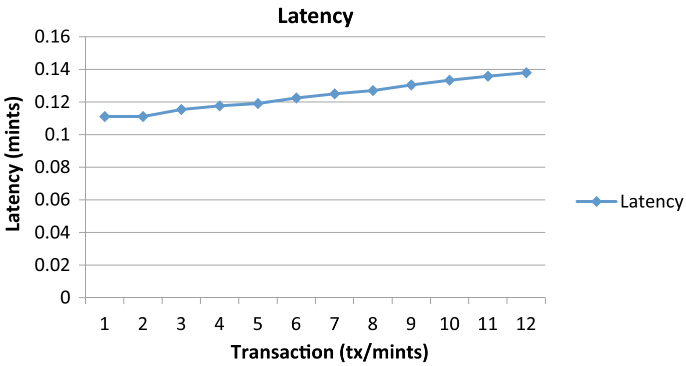


Fig. 8 Latency for the data transaction

concerns. Following on this paradigm, have developed a paradigm for how contact tracing could utilize blockchain to improve user's privacy and reliability by employing an android app to track the user's location using a GPS-enabled Smartphone with a timer system, and then storing this information in BC. Depending on such circumstances, examined how the suggested method performs in various situations and show that it is a credible and effective method for contact tracking in the fight against COVID-19 while maintaining risk management. This system has been effectively evaluated and put into use, and the findings suggest that it complied with all the requirements in the designed model.

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Understanding the Impact of SNS on Education

Deepali Arvind Mahajan and C. Namrata Mahender

Abstract Internet is now the part of life for the generation. Young generation is adaptive in nature, and hence, it is adapting the vigorous change in the technology. It may adversely impacts on their academics, personal life, social life, and physical and mental health. This chapter discusses the predictive technique of machine learning for predicting the impact of excess use of Internet on the student's education by implementing the different regression techniques. For collecting the data from UG and PG students, author has implemented the cross-sectional design. In the study, 31 items questionnaires have been used for collecting the responses. There are 484 participants included in the survey, and it has been conducted in offline as well as online modes. Before COVID-19 pandemic, it was offline, and after closure of all educational institutions, the survey has been conducted in online mode. We discover that excessive Internet use has no significant impact on a student's education after using bi-variable and multivariable regression methodologies.

Keywords SNS · Facebook · Social media · Social networks · Online communication · Machine learning · Regression · Questionnaires · Excess use · Education

1 Introduction

The Internet is embedded in the life of every person nowadays. Internet is likely to use for sharing the information for education or enjoyment. It is also used for the communication and e-business. E-business is a new way of commerce. Because of the rapid development of social media, people's social interactions and behavior have changed. Every social networking application tries to attract users by offering a variety of options. The online conversation between people is the heart of all of

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these social networking sites. Students may have hundreds of online friends, and all of them are virtual. The students are strange with many of them. Many people's daily activities are heavily reliant on the use of such applications. In all of this, the topic of whether social media websites have a positive or negative impact on a student's academic and social life must be explored.

Facebook's popularity as a platform for communication is rising. Social networking sites are used by youth to develop and maintain relationships. Social media is being used for information collection and dissemination as well as enjoyment and connection. Students in the educational sector use social media to interact and connect with one another with the aim of learning. The academic performance of a student is negatively impacted by excessive Facebook use. Academic performance and Facebook addiction are negatively correlated.

Social networking sites (SNSs) allow users to construct public or semi-public profiles inside a boundary system by listing other users they are connected to. Numerous social networking websites, including Twitter, Facebook, WhatsApp, LinkedIn, YouTube, Myspace, Snapchat, and Telegram, are available online. Among these various social media platforms, India has the largest Facebook user base worldwide, with 2.8 billion monthly active users on the social networking platform. Students are developing Facebook addictions despite the fact that it is a great tool for socializing and learning since they use it for longer periods of time. When an app gets addictive, it begins to affect all aspects of a person's life, including their profession, schooling, and social life.

More than 1.5 billion students throughout the world have been affected by the COVID-19 pandemic. This situation forces the education sector to switch to online education so as to avoid the educational loss of the students. Many applications come in light to resume the education like zoom, google meet, cisco WebEx meetings, and teams. Online teaching learning methodology is having its own pros and cons.

Using SNS in the classroom has been a contentious topic for several years. Many parents and educators are concerned about the consequences of allowing social media in the classroom. As a result, cell phones have been outlawed in the classroom, several popular social networking websites have been restricted by schools [1]. Parents were also restricted their children's access to the Internet and the use of mobile phones.

After the pandemic of COVID-19, because of the closure of the schools and colleges, to stop the academic loss of the students, the education sector has to adopt the online teaching learning mechanism. Every sector now moves to online. After the implementation of online education, now parents and teachers are using different social media sites and applications for the betterment of the student's education.

Today the scenario of looking at social media has changed in the perspective of all. Like before pandemic globally, major researchers were looking at the adverse effect of using social media on adolescents and adults.

Tawaziwa Wushe and Jacob Shenje state in their study that social media use may have a harmful effect on an employee's productivity. They discovered that visiting social media sites like Facebook, Twitter, WhatsApp, and Skype while at work has a negative effect on employee productivity. They also discovered that social media caused a significant decline in employee productivity at the office [2]. According to

Khurana N, social meetings are hampered since users are so engrossed in these social networking sites that they are prone to overlooking other important social occasions in their lives [3].

The use of technology has become essential on many fronts since the epidemic. In education sector, teachers and students have to come in line with the technology and use social media for better understanding of the concept.

Maria Reyes González, Jose Gasco, and Juan Llopis state in their studies that the use of Facebook as a teaching tool; for example, the majority of studies highlight Facebook's benefits as a space for collaboration, cooperative work, and engagement. They also state that improved levels of satisfaction that users of this technology can achieve, increased motivation on the part of students as a result of working with a well-known and user-friendly tool, increased engagement or dedication to studying that is likely to grow as a result of using Facebook, and the ability to make or maintain friendships that contribute to improving the study or work environment [4].

Hyunjin seo, Ren-Whei Harm's study's most intriguing conclusion is that use of social media is correlated with reported social adjustment but not perceived social support [5].

1.1 Popular Social Media Application

With over 2.89 billion monthly active users, Facebook, the most famous social media site, was the first to surpass one billion registered accounts. The company's four major social media platforms are Facebook, YouTube, WhatsApp, Instagram, and Facebook Messenger, each of which has over one billion monthly active users (Fig. 1).

According to the statistical reports available, it is clear that the most popular social media network used is Facebook, and this is the reason why we have conducted our research studies on Facebook usage of the students.

Facebook is rich with the characteristics. It covers almost all the characteristics which belong to other social media websites. And it is not viable to cover all the social media in one chapter. In this chapter, we will concentrate on the study of Facebook. It will make it easy to understand other social media usage.

1.2 Machine Learning in Social Media

Machine Learning

Machine learning is a discipline of artificial intelligence that deals with the analysis of calculations that can be learned. Instead of following completely static program instructions, ML computations develop a model from case contributions to request and settle on information-driven forecasts or choices communicated as yields [7]. Machine learning is a branch of computer science that analyzes and investigates how to train algorithms to recognize patterns or learn how to do specific jobs.

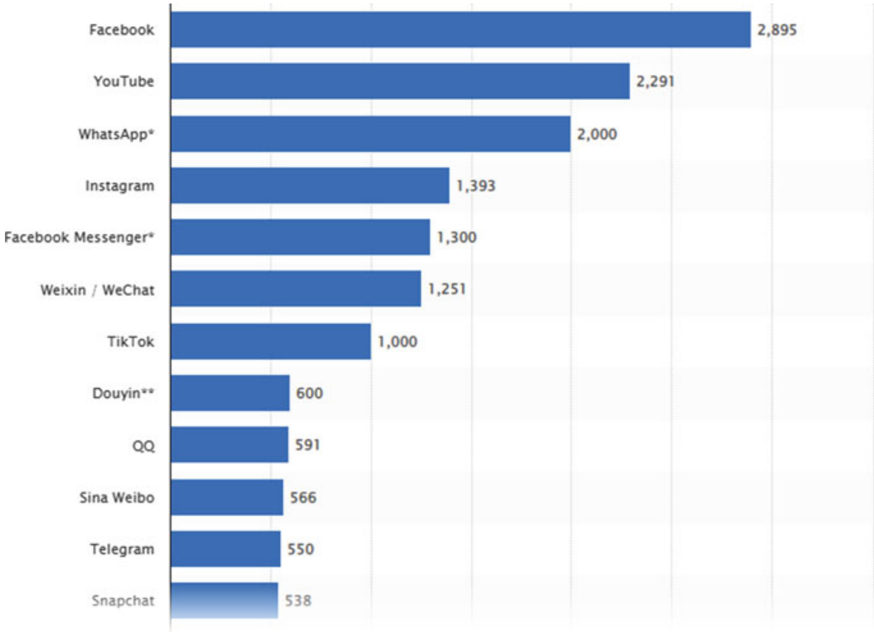

Fig. 1 As of October 2021, the most popular social networks in the world were rated by the number of active users [6]

Machine Learning Techniques in Social Media

Social media analysis is the art and science of extracting important hidden information from enormous amounts of structured and unstructured social media data in order to make informed and observant decisions. Billions of individuals use social media sites like Facebook, YouTube, Twitter, and Google+ to connect and share their expertise and private opinions, thoughts with others [8].

Many machine learning techniques have been used by the researchers for the analysis of social media uses. Data mining algorithms like sequential minimal optimization (SMO), Bagging, REP tree, and decision table (DT) extracted from a decision tree or rule-based classifier have been used to get better the effectiveness of academic performance in instructive institutions for students who consume alcohol. For prediction, various classification data mining techniques such as naive Bayes, LibSVM, C4.5, random forest, and ID3 are also effective techniques. Latent Dirichlet Allocation (LDA) and probabilistic latent semantic analysis (PLSA) are used to forecast student grades. For classification, logistic regression models are employed. Also the researchers implement algorithms like Naïve Bayes, decision tree (J48), random forest, Naïve Bayes numerous nominal, K-star, and IBk algorithms to study the student's performance for the comparison.

In our research, we are implementing the regression analysis of the data collected from the students.

Regression Analysis

Regression analysis is a statistical method for assessing the associations between one or more independent variables or predictors and the dependent variables or criterion variables. The criteria's conditional expectation is based on predictors, which give the average value of the dependent variables when the independent variables are altered. Determining the strength of predictors, predicting an impact, and trend forecasting are three primary applications of regression analysis [9]. AS in our research, we are predicting the impact of using social media on students' education and other aspects, we have applied the bi-variable and multivariable regression techniques on our data.

Why to Choose Regression

When you wish to predict a continuous dependent variable from a set of independent factors, you utilize regression analysis [10].

We have implemented the linear regression techniques on our survey data. Linear regression analysis is a statistical technique for predicting the value of one variable based on the value of another. The dependent variable is the variable you want to predict. The independent variable is the one you are using to predict the value of the other variable. We have the dependent variables as education and independent variables as excess use. Excessive use of the social media impacts on the different aspects of the students like education, disturbed social life, negligence of the work, and many more. In our study, we have implemented the bi-variable regression and multivariable regression techniques.

There are total 31 questions designed to extract the different aspects. In computing the dependent and independent variable, we have generated composite variables by selecting the specific questions that are significant for the evaluation of the particular variable.

2 Data Collection Method

We used both an offline and an online survey strategy to collect data in this study. For this challenge, a cross-sectional design has been used. We developed 31-item original questionnaires to evaluate the impact of Facebook usage on students which consists of multiple choice options. These questions are designed to analyze the different factors like excess use, salience, anticipation, neglect work, self-control, and neglect of social life. For collecting responses, survey questionnaires were produced and delivered to undergraduate and postgraduate students. We conducted a survey both locally and online based on the COVID-19 circumstance. Undergraduate, post graduate, and university students made up the total of 484 participants.

These questions can be used to evaluate how Facebook has affected different parts of a student's development. For this study, closed-ended questions were created. As English is the language that is most frequently used in our educational system that is the language in which the questions were written. The surveys were provided to the students on paper, and once they had finished them, they were collected.

Some students did not respond to any of the questions. Such students were neglected because of their blank responses.

3 Analysis of Data

For statistical analysis, we used the SPSS software platform (Statistical Package for the Social Sciences, or SPSS). By offering statistical analysis for survey research, this program enables the researcher to learn important new things from the responses gathered through questionnaires. With the use of this software, we can describe our results more accurately.

3.1 Bi-variable Regression Analysis

For application of linear regression, first we have to check the linearity of the data. If we have the linear data, then only we can implement the linear regression. This will be checked by comparing the mean values. For this, we need to compute the ANOVA table, if the significance value is less than (<) 0.05, then there is no linear relationship and if the significance value is greater than (>) 0.05, then there is a linear relationship.

For the test of linearity, we will check the significance value in Table 3. ANOVA, it is 0.904 and greater than 0.05 which shows that the data is linear. Now we can apply the linear regression technique on our data.

First, we are applying the bi-variable regression technique. In this independent, variable is excess use and the dependent variable is education. We are predicting the impact of excess use of the Internet on the student's education. Table 1 shows the information about the variables we use in the regression, i.e., dependent and independent variables. Table 2 is the model summary, which shows the r value, i.e., the correlation between excess use and education of the students. In Table 4, ANOVA table for bi-variable regression, the f-value $(1, 72) = 0.15, p > 0.001$, it indicates that the excess use is not significantly impacts on the student's education ($b = 1.558$, $p > 0.001$) (Fig. 2 and Table 3).

Table 1 Variables entered/removed

Model	Variables entered	Variables removed	Method
1	Excess use[b]	.	Enter

[a] Dependent variable: Education
[b] All requested variables entered

Table 2 Model summary

Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate
1	0.014[a]	.	Enter	

[a] Predictors: (Constant), Excess_Use

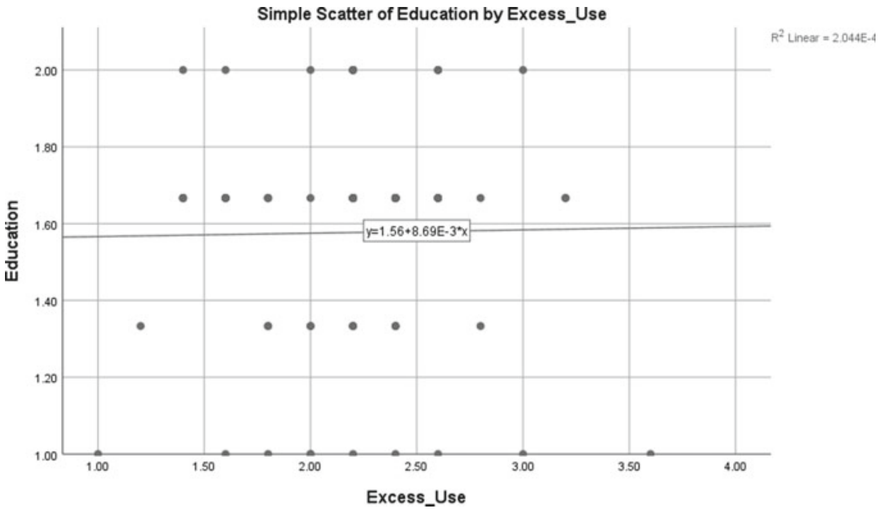

Fig. 2 Bi-variable regression

Table 3 ANOVA table for bivariate regression

Model		Sum of squares	Def	Mean square	*F*	Sig.
1	Regression	0.001	1	0.001	0.015	0.904[b]
	Residual	6.509	72	0.090		
	Total	6.511	73			

[a] Dependent variable: Education
[b] Predictors: (Constant), Excess_Use

Table 4 Coefficients

Model		Unstandardized coefficients		Standardized coefficients	*T*	Sig.
1	(Constant)	1.558	0.160		9.766	0.000
	Excess_Use	0.009	0.072	0.014	0.121	0.904

[a] Dependent variable: Education

Table 5 ANOVA table for *t* multivariable regression

Model		Sum of squares	Def	Mean square	*F*	Sig.
1	Regression	0.751	5	0.150	1.921	0.101[b]
	Residual	5.866	75	0.078		
	Total	6.617	80			

[a] Dependent variable: Education
[b] Predictors: (Constant), 31. Last thing before going to bed do you check the Facebook?, 17. Do you check all videos shared by your friends?, 6. Have you created any general group?, 11. Do you feel excited and happy while using Facebook?, 30. Do you check Facebook as the first thing after getting up in the morning?

3.2 *Multivariable Regression Analysis*

For multivariable regression, we have considered five independent variable, i.e., question 6, 11, 17, 30, 31 for analyzing the impact of creation of general groups, the excitement of using Facebook, watching all the videos shared by the friends and checking the FB as the first and last task of the day, on the student's education. Here, also our findings support the results of the bi-variable regression. As shown in Table 5, f-value $(5, 75) = 1.921, p = 0.101 > 0.001$, indicates that the independent variables are not significantly impacting on the student's education.

4 Future Research Directions

In our current studies, we have focused on Facebook, social media application for predicting the impact on education as it is the more popular. Nowaday, there are numerous social networking sites are available. So it becomes essential to study the impact of different SNS on the academics of the students. Not only academics but salience, social life, neglecting work are also the important aspects of the student's life that to be studied.

5 Conclusion

In the era of technology, we cannot avoid the use of the Internet and social media, as it becomes mandatory. Our studies involve the data before and after the COVID-19 crises. To stop the spread of virus, educational institutes have been shut down, during which whole education system stands on the pillar of online education. This tends to move the impact of using Internet from negative to positive effects. The technology is for the betterment of the human being, so how students are making use of the Internet and social media is important. Users can make use of the Internet for information interchange and collection instead of only for the entertainment. The results we found in our regression analysis show that the use of the Internet and social media is not impacting on the academic performance of the student. The regression analysis states that there is no positive or negative impact on education because the use of the social media. The studies found the moderate use of SNS in the students. In case of excess use of SNS, it may impacts on the education.

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IoT-Based Real-Time Air Quality Monitoring and Alerting System for Patients with Chronic Respiratory Disease

Md. Azizul Hakim, Hasan Shahrier, Tashfat Fatema, Mohsena Ahmed Dunia, Ali Ahamed, and Bijan Paul

Abstract Chronic respiratory diseases (CRD) are affecting millions of people around the globe. Asthma is one of the most common CRDs. Asthmatic reactions depend on a number of factors, ranging from genetic factors, daily lifestyle, etc. However, the presence of dust in the air is a direct addition to the asthmatic reactions. We can take a decision by considering the dust density data in this regard. On the other hand, the reaction to dust mites triggers the asthmatic reaction heavily. The tendency of dust mites to be born in the air can be analyzed from the properties of temperature and humidity. Since it is impossible to get rid of this disease in a lifetime properly, it is very important to mitigate the asthmatic reactions. We are proposing a system that will help asthma patients to take precautionary steps. Trying to get rid of the pain of asthma with timely precautionary steps in this way will be much more helpful for not only the asthma patients but also the patients of any chronic respiratory diseases.

Keywords IoT · Air quality monitor · Arduino IoT cloud · Asthma · Chronic respiratory disease

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1 Introduction

Any disease or dysfunction of the airways and lungs that affects human respiration is referred to as respiratory disease [1]. And chronic diseases are defined as any disease that lasts for more than 3 months or longer—according to the National Cancer Institute (NCI) definitions [2]. There are many chronic and respiratory diseases. 7% of the total deaths were due to only chronic respiratory diseases (CRD) in 2008 [3]. Asthma is holding a very large percentage of all chronic respiratory diseases. This is why the prior focus of this study is asthma. Asthma is one of the most common and deadly incurable chronic respiratory diseases. It is among the major non-communicable diseases that is affecting not only adults but also children. Asthma symptoms include coughing, wheezing, shortness of breath, and chest tightness due to inflammation and constriction of the tiny airways in the lungs [4]. Around 300 million population are now suffering from asthma worldwide. According to the Centers for Disease Control and Prevention (CDC), asthma claims the lives of an estimated 250,000 people around the world each year.

Taking precautionary measures is the most fruitful way to mitigate asthma. The more severe form of asthma can be avoided by reducing one's exposure to house dust [5, 6]. According to most of the research, PM2.5 levels of 12 $\mu g/m^3$ or less are generally considered healthy, whereas it is considered unhealthy if the amount rises to 35 $\mu g/m^3$ in a 24-h period [7]. Another indicator in this regard is the presence of dust mites which are tiny insect-like pest that feed on dead human skin cells and flourish in ward, humid conditions [8]. People with asthma can have a negative influence on their health if they are exposed to dust mites regularly at home. At 25 °C and 80% relative humidity, mites could thrive in house dust [9].

We can combine these two criteria of dust density and dust mite presence to take the decision on the precautionary measures. Real-time dust density measurements will help asthmatics to take immediate precautionary measures. And, real-time temperature and humidity measurements will help asthmatics to be careful about the possible presence of dust mites. In this study, we are proposing a cloud-based system to monitor and alert asthma patients. The full system will act as a portable device for asthma patients in taking precautionary steps which will also have the ability to store dust density, temperature, and humidity data in the cloud. As an incurable chronic respiratory disease, taking precautions is unavoidable to reduce the pain of asthma.

2 Related Work

Pangestu et al. [10] proposed an indoor air quality monitoring system based on IoT. According to them, a healthy air condition can be ensured by monitoring dust and temperature. They considered the air unhealthy if the dust of a room exceeds the threshold of 0.15 mg/m^3. And, if the dust threshold exceeds in the 35 °C of temperature, it is more concerning. Their proposed system had two alerting LEDs.

One alerts when the dust threshold is crossed and the other one lights up if the temperature threshold is crossed. They also have an automated sprayer to neutralize the air and the temperature.

Mahammad [11] raised the importance of air pollution monitoring to raise public awareness. They showed how people's health is harmed by air pollution which causes asthma and lung problems. They are proposing an IoT-based portable outdoor dust density monitoring system. They created the prototype with NodeMCU and Sharp's GP2Y1010AU0F. They used the Blynk server to connect the system to the cloud.

Kumar and Jasuja [12] proposed a real-time independent air quality monitoring system. They used Raspberry Pi along with various sensors. They were a pressure sensor, DHT22 sensor along with DSM501A dust sensor module, MQ9 CO detector, and MQ135 which can detect CO_2, NH_3, smoke, etc. Their IoT solution measured and showed PM2.5, CO, CO_2, temperature, relative humidity, and pressure values on the IBM Watson IoT Platform.

Sundari [13] also proposed an air quality monitoring system using Raspberry Pi. It had MQ2, MQ7, and MQ135 gas sensors. They were measuring CO, CO_2, CH_4, and smoke. They were storing sensor data every 30 s. In that system, they were showing the sensor data to the LCD and cloud server.

These are some similar sorts of air quality monitoring systems. But none of these studies directly addressed dust mites. That is why none of these studies considered combined temperature and humidity relation. In our study, we combine temperature and humidity values to decide on the presence of dust mites.

3 System Model and Methods

3.1 Decision-Making Method

In our study, we are proposing a system that measures the dust density in the air as well as the temperature and humidity of the environment. We use the combination of these three data to alert asthma patients. Dust density data directly tells the presence of dust particles in the air which has direct reacting power on the asthmatics. If the average real-time dust density is above 35 $\mu g/m^3$ in a 24-h period, the system warns people to take immediate precautions as the air quality is severely bad for an asthmatic. And, if the average real-time relative humidity is more than 80% and the temperature is more than 25 °C, the system warns people about the possibility of the presence of dust mites. The decision that is going to be taken will follow the above-stated decision-making method. The system reads the temperature, humidity, and dust density first. If the 24-h average temperature is greater than 25 °C and the humidity is greater than 80%, it shows the dust mite presence alert on the screen. If this condition is not satisfied, it calculates the 24-h average dust density. If the value is greater than 35 $\mu g/m^3$, it shows the emergency alert on the screen. It only shows the sensor measurements if the condition is not satisfied.

3.2 Hardware Components Used in the Prototype

To design and experiment with our proposed system, we develop the prototype in the Arduino MKR1000 Wi-Fi microcontroller board. We use two sensors to collect the data we need to take the alerting decision. They are GP2Y1010AU0F and DHT22. The first one gives the dust density measurement in the air, and the second one gives the temperature and humidity value of the environment. We also use an LCD screen to show the alert to the user. A 220 μF capacitor, a 150 Ω resistor, and a 9 V battery have also been used.

3.3 Sensor Principles and Specification

PM2.5 GP2Y1010AU0F Optical Dust Density Sensor

The GP2Y1010AU0F is an optical sensor that measures the dust density in the air. This sensor can detect the reflected light of dust in the air. It works in a voltage supply of 4.5–5.5 V. And, it has an output voltage range of 0–4.2 V. It produces an analog voltage based on the amount of dust in the air, with a sensitivity of ± 0.15 V/(0.1 mg/m^3). It can measure fine particles that are larger than 0.8 μm in diameter in a range of 0–500 μg/m^3 [14].

To perform optical sensing, an infrared emitting diode (IRED) and a phototransistor are used by this sensor. The sensor measures the amount of reflected light of dust in the air and generates an output voltage that is proportional to dust density [15]. To convert the output voltage into the equivalent dust density, we use the linear equation of Chris Nafis (1) [16].

$$\text{Dust Density} = \left[(0.172 \times \text{Output Voltage} \times 5)/1024 - 0.999\right] \times 1000 \tag{1}$$

Using the above equation, we get the dust density reading in μg/m^3 unit. The dust sensor has a LED built-in which is getting power from our microcontroller. Its purpose is to turn on and stay on for around 280 μs (with 40 μs delta). During this time window, the dust sensor collects information on the density of present dust particles present in that tiny cavity and then gives us output in voltage. This voltage output data is later mapped into integers of range from 0 to 1024. This mapped integer data is later used in Chris Nafis linear formula to get the final reading in micrograms per cubic meter.

The GP2Y1010AU0F has six pins. To power the sensor, it uses V_{CC} and S-GND pins. On the other hand, to power the internal LED, it uses V-LED and LED-GND pins. V_0 provides the analog output to the microcontroller. And, the LED turns on and off based on the input coming from the microcontroller. The overall pin diagram is shown in Fig. 1 [14].

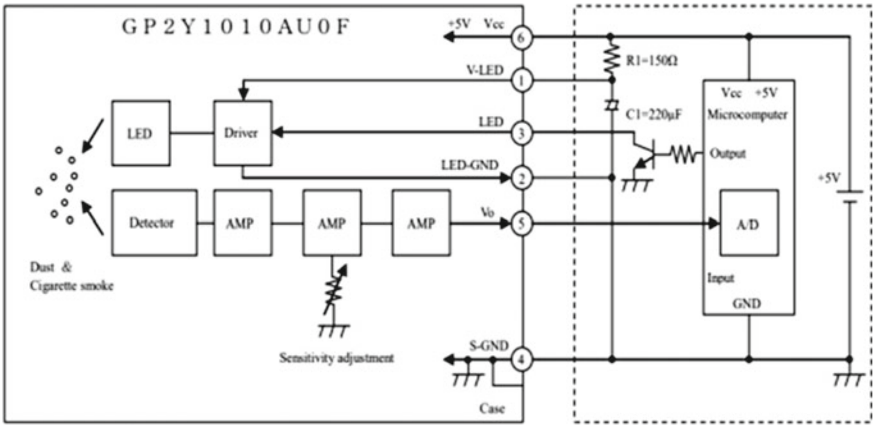

Fig. 1 System connection of the GP2Y1010AU0F with microcontroller unit

DHT22 Digital Temperature and Humidity Sensor

The DHT22 is a digital sensor for measuring temperature and humidity that combines a negative temperature coefficient (NTC) thermistor with a capacitive sensor. It works in a voltage supply of 3.3–6 V. It can read 0% to 100% relative humidity with ± 2–5% accuracy and − 40 °C to 80 °C temperature with ± 0.5 °C accuracies [17]. DHT11 is another sensor that can measure humidity with ± 5% accuracy. But for our study, we need to use a sensor that can read humidity up to 100%. The sampling rate of DHT22 is 0.5 Hz indicating that we get one reading for every two seconds from the sensor.

DHT22 has a moisture-holding substrate between its two electrodes. The conductivity of that substrate or the resistance between these electrodes changes with the changes in humidity. DHT22 uses this process to measure the humidity of the environment. And, to measure temperature, the sensor uses the thermistor. A thermistor is a variable resistor that changes resistance in response to temperature variations [18]. It has such a semiconductive substance that provides larger changes in resistance with small changes in temperature (Fig. 2a).

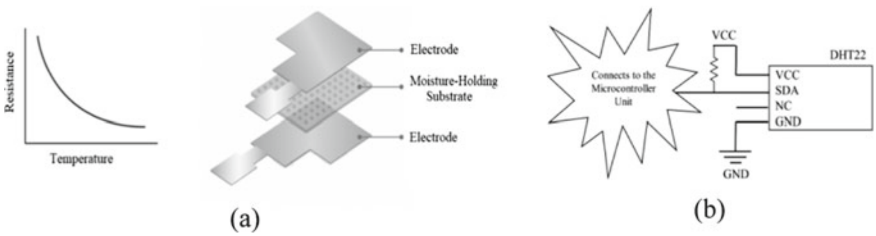

Fig. 2 **a** Thermistor's resistance–temperature characteristics (left) and humidity-measuring structure (right), **b** pin diagram of the DHT22 sensor

The DHT22 has four pins. VCC is the power pin. SDA is the data pin. It connects to the digital input pin of the microcontroller. The sensor reads the data and sends it to the microcontroller using this pin. NC is the null pin, and GND is the ground pin. The overall pin diagram is shown in Fig. 2b.

3.4 Hardware Design

To design the system, we create a circuit diagram that consists of Arduino MKR1000 Wi-Fi, SPI LCD module, dust density sensor, and temperature and humidity sensor. To power the Arduino, we connect a 9 V power supply and ground it properly. We generalize the voltage input and GND pin in the breadboard so that all the other components can get power from the Arduino. Then, we connect the necessary data pins and analog/digital input/output pins of different modules to the Arduino. The complete block diagram is shown in Fig. 3.

We connect the pins of DHT22, GP2Y1010AU0F, and SPI LCD module with the Arduino MKR1000 Wi-Fi. The exact pin connections between the sensors and the Arduino are given in Table 1.

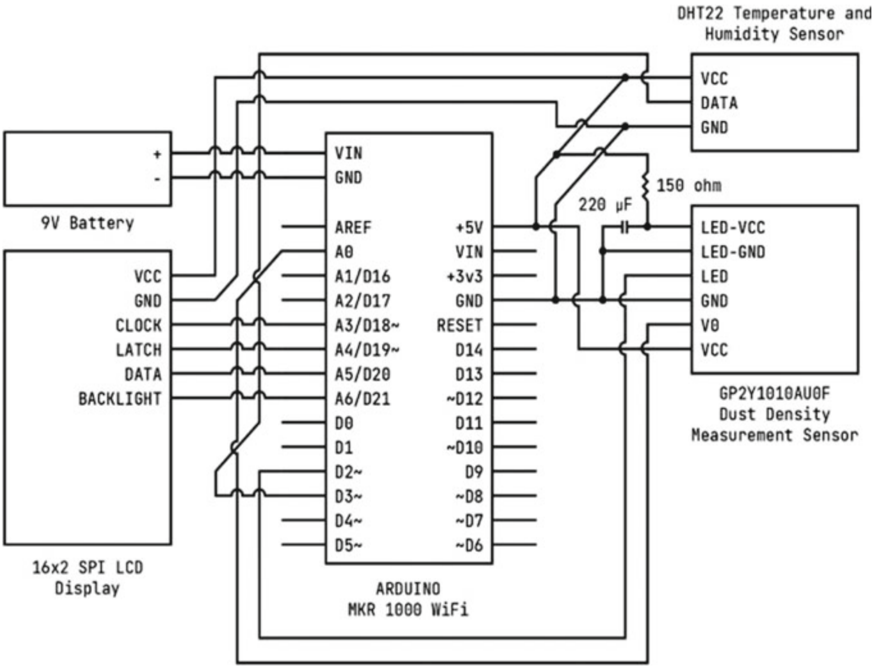

Fig. 3 Block diagram of the prototype

Table 1 Pin connection of Arduino MKR1000 Wi-Fi, DHT22, GP2Y1010AU0F, SPI LCD

Arduino MKR1000 Wi-Fi	DHT22	GP2Y1010AU0F	SPI LCD
+5 V	VCC	VCC, LED-VCC	VCC
GND	GND	GND, LED-GND	GND
D3	DATA	–	–
D2	–	LED	–
A0	–	V0	–
D18	–	–	Clock
D19	–	–	Latch
D20	–	–	Data
D21	–	–	Backlight

3.5 Cloud Connectivity

We use Arduino IoT Cloud as the cloud platform to connect the sensors to the network. Arduino IoT Cloud has an integrated Web Editor and devices connectivity system. To create an IoT setup, we need to create a Thing in the Arduino IoT Cloud first. Then, we connect the microcontroller device to the created Thing. At the same time, we connect the Thing to the network via a Wi-Fi connection. After setting up the Thing and the hardware, we program the system in the Web Editor. To monitor the necessary data, we create a variable in the Thing and link the variable with different sorts of the statistical dashboard (gauge meter, chart, etc.). After preparing the complete setup, we will be able to see the visualization of data in the web dashboard as well as in the IoT remote app which is supported by both IoS and Android. Arduino IoT Cloud will help to make the device more portable to use. The real-time data can be viewed from anywhere in the world from the smartphone.

3.6 Software Design

We use Arduino IoT Cloud Web Editor to program the microcontroller and the sensors. We use the following pseudo-code to read the dust density from the GP2Y1010AU0F sensor.

```
Function ReadDustDensity( )

   V0Measured ← GetAnalogSensorReading();
   MappedInteger ← V0Measured * (5.0/1024.0);
   DustDensity ← ((0.172 * MappedInteger) – 0.0999) * 1000.0;
   RETURN DustDensity;
```

It uses the Chris Nafis linear equation that we described earlier to calculate the voltage-converted dust density value [10]. The V0Measured stores the analog reading from the sensor which is the voltage reading. By using the Chris Nafis (2012) linear equation, we get the desired dust density value. We get the temperature and humidity value by using the Adafruit Library functions ReadTemperature and ReadHumidity, respectively. Then, we measure the average temperature and humidity.

```
Function GetAVGTemp(_T)

   AVGTemp ← _T;
   TempReadCount ← TempReadCount + 1;
   RETURN AVGTemp/TempReadCount;
```

The ReadTemperature and ReadHumidity method reads the DHT22 provided values of temperature and humidity, respectively. Then we calculate the average values in a 24-h time span. The loop method then processes the alerting system from the values it got from these two functions. The pseudo-code of the function is as follows.

```
Function Loop()

      UpdateArduinoIOTCloud();
      Delay ← DefaultDelay;
      LoopCount ← LoopCount + 1;

      T ← ReadTemperature();
      H ← ReadHumidity();
      D ← ReadDustDensity();
      S ← TRUE;

      if AVGTemp >= CloudTemperatureThreshold then

         S ← FALSE;

      if CheckErrors(T, H, D) == TRUE then

         Display(T, H, D);
         RETURN;

      else

         SetCloudVariables(T, H, D, S);
         Display(T, H, D);

      if LoopCount == ReadingSpan then

         AVGTemp ← GetAVGTemp(T);
         ResetVariables();

      else

         GetAVGTemp(T);
```

```
if S == FALSE then

  DisplayAlert();
  RETURN;
```

The loop method continuously reads the sensor data and displays necessary information in the LCD screen based on the decision-making method that we described in the earlier section. As the complete setup is created in the Arduino IoT Cloud, all the linked variables store their value in the cloud and show the dashboard in the web dashboard and IoT remote app.

4 Experiments and Results

We have developed a complete prototype of the system that we proposed in this study. The complete setup is so portable and placed on a breadboard. But for demonstration purposes, we have aligned different components discretely (Fig. 4). All the sensors will send their data to the microcontroller. It will go to the cloud according to the program we wrote.

To experiment with the system, we test the sensors first. We get environment temperature and humidity from the DHT22 sensor and the dust density value from the GP2Y1010AU0F sensor. The real-time reading is displayed in the SPI LCD module as well as the dashboard of the Arduino IoT Cloud on both the web version and Android version (Fig. 5). If the defined threshold outreaches, an alert will show on the LCD. It will be an indicator to the asthma patients to take necessary precautions.

To experiment with different real-life dust density values, we created excessive dust density values by lighting up a matchstick and flowing some outside dust around the dust density measuring sensor. To experiment with temperature and humidity

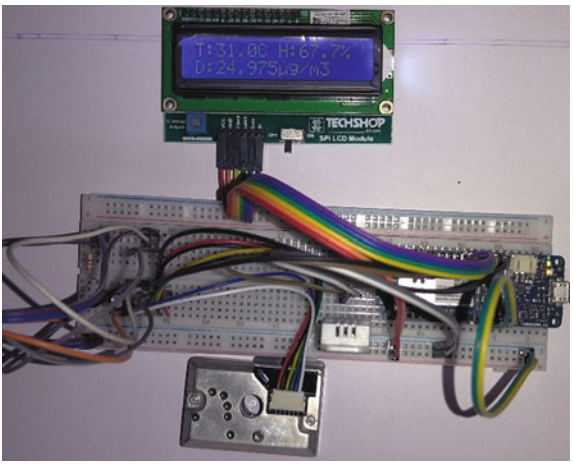

Fig. 4 Complete prototype of the project

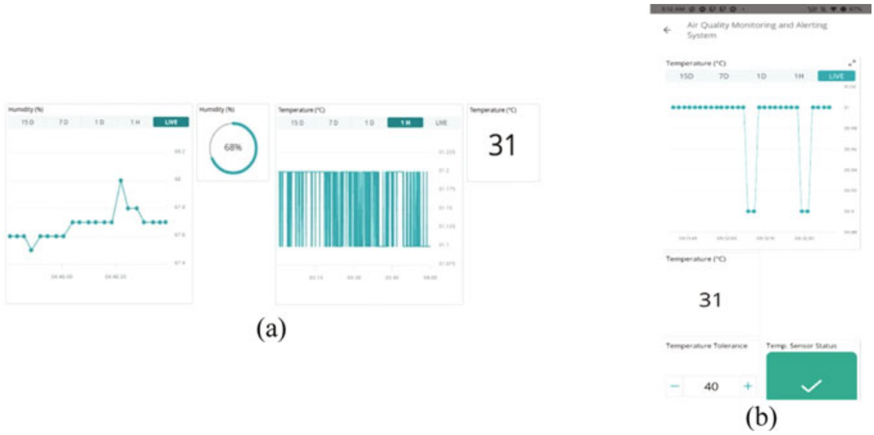

Fig. 5 Arduino IoT Cloud. **a** Web dashboard view, **b** android dashboard view

values, we changed threshold values according to the environmental temperature to view different outputs. In one case, we got a temperature value of 30.6 °C, a humidity value of 66.8%, and a dust density value of 0.736 $\mu g/m^3$. It showed the values on the LCD and the Arduino IoT Cloud Dashboard.

5 Conclusion

We addressed one of the most painful chronic respiratory diseases, asthma, in our study. Timely precautions can help to mitigate the pain of asthma. We proposed a prototype of a portable device that may help asthma patients to take timely precautionary measures by alerting them timely. As a complete IoT-based solution, it has the potential to be a perfect device that can be set in the home condition where the users will be able to monitor the real-time dust, temperature, and humidity conditions. And, by the automated cloud-based system, the asthmatics will be able to take proper safeguards timely. In the future, we want to implement the system with a more sensitive dust density measuring sensor. Also, we want to make a machine-learning-based solution to alert early by making predictions.

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Analysis of Sensors Used in Medical Body Area Networks for Alzheimer's Patients

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Abstract In this paper, a survey about the current types of sensors used in a medical body area network (MBAN) related to Alzheimer's patients has been set forth. Alzheimer's disease (AD) affects the cognitive function of a patient due to which the patient is unable to perform basic and straightforward everyday tasks. The patient needs to be looked after with intensive care by their family members. This survey about the various sensors can be studied for the development of a healthcare system that aims toward providing support to the family members to take care of the patient and provide mental relief to the patient to some extent. The detailed architecture and working of various sensors have been explained in this survey paper.

Keywords Alzheimer's disease · Healthcare system · Medical body area network · Sensors · Smart health

1 Introduction

Alzheimer's disease (AD) is a type of dementia that affects elderly people. It is estimated that initially, in the twenty-first century, there were about 24 million people suffering from dementia worldwide. Majority of them are thought to be suffering from AD, and this figure is predicted to rise to 81 million by 2040. AD is a disastrous disease not only for the patient but also for their family members due to the slow and steady decline of memory, along with the changes in personality and behavior [6].

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The patient suffering from AD becomes indifferent of their surroundings as they are not able to comprehend all that is happening around them. Some of the recognized core features of AD are apathy, depression, aggression, and psychosis. Higher severity in these symptoms usually indicates loss of independence, faster cognitive decline, or even shorter survival [7].

Apart from diminishing the symptoms to some extent, an effective way of treating AD does not exist. Therefore, it is necessary to prioritize research regarding the treatment and handling of AD patients. Consequently, they require someone to perform their daily tasks and take care of their behavior and health constantly. Families with such patients usually hire a caretaker, but the cost of the same over a longer period is high.

By developing a healthcare system for the monitoring of AD patients, the need for a full-time caretaker would not exist. The healthcare system can be used for various applications like fall detection, location tracking, vital signs tracking, sending emergency alerts, etc. Such a healthcare system can be based on a medical body area network (MBAN).

MBAN is a type of body area network (BAN) which is based on applications in the medical domain. It can interact with Internet and various wireless connection technologies like Bluetooth, Wireless LAN (WLAN), video surveillance systems, and cellular networks. The sensors used in MBANs are capable of providing real-time feedback to the user along with monitoring, sampling, processing, and communicating different kinds of data all while avoiding discomfort. The patients experience greater flexibility and mobility due to such a continuous monitoring system. It also helps doctors to have a clearer view of the status of the patient's health [9].

Some of the major challenges faced in such a system are max network lifetime, reducing unnecessary communication regarding energy consumption, max throughput, and min delay. User-oriented challenges of the MBANs also exist and are equally challenging; security, privacy, easy usage, safety, price, etc. [9].

The organization of this paper is as follows—firstly, the different kinds of sensors that may be used in a healthcare system for AD patients and the basic structure of the system that has been explained.

2 Structural Design of MBAN for AD

The healthcare system for AD patients consists of three main components, namely sensors, processors, and output devices. Various sensors can be used based on the requirements of the healthcare system. The processor is fed the data that is read by the sensors for transmission. As the data is in raw form, the processor processes the data and then transmits it to the output devices through which the user can comprehend the data. When developing a MBAN system for not only AD but also other topics, various factors need to be taken into consideration. These are the design factors which include, but are not limited to:

Scalability
When studying a specific phenomenon, the number of sensors that need to be considered in the sensor network can be in the order of thousands depending on the requirements. Algorithms that can work with this huge amount of sensor nodes must be taken into consideration [1].

Production Costs
As the number of nodes is huge, cost of each and every single node needs to be considered for the overall cost of the network. In a case where the cost of a network is costlier than traditional sensors, the network is not cost justified. Hence, each node needs to be kept at minimum possible cost [1].

Hardware Constraints
The components included in a sensor node consist of four basic components: a sensing unit, processing unit, transceiver unit, and a power unit. Additional components may be included based on the application. All these components may be needed to fit into a small-scale module. The size of such a module may be as small as a cubic centimeter. Other constraints include, having low power consumption, operative in high volume densities, and low production cost, have autonomous operation and be adaptive environmentally [1].

In case of sensors, they are devices that detect and measure different kinds of physical quantities, while taking into consideration accuracy and reliability over longer periods of time. Sensors are made to be faster and efficient by using various technologies like microelectronics, integrated optics, micromechanics, and much more. Power consumption and energy harvesting are also factors to be considered while designing sensors [17].

This paper discusses the various kinds of sensors that can be used in the development of a MBAN for AD patients.

2.1 Inertial Measurement Uni (IMU)—MPU6050

The IMU, MPU6050 consists of a three-axis accelerometer and a three-axis gyroscope. The measurement of acceleration, velocity, orientation, displacement, and many other motion-related parameters of a system or object is done by the MPU6050 [3].

MPU6050 is one of the smallest devices which consists of the integration of gyroscope and accelerometer on-chip. Therefore, it can be easily embedded into small-scale products and applications. It is a MEMS-based motion tracking device. It consists of a three-axis gyroscope and three-axis accelerometer along with a temperature sensor. The device has high accuracy and low power consumption, high shock

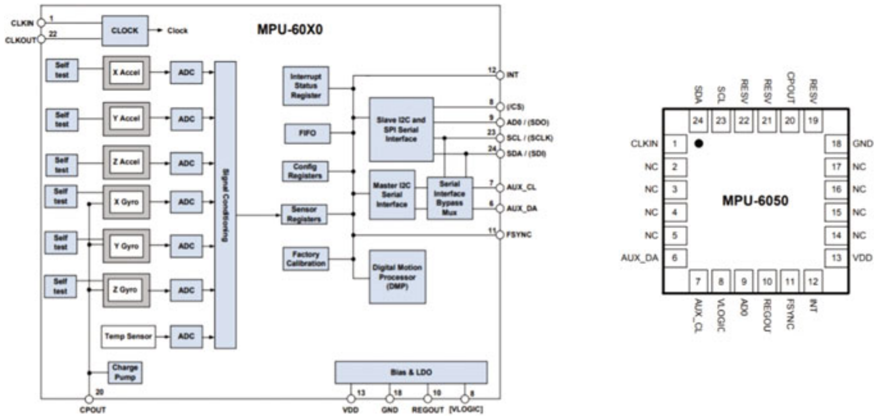

Fig. 1 MPU60X0 architecture and pin diagram [8]

tolerance, and application-specific programmability. It can also be easily interfaced with other sensors like microcontrollers and magnetometers [11].

Rotation can be detected along three axes with the gyroscope present in the MPU6050. The gyroscope consists of a small vibrating mass. When this is rotated, it experiences a Coriolis force which displaces the mass form its original path. Capacitance is then used to detect the displacement, and an output in the form of number of counts is given. After that, the signal is amplified, demodulated, and filtered to generate a voltage proportionate to the angular rate. ADCs are then used to digitize the voltage [3] (Fig. 1).

The DMP on the MPU6050 offloads motion-sensing algorithm computation from the host CPU. DMP collects data from all sensors and saves the calculated values in its data registers or FIFO. The serial interface can be used to access the FIFO. More than one MPU6050 module can be interfaced with a CPU using the AD0 pin. The MPU6050 is packaged in a compact 444.9 mm box. At the wafer level, the MEMS structure is sealed and bonded hermetically [2].

The on-chip accelerometer on the MPU6050 can measure acceleration. The full-scale ranges of 2g, 4g, 8g, and 16g can be programmed. In the MPU, the movement along *X*, *Y*, and *Z* axis is sampled by the three 16 bits analog-to-digital converters. Four programmable full-scale ranges of 250°/s, 500°/s, 1000°/s, and 2000°/s regarding the angular movement are monitored by the gyroscope which is on-chip in the MPU. The rotation around *X*, *Y*, and *Z* axes is monitored by three additional 16 bits analog-to-digital convertors. The sampling rate has a range from 3.9 up to 8000 samples per second. The MPU6 also has an inbuilt temperature sensor across a range of − 40 to 85 °C and a 1 °C precision [2] (Fig. 2).

Some of the applications of the MPU6050 related to the MBAN are

- In-air gesture recognition
- Fall detection
- Wearables used for health, fitness, and sports

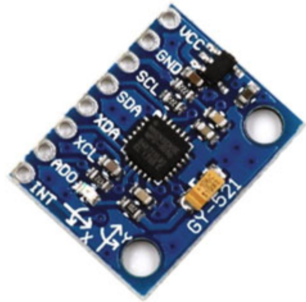

Fig. 2 MPU6050 [8]

- IMU measurements
- Applications in location-based services.

ADXL335, ADXL345, and MPU9250 are some of the alternatives that can be used instead of the MPU6050. The datasheet for this module contains additional information on its electrical characteristics and interrupt logic [5].

2.2 Passive Infrared (PIR) Sensor—HC-SR501

The range of a basic PIR sensor for the detection of human movement is around 10 m from the sensor. 10 m is considered to be the average range of a sensor. The higher and lower limits are studied to be around 12 m and 5 m, respectively. These sensors basically consist of a pyroelectric sensor for the detection of levels of radiation (infrared). The major applications for PIR sensors are regarding projects where the knowledge regarding the activity of a person is important. A few advantages of PIR sensors are flat control without effort, easy to use, and have a larger lens range [15] (Fig. 3).

A PIR sensor or a passive infrared sensor can be implemented to detect the presence of humans in its surroundings. The output signal may be applied to control the movement of things like doors or windows.

Fig. 3 PIR sensor. https://www.electronicwings.com/storage/PlatformSection/TopicContent/121/description/PIR%20Sensor(0).jpg

Motion detection is dependent on detection of the presence of infrared light through light sensors. This is released by a warm object. It is also used to detect the lack of infrared light when an object blocks a beam emitted by another portion of the device.

The infrared light emitted by a warm item is detected by a PIR sensor. It is made up of pyroelectric sensors that convert temperature changes (due to incident infrared radiation) into an electric signal. When it strikes a crystal, a charge is generated. As a result, a PIR sensor detects human presence within a 14-m detection range [19].

For the adjustment of the following parameters, potentiometers are used:

Time

Time is used to predict the duration for which HIGH is seen in the output after detection. The maximum and minimum duration requires 300 s and 3 s, respectively.

Sensitivity

This parameter is used to predict the actual distance of detection in the sensor. The maximum range is 7 m, and minimum is 3 m. Depending on the current state of the environment, this range may vary (Fig. 4).

It also consists of a few jumper wires which may or may not be soldered. The two options available are

H—The Repeat/Retrigger/Hold button. As long as the HC-SR501 detects movement in this posture, it will continue to generate a HIGH signal.

L—This stands for Intermittent or Non-Repeat/Non-Retrievable. The output remains HIGH during the time period defined by the potentiometer adjustment for time in this position [15].

Ideal operation of PIR sensor: The PIR sensor works by changing the room temperature equilibrium inside its detection area by radiating the person's body heat.

The passive infrared sensor emits more light when the detected object is hotter. The Fresnel lens collapsed on the pyroelectric chip generates electric charges due to the electromagnetic radiation. The material is crystalline or ceramic. The output voltage remains high as long as the action continues.

Limitations

The poor tolerance of infrared sensors to reflections such as ambient light or vivid object colors has historically hindered their performance. The temperature limit values of PIR sensors have had their own tolerance concerns. Circuit designers are currently striving to overcome these restrictions [15].

Applications

Thermal imaging/passive infrared imaging: Inside a thermal imaging equipment, an infrared sensor is modulated, which detects the object's thermal radiation with excellent accuracy and generates images of infrared radiation received. The temperature difference will be visible on the thermometer as images in different color shades. In

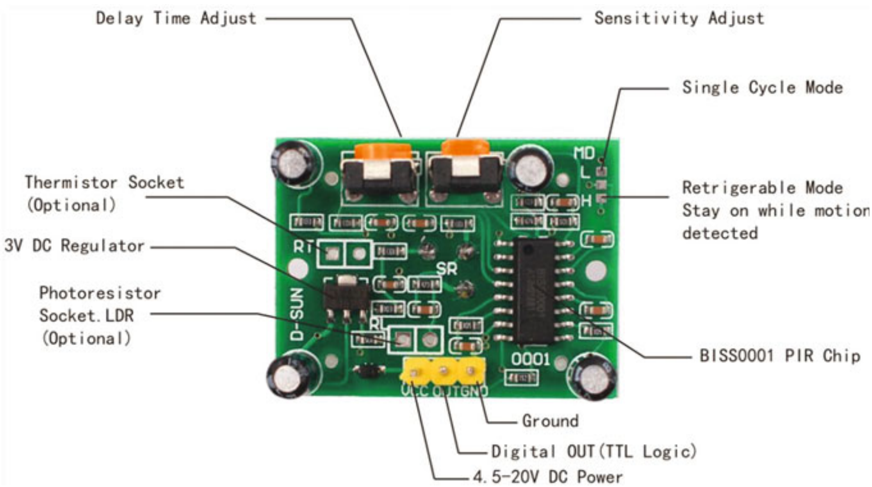

Fig. 4 PIR sensor chip. https://osoyoo.com/wp-content/uploads/2017/07/pir-motion-pinout-1-768x405.jpg

security services such as airport customs, military equipment, and human tracking, thermal imaging is used.

Human body detection: The sensor creates a high signal when a moving human body enters the detecting zone. The PIR sensor's receiver receives the emitted infrared radiation from the human body. Automatic doors, security systems, medical applications, surveillance, and civil applications are all in demand for human detection systems [19].

System for opening doors automatically: In locations like shopping malls, theaters, restaurants, etc., where someone is expected to open the entrance for guests on a regular basis, opening and closing doors tends to be a laborious job. A PIR sensor detects human presence and delivers pulses to the microcontroller. By sending pulses to its input and enable pins, the motor for the door can be controlled.

2.3 Radio Frequency Identification (RFID) Sensor (RC522)

Radio frequency identification (RFID) is a system that detects and identifies things using radio waves. RFID employs radio frequency (RF) to identify "tagged" things. Using an RF Reader, this data is gathered and delivered to a host system.

RFID technology is already quite useful in the business world. It expands into new fields of application, and new markets emerge. The architecture of today's RFID systems is based on those of other auto-ID systems, namely optical barcode systems [4] (Fig. 5).

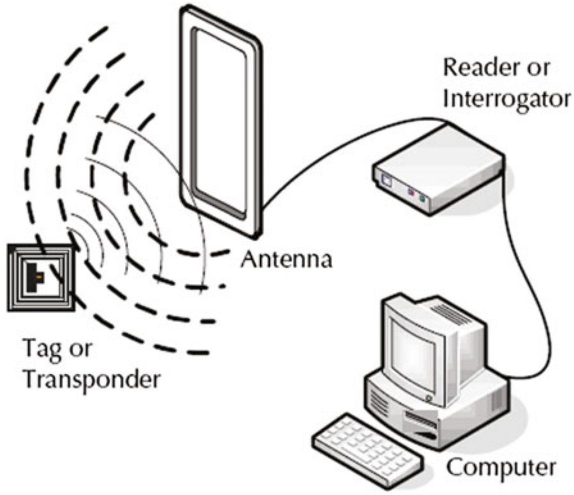

Fig. 5 Basic RFID system [14]

A tag that has been attached to an object to be identified and a reader or an interrogator are the basic and most important components of a radio frequency identification (RFID) system.

High-frequency electromagnetic fields are provided by an antenna and a RF module through the reader. While the tag is usually just a passive device, i.e., it does not have a battery. It has a microchip that processes and saves the data, along with an antenna for transmitting and receiving signals [16] (Fig. 6).

Fig. 6 RC522 RFID reader and tags. https://nabatechshop.com/wp-content/uploads/2022/07/RC522-1356-Mhz-RFID-Reader.jpg

For ISO 14443a tags, an electromagnetic field of 13.56 MHz is generated to communicate with RFID tags through the RFID Reader module. Serial peripheral interface (SPI) enables the interface between the microcontroller and reader at a data rate of 10 Mbps (max). UART and I2C protocols are supported for communication. An interrupt pin is also present. The range of the operational voltage is 2.5–3.3 V [16].

Tags. A microchip is used for computing and storing, while an antenna coil which is a coupling element is used for communication. A contact pad may be included on tags. Write-only, read-once, fully rewritable, or read-many tag memory are all options.

In general, the tags are divided into three groups:

Active tags. An active tag is one that has a power supply for its antenna and circuitry. Readability from a distance of 30 m or more is one of the advantages of an active RFID tag, as is the ability to have various sensors that can be powered by energy [4].

Passive tags. The reader supplies the electricity to the passive tag, which has no power source. The tag gets its power from the antenna's inductive connection. The main disadvantage of such a tag is that it has a range of a small distance, usually only a few meters. However, there are numerous benefits. The tag does not require a battery, extending its life to a maximum of 20 years. The tags are cost effective, and they are significantly smaller. In consumer goods and other domains, these tags have numerous applications [4].

Semi-passive Tags. These tags, like passive tags, provide identification information by reflecting (instead of transmitting) radio frequency back to the interrogator. These tags include a battery that powers their integrated circuits. This opens up some applications, such as when a sensor is built inside the tag and can communicate real-time data like temperature, humidity, and time stamp. Semi-passive tags accomplish a balance between cost, size, and range by using the battery solely to power a small IC and sensor and not having a transmitter [4] (Fig. 7).

VCC is used for providing power to the module. It has a range of 2.5–3.3 V.

RST pin reset input along with turn off system. When this pin is LOW, power-off gets activated. This causes disconnection of the input from all the different inputs, and also all the internal current sinks are turned off. This also includes the oscillator. Reset occurs on the rising edge.

The microcontroller is notified regarding the presence of a tag by using the IRQ pin.

On activation of the SPI interface, the Tx pin (MISO/SCL) represents a Master In Slave Out (MISO). On activation of I2C, it works as a serial clock, and when UART is turned on, it is a serial data output.

The RC522 module enables Master Out Slave In or MOSI as a SPI. The SPI bus Master sends clock pulses to serial clock (SCK).

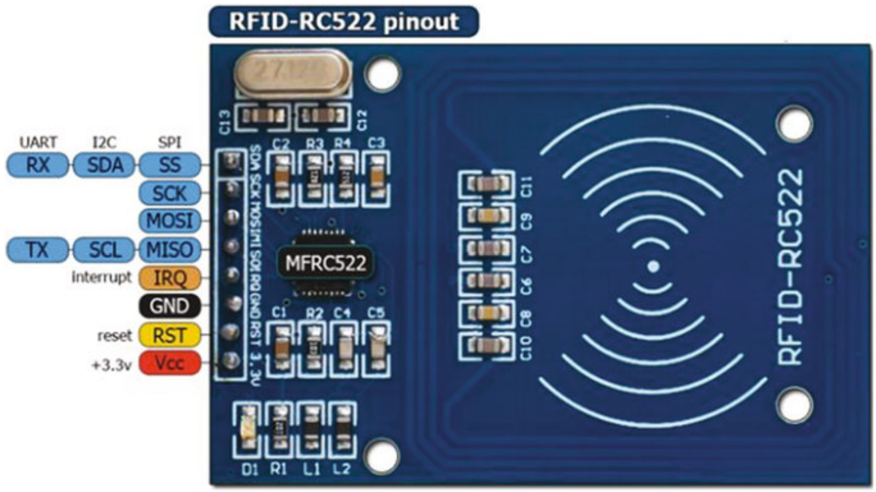

Fig. 7 RC522 pinout. https://camo.githubusercontent.com/cfeb907e5f916951c17a5ff760bc6a6ce308c63c2d812173492bef9a637b7fcc/68747470733a2f2f686f6d652e6374772e757477656e74652e6e6c2f736c6f6f74656e76616e662f77702d636f6e74656e742f75706c6f6164732f3230313362f30352f524649442d52433532322d70696e6f75742e706e67

The Rx pin (SS/SDA) works as a signal input when the SPI is active and when the I2C is enabled, as serial data. On enabling UART, it becomes serial data. For easier identification, a square is used for the identification of this pin [4].

Limitations

Due to its higher cost, the scope for accuracy, speed, and return on investment is high, and RFID cannot totally replace barcode technology. It offers certain technological advantages when used properly. There are still certain obstacles to overcome for optimization in applications. These flaws include a high level of investment and a lack of expertise, security, and privacy, as well as several issues relating to the RFID technology.

Cost. The RFID tag is more expensive than a barcode system, which is a big disadvantage.

Privacy and security. RFID security and privacy pose a significant threat to consumer privacy. Consumers that use RFID-tagged products can be easily tracked. The ID serial number or Electronic Product Code (EPC) is transmitted by the RFID tag to a nearby reader. This results in a greater chance of privacy violations.

Technology. Because RFID is based on the radio frequency notion, it can be hampered by other radio broadcasts, metals, liquids, and so on. The amount of interference is determined by the tag's frequency and the usage context [4].

2.4 Healthcare System Objectives Examples

Location Tracking

As the patients are not able to recognize familiar faces and locations, they tend to wander or become confused about their location. Wandering is common, but it can be dangerous or even life threatening [10].

In such a case, remote tracking of the patient can be very helpful. It can provide updates about the location of the patient to a family member's mobile phone. Priority alerts can also be issued if the patient strays outside a specific "safe zone" [12].

Fall Detection

Occurrence of falls in patients is frequent and can cause fractures, cognitive decline, and other issues. Preventing a fall should be of top priority, but in a case where it could not be prevented the patient needs to be taken care of immediately. In case of serious injuries, the patient needs to be taken to a hospital [20].

A fall detection tool can be used to detect the same, and priority alerts can be sent to a family member's mobile phone. This feature can also be beneficial for elderly or physically challenged people and for sports persons like cyclists, hikers, etc., in case of emergencies [13].

Psychologically Comforting Devices

One of the most challenging problems of Alzheimer's disease is the behavioral and psychological disturbances in patients. The patient tends to become aggressive, anxious, or agitated. Simple comforting devices can be used to reduce the patient's anxiety and provide calm and comfort [18].

Devices like aromatherapy diffusers and soothing music players can be turned on and off automatically based on the location of the patient.

Vital Signs Tracking

Vital signs of the patient like blood pressure, pulse rate, and body temperature can be monitored to detect medical problems or emergencies. The tracking can also be used for patients who are suffering from other medical complications like high blood pressure, diabetes, etc.

Monitoring Appliance Usage

When a patient advances through the stages of Alzheimer's, forgetting to turn off electronic appliances can become an issue. Devices like microwave, TV, clothes iron, etc., can be dangerous in such cases. The usage of such devices can be monitored through a family member's mobile phone.

3 Conclusion

Currently, the treatment methods available for Alzheimer's disease only help to alleviate the symptoms like memory loss and problems with thinking or reasoning to some extent.

Through the medications for Alzheimer's, the performance of chemicals that exchange information between adjacent brain cells is improved. However, they do not tackle the main cause that is the deterioration and decease of the brain cells. As more cells get affected and die, Alzheimer's disease keeps on getting worse.

Even if this is the case, there is optimism among scientists regarding the research for developing medicines that can hugely decrease the progression of Alzheimer's. Based on the changes the brain undergoes, some treatments which may tackle core disease processes are being developed. The treatment in the future may consist of a combination of drugs, comparable to how various tumors and STD therapy include more than one treatment.

Even though the prevention and in the worst-case scenario, treatment of the Alzheimer's disease is of utmost importance, and the monitoring of the patient throughout this process is also necessary. For this purpose, healthcare system that aids the family members and the patient to carry on with their daily lives needs to be developed.

This paper gave an overview of the various kinds of sensors that can be used in the healthcare systems (medical body area networks) for Alzheimer's patients. The main focus has been on devices that can be used for the motion detection and tracking of the patient.

Because of its small size and low power consumption needs, MPU6050 is ideal for portable devices and battery-powered systems. A handheld mobile phone can be transformed into a powerful 3D intelligent gadget with the MPU6050.

Passive infrared sensors are often referred to as passive infrared detector (PID) or PIR. As energy is not given out for detection, they are called as passive. The radiation emitted by objects is used for the detection.

Even though they detect movement, they cannot give the objects nature and identification. This can be done by using an imaging infrared sensor.

In the not-too-distant future, RFID technology will be an unavoidable part of our daily lives. It has a wide range of applications that increase productivity, improve comfort, and open new markets. RFID tags will be used to tag and identify a wide range of commodities. One of the key research aims in the field of RFID is to develop concepts and technologies that offer security and privacy protection for systems with a worldwide reach. In addition, there are a number of quality standards, such as dependability, scalability, adaptability, openness, and sustainability, as well as security and privacy. There are a slew of other research problems to solve. Inter-organizational business procedures must be supported by systems. In addition, integrating people who wear RFID tags ("tag bearers") into the system is critical for information self-determination.

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Banking Software Services: Current Status, Challenges, Impact and Prospects

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Abstract *Background*: As the world is developing at lightning speed, the financial technologies in the banking sectors are seeing abrupt developments which are imposing unprecedented challenges for the existing banks. In this situation, banks require local software companies that provide them with software that enables them to offer better administrations to their clients safely, dependable and reasonably and support upper hand over different banks. Some of the banking industry's early adopters are upgrading, while others are deploying core banking software (CBS) to boost competitiveness, operational efficiency and regulatory compliance. Most institutions, however, find such attempts difficult. *Objective*: This exploratory study sought to explore the problems that commercial banks in Bangladesh face when implementing or upgrading basic banking systems. Almost all banks are using software to minimize banking issues, but from the perspective of Bangladesh, some of the problems are still there. So in this situation, to mitigate the challenges on Bangladeshi banks, we have studied and pointed out challenges and impacts in local software companies. This study will help to cope with the advancements that are covered with explanations of the factors that could support the banks' digitalization and also show how the local software companies come up with the solutions to maintain the competitiveness of banks in the market.

Keywords Software solutions · Banking software · Local software solutions · Local software companies · Local banks · Core banking software

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1 Introduction

Banking software is a type of business software that is used in the banking industry. In most cases, banking software refers to core banking software and its interfaces, which allow commercial banks to link to other modular software and interbank networks. The banking software can be developed by the in-house team, third-party, or foreign vendors to the banks. Setting up an in-house team for producing software is expensive in terms of time and money, but managing the software and adding the customized features are easier, which is essential for customer satisfaction. Similarly, purchasing software from a third party or foreign vendors is easy, but later customizing software as per customers' demand is challenging. Emerging technologies like artificial intelligence and machine learning have been incorporated into banking software, which plays a significant role in predictive analysis.

The government of Bangladesh is helping to maximize the use of digitalization in banking. Bangladesh Bank, the country's central bank, has been active in assisting and encouraging banks to implement digitalization initiatives by establishing associated departments and enacting supportive laws and standards. Banks in the country are now employing core banking software, and some activities have already been automated. Most banks in Bangladesh have already begun to offer digital products to their consumers, such as ATM/POST services, Mobile/Tele banking, Web banking, "Anytime" and "Anywhere" banking and so on. Bangladesh Bank launched an automated CIB service, which sends credit-related data to banks electronically for both new and existing borrowers [1, 2].

1.1 Objective of the Study

The objective of this study is:

- To investigate the current status, challenges, impact and prospects of banking software used by Bangladeshi banks.

The rest of this paper is structured as follows. The research methodology is stated in Sect. 2, and solutions developed by local software company have been discussed in Sect. 3. Section 4 presents problems and prospects in the local software companies. In Sect. 5, the challenges of implementing new solutions, and in Sect. 6 a comparison between local and foreign banking software have been presented. In Sects. 7 and 8, we have presented recommendation and limitation of this study consecutively. Finally, in Sect. 9 we came to a conclusion and discussed the direction of future study.

2 Methodology

This study is based on the software that are being developed and provided by the local software companies. The information of this study is based on primary and secondary sources which means the information in the study has been taken from different published articles, newspapers, websites and also through interviews with the bank officials. This paper also includes the present status of the local software companies working with the banks of Bangladesh.

2.1 Data Collection Method

We made some questionnaires for both customers and employers end, and we asked them what problems they do face while taking and providing their services and also is there any suggestion they would like to give which may improve their future working experiences. We interviewed employees and customers of different banks as well as collected data of different software firms from their employees and website.

2.2 Sources of Data

All the relevant data regarding this study are collected from two sources which are primary and secondary sources. Primary data sources are (i) interviewing with the bank officials of software, (ii) official records and observing practical work, (iii) face-to-face conversation with the officer and (iv) face-to-face conversation with the client. Secondary data sources are (i) annual report of different local software companies, (ii) website of Flora Systems Ltd and (iii) various published documents.

2.3 Data Analysis

The data represented here has been reviewed and analyzed with the help of Microsoft Excel.

3 Solutions Developed by Local Software Companies

There are many software companies who provide banking solutions to the banks in Bangladesh. In this study, we had the opportunity to collect data from five local software companies who already have provided banking solutions to different banks. The software companies are Flora System, Flora Limited, Leads Corporation, Millennium Information Solution Ltd and ERA-Info-Tech Ltd, respectively.

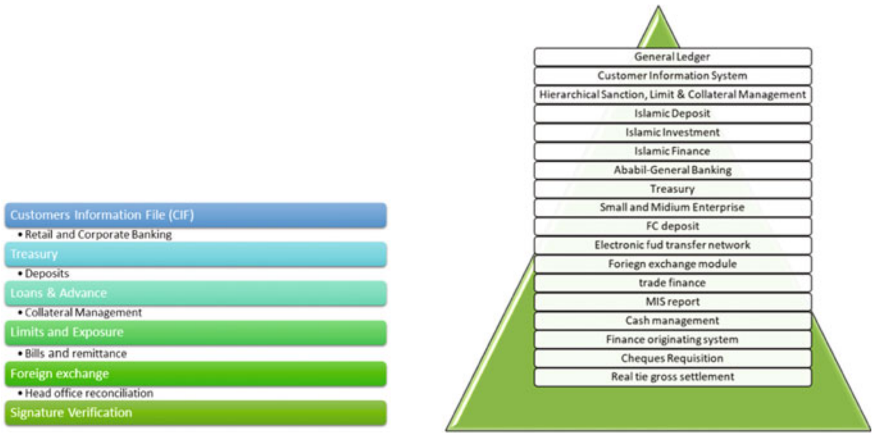

Fig. 1 Functional module of the Flora Bank-core banking system (CBS) and ABABIL

3.1 Software Solutions

We were able to list out some of the software features which is provided by the local companies to the banks.

Flora System Ltd: Flora Systems Limited has grown to leading ICT Company with many satisfied customers. One of the main software of this company is Flora Bank-core banking system (CBS) which is provided to the banks. The main modules of this software are presented in Fig. 1.

Millennium Information Solution Ltd (MISL): MISL has mounted itself as a dependable software program enterprise with inside the banking and finance industry at home and overseas. Their software name is Islamic core banking solution “ABABIL”. The main functional module of the ABABIL software is presented in Fig. 1.

LeadSoft: For both domestic and international markets, LeadSoft is involved in the design, development, implementation and maintenance of business application software. LeadSoft provides a core banking solution (BankUltimus). The main features of this software is given in Fig. 2.

ERA Info Tech Ltd: ERA Info tech is an IT Venture company is co-founded by Bank Asia Limited. ERA Info tech has developed a real-time centralized banking solution for Islamic and non-Islamic banks and for the agents. IT has credit approval systems, payroll systems, etc. The main software of this company is “iStealer”. The main features of iStealer are presented in Fig. 2.

Fig. 2 Features of BankUltimus and iStealer

Clients Name			
Flora System Limited	LEADS Corporation Limited	Millennium Information Solution Ltd	ERA Infotech Ltd
Flora CBS	Ultimus	ABABIL	iStealer
1. Trust Bank Ltd	1. Probashi kollyan bank.	1. Islami Bank Ltd	1. Bank Asia
2. Bangladesh Krishi Bank	2. Premier bank	2. City bank Ltd	2. Bangladesh commerce bank ltd
3. NCC Bank Ltd	3. Uttara bank	3. Al-arafah Islami bank ltd	3. Bangladesh development bank ltd
4. Midland Bank	4. Rajshahi Krishi unnanyan bank	4. Union Bank ltd	4. Uttara bank ltd
5. Bengal Commercial Bank	5. Shahjalal Islami Bank	5. Social islami Bank ltd	5. Sonali bank ltd
6. Jamuna Bank	6. Modhumuti Bank		6. First security islami bank ltd.'
7. Shimanto Bank	7. Standard Bank		7. Standard Bank ltd
8. South Bangla Agriculture and Commerce Bank	8. Southeast bank		8. Mercantile bank ltd
	9. First Security Islami bank		9. NRBC bank ltd

Fig. 3 List of banks who use local banking solutions

3.2 *Clients of Local Software*

In this study, we not only investigated the software solutions developed or provided by local software companies but also investigated the companies or clients who are suing the software. Here we list the names of clients who have used the companies' software and responded positively (Fig. 3).

4 Problems in the Local Banks

This paper is prepared following an extensive discussion with IT staffs and clients. During preparation in the paper, we got an opportunity to have in-depth knowledge of all banking activities. After going through a lot of session with the clients and banking officials, we pointed out some issues or problems which is presented below.

PS 01: Core banking solution or system (CBS) is not the complete solution for a bank, it is rather the core data management system. Locally sourced products usually come with the added benefit of faster delivery, often with a fraction of support and customization cost than the foreign ones. As a result, the banks hesitate to use software from local companies thinking about the cost and the ability to execute the software [3].

PS 02: The bank officials are reluctant in changing their traditional way of banking with the e-banking procedure and also the lack of IT graduates in the banking sector discourages their thought process to accept changes [4].

PS 03: Another challenge the banks face is when the banks fall victim to phishing attacks where they unintentionally confer sensitive information such as usernames, passwords and credit card details on malicious sites.

PS 04: Lack of proper publicity and advertisements of the products and services of the banks is causing obstacles to growth for foreign trade in the upcoming years that might contribute hugely to the growth of the economy [5].

PS 05: The lack of experienced IT specialists like cyber security expert is a major factor in banking industries to hold on to their reputation and image to the clients.

5 The Challenges of Implementing New Solutions

The challenges of implementations of core banking technology in the banks are presented below in details:

- Time and Cost: While working with core banking software system, it takes a very long time to finally execute a project due to repeated project extensions which leads risk of losing jobs as the project expenditure increases. As a result, banks that want to convert their intermediate banking system must have a legal venture control framework in place that carefully examines project development and minimizes the risks [6].
- Longer Pay-off Periods: As the banking projects face extensions and the investments are huge, therefore the banks undergo evaluations with the help of turnover ratios, strong management teams with solid strategies and a technique development approach that may increase the return on investment (ROI) [6].
- Stakeholder Management: There are two types of stakeholders in the banking quarter which is internal and external. In order to provide maximum value for the intermediary banking device, it is difficult to have mutual agreement and long-term commitments from all the internal stakeholders.
- Adaptability Issues: For any other authoritative changes, core banking software implementations face a troublesome changes for execution of projects digitally.
- Lack of trust: It is a big issue in the banking sector of Bangladesh. People suffer from lack of trust while depositing a large amount of money in the banks due to the blunders that has been repeatedly occurring in the re putative banks of Bangladesh. This happens due to the lack of IT specialist appointed in the banks and the management who lags behind in protecting the data and financial in formations.
- Insufficient software quality: The effect of insufficient software quality is hard to characterize it in severe terms.

6 Comparison Between Local and Foreign Banking Software

6.1 Centralized Core Banking System

An aggregate of 88% of banks in Bangladesh has set up incorporated CBS, which is permitting them to turn away misrepresentation, cut cost and offer ongoing types of assistance online to clients, as indicated by new exploration. Banking software (CBS) usage rate increased from 59% in 2010, according to a Bangladesh Institute of Bank Management (BIBM) survey. In 2010, a quarter of banks had a segregation of segregation, yet it declined to 5% this year, according to a survey [7]. Adaption of CBS by local banks has been presented in Fig. 4.

6.2 Market Share of CBS

It is obviously perceived that our banking industry is as of now overwhelmed by Foreign CBS by an enormous degree. A total of 27 local banks are utilizing foreign CBS. Before 2005, 45 banks utilized local software, while in 2017 just 19 banks use it. The equivalent is valid for in-house software too. Number of banks utilizing in-house software are declining. The situation is different to some extent for joint venture software. During the period 2005 to 2017, the quantity of banks utilizing joint venture programming is expanded from 2 to 6. We got the data till 2017; therefore, we presented market share of CBS till 2017 in Fig. 7 [8].

CBS Market Value in Crore Taka: Table 1 represents the current market worth of CBS in crore Taka. We have around 9400 bank branches in Bangladesh [8]. The details of current CBS market value are presented in Table 1.

Distribution of CBS in Bank: Considering number of banks, we observed that the most well-known CBS in our financial industry is Bank Ultimus. Around 16% local banks are using this CBS. Second biggest piece (14%) is driven by Temenos

Fig. 4 Centralized core banking system and market share of CBS

Table 1 CBS market value in crore Taka

CBS type	Licensing or fixed cost	Implementation	AMC
Local	295	225	38
Foreign	495	446	130
Joint venture	325	235	107
In house	583	124	

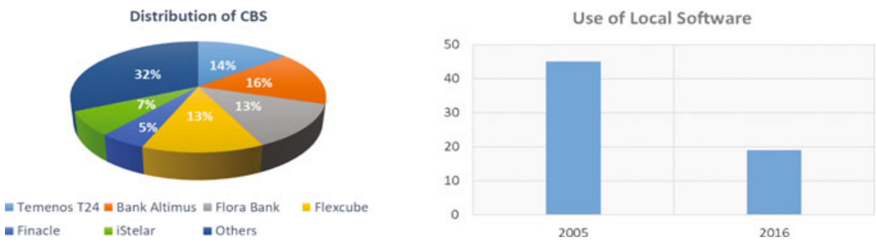

Fig. 5 Distribution of CBS and use of local software in the local banks

T24. Apart from these software, the overall local banking industry is similarly overwhelmed by Flexcube and Flora Bank by 13%. Other well-known software are I-Stelar, Misys and Ababil. Distribution of CBS in local banks is presented in Fig. 5.

6.3 Use of Local Software

Prior to 2005, about 45 banks were using local software and 19 banks were deploying it in 2016, according to research results. Day by day the usage of local software is decreasing because lack of the proper guides and trust issues [9]. The current usage of local software by local banks is presented in Fig. 5.

6.4 Replacement of CBS

Level of banks that changed their CBS is displayed in Fig. 6. It is observed that 41.4% banks traded their CBS for twice, which demonstrates that they are absolutely discontent with the recently utilized CBS. More Remarkably, 20.7% banks changed to new CBS for multiple times. By seeing this addressing propensity for CBS in our financial local area, we can say that our product market isn't steady in any way. It is very well might be noticed that 28% banks who don't change their CBS for a solitary time frame are either 3rd or then again 4th generation of banks who are world-class CBS all along or they do not want to change their CBS on the grounds that they are new participant on the market.

Number of Time CBS Change	Percentage of Banks
No Change	28.0
1 Time	37.9
2 Times	41.4
3 Times	20.7

Willingness	% Of Banks
Local to Foreign	29.4
Local to Local	47.1
Local to In-House	2.9
Foreign to Foreign	5.9
Local to Joint Venture	11.8
Foreign to Local	11.8

Fig. 6 Replacement of CBS and willingness to change CBS

Reasons to replace CBS	% Of Banks
Transformation from Old to New Architecture	12
Poor Functionality	12
Less Flexibility	9
Legacy/Distributed System/Not Centralized	45
Poor operational Performance	7
DB, HW and OS Dependency	9
Poor Security	6

Comments of HOITs using Foreign CBS

- ✓ Functionality does not support business innovation and expansion.
- ✓ Re-engineered business process required.
- ✓ Functionality does not support rapid development and launch of new products, with business agility to respond quickly to market and customer demand.
- ✓ New and improved performance monitoring tools and consoles are not present.
- ✓ Operational risks are higher and more customizations needed.
- ✓ Existing version of a3S is not fully supported by vendor.
- ✓ Already running for more than 5 years. Product life cycle is almost finished . Support will become an issue if the product is declared "End of life" by the vendor.
- ✓ To cope up with on-going Fin-Tech trend of Banking industry and cater customer digital requirements, existing system is either required . be upgraded or platform . be changed.

Fig. 7 Reasons behind replacing CBS

6.5 Willingness to Change CBS

For the most part, clients of Local CBS are selecting another CBS, as seen from Fig. 6 that, 47.1% banks have chosen to change their current Local CBS for another nearby one. 29.4% banks express that they will supplant their Local CBS with a Foreign CBS and 11.8% banks will go for a Joint Venture CBS by supplanting their Local CBS.

6.6 Reasons Behind Replacing CBS and Factors that Influence Banks to Replace CBS

The main reasons behind changing CBS and factors that influence banks to replace CBS are explained in the table below. A significant part of the banks (45%) changed their product since it was not unified. Then, at that point, 12% banks expressed that they have changed their product because of unfortunate usefulness. Database, hardware and operating system dependency also compelled 9% banks to change their software [10] (Fig. 7).

7 Recommendation

In this study, we have figured out many challenges related to current Banking Software which are already been used by local banks. To improve or overcome the challenges of e-banking administrations of the banks of Bangladesh, there are a few proposals.

- Build an integrated network that can achieve operational efficiency.
- Develop a flexible management system to study new development processes.
- Manage technical issues with a focus on clustered messaging systems.
- E-banking frameworks ought to be easy to utilize, quick and easy to understand.
- E-banking administrations ought to be normalized so any place the arrangement is utilized the client knows about the methodology followed government.
- Ought to urge the financial areas to mechanize their activity and going on the web by a particular period.

8 Limitation of This Study

The employers cooperated a lot, but they were too busy to give us time to meet practical activities. We faced some common issues during the interaction session such as bank officers were sometimes unable to provide information due to their busy schedule work. Many employers properly do not know much about their used banking software system. We had great difficulty collecting this information, and other required information was not provided due to confidential reasons.

9 Conclusion

The customer would like to have the banking services through the latest and advanced software system which will give them a smooth experience. They need to rely on the existing financial framework in Bangladeshi banks. The customer wants to get banking services without having to visit the bank in person, which saves time and money. This is because people's dependence on banking information is growing rapidly. Therefore, there is an urgent need of the upgradation of the banking services.

In this study, we selected some banks and then found out some local software companies that are providing existing IT support and then we analyzed what else are missing and what should be done to make the banks more efficient and user friendly. In this paper, we described local banking software provided by local software companies which are most widely used in the local Banks. We also described current status, challenges and impacts of the software which are used in the local banks developed or provided by local software companies. This study will help the stakeholders to take necessary initiatives to make banking software system more user friendly by replacing the existing banking software system with the suitable one.

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Enhanced AES for Improved Privacy in 5G-Enabled IoT Network

K. Shamshuddin and G. Naragund Jayalaxmi

Abstract The world is going to be surrounded by smart objects and most of them will be physical entities that are connected and interacting with each other, this will be possible because of the advancements in the Internet of Things (IoT) enabled with 5G. The IoT contains a vast quantity of devices and substances to encompass exceptionally low or fictional processing and communication assets of a high number of devices. The 5G term is very popular in industry because it will provide high speed data transmission, sufficient radio frequency (RF) coverage to interconnect different types of wireless networks and also connects an enormous amount of personal devices. The challenge is to provide security and privacy to these personal devices. In this paper, an adapted encryption standard named as Enhanced Advanced Encryption Standard (E-AES) is proposed, which enhances the security and privacy of IoT-enabled 5G network. The authors of the paper compared the anticipated E-AES algorithm next to the Advanced Encryption Standard (AES) in terms of delay and area, by simulating in the Cooja simulator and implementing both algorithms in field programmable gate array (FPGA) using Verilog hardware descriptive language (Verilog HDL). It is found that the E-AES algorithm performs better than the AES algorithms in provisos of encryption such as conversion time and power consumption.

Keywords Internet of Things · 5G · Cryptography · Privacy · Security · AES

1 Introduction

The improvements from the first generation (1G) to the fifth generation (5G) in communication technologies are taking place rapidly, in 40 years, have created several ways of data transfer and communication between two devices and also

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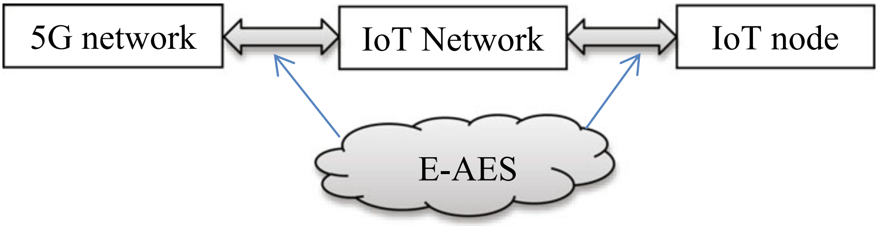

Fig. 1 5G and IOT network scenario

between different devices like IoT devices, servers and sensors [1]. These advancements are providing a platform for the new advanced applications which are transforming into an indispensable component of our community as well as our economy. The 5G technology's performance is a very big leap as compared to the 4G [2].

The broadcast nature of IoT makes IoT networks vulnerable to eavesdropping and threatening data secrecy. Therefore, data need to be protected from eavesdropping while sending and receiving. Data security is becoming a significant feature of today's Internet, and it is becoming more significant day by day. Because of broader online data transfer, connections and payments; secure information transfer and secure payment have turned out to be a region of apprehension [3].

Security and privacy are always important topics of discussion and also the main concern for data transfer in IoT. The user information such as identity and location leakage may result in a breach of privacy and confidentiality. The number of smart cities around the world is increasing, and thus, researchers are paying more attention to security and privacy in IoT [4]. Many researchers have proposed techniques to preserve privacy and protect user information. In this paper, the focus is on protecting the privacy of the data shared between IoT nodes and 5G network as shown in the diagram Fig. 1.

In this paper, one such technique is described to improve privacy preservation in IoT and it is implemented in Contiki's Cooja simulator. Contiki is an OS with a focus on low power IoT devices. Cooja is Contiki's network simulator. Cooja allows the large and small networks of Contiki's motes to be simulated, and the IoT enables objects to interact with one another. To study the performance algorithm on hardware, Verilog HDL code is implemented on the FPGA board.

The organization of the paper is as follows: Sect. 2 related works, Sect. 3 proposed method, Sect. 4 describes simulation results, and Sect. 5 discusses the conclusion.

2 Related Work

To understand privacy and security issues in IoT, we reviewed many types of research. Authentication, data integrity, confidentiality and authorization are the security issues of any network; also they are the key requirement to secure any network from various security attacks [5, 6]. The security issues in IoT can be classified as accountability, privacy, legal and security [7]. The most important security challenges in IoT are classified as information storage, authorization, verification, access control, privacy and system configuration [8].

IoT devices exchange a very high volume of data over using communication services of a 5G network. The data needs protection to avoid any type of attack by the attacker to breach the privacy of the user. The IoT network can use different types of architecture to reduce the traffic, which needs to be handled by the 5G network, e.g., device-to-device (D2D) communication. D2D communication has many security issues because of its open communication nature. A few of the D2D communication threats are data modification, free-riding, jamming and privacy violation [9].

The biggest challenge in IoT networks is to provide security and privacy, because of the massive number of devices. Privacy preservation is required in IoT networks because information such as location trajectories can reveal interests and relationships of personal information. To protect personal information, we need privacy preservation techniques [10]. Similarly to protect data shared between devices, cryptographic techniques were used to avoid the disclosure of user information [7], one such technique is presented in this paper using a symmetric key.

Security is very important in many areas like communication or storing data on clouds and storage. Cryptographic methods are used to provide a way to secure data against unauthorized access. Nowadays, many cryptographic algorithms have been developed for attaining better security. Here, we have used the Enhanced AES algorithm.

AES is constituted of some bit substitutions, permutations, round key functions and transformations, sub byte functions, shift rows and mix columns. AES is a faster algorithm. AES is one of the most reliable encryption standards for the advanced security of information. Some modifications are made for making the calculation easy and to increase the efficiency of the algorithm [11].

For encryption of the plaintext, a secret key is used by symmetric key algorithms and in the case of decryption none other than the same key is needed for obtaining the plaintext. Here, symmetric key algorithm is selected because of its comparatively high speed and computational efficiency to control a huge amount of data. If the length of the key is large enough, then encryption will be stronger.

Generating keys is very important in encryption methods. The keys are generated in a way that the hacker cannot get access to the secret key. For AES-128, there are total of 10 rounds. Thus, a total of 10 round keys need to be generated from the cipher key. The mix column is replaced with a transposition. Thus, it reduces the computational complexity of the algorithm and easier to implement. It also provides faster encryption or decryption as compared to the AES algorithm. These modifications are made for the better performance of the algorithm [12].

3 Proposed Method

Advanced Encryption Standard (AES) is widely used encryption algorithm with modest key space, but computational methods are extremely difficult. In this paper, physical unclonable functions (PUFs) are used to improve the performance of AES {Formatting Citation}. The secret keys are randomized using PUFs as shown in Fig. 2. If the secret key is made public, then intruder can access to any round key and can reconstruct plaintext because the decryption algorithm is already known. Therefore, protecting secret key is very important. The AES security is improved using pseudo-random sequences of adequate length. PUFs are used to generate pseudo-random number. To prevent the intruder from deriving any sequence and launching multiple identities attack, pseudo-random number is used. This technique increases difficulty for the intruder to guess secret key [14].

After the 10–round encryption the execution of the algorithm converts plaintext to ciphertext. AES encryption executes three important steps, Step 1: input key and plain text. Step 2: using plaintext pre-round transformation is performed. Step 3: perform transformation per round and rounds are confirmed based on key length. Step 4: repeat step 3 if per round transformation is less than 9 times, and Step 5: perform the last round transformation. Step 6: obtain cipher text as shown in Figs. 3 and Fig. 4.

In AES decryption, the steps are executed in reverse order using the same key used in AES encryption because AES is a symmetric key algorithm and ciphertext as input. The key generator takes input externally using PUF, this is encoded into public data and a secret key, and later secret key is discarded while public data is used for key generation in a later process.

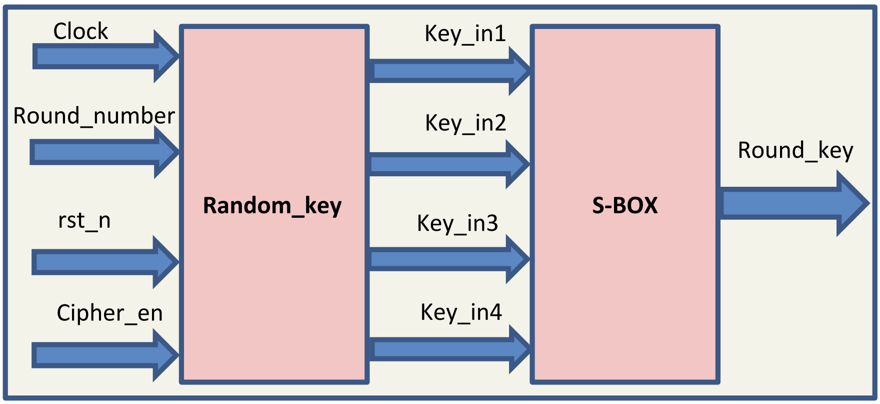

Fig. 2 Key generation

Algorithm 1: Algorithm for encryption

Start
Input: 128-bit plain text
Input: 128-bit key
Output: 128-bit cipher text
Perform pre-round transformation on plaintext
while *Round* $\geq$ *10* **do**
  if *Round* $\neq$ 10 **then**
    {Perform per round transformation i.e sub Bytes, Shift rows, Mix column and add round key}
  else
    if *Round* ==*10* **then**
      {Perform last round transformation i.e sub Bytes, Shift rows and add round key}
End

Fig. 3 Algorithm for encryption

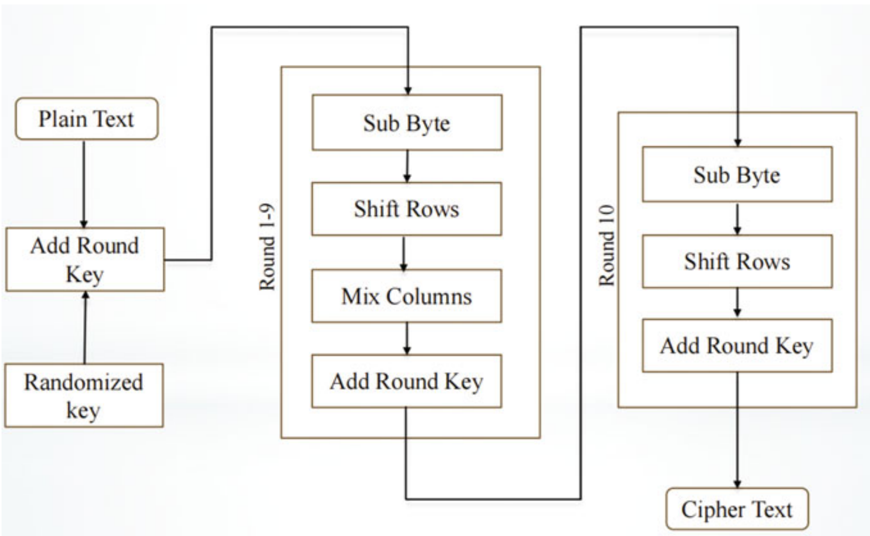

Fig. 4 Block diagram for an Enhanced AES algorithm

Advanced encryption supports a variety of key lengths like 256 bits, 192 bits and 128 bits. The strength of AES is very much dependent on the size of the key. 128-bit AES needs a total of 10 rounds. 192-bit AES needs a total of 12 rounds, and 256-bit AES needs 14 rounds. From the initial key, 10 more round keys are generated which are applied to each round. Each key is divided into four words. So, a total of 44 words are needed. Four words or a total of 16 bytes are arranged in a matrix order of 4×4.

Initially, a logical XOR operation is performed between the cipher key and plaintext. Then, in each round, there are several types of operations are performed which are described as mentioned below:

Sub-bytes: The values of each column and row element are substituted from a fixed table known as S-Box. After substitution, it constructs a 4X4 matrix.

Shift rows: Cyclically byte shifting operations are held here. The first row of the matrix is unchanged. First, second and third positions shifted to the left for the second, third and fourth row, respectively.

Mix columns: Each column of the matrix after shift operations is multiplied by a predefined matrix. Thus, the way each column is transformed and a new 4X4 matrix is formed. 4. Add Round Key: The matrix constructed after the mix columns operation which represents 16 bytes are treated as 128 bits. At each round, a round key is added after the mix columns operation.

4 Simulation Results

4.1 Cooja Simulator

The Cooja simulator is used to analyze the IoT nodes [15]. It is used to simulate the communication between two IoT nodes in a radio traffic environment. In the Cooja simulator, client node and server node can be created by importing programming files into the motes [16]. The simulation is run to verify the packet exchange between the client and server node. Contiki's Cooja simulating window displays the time at which the packet is transmitted, information about the text transmitted, ciphertext, request from a client, response from the server and IP addresses of the client and server nodes, as shown in Fig. 5 [13]. Mote output window displays the all information about the packet transmitted between client and server including IP address, time of transmission, plaintext, ciphertext and UDP process. It also displays a simulation of the motes, and their radio environment and the positions of motes are identified by the IP addresses assigned to the client and server motes as shown in Fig. 5.

The server receives the cipher text from client and decrypt's the ciphertext by using inverse blocks of Enhanced AES. Node 2 acknowledges client after receiving the packet from node 1 as shown in Fig. 6. In the client side, the plain text is converted into cipher text, then sends the packet to the server. Figure 7 displays the information about the packets transmitted and received between client and server motes. After decryption, the server displays the message which is the decrypted, the plain text exactly matches the original plain text. Same experiment is repeated for more nodes, and results show that all the nodes were able to exchange encrypted information between them. The conversion time is also remaining same for communication between nodes, as each node has to perform the conversion independently [21].

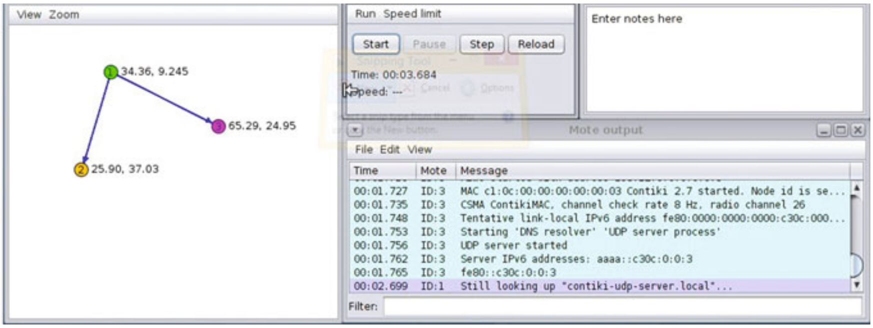

Fig. 5 Server identified to send the text

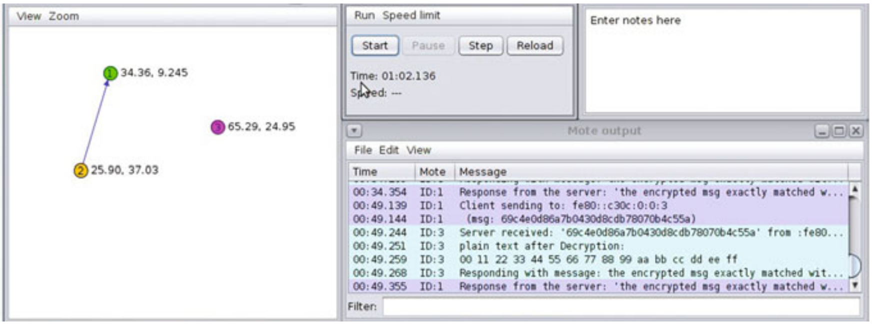

Fig. 6 Acknowledgment received from node-2

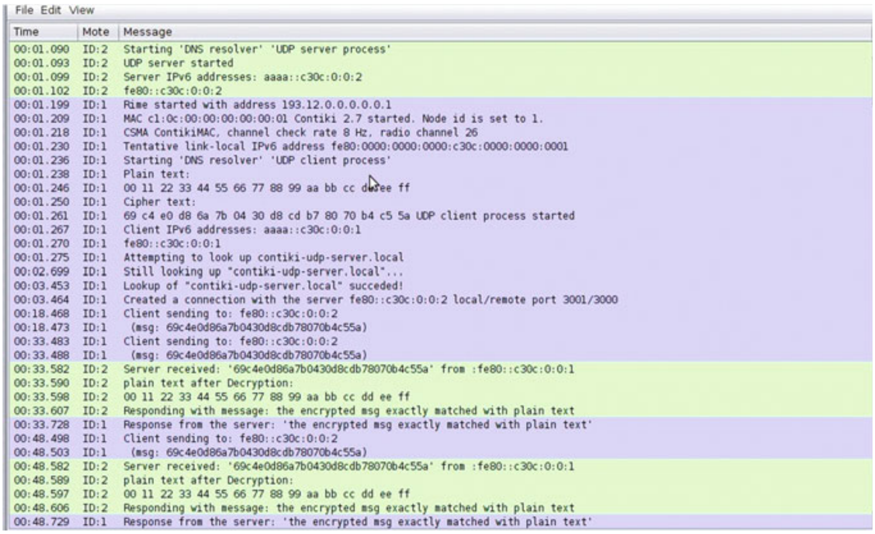

Fig. 7 Results of Enhanced AES-128 bit security algorithm to IoT nodes

Table 1 Timing constraints (in nano seconds)

Device	Spartan 6		Artix 6		Kintex 7		Vertex 6	
Algorithm	AES	E-AES	AES	E-AES	AES	E-AES	AES	E-AES
Delay	6.691	6.66	4.659	4.404	3.905	3.658	4.667	4.314
Offset	9.032	9.013	3.576	3.267	2.927	2.610	3.539	3.245

Table 2 Device utilization summary

Device	Spartan 6		Artix 6		Kintex 7		Vertex 6	
Algorithm	AES	E-AES	AES	E-AES	AES	E-AES	AES	E-AES
Slices LUTs	2366	2197	1674	1385	1651	1419	1645	1394
Registers	706	706	542	528	542	528	542	528
FFs	435	435	541	360	541	360	541	360
BRAM	8	12	8	12	8	12	8	12

4.2 HDL Simulation

The server receives the cipher text from a client and decrypt's the ciphertext by using inverse blocks of Enhanced AES. Node 2 acknowledges the client after receiving the packet from node 1 as shown in Fig. 6. On the client side, the plain text is converted into cipher text and then sends the packet to the server. Figure 7 displays the information about the packets transmitted and received between client and server motes. After decryption, the server displays the message which is decrypted, the plain text exactly matches the original plain text. The same experiment is repeated for more nodes, and the results show that all the nodes were able to exchange encrypted information between them. The conversion time is also remaining the same for communication between nodes, as each node has to perform the conversion independently [21] (Tables 1 and Table 2).

5 Conclusion

In IoT-enabled 5G network, data security and privacy are major areas of concern and the amount of data handled will be very huge in an IoT network. Therefore, using the cryptographic technique for data transmission is a must. In this paper, Enhanced Advanced Encryption Standard (E-AES) is proposed. This technique utilizes physical unclonable functions (PUFs) to provide improved privacy for data sharing between IoT devices. Simulation is conducted with Contiki's OS, Cooja simulator and using Verilog HDL, the E-AES is implemented on FPGA, the results in Figs. 8, 9, 10, 11 and 12 show that proposed techniques perform better in terms of speed and area. To improve security and privacy, E-AES can be used in the IoT network.

Fig. 8 Device utilization on Vertex 6

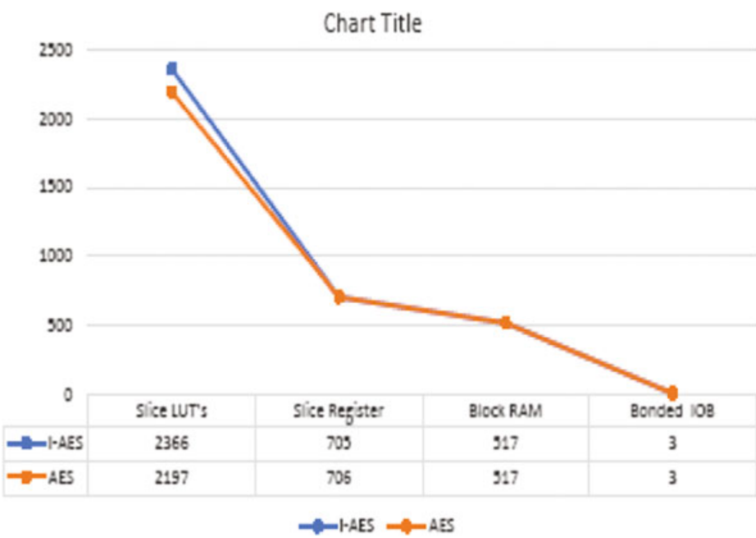

Fig. 9 Device utilization on Spartan 6

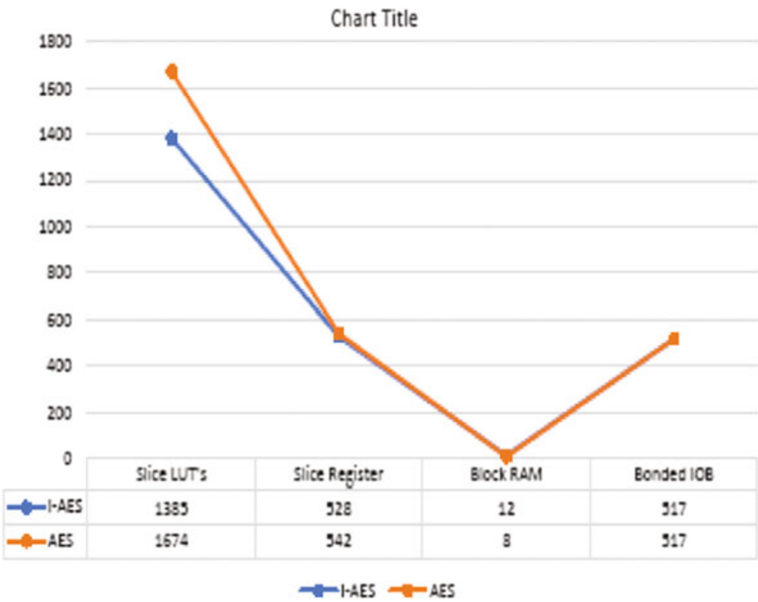

Fig. 10 Device utilization on Artix 7

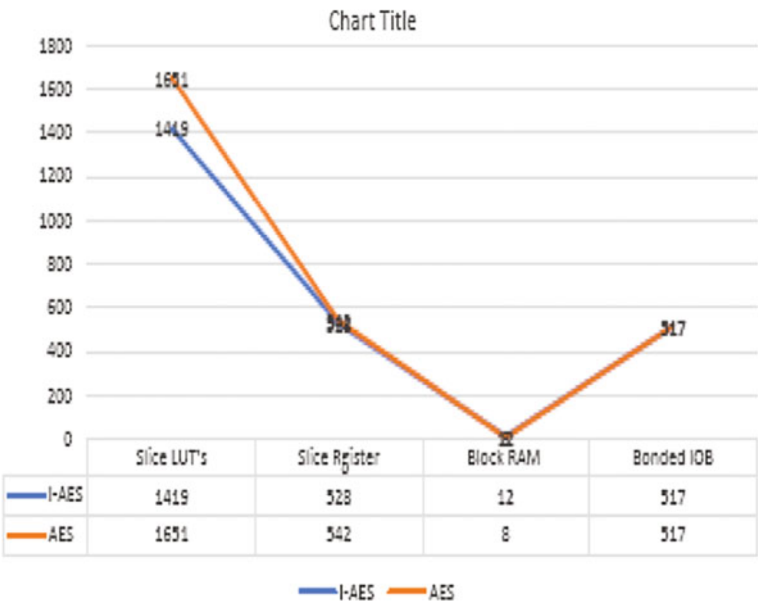

Fig. 11 Device utilization on Kintex 7

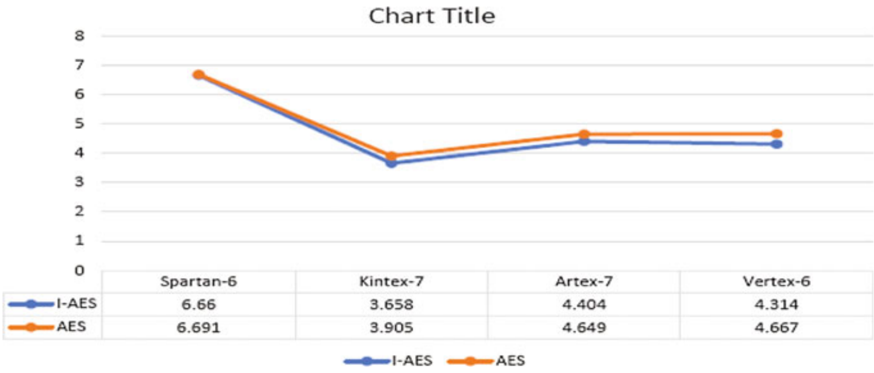

Fig. 12 Variation of delay on different FPGA devices

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Rainfall Forecasting Using Deep Learning Models

Menon Anjana Sreekumaran and R. Shanmughasundaram

Abstract Agriculture is very important and the oldest profession for survival. The significant influencers like rainfall, temperature, etc. are taken into account for weather forecasting. In this paper, models of deep learning like multi-layer perceptron (MLP), convolutional neural network (CNN) and long short-term memory (LSTM) are used to predict the rainfall of India from the year, 1901–2015. The algorithms are implemented in Google Colaboratory. From the results, it was observed that the performance of LSTM is better than MLP and CNN as it has least performance metrics. The LSTM could be used for precise weather forecasting.

Keywords LSTM · CNN · MLP · Deep learning · Rainfall prediction/forecasting

1 Introduction

Deep learning models help to create a model from the existing data. Humans do not start from fresh every thinking they think. Our thoughts are tenacious. This is something traditional neural networks are incapable of, and it looks to be a fundamental weakness. Long short-term memory (LSTM) is a recurrent neural network (RNN) type that can learn long-term dependencies. Predicting future values of a time-series phenomenon helps to improve service quality. The accurate forecasts, for example, can drastically improve performance in fields such as medicine, engineering, meteorology, telecommunications, control systems, business intelligence, cryptocurrency, and, most importantly, and financial results.

Correlating interdependence entails predicting, adequate predictors and indicators from historical data using statistical and computational methods. It is crucial to note that weather forecasting is important not only for people's daily lives, but also for agriculture and a variety of other businesses. These projections can also help businesses make decisions that will help them avoid disasters. Rainfall is an important part of farming, making food, managing water resources, and other natural systems.

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Rainfall's structure and behavior, as well as where and when it falls, are affected by many things, such as humidity, pressure, temperature, and possibly the direction and speed of the wind. When it comes to rainfall, a time series is frequently used and incorporates local elements as well, such as bursts of intense rain between lengthy periods of low-intensity rainfall. The physical simulations have been used to perform atmospheric forecasting for decades. The current sample of the atmosphere's state is taken, and the state of the future determined by fluid dynamics and thermodynamics equations are quantitatively solved. The hydrological requirements usually dictate the temporal and spatial aspects of rainfall forecasts. A hydrological model is a simulation of actual hydrological properties.

In this paper, rainfall data with different parameter from Kaggle has been preprocessed, and deep learning models like MLP, CNN, and LSTM have been applied. Mean absolute error (MAE) and mean square error (MSE) are the performance metrics used. Prediction of rainfall for next 7, 15, and 30 days have been done.

The authors of [1] used deep learning techniques like multilayer perceptron (MLP) and autoencoders to predict rainfall. Feature extraction was done by autoencoders, and prediction was done by MLP. The accuracy was obtained by using root mean square error (RMSE) and mean square error (MSE). In [2], the long short-term memory (LSTM) was used on Bangladesh's time series weather data to predict the monthly temperature and rainfall. The rainfall had a relatively low mean prediction error of − 17.64 mm. In [3], total of 12 parameters, with rainfall being one of them were used. The LSTM approach was used, with a 95.89% accuracy.

In [4], LSTM and ConvNet were used for rainfall prediction considering mean absolute percentage error (MAPE) and root mean square error (RMSE) as performance metrics. RMSE for ConvNet and LSTM was 2.44 and 2.55%, while MAPE was 1.7281 and 1.6891%. In [5], MLP was applied on the dataset for prediction rainfall with RMSE accuracy as 2.75%. Shikha Srivastava et al. [6] used back propagation neural network (BPNN), linear regression (LR), long short-term memory (LSTM), and support vector regression (SVR) for prediction. The LSTM gave high accuracy of 94.78% as compared to other models. In [7], LSTM and ANN were used on dataset from 1971 to 2013 with RMSE as 2.57%. In [8], a single LSTM was used to predict the rainfall using CAMELS dataset with an accuracy of 94.53%.

In [9], Bangladesh Meteorological Department (BMD) weather dataset was used to predict with LSTM with an accuracy of 76%. Anjali Samad et al. [10] used data from 2007 to 2015 with rainfall, pressure, temperature, wind, and speed as the atmospheric parameters for predicting the rainfall. LSTM outperformed ANN when MSE, MAE, and RME were used as performance metrics. In [11, 12], LSTM model is used for fast learning of robot and SoC. In terms of RMSE value, LSTM performed better than EKF. In [13], weight optimization of ANN has been done using hybrid combination of neuro genetic model. It was observed that BPNN-GA gives better average prediction accuracy than FF-BPNN.

2 Methodology

See Fig. 1.

In this paper, rainfall data in given as input to the system. The data was pre-processed, and different deep learning models are applied. The data is analyzed in different scenarios and was divided into test and train.

2.1 *Description of Dataset*

Data analysis and gathering are followed by data pre-processing. There are two datasets under consideration. Dataset 1 shows rainfall in India by state from 1901 to 2015. Dataset 2 contains rainfall data by district in India from 1901 to 2015. Individual months, annual months, and combinations of three consecutive months, subdivisions, and year are among the 19 qualities.

2.2 *Hyper-Parameter Selection*

Deep learning models such as MLP, CNN, and LSTM have been parameterized and were applied using different layers. The same models were used for both datasets. The activation functions applied were rectified linear activation unit (RELU) and Sigmoid with adaptive moment estimation (ADAM) as the optimizer.

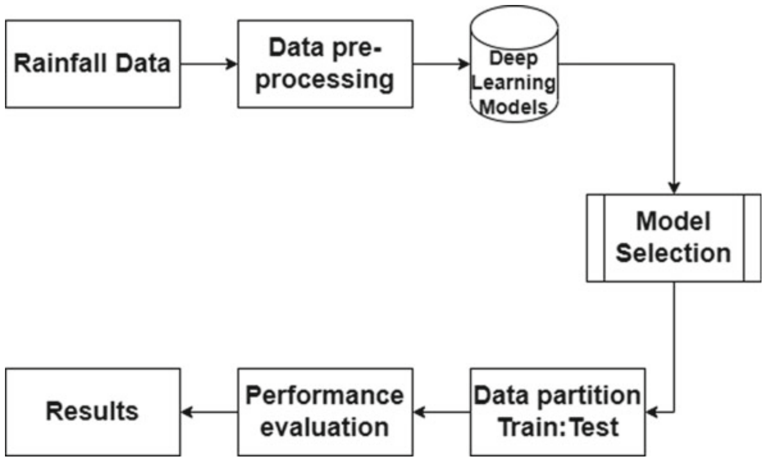

Fig. 1 Methodology

Table 1 MLP

Type of layers	Shape of output	Parameters
MLP	(None, 32)	200
Dense	(None, 64)	6464

Table 2 CNN

Type of layers	Shape of output	Parameters
conv1d_2(Conv1D)	(None, 3245, 64)	192
max_pooling1d_2 (MaxPooling1D)	(None, 1622, 64)	0
flatten_2 (Flatten)	(None, 103,808)	0
Dense	(None, 64)	10,380,900

Table 3 LSTM

Type of layers	Shape of output	Parameters
LSTM	(None, 64)	40,800
Dense	(None, 32)	3232

2.3 Proposed Model

In this paper, an architecture of MLP, CNN, and LSTM is used to process and predict the rainfall data. MAE and MSE are considered as the performance metrics for predicting rainfall for next 7 days, 15 days, and 30 days. In MLP, the input layer receives a sequence of 3245 and 32 filters. The optimizer used was Adam. In CNN, the sequence of input layer and filters was 3245 and 64. The Max-pooling contains half of the CNN layer. The feature data is then flattened into 1D vector.

LSTM contains same input sequence that was for MLP and CNN with 32 filters. The optimizer used for all the models was Adam, and the activation function used was RELU. The details for MLP, CNN, and LSTM for predicting the rainfall are given in Tables 1, 2 and 3, respectively.

3 Results

The deep learning models have been simulated using Google colaboratory. Table 4 shows MAE and MSE of MLP, LSTM, and CNN for 10 epochs. Among these models, it was observed that LSTM gives better results.

Figures 2 and 3 show the heat map of monthly correlation of rainfall. Heat map basically shows the correlation between the amounts of rainfall over months. Here, it is observed that the lighter color of blocks indicates higher amount of rainfall and the darker one represents lesser amount of rainfall. In the months of June, July, August, and September, the amount of rainfall is higher as compared to the other months.

Table 4 Comparison of deep learning models

Model	MAE	MSE
MLP (Dataset 1)	0.2022	0.0525
MLP (Dataset 2)	0.1587	0.0511
LSTM (Dataset 1)	0.2266	0.0568
LSTM (Dataset-2)	0.1410	0.0395
CNN (Dataset-1)	1.2060	0.3648
CNN (Dataset-2)	0.1350	0.1687

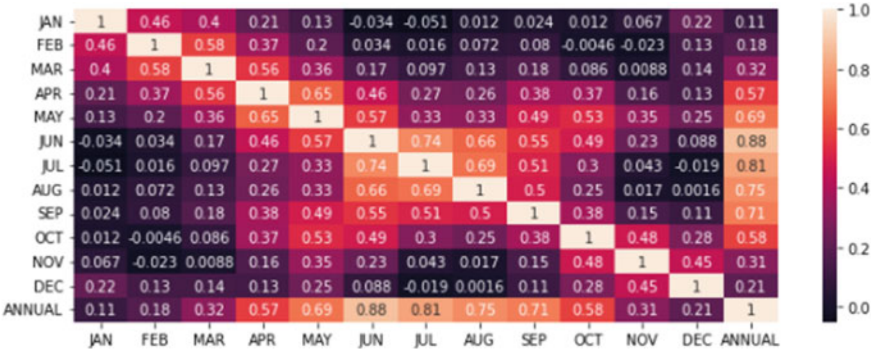

Fig. 2 Heat Map for Dataset 1

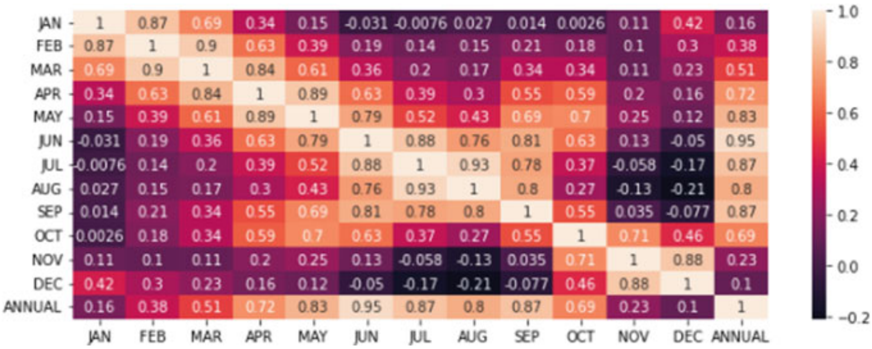

Fig. 3 Heat Map for Dataset 2

Figures 4 and 5 show the prediction of rainfall for dataset 1 and dataset 2 using. Considering the combination of three months, i.e., Jan, Feb, and March, the prediction up to next 7 and 30 days have been done. The results show that the predicted value is closer to ground truth.

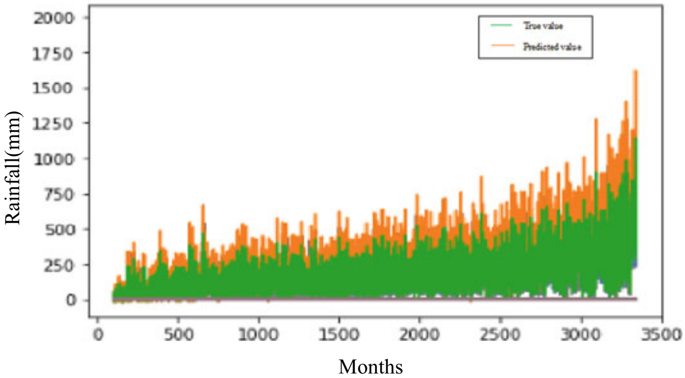

Fig. 4 Rainfall prediction using LSTM for Dataset 1

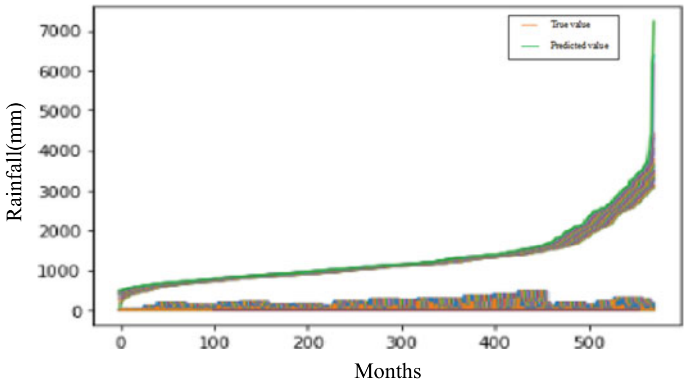

Fig. 5 Rainfall prediction using LSTM for Dataset 2

4 Conclusion

In this paper, the deep learning models, namely, MLP, CNN, and LSTM are used to predict the rainfall of India from the year, 1901–2015 using two datasets with 19 parameters. The performance of the algorithms is compared based on MAE and MSE. It is observed that LSTM performs better than MLP and CNN. The time-series rainfall data available for different countries can also be used for prediction using these models.

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Adaptation of Agile Development in Medical Industry

G. S. Mamatha and Vaibhavkrishna Bhosle

Abstract Over the past number of years, the medical care sector has actually undergone an improvement and it continues to progress rapidly. The formerly underserved sections such as assisted living, senior citizen therapy, persistent illness surveillance, along with wearables have actually made outstanding strides in an international market, which deserves above $300 billion. This boom is partly fueled by the advent of consumerism in the health care market and also the comprehensive adoption of totally expanded gadget systems by customers. Consequently, these systems are increasingly being made use of as adaptation of systems from professional devices. The selection for these systems has actually caused the Food along with Drug Management (FDA) to give an official advisory for clinical wellness applications. To develop such medically advantageous devices there are different approaches to design and develop. Agile methodology is one among it. Which will have major and significant positive impact on the development cycle. Few of the examples of adaptations and advantages are discussed in this white paper.

Keywords Medical industry · Agile · Regulated environment

1 Introduction

The efficient system and also techniques that personify Agile software program growth have been around for more than some years, as well as have actually been advertised as having "went across the gorge" by firms such as the Agile Partnership, Gartner, as well as Forrester Research. Several types of research recommend that when carried out appropriately, it can cause a much better, much shorter time to market, as well as additionally far better exposure right into the advancement standing than typical software program application advancement strategies. Despite that, various companies have established numerous items for very handled fields, such as Clinical Gadgets, Aerospace, or Automotive, assert that Agile "does not operate"

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within their markets. This paper speaks about exactly how activity is performed in the clinical device market's ambiance. Agile development is definitely the most modern approach for developing software or software-based systems, with numerous benefits. However, the adoption of Agile varies considerably across different business domains [1].

2 Literature Survey

A. **Agile and Regulated Environments**

Agility is the capacity to respond to change in the development environment. The world around us is transforming faster than ever. For a service to succeed, what is frequently called "organization agility is essential". Business agility describes as replying to transforming customer needs, market conditions, new technology participants, as well as also regulation or consumer perceptions. Keeping one action successful requires the capability to react promptly to the adjustments when needed. There's a fine line in between chaos as well as thoroughly differing the plan in a taken into consideration way to meet transforming needs. This is where nimble can be found.

Adrian Barnes of ResMed, a Clinical Device manufacturer, gives an example of that preliminary element: he defines "A long-lasting man would absolutely try to convince the FDA that Agile is good to be followed" [2]. This declares that the "regulatory authorities won't approve Agile". This situation is maybe amongst one of the most typical arguments, in addition to happenings from a misdirected perception that Agile shuns data and also treatments. This assumption probably stems from the truth that the Agile statement of belief (the preliminary basis for Agile principles) was deliberately composed in a remarkable approach. This "pull" approach is markedly different from the "push" approaches of the past [3].

The very first of the four specified within the Agile Manifesto is "People in addition to interactions over procedures and tools". This has in fact generally been taken suggesting Agile objections process-centric development, as an anti-tool. The 2nd worth statement is "Operating software over extensive paperwork", which can be misinterpreted as "don't tape". The follow-on statement to those worth's, nonetheless, is vital to evaluate the effectiveness of the declarations suitably: "while there is value in the items on the right, we value the items on the left a lot more".

B. **Agile manifesto and Medical Industry**

The appropriate interpretation of the very initial benefit for the declaration of energetic statements is that, treatments along with devices should maintain and likewise aid efficient product advancement groups. Instead of developers implementing treatments without thinking about the process. The 2nd benefitable statement ought to be taken is "keep your eye on the conclusion goal: giving worth to the customer" [4]. The intuition behind the 2nd benefit is that first to completely stop producing unnecessary documentation, or over-documenting things, and additionally of all to concentrate on retiring threat asap, by providing operating software programs iteratively along with incremental procedure.

The problem with badly documented software activities is, specifically with software program demands. That is a widely known as well as enduring one-poorly specified requirements (both because of obfuscation over paperwork as well as inappropriate documentation) is mentioned as the significant reason for software projects failing in the annual Standish Team's DISORDER News [5].

The Clinical Gadget industry has actually likewise seen the execution of dexterous in their industry around the completion of 2012. The Association for the Advancement of Medical Instrumentation (AAMI) released Technical Info Report 45 "Guidance on the use of AGILE methods in the development of medical device software program". This report wraps up those Agile practices which can be put on developing clinical tool software applications. And, also can be done so it adheres to the regulative framework. Which gives a mapping between Agile terms, methods, and also the tasks called out by the IEC 62304 requirement [6].

3 Agile Development in Regulated Environments

Carrying out methodologies such as Agile calls for a cultural shift within a company. Considering that Agile groups often run in smaller-sized groups, it makes doubters fret about the truth that several smaller-sized teams working autonomously may result in an absence of control, liability, as well as governance. Nonetheless, what doubters fail to comprehend is that leveraging the best methods to apply Agile in regulated settings can have significant advantages, including enhanced speed-to-market, minimized expense, and improved end results.

In an Agile setting, effective compliance management indicates using Agile methodologies to construct software that has the greatest feasibility and high quality, while guaranteeing adherence to all governing as well as compliance standards. Applying agile in a complicated controlled environment can present unique difficulties that include risky projects, unclear demands, limited target dates, etc. If intended as well as taken care of proactively it can lead to enterprise-wide advantages such as better top-level quality, stakeholder interaction, predictable distribution. Regulated environments are characterized by businesses where characters like quality assurance, safety, security, or traceability are considered as major parts that should comply with some certain regulations, guidance, and standards [7].

Implementing Agile in Regulatory Environment Huge ventures frequently operate in very intricate environments that are regulated by a wide range of policies. Presenting Agile at an enterprise can make it less complicated for teams managing items to function incrementally on any regulatory modifications that are presented midway, i.e., during the item growth stage. Agile is a wonderful way to better respond to altering organization dynamics as well as unpredictability, especially in highly controlled business atmospheres. Since the groups are smaller-sized, structured, and also distinct they are much better furnished to include any kind of new versions or changes prominently.

It is exceptionally vital for business experts, product proprietors, and also groups to clearly recognize the regulatory as well as compliance standards that apply to their sector as well as product offerings and the implications of any type of lapses. With the constantly altering standards, company analysts have to remain on top of these changes and keep other stakeholders (developers, software application testers, etc.) abreast of these modifications.

Applying methodologies such as Agile needs a social change within a company. Given that Agile teams commonly run in smaller groups, it makes skeptics stress over the fact that multiple smaller teams working autonomously could lead to a lack of control, governance, and responsibility. However, what skeptics stop working to comprehend is that leveraging ideal methods to apply Agile in managed settings can have major advantages, consisting of improved speed-to-market, lowered price, and boosted results.

4 An Agile Approach to Medical Device Design

With aesthetic management, Agile teams can improve their capability to function properly by presenting the information in a visual way instead of in a list-form on a spreadsheet or in a wiki. By doing this, it is easier to understand job details as well as to take care of adjustments.

Major advantages of aesthetic task management for Agile include:

- Ability to adjust to adjustments
- Increased group efficiency
- Visibility of job details
- Ability to range.

For the developers of software applications, Agile is usually taken to describe techniques and techniques connected with the Manifesto for the Agile software development released by the Agile Alliance in 2001. This Manifesto, as well as the linked 12 principles of Agile software application advancement, were birthed out of the real-life limitations as well as obstacles experienced with using the standard fall growth approach when establishing complex software systems [8].

Rather than the considerable planning that needs interpretation, and analysis in advance normally linked with waterfall growth, Agile methodologies allow for advancing requirements with time by enabling cross-functional teams (covering the main software development features of coordinators, programmers, developers, and testers) to service succeeding versions of the product, generally over a fixed period.

Agile as a result relies on a much more transformative and step-by-step technique than the sequential circulation linked with standard waterfall development. In comparison, an Agile strategy would certainly seek to slice the development right into a collection of incremental design versions, each structure on the previous launch and the responses gained from the actual usage of a launched, examined software application item.

One of the vital principles behind using Agile for software application development is to accomplish consumer demands with the constant and very early shipment of working software applications. Agile gives normal and constant releases of software applications that are sensible items that satisfy a part of the individual's requirements. When done well, Agile can offer a number of benefits over an extra conventional, consecutive product development approach, including:

Agile as a result relies on a much more transformative and also step-by-step method than the consecutive flow associated with typical falls growth. A traditional waterfall advancement procedure is highlighted (Fig. 1). This is a series of sequential actions that cover the entire advancement. In contrast, an Agile technique would seek to slice the advancement right into a series of incremental style versions, each structure on the previous release as well as the feedback acquired from the real use of a launched, evaluated software application item, as shown below with agile approach model (Fig. 2).

- Speed-to-market–a functioning product is delivered faster and succeeding models can be supplied often at a normal rate.
- Flexibility–adjustments to requirements can be included at any point of the procedure–also late in advancement.
- Closer interaction–Agile can promote closer partnership between programmers as well as businesses. Agile likewise offers a very clear method to functioning, in regards to the task, progression, as well as problems.
- Robustness–the responses device integral in a lot of agile techniques provides a great opportunity for continuous renovation.

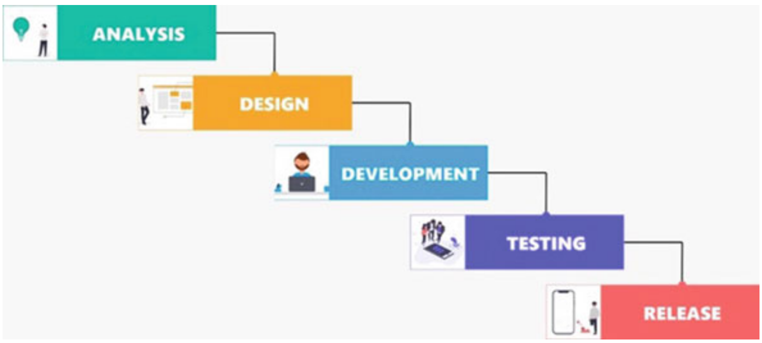

Fig. 1 Waterfall model

Fig. 2 Agile model

5 Agile and Medical Industry Implementation

Organizations might originally incorporate the Agile approach within their technology portfolio as a starting factor. Technology centers or groups are often working with risk but tactically important tasks are left out. Experience in the transformational buy-in from elderly leaders is crucial to creating space for few Agile teams to team up and collaborate. To succeed, separate units within the organizations, like business planning as well as infotech, need to offer their personnel flexibility as well as versatility to join these teams. Hiring patients to be part of these teams guarantees that the emphasis stays on individuals getting solutions.

To make it possible for clinicians to suggest digital applications at the point of care, Inception Health partnered with a business called Xealth to produce a digital health formulary, linking in third-party digital health applications with the electronic wellness document as well as medical operations. An Agile group was developed from participants of Inception Health to manage the work and lead, consisting of care redesign and also informatics leads, analysts from Froedtert health and wellness information technology (IT), and also Xealth designers. The Agile group reacted to these altering requirements by prolonging the technological integration to meet these needs, highlighting just how the group was able to react to altering needs instead of holding to the initial proposition [9].

Likewise, such methods can help significantly and produce a major outcome when implemented properly. A core tenet of our strategy is that for each development, health industry establishes an Agile group composed of clinicians, engineers, managers, information scientists, and user agents. While the core group consists of a very few of the employees, several people from member health care systems have participated in these Agile tasks.

By moving to Agile, teams can now work directly with individuals for layout as well as responses, IT group participants persist with initiatives instead than relocating off of jobs after initial go-live, as well as spending plans and also strategic plans are maintained as adaptable as feasible to account for the unpredictability fundamental in the process.

The values of the Agile Manifesto are fundamental to the team-based work led by a health industry. The groups do not follow authoritative techniques or established tools, although do utilize some organizational frameworks such as scrum to plan jobs. Prototypes, or minimally feasible products, are prioritized to allow early launch and also experience; commonly, these are at first carried out in a small area to enable renovations and also collect information. Documentation in the types of process, training products, or code advancement is developed as part of the natural procedure of teaming up, advertising sustainability but with the preliminary intent on communication. For several of the external partners, the teams aim for a partner relationship as opposed to being just a client. Being constructed in a means that advertises dexterity, with committed lawful support embedded within the teams, Inception Health offers a laboratory for firms to co-develop services. In these means, cooperation is focused on obtaining the most positive contract terms. Lastly, groups concentrate on vision as well as objectives, both lasting as well as brief, define key metrics and also efficiency signs, and also take part in iterative cycles of work. Teams pivot when data and also individual reports show that solutions or devices are not being used as initially conceptualized, or when the individual needs modification.

6 Does the Medical Industry Really Need Agile?

Several medical care companies have actually struggled to keep pace with an ever-changing company landscape. Thus, the search of being agile–a company's capability to adapt swiftly as well as successfully when faced with quick-change–has taken on raised importance. In numerous markets, the companies flourishing most have taken care of to split the mystery of dexterity, balancing a steady structure of core processes and capacities with the ability to dynamically redeploy those abilities to attend to arising challenges and possibilities.

Both stability and also dynamism are required to excel organizations. When obtained the balance wrong, can discover themselves either having a hard time to maintain or strained with an administration that leaves them incapable to react to altering market problems.

The principle of agility is particularly relevant to healthcare, which has actually withstood remarkable turmoil recently. The sector continues to see solid development. Financial and also regulative pressures have grown. With the greatly boosting stress on health care solutions, there is a dire demand to move toward ending up being active to effectively as well as effectively manage existing resources and services.

7 What If Agile Is Not Present in Medical Industry?

The principle of dexterity and also agility stretches back greater than a century, with organizations from the United States military to Japanese manufacturers working as evangelists. Much more lately, the software growth industry began concentrating on nimble approaches, and the principle has spread to application advancement functions within more conventional markets. In some firms, the bureaucracy had so slowed down product growth cycles that businesses were investing numerous millions on significant IT applications just to discover that developing consumer needs had actually provided the applications obsolete by the time of release. only a handful number of industries operate their development process in a purely traditional or agile manner (under 15%) [10].

An Agile growth procedure has actually made it possible for firms to function quicker and extra collaboratively to lower the moment to market for brand-new products, hence making sure that businesses respond swiftly to the altering external elements as well as client requirements. Organizations that are not nimble are typically so slow to adjust to changes they locate they must pursue a relatively disruptive organizational restructuring every 2 or three years, simply to keep up with adjustments on the market costing them a lot of funds, resources, and initiatives which are damaging to the lasting goals of the company.

Thinking about the growing pressure on the health care services, organizations need to be extra effective in supplying their services, as well as, taking into consideration the shortage of clinical personnel as well as old aged population, organizations are required to be able to utilize their complete resources properly, in fact, extra so than ever. To ensure that a company gets the maximum out of it.

8 Advantages of Agile in Medical Device Design

There are numerous distinct characteristics to executing an Active advancement procedure, making it eye-catching to clinical tool development, which includes continuous high quality, noticeable development, boosted danger administration, and also a secure and also efficient item. Allows expand upon each of these advantages and also what they mean to product growth groups.

A. **Continuous Quality**

Functioning functions are generated regularly throughout the growth cycle. Verification becomes part of Agile advancement as well as is understood via device tests, regular builds, repetitive hand-operated confirmation, and also regression screening. System combination time is also decreased because of constant, smaller combination initiatives. One of the most difficult aspects of software engineering is estimating the effort put by and employee in agile development [11].

Once constant quality has begun within a team, division, or firm, the problems are discovered usually and also soon, substantially minimizing job and product risk. This is a powerful change and also is a by-product of adopting the active advancement process.

B. **Progress Visibility**

All stakeholders–marketing, item administration, executive enrollers, high quality, governing, manufacturing, customers, etc., see substantial development as functions are shown during each sprint, promoting very early review and also comments.

Development Exposure additionally has a cultural element, too. As the item makes step-by-step progress in the direction of the ended-up product deliverable, there is a feeling of both individual and group success. With well-known active practices, such as stand-ups and normal sprint reviews (we will broaden on these methods later on in the item), each staff member is provided the floor, alongside the entire group, to share what is completed, what will certainly be accomplished very next, and what obstacles may be in the means of conclusion.

As the team makes progress toward the goal, aesthetic indications are a suggestion that the time and effort spent by everyone in their contribution to the item has a dynamic as well as living high quality. A top-quality culture that promotes incremental development is a positive change for groups that are accustomed to years-long layout stages from the fall product advancement design.

C. **Improved Risk Management**

The repetitive nature of Agile development offers consistent recognition as well as update of dangers. In Agile, the biggest uncertainty and also most essential aspects to the performance of the new product are serviced first, taking on the problem head-on. This method is incredibly powerful in a number of ways. By attacking crucial and also unclear things initially, the team can uncover if the item could be developed in a much more easy and uncomplicated method or identify if the item deserves development at all.

There is a preference in the direction of simpleness with Agile. There is clarity and also focus when a group identifies what the item will not do as well as will not include. This simplicity can pay returns later when total product cost is contrasted to the initial quote or the initial V&V stage figures out how to match cases to performance. An Agile-based approach allows an engineer in the development process to rapidly and validate every single possibility before taking a critical decision [12].

Something frequently referred to in Agile growth is the concept to “fail quick”. For example, if it is located that a critical subsystem will not function with a present collection of elements, the company can make a fact-driven choice to not continue to the following stage of manufacturing. In this situation, the firm failed quickly by recognizing vital barricades early on and can currently make a decision whether to shelve the product temporarily or buy new sources to fix the concern.

D. **Product Success**

The purpose of the research and also efforts as medical gadget specialists is to increase as well as enhance favorable person results. In order for that to be achieved, our products should satisfy client needs.

Agile reinforces and also motivates constant as well as recurring client calls at all times. When there is a close as well as continuous connection with customers, demands might alter. This brings us straight to our definition of product success. The increased presence and determination to accept those adjustments throughout the growth procedure assures the building of a successful product that satisfies individual requirements. The results of the Agile initiatives in fulfillment to the companies' expectations has come out to be fruitful [13]. Many of these results match significant benefits of Agile that the 2020 State of Agile report was identified [14].

Any kind of adjustments that occur during the course of the product's advancement is rolled into the energetic growth process, instead of a re-trek of the whole procedure that would take you back to a fresh start.

9 Challenges

The terminology used (e.g., sprints, stories, impressions, increments, release) is most likely acquainted to most software program designers yet may have little significance to a mechanical designer or human factors specialist. A direct Gantt has its disadvantages, yet a lot of developers and company stakeholders can conveniently straighten expectations in terms of what requires to be done, when by, as well as with what dependencies. There is no such equivalent in Agile, yet a feature Gantt graph that concentrates on the work (as well as out the employees) can be really valuable in broader communication concerning development and also top priorities [15].

Hardware is also not as very easy to transform as software programs late in development. As a whole, changing requirements late in growth does not function well! Traditional medical tool advancement has a demand for lockdown, which disputes with the Agile frame of mind of welcoming modification. Implementation of Agile in Indian hospitals has any implication on patient's perception and understanding of their satisfaction [16].

For companies creating innovative medical products where this may not hold true, or where it is feasible to flex range and welcome a detailed release train, then Agile development techniques could well supply benefits to organizations prepared to look beyond the conventional means of creating a medical product.

Via the Agile layout and additionally development method, all facets of professional gadget design are being functioned out–customer demands, design inputs in addition to outcomes, confirmation as well as additional validation, as well as evaluations; in addition to complete traceability and also risk decrease from starting to wind up. If done well and also thoroughly, the supreme outcome is a premier scientific device that pleases the individual's demands, regulative requirements, and additionally prepares to advance to its following lifecycle phase [4].

Agile can similarly be viewed as a reason for having in fact incorrectly taken care of product growth procedures, which plainly have to have no area in the medical item improvement globe. When developing clinical things Agile may provide clear advantages when the demands aren't plainly defined.

10 Conclusion

Utilizing an Agile development process can increase danger administration and also high-quality management with routine screening, release, and likewise assimilation; far better as well as likewise earlier exposure of verifiable progression; as well as a lot of considerably, making specific that medical device companies are introducing the perfect thing that satisfies existing consumer and likewise firm needs.

For clinical device industries considering utilizing an Agile-based technique for item style as well as likewise growth, it's important to guarantee, and it is applied to make usage of the best high-quality administration system. We at Agile Medical Device Design make use of Greenlight Guru's clinical gizmo QMS software, which improves Agile sprint processes using its interconnected multi-level design controls and also threat monitoring process.

Agile principles compose a structure that might be adapted and also used depending on the company's framework and also ideology. Beyond inner tasks, the Agile concepts could be applied to revamp the overall treatment experience. To totally comprehend the value of development and modern technology, we recognize that the redesign of the healthcare practice is paramount. This integration can be achieved by connecting the procedure of treatment redesign and also of the modern technology advancement making use of Agile technique. The Agile technique–if welcomed by healthcare organizations–will enable new Agile health and wellness methods, enable like be extra flexible as well as receptive to brand-new expertise, improve treatment procedures to supply even more worth, and also better embrace brand-new modern technologies to boost the treatment of their patients.

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Machine Learning-Based Malicious URLs Detection

Shivaraj Hublikar, Adishree Kalginkar, and N. S. V. Shet

Abstract Malicious URL's also known as harmful website which is a serious and common thread to network security. World Wide Web (WWW) (Vanhoenshoven et al. in 2016 IEEE symposium series on computational intelligence (SSCI). IEEE, 2016 [1]), which encourages a wide range of illicit actions like financial fraud, malware distribution and e-commerce. It is of vital importance to discover and act on different ventures on time. Several procedures like blacklisting have been carried out to detect malicious Uniform Resource Locators (URLs) (Catak et al. in Malicious URL detection using machine learning. IGI Global, 2021 [2]). To advance the majority of harmful Uniform Resource Locator's, different machine learning algorithms are executed in the modern years. Here, in this research paper, we are addressing malicious URLs detection as a problem of classification and also to understand the working and functioning of known machine learning classifiers, namely support vector machines (SVMs), K-nearest neighbors (KNNs), random forest (RF) and Naive Bayes (Vanhoenshoven et al. in 2016 IEEE symposium series on computational intelligence (SSCI). IEEE, 2016 [1]).

Keywords Uniform Resource Locators (URLs) · Support vector machines (SVMs) · K-nearest neighbors (KNNs) · Random forest (RF) · Naïve Bayes

1 Introduction

In modern years, the recently developed communication methods made a huge impact in widening and advancement of businesses spanning over numerous implementations [3]. Due to this, the seriousness of World Wide Web has been continuously increasing gradually. Sadly, the technological improvement comes along with

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latest techniques to strike and hustle the users. These attacks comprise of different webpages that vend fake goods, monetary cheat the users by making them to release their sensitive information which guide to theft of funds. There are many varieties of methods to execute these kinds of attacks, such as social engineering, explicit hacking attempts, denial of service, phishing, SQL injections, distributed denial of service, loss/theft of gadgets [4], drive-by download and more. Considering different type of attacks and many circumstances where these attacks can develop caused the complexity to design a system that identifies the network security contravention. Hence, various machine learning algorithms are been implemented to detect spam URLs. This paper presents the different learning algorithm's that are used to detect harmful (malicious) Uniform Resource Locator (URL).

The paper is organized as follows. Section 2 narrates about the review on current approach and synopsis of publications in the domain of detection of malicious URLs. Section 3 is a summary of various classification algorithms used for malicious URLs detection. The experiment outcome is put forth in Sect. 4. Lastly, in Sect. 5, conclusion and remarks are designated [1, 4].

2 Bibliographical Review

Today, the Internet has become an integral part of our personal as well as professional lives. With cyber threats getting more sophisticated every day, prevention is key to avoid becoming a victim of cyber-attacks. These are some of the research papers who came up with the solutions for malicious URL detection.

a. Catak et al. [2] in their paper demonstrated that utilizing of machine learning algorithms, had the capacity to get extremely high measure of accuracy. By utilizing the random forest algorithm and gradient boosting algorithm. The experimental outcome of this research paper indicates that the accuracy of the machine learning algorithm (random forest) in predicting the website as benign or malicious is 98.6%.
b. Firdausi et al. [3] analyzed harmful and safe URLs websites by gathering 250 safe and 220 harmful Uniform Resource Locator samples to teach the machine learning model such as Naive Bayes, k-nearest neighbor, J48 decision tree, support vector machine (SVM) and multi-layer perceptron (MLP) neural network on the dataset. The highest accuracy is obtained J48 decision tree algorithm with accuracy of 96.8%.
c. Vanhoenshoven et al. [1], they give an idea of detecting harmful URLs as a problem of binary classification and examine the accuracy of different machine learning algorithm's, viz. support vector machines (SVMs), k-nearest neighbors, multi-layer perceptron, decision trees, random forest and Naive Bayes. The results of this paper showed that the accuracy of random forest is 97.69% and it is the highest achieved accuracy among other algorithms.

d. Komiya et al. published a paper that aimed to detect SQL injection and XSS attacks. The machine learning models that were used in this paper are K-nearest neighbor and support vector machine (SVM). The results showed that support vector machine has a performance rate of 99.16% for SQL injection and 98.95% for XSS attacks.

3 Methodology

Figure 1 describes the block diagram of detection of harmful URL's using machine learning algorithms. The detection of harmful URL's using different learning algorithms consists of two phases: training phase and detection phase [4].

In [4] the training stage to determine harmful URLs, it is mandatory to gather both harmful URLs and safe URLs. After this the harmful URLs and safe URLs are rightly labeled and moved forward to attribute extraction. These attributes will be the finest for deciding which URLs are safe and which are harmful. Finally, this dataset is splitted into two parts: testing data used for testing process and training data used for training machine learning algorithms. Depending upon which machine learning model has highest classification performance that algorithm will be used in the detection phase. In detection phase, the recognition of harmful URL's is performed on each input URLs. First, the URLs will go through attribute extraction procedure. Next, these attributes are given as input to the classifier to sort whether the URLs are clean or malicious.

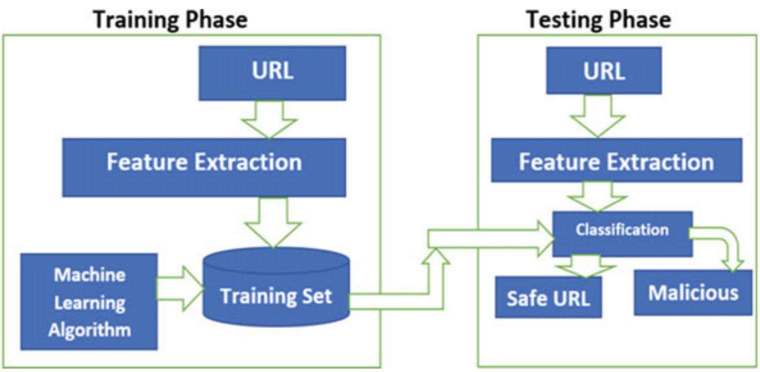


Fig. 1 Detection of malicious URLs using machine learning algorithm

4 Classification Techniques

URL is short for Uniform Resource Locator and is used to note resources on the Internet. The two main components that URL is made up of are resource name and protocol identifier. Resource name identifies the location of resource by knowing its IP address, and protocol identifier shows what type of protocol to be used. Each and every URL present on the Internet has a determined structure and format. In order to deceive users, attackers often try to change one or more components of the URL's structure. These changed URL structures are harmful URLs that adversely influence the users. These harmful URLs will redirect users to resources on which attackers can implement codes on users' computers, divert users to unwanted websites or another phishing site, or malware unload. So, to avoid this, machine learning techniques have been used to categorize URLs as clean or malicious [7, 8]. This research employs four supervised machine learning algorithms: Nave Bayesian (NB), random forest (RF), support vector machine (SVM) and K-nearest neighbors (KNNs).

4.1 Support Vector Machine (SVM)

One supervised machine learning approach that may be applied to both classification and regression problems is the support vector machine (SVM) [3]. Here, we depict each sample of data as a point in n-dimensional space. In SVM, firstly we try to identify the right hyperplane by assuming that all information's from the dataset are at least distance 1 from the hyperplane where individual data items are marked to one of two groups:

$$\mathbf{w}^{\mathbf{T}}\mathbf{x_a} + b \geq 1 \quad \text{if } y_i = 1 \tag{1}$$

and

$$\mathbf{w}^{\mathbf{T}}\mathbf{x_b} + b \leq -1 \quad \text{if } y_i = -1. \tag{2}$$

Hyperplane is drawn between two categories by using equation

$$\mathbf{w}^{\mathbf{T}}\mathbf{x} + b = 0. \tag{3}$$

Equating (1) and (2), we get $\mathbf{w}^{\mathbf{T}}(\mathbf{x_a} - \mathbf{x_b}) = 2$.
Since the separation between each sample and the hyperplane is

$$r = y\frac{\mathbf{w}^{\mathbf{T}}\mathbf{x} + b}{\|\mathbf{w}\|}$$

The margin is

$$\rho = \frac{2}{\|\mathbf{w}\|}$$

Now the support vector machine is seen as portrayal of samples as points or dots in space, with an aim of splitting each sample in different groups which are separated by a clear gap. Precisely, in an endless or high-dimensional space, support vector machine attempts to find a single hyperplane or set of hyperplanes. Later, it draws two parallel hyperplanes using Eqs. (1) and (2) which will be passing through one of the nearest points [9]. The distance between main hyperplane and parallel hyperplane is known as marginal distance. Since it can have multiple hyperplanes in *n*-dimensional space, it selects that hyperplane which has maximum marginal distance so as a good separation can be achieved. This is how SVM works in classification problems.

4.2 Random Forest (RF)

Random forest, or RF [3], is one of the well-liked machine learning methods used for supervised categorization. Random forest classifier or regressor is a bagging technique. Working of random forest is simple. Consider a dataset of '*d*' rows and '*m*' columns. Since it is a bagging technique, we have many base learner models in this algorithm. The base learner models are basically decision tree algorithm. Form the dataset, the algorithm is going to select several bootstrap samples. The magnitude of approximately two-thirds of the entire training dataset comprises the chosen data sample. Each bootstrap samples will be given to individual base learner model (decision tree). Now the decision tree algorithm will give the accuracy or prediction. The result is calculated by considering majority of all the individuals' decision tree predictions. RF algorithm works well with most of the ML technique used cases.

4.3 K-Nearest Neighbors (KNNs)

Another supervised learning algorithm is the k-nearest neighbors algorithm (KNNs) [3]. It is used to solve both regression and classification problems. In the first step, we choose the initial value for '*k*'. '*k*' value indicates that how many nearest neighbors we are going to consider in terms distance. If the value of '*k*' is small, it is sensitive to noise. '*k*' works well when value of '*k*' is large. But enormous value of '*k*' may append majority points from other class. After finding the value of '*k*', we try to find the distance between neighbor points by using Euclidean Equation, i.e., $\sqrt{\sum (X_i - Y_i)2}$. Or by using Manhattan distance formula. The mode of the selected neighbors' class values, in a classification context, serves as the output. Hence, *k*NN is called as lazy learning or a type of instance-based learning.

Table 1 Results of the test model

Algorithm's	TP rate	FP rate	ROC area	Precision	Recall	Accuracy (%)
Support vector machine	0.974	0.009	0.998	0.975	0.975	97.4935
Random forest	0.972	0.005	0.993	0.971	0.970	97.0196
Naïve Bayesian	0.848	0.037	0.979	0.866	0.850	85.0293
K-nearest neighbors	0.738	0.066	0.9208	0.758	0.729	73.5731

4.4 Naive Bayesian (NB)

Simple models that assign issue occurrences class labels, expressed as vectors of feature values, and draw the class labels from some finite sets are known as naive Bayes classifiers. For training such classifiers, there is not a single algorithm, but rather a family of algorithms built on a similar tenet: all Naive Bayes classifiers believe that given the class variable, the value of a specific feature is independent of the value of any other feature. Based on the Bayes' rule, Bayesian networks compute the posterior probability of each explanation during the inference process. The learning process must establish the model's parameters and graph structure (the conditional probability distribution at each node).

5 Datasets and Experimental Results

5.1 Datasets

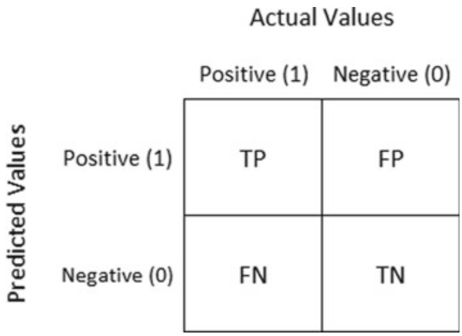
In this study, we used a freely available dataset from the UCI Machine Learning Repository, which can be found at URLs that are not used in training set. By computing the probability of correctly predicting each test set, all numbers from the experimental outcomes were obtained. The outcomes of various machine learning algorithms used to identify malicious URLs are displayed in Table 1 [1].

5.2 Results and Discussion

5.2.1 Confusion Matrix

A matrix with N rows and N columns [$N \times N$] is known as a confusion matrix used for estimation of performance of a different machine learning algorithms in classification problem, and the number N denotes the quantity of target classes [1] (Fig. 2).

Fig. 2 Confusion matrix



To determine the performance and accuracy of different machine learning models, we use seven different metrics which are listed below.

5.2.2 TP Rate

The likelihood that genuine positive data samples will result in a positive test result is known as the true positive rate (TPR).

$$\mathrm{TPR} = \mathrm{TP}/\mathrm{TP} + \mathrm{FN}.$$

5.2.3 FP Rate

The ratio of the number of negative events that were actually negative but were mistakenly classified as positive is known as the false positive rate, or FPR.

$$\mathrm{FPR} = \mathrm{FP}/\mathrm{FP} + \mathrm{TN}.$$

5.2.4 ROC Area

The receiver operating characteristic curve (ROC curve) is a graph that displays how well a classification model performs across all categorization levels:

- True positive rate
- False positive rate

5.2.5 Precision

The ratio of accurately forecasted positive sightings to total expected positive sightings is known as precision [4]

$$\text{Precision} = \text{TP}/(\text{TP} + \text{FP}).$$

5.2.6 Recall

Recall is a metric for determining how much of a positive class prediction was produced using all of the data's positive cases [4]

$$\text{Recall} = \text{TP}/(\text{TP} + \text{FN}).$$

5.2.7 Accuracy

Based on the input or training data, accuracy is the metric used to discover which model (algorithm) is best at finding correlations and patterns between variables in a dataset [4]

$$\text{Accuracy} = (\text{TP} + \text{TN})/\text{Total}$$

5.3 Results of the Test Models

See Table 1.

6 Conclusion

With the development in system and computer technologies, users exchange information or data over the Internet for service purpose. Now with the increase in number of applications over the Internet caused the end user to become the main target for the attackers. Nowadays, the increase in formation of new harmful webpages has reached its peak. Only by viewing these hazardous URLs can users who are ignorant of anything become victims. Many studies have been made in order to control the growth of harmful websites and to create a model which can be used for identification of these websites. Different machine learning algorithms have given the best result in detecting malicious URLs. In this study, we evaluated the effectiveness of various learning methods that might be applied to malware detection. We have used four machine learning algorithms for malicious URL detection, and they are (1) support vector machine (SVM), (2) random forest, (3) Naïve Bayesian and (4) K-nearest neighbors. The results of this research are shown in Table 1 which demonstrate that the support vector machine (machine learning model) performance in analyzing the vast dataset and classifying a website as safe or hazardous is rather excellent (97.4935%). The prediction accuracy of random forest technique is also good with 97.0196% [1].

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Workload Prediction for Resource Scaling and Migration in the Cloud

K. Lalitha Devi, K. Deepa Thilak, K. Kalaiselvi, and K. Arthi

Abstract The resources in cloud computing are provisioned to fulfill the application's computational requirements. The load balancer in a cloud data center assigns resources to virtual machines. However, the fault occurs when the server is under heavy load. As a result, resources must be adjusted. In this study, we are combining the support vector regression technique (SVRT) prediction model with resource scaling and migration. SVRT is used to predict future utilization of multi-attribute resources of a host. The approach is ideal for coping with nonlinear cloud resource workloads. After scaling the resources as required by the expected workload, the migration is in use to attain load balancing in the VMS. This paradigm for cloud computing infrastructures aims to improve system usage, lower costs and power consumption, and meet service level agreements (SLAs). We have evaluated the applicability of this framework using Google Cloud Trace.

Keywords Cloud computing · Workload prediction · Resource scaling · Migration

1 Introduction

Cloud computing is a type of distributed computing that makes computing resources available to everyone. Data storage (cloud storage), and processing power to computers. In an on-demand, pay-as-you-go approach, it can be done without the user's direct active administration. Real-world applications do not have a consistent workload; for example, Internet traffic varies dramatically between day and night. In

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many circumstances, the workload is even bursty, meaning that it increases dramatically in a short period of time. Another reason could be a product launch or a global event in social networking platforms, which makes even forecasting the worst-case scenario difficult.

In large-scale data centers, the workload fluctuates dynamically over time in each node, resulting in workload imbalance. As a result, the burden in some machines may exceed the threshold, which further fails to meet QoS requirements [1], but also wastes resources. Scalability refers to an IT resource's capacity to handle increasing or decreasing demands in a competent manner. One of the most popular and advantageous aspects of cloud computing is the ability to scale up or down to suit organizational demands based on season, projects, growth, and other factors. Cloud scalability allows resources to grow in parallel with traffic or organizational growth, and vice versa [2].

The best solution for this problem is to give resources in a timely manner based on the application's actual demands by precisely forecasting the VM's future resource usage. This reduces the demand for more PMs although simultaneously enhancing their resource consumption. In recent years, machine learning (ML) methods have become increasingly prominent in this field. Their capacity to identify complicated patterns in data makes them more suitable for forecasting. The goal of this project is to create a resource management that can scale and transfer resources in response to workload forecasts. When the requests are really large, VM migration is likely to be employed to achieve load balance.

We present a resource provisioning system that may be used in any virtualized data center that provides infrastructure as a service to maximize cloud profits (IaaS). The significant contribution of the paper is as follows:

1. To use CloudSim to create a cloud environment.
2. Using historical data and the current period or trend, train a model to estimate workload.
3. Make a forecast of future workload using SVRT model.
4. To vertically scale resources based on predictions for various trends and time periods.
5. If vertical scaling is not achievable, transfer the virtual machine to another physical machine.

2 Related Work

Guo, J et al. [3] given NUP, a hybrid prediction method that dynamically judges workload categories and self-adaptively switches prediction algorithms based on workload type. NUP employs linear regression and period similarities. NUP adopts linear regression combined with ARMA to predict the trend and SVR for the period Abdullah Let al. [4] suggested a cloud computing environment in which resource waste is eliminated by resource utilization optimization in cloud data centers. It forecasts future utilization of multi-attribute host resources using the support vector regression technique (SVRT). Qing chen Zhang et al. [5] stated that efficiently training a deep learning model is a difficult issue since deep learning models frequently include a large number of parameters. To estimate cloud workload, an effective deep learning model based on canonical polyadic decomposition is proposed. [6–8] to accurately predict the virtual machine's future workload, the suggested solution aggregates the volume and timing of historical task requests over a predetermined period of time. NICBLE was proposed by Hong-Wei Li et al. [9] to provide precise CPU resource provisioning for application workloads operating on virtual machines. NICBLE can be used to determine whether increasing the number of CPUs has a substantial impact on application performance.

To reduce workload imbalance, Liang Shao et al. [10–12] developed the idea of virtual machine migration. It is carried out in two stages. It is decided which virtual machine will be moved in the first step. The goal is to provide excellent customer service, maximize resource usage, and reduce relocation costs. The virtual machine that needs to be relocated is decided in the second phase. According to Wathit Chaloemwat et al. [2], virtualization technology is the foundation for cloud services. The cloud service provider creates a virtual machine and allots the necessary resources, like CPU and RAM, to the user when the user demands computing resources.

Chen and Wang [13] proposed EEMD-RT-ARIMA, a hybrid technique based on ensemble empirical mode decomposition for short-term host utilization prediction. EEMD, RT, and AIM (ARIMA). Status monitoring, planning, decision-making, fault prediction, detection, and root cause analysis for recovery activities are important components of autonomous computing [2] which increase system dependability, availability, and utilization by scaling resources in response to changes in cloud system state. In recent study, the authors [14] present a linear numeral program approach that considers energy (LNP). Following the termination of the overhaul, it promises to steadily increase energy efficiency and is based on virtual machine migration. This work will provide a novel method for minimizing the total number of migrations by using machine learning (ML) to accurately choose the virtual machines that should be moved. Because of the excessive use of PMs, it also results in a decrease in energy consumption.

3 System Architecture

The cloud scaling and migration architecture based on the future workload is depicted in Fig. 1. There are three parts to the architecture: The first component is to set up a cloud environment in CloudSim, and the second is to develop an SVRT prediction model for projecting future cloud workload, from which we can derive future cloud resource requirements. The third component is the cloud scaling/migration mechanism, which may scale the required resources based on the expected workload and then migrate virtual machines as needed to achieve load balance.

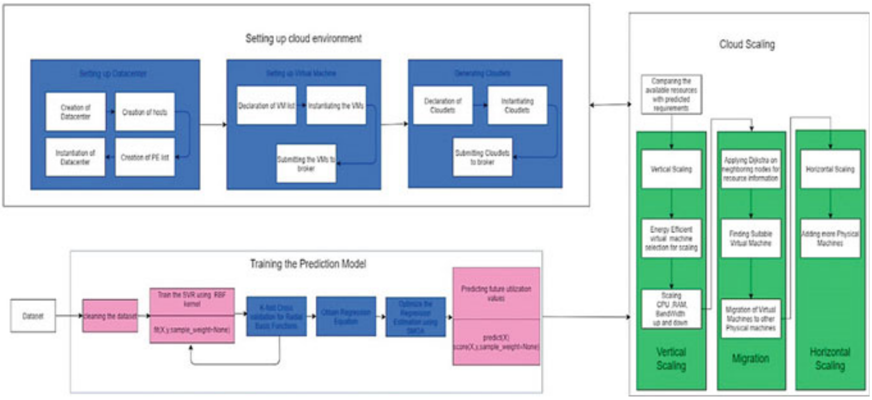

Fig. 1 Cloud scaling and migration system

3.1 Creation of Cloud Environment Using CloudSim

Data center is created with required number of host and virtual machines. Creation VM list is explained in Sect. 4.1.1.

3.2 SVRT Prediction Model

Algorithm 1: CPU usage prediction using SVRT
Input: CPU usage, Memory usage, Disk usage
Output: Predicted CPU Usage
1. Split the input and division point
2. Train the SVR using rbfKernel class
3. Fit the SVM model to the training data provided
4. While(i < n)
SVR (kernel = 'rbf')
regressor.fit (CPU usage, Memory usage)
regressor.predict(CPU usage)
End while
5. Predict the CPU usage value for the multi-attribute data

The process for forecasting future CPU needs based on historical CPU, memory, and disk utilization is described in Algorithm 1. Linear, poly, rbf, sigmoid, pre-computed, or callable are the possible kernel types. If none is given, the "rbf" is utilized. The kernel matrix is pre-computed using a callable. Adapt the SVM model to the given training data. The number of features is n features, whereas there are n samples. When kernel="pre-computed" is used, X should have the shape (n samples, n samples). Objective standards (class labels in classification, real numbers in regression). weights for each sample Rescale C for each sample. The classifier is compelled to give these points more weight by higher weights. Regression analysis with samples in X for a one-class model, it returns either +1 (inlier) or -1 (outlier). Give the R2 determination coefficient for the forecast. A pre-calculated kernel matrix or a list of generic objects with the shape (n samples, n samples fitted), where n samples fitted is the number of samples used to fit X's real values, could serve as samples for testing.

3.3 Cloud Scaling and Migration

Scaling mechanism, as known as elasticity, enables the dynamic addition or removal of computing resources such as virtual machines in the cloud system.

3.3.1 Vertical Scaling and Horizontal Scaling:

Vertical scaling is used when the computing resources are available in the same physical machine (PM). This can be achieved by increasing (scaling up) or decreasing (scaling down) the computing resources allocated to respective VMs. Horizontal scaling is used when all physical machines are overloaded. In horizontal scaling, additional physical machines will be added to the datacenter.

Algorithm

Using the output of the prediction module and the current available resource is known; thus, correspondingly, scaling, the CPU, memory resources are increased or decreased in order to maintain QoS as well as reduce wastage of resources. If no physical machines can be scaled further, then more physical machines are added.

3.3.2 Migration

Migration is the process of moving tasks from an overloaded PM to another PM. This is used for improving the utilization of resources and to avoid resource wastage.

Algorithm

The implementation is heavily reliant on the Dijkstra shortest path algorithm. When there are insufficient resources in a virtual machine to execute a cloudlet request, each data center maintains a neighbor virtual machine table. When a request arrives at a cloud data center, the data center verifies its neighbors and sends the request information to the neighbor. A confirmation is sent if any neighbor has a configuration related to the request. If two or more responses arrive, the data center takes the shortest path. When a neighbor does not have enough space, it sends a message to another neighbor with information about the request. If space is available, it responds true; otherwise, it recursively forward to its neighbor. If a neighbor receives identical packets from another neighbor, it seeks the shortest path.

4 Experimental Analysis

4.1 Experimental Environment Setup

4.1.1 Create Virtual Machine and Allocation of CPU and Memory in CloudSim Tool

a. **Declaration of VM list**

Declared with a private access modifier, Vmlist is a list data structure of type "VM" class, (i.e.,) it will store objects of VM class. **Private static List < Vm > vmlist;**

b. **Instantiating the Virtual Machine**

Create required virtual machines, these will be created with some specific characteristics and are passed to constructor of Vm class. The constructor invocation will be done by passing parameters:

{int vmid = 0;intmips = 1000;long size = 10,000;int ram = 512;long bw = 1000;

int pesNumber = 1;String vmm = "Xen";

Vmvm = new Vm(vmid, brokerId, mips, pesNumber, ram, bw, size, vmm,newCloudletSchedulerTimeShared());

vmlist.add(vm);}

c. **Submitting virtual machines to the broker**

Create broker and get its unique ID in the simulation system (act as identifier for broker).

Now submit list of virtual machines to broker, so that virtual machines can be hosted on the hosts of datacenter(s) as specified by utilization (execution) model.

DatacenterBroker broker = createBroker();

int brokerId = broker.getId();

broker.submitVmList(vmlist);

4.2 Dataset

We consider CPU utilization, memory usage, disk IO, and network bandwidth for predicting the workload. Dataset [14] is taken from Google Cloud Platform in task_usage where 5th and 6th column is the CPU utilization and memory utilization, respectively. 80% will be taken for training, and 20% will be taken for testing.

4.3 Prediction Model

The prediction model designed using Python libraries in jupyter. From the task usage data of Google cluster data: Disk usage, maximum memory usage and maximum CPU rate, and sampled CPU usage are the features considered to predict the future workload. The predict function predicts the CPU usage value for the multi-attribute data.

4.3.1 Metrics for Evaluation

The prediction model is evaluated using the metrics listed below.

$$\text{Mean Average Precision error(MAPE} = \frac{1}{N} * \sum \left(\frac{\widehat{Y}\text{i} - \text{Yi}}{\text{Yi}} \right)^2$$

$$\text{Mean Absolute error(MAE)} = \frac{1}{N} * \sum \left(\widehat{Y}\text{i} - \widetilde{Y}\text{i} \right)^2$$

$$\text{Mean Squared error(MSE)} = \frac{1}{N} * \sum \left(\widehat{Y}\text{i} - \text{Yi})^2 \right)$$

$$R^2 = 1\text{-}\sum \frac{\left(\text{Yi} - \widehat{Y} \right)^2}{(\text{Yi} - \overline{Y})^2}$$

Figures 2, 3, 4, and 5 show the training accuracy of the predicted model over the different split of training data. SVRT will have better accuracy than LRT in both single step and multi-step. SVRT has the highest accuracy than all performance metrics. SVRT method improves prediction accuracy percentage and also reduces the error percentage. Thus, SVRT is used in this model.

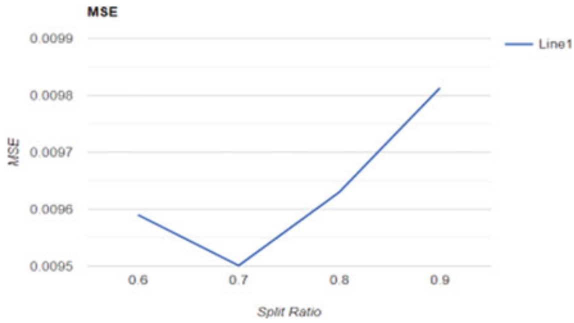

Fig. 2 Mean squared error

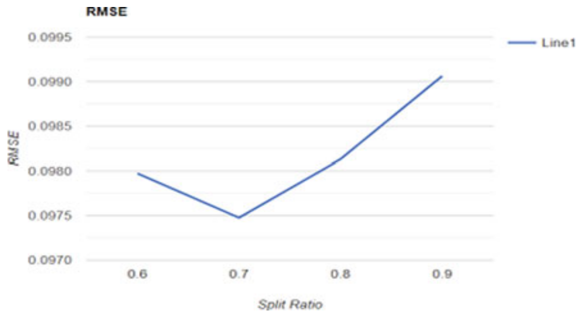

Fig. 3 Root mean squared error

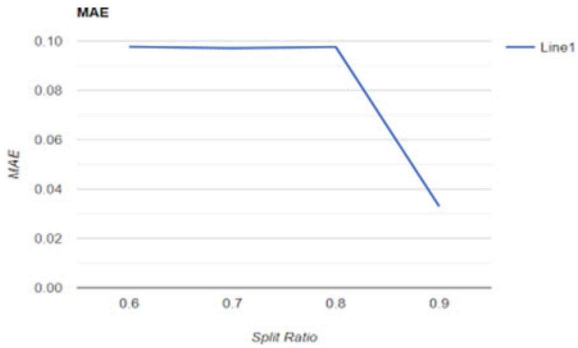

Fig. 4 Mean absolute error

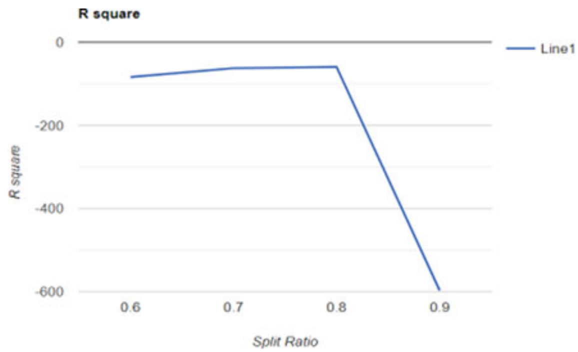

Fig. 5 R square coefficient

4.4 Cloud Scaling and Migration

The use of VM resources such as RAM, CPU, and BW is taken into account when horizontal scaling VMs. Because each Cloudlet has its own UtilizationModel for each of these resources, the total VM usage of a given resource may be calculated by adding the usage of all presently running Cloudlets.

Threshold Value: In order to scale in or out, the horizontal auto-scaling mechanism requires a threshold value to identify overused and underused VMs. Lower utilization threshold is the lowest utilization value (between 0 and 1) below which a virtual machine is considered underutilized. The upper utilization threshold is the value above which a virtual machine is considered overloaded. The upper utilization threshold is used by the load balancer inside the broker to determine when a new VM must be launched in order to balance the arriving Cloudlets among these VMs. It also uses the lower utilization criterion to determine when a VM should be destroyed. In this technique, a VM no longer has Cloudlets and will be destroyed once all VMs of the same broker have completed.

4.5 Time Complexity

Using an adjacency list representation of the graph and a min-heap to store the unvisited vertices, the time complexity of Dijkstra's algorithm can be decreased to O((V + E)logV), where V is the number of vertices and E is the number of edges in the graph. With this approach, the time to process all of a vertex's neighbors is O, and the time to visit each vertex is O(V + E) (logV). Time for visiting all vertices = O(V + E) and time needed for processing one of the vertex = O(logV). So, time necessary for visiting and processing all of the vertices is O(V + E)*O(logV) which is equal to O((V + E) logV).

5 Conclusion

The accuracy of the forecast is determined by the training data provided to the model. The resource utilization in real-time cloud computing systems cannot be reliably anticipated if the training data do not match the actual trend. As a result, this can be turned into a real-time system in the future by using current usage trends to train the model. This improves the accuracy of the prediction and benefits the cloud service provider by ensuring market compatibility at all times.

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Material Performance Evaluation of Waste PET Fibers as a Concrete Constitute

Nirav M. Patel, M. N. Patel, and Prithvi M. Lilawala

Abstract Environmental conditions have deteriorated in recent decades with increasing human intervention. Plastic is the most commonly used manufacturing material due to its low manufacturing cost, availability, durability, and long life. It also has one of the lowest degradation rates for plastics. Due to this property, removing plastics from the environment can be a very difficult task. Environmental protection is calling on communities to reuse plastic waste. Such reuse occurs in the construction of buildings. This paper presents strong performance test values for concrete modified with in addition to waste plastic fibers. Waste bottles made up of polypropylene terephthalate (PET) were used in the research work. Flexural and compressive strength were obtained to identify the viability of PET fibers as concrete components. A total of 14 batches of concrete were cast in classes M40 and M25. Waste PET fibers were added to the concrete in alternating proportions starting at 0–1.5% and in incremental intervals of 0.25 volume mix. A critical goal is to determine the amount of PET incorporated into concrete. Consistent with the results, the strength behavior of M40 and M25 concrete mixtures is somewhat similar.

Keywords Waste plastic concrete · Strength performance · Plastic waste fibers · Green concrete · Durable concrete

1 Introduction

Plastic word has been accomplished by "plastikos," which means "ability to mold or shape" [1]. Presently, the usage of plastic is quite large and used all over the world. In June 1951, E. I. DuPont de Nemours used the trademark "Mylar" for the first

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time, and it was registered in 1952 [2]. Light in weight with low density, and also has good strength, longer life of span, easy fabrication abilities, and mainly lower production cost. Due to these considerable privileges, plastic has become an essential and indivisible part of regular human tasks [3]. After meeting service requirements, the plastic packaging materials are abandoned as waste and will not biodegrade for decades. Recycling plastic waste is one possible alternative to reduce environmental hazards, but recycling is energy and manpower intensive.

Currently, the Indian construction industry consumes about 328 million tons of cement per year and is expected to reach almost 550 million tons per year by end of 2022 [4]. Concrete is created by using natural substances and recreates natural materials beyond human control. Currently, it is important to use various non-natural resource alternatives in combination with conventional materials in order to minimize the large and rapid utilization of natural resources. A new idea was born to work around the problem. It is provided by using established natural resources as well as the results or by-products of numerous industrial wastes. Different wastes have already been added and tested for different research and effects of different aspects of concrete properties [5].

Concrete has specific limitations regarding microcracking and imperfections that prevent water and chemical penetration. When these microcracks in concrete start to propagate, they lead to impact strength and stress on the concrete due to chemical attacks. Direct use of plastic waste to meet the needs of the concrete industry is a novel approach [6]. The most common material found in PET bottles and similar packaging is polyethylene terephthalate (PET). In general, he recommends the use and disposal of PET materials, as recycling can have a negative impact on consumer health [4].

This is an important way to contribute to the 3R tactics, especially the global call to reduce, recycle, and reuse hazardous and non-degradable waste plastic. An application of used waste plastic to the concrete has highlighted an opportunity to develop new sustainable concrete as a safe alternative to plastic waste disposal. Plastic developers containing different resins exhibit different properties, reactions, and properties when applied to the concrete. However, research is influenced by the application of a specific type of plastic waste, mainly polyethylene terephthalate (PET) waste carry bags and bottles [7–18]. The use of fibrous and stripped PET waste bottles in concrete affects the fresh and hardened characteristics of conventional concrete, with different sizes of the fraction's inclusion [19, 20]. As a result, there was a need to thoroughly study the use of PET to examine specific responses, behaviors, and effects on responses.

1.1 Research Study

Inoculate polyethylene terephthalate (PET) fibers as binding elements in concrete to improve their tensile and compressive strength [21]. Increasing compressive and tensile strength reduces the development of macro-shrinkage cracks that eventually lead to significant cracking. A high percentage of fibers revamps concrete performance but is not recommended as it reduces concrete workability. This is mainly due to the fiber's smoothness and reduced adhesion between concrete ingredients. The rate of degradation of PET is significantly lower compared to that of reinforced concrete. The proposed method improves the resilience of concrete components by incorporating the concept of sustainability [22].

1.2 Investigation Relevance

The results of this investigation studies represented in this article are an attempt made to solve the following statements regarding new applications for the entrapment of PET scrape fibers in concrete;

- An ideal proportion of PET fibers should be included in the concrete.
- Varying strength changes due to the addition of PET to concrete.
- Adding PET to concrete can change its strength.

The question was answered by examining the compressive strength, splitting tensile strength, and flexural strengths of concrete containing PET fibers.

2 Ingredients and Their Mixing Ratio

2.1 PET Plastic Waste Fiber

PET was cut into fibers from used soda and water bottles using a crusher, as shown in Fig. 1. The investigation was performed with a fixed fiber length of 20 mm and width of 2.5 mm. The test properties and general description of PET are shown in Table 1. The waste fibers were added to the concrete at various ratios ranging from 0 to 1.5% at regular intervals of 0.25 in the mixing volume.

2.2 Samples and Mix Ratio

A total of 14 concrete batches (7 batches in all) were produced from class M25 and M40 concrete, with water-cement ratios of 0.50 and 0.42, respectively. The respective mixing ratios are shown in Table 2. For each and every batch, three specimens were created to evaluate the mean value of compression, flexure, tensile, and density values of the blends. A total of 126 test patterns, 42 cubes, 42 cylinders, and 42 beams, were prepared. The concrete mix batching details are shown in Table 3.

Fig. 1 Waste PET fibers

Table 1 General descriptions/test properties of PET

Sr. No.	Descriptions/properties	Remark
1	Name	Polyethylene terephthalate
2	Resin type	Polyester
3	Recycling code	1
4	Density	1.37 g/cm^3
5	Tensile strength (tested)	137.3 N/mm^2
6	Elongation (tested)	64%
7	Thickness	0.0625 mm
8	Aspect ratio	320

Table 2 The concrete mixing ratio of 1 m^3 volume

Mix	Cement (kg)	C.A. (kg)	F.A. (kg)	Water (L)	W/C ratio
M25	375	1180.6	699.8	186	0.50
M40	445	1142.8	677.5	186	0.42

3 Experimental Program and Tests

The tests were carried out on hardened concrete to obtain values for compressive strength, flexural strength, and splitting tensile strength for the above samples and mix ratios. The test outcomes were obtained as the average of the 3 test scores for all the test categories.

Table 3 Batch allocation of concrete mix

Mix batch	PET (%)	PET (kg/m^3)	PET size ($W \times L \times T$)
M25-S	0.00	–	(20 mm × 2.5 mm × 0.0625 mm)
M25-P-0.25	0.25	3.43	
M25-P-0.50	0.50	6.85	
M25-P-0.75	0.75	10.28	
M25-P-1.00	1.00	13.70	
M25-P-1.25	1.25	17.13	
M25-P-1.50	1.50	20.55	
M40-S	0.00	–	
M40-P-0.25	0.25	3.43	
M40-P-0.50	0.50	6.85	
M40-P-0.75	0.75	10.28	
M40-P-1.00	1.00	13.70	
M40-P-1.25	1.25	17.13	
M40-P-1.50	1.50	20.55	

3.1 Compressive Strength

Cubic samples were tested for axial compression on a Compression Testing Machine with a load capacity of 1500 kN and the rate of the loading was kept constant at 15 N/cm^2/min until the specimen reached final failure. The faces of the specimens were gently trimmed and loaded to match the appropriate faces and flattened. Prior to conducting the test, the mass of each sample was measured on a weighing machine for density determination. The compressive strength of the cube was calculated as the strength value, the breaking load divided by the surface area of the cube (150 mm × 150 mm). Figure 2 shows the compressive strength test equipment.

Fig. 2 Compressive strength testing apparatus

Fig. 3 Flexural strength testing apparatus

3.2 Flexural Strength

A 150 mm × 150 mm × 700 mm concrete beam was poured and a three-point loading system was applied. The bending response of the specimens with a point load at the midspan was acquired by computing the bending strength as the modulus of rupture and measuring the deflection at the appropriate value of the load. The outcomes were presented as load versus deflection curves and modulus of rupture. At a continuous load factor for bending, the deflection to the ultimate failure of the test sample was calculated. The fracture of the specimen was mainly abrupt due to the flex crack that occurred in the middle of the span under the concentrated load. Due to the PET fibers, there was no noticeable change in the failure pattern of either component. Figure 3 shows the flexural strength test equipment.

3.3 Splitting Tensile Strength

Tensile strength is used to measure the indirect tensile strength of concrete. Cylinder specimens (300 mm high × 150 mm diameter) were compressed by him on a Compressive Testing Machine with a load capacity of 1500 kN to measure the tensile strength of concrete specimens. The experiment is responsive to contact points between the sample surface and the loading plate. A square steel plate was used to confirm a good consistent load implementation throughout the complete height of the sample. The top and circumference of the cylinder were recorded before being placed on the test apparatus for testing to distinguish the axial crack pattern. Figure 4 shows the split tensile strength tester.

Fig. 4 Test apparatus of splitting tensile

4 Test Results and Its Discussions

4.1 Compressive Strength

Figures 5 and 6 show the results of the compressive strength test. As the percentage of PET expands, the compressive strength of fiber concrete increases up to a fiber dosage of 1% PET fiber content based on the volume of the mixture. Experimental values show that the extension of small amounts of PET fibers remarkably changes the compressive strength of concrete mixes.

Experimental investigations have shown that the compressive strength of fiber concrete continues to increase, reaching optimum values of up to 1% and 0.75% for M25 and M40, respectively, compared to the base concrete mix. We can also see a slight increase in strength values compared to the base compound at 1.25 and 1% for M25 and M40. However, a decline in compressive strength values was detected.

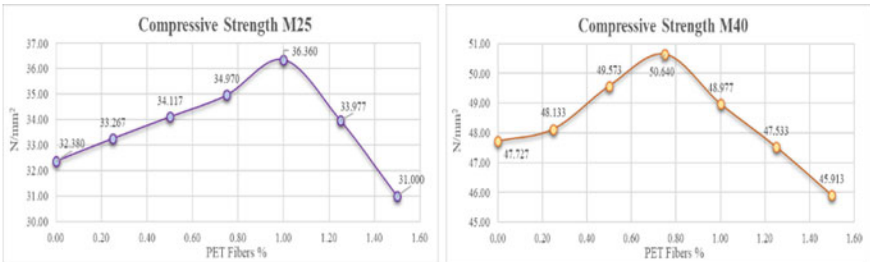

Fig. 5 Correlation between compressive strength and dispersion of PET scrapes

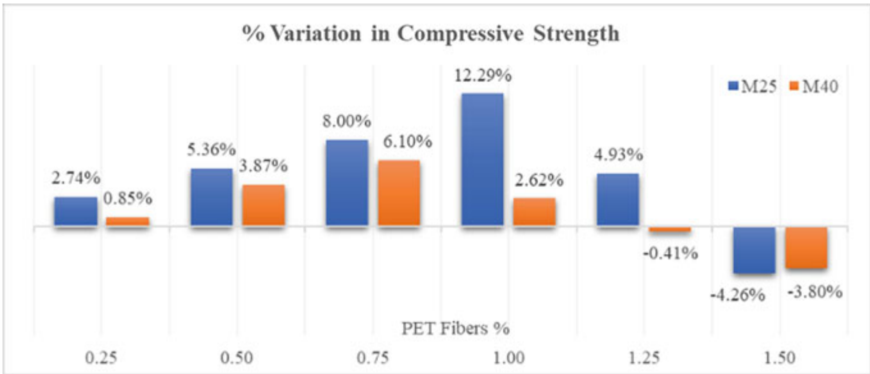

Fig. 6 Variation in compressive strength of different PET fibers

Adding more PET fiber amount increased the rate of compressive strength loss, also showing lower strength in both mixtures than in conventional concrete samples.

The M25 concrete mix showed an ultimate strength reaching up to 12.29% at 1% fiber content and the M40 concrete showed a strength that can be maximized up to 6.10% at 0.75% fiber. Compressive strength increased in the range of 2–12% and 0.5–6% for M25 and M40, respectively.

The first crack was first observed in the upper-stress plate and grew into a progressively wider crack toward the base. During the experiment, we carefully observed the error pattern of the test samples. Fracture cracking investigations are one of the main factors in determining the impact of PET fibers on the evaluation of crack resistance phenomena, changing the behavior of concrete mixtures from brittle to ductile.

The crack pattern that developed in the test samples during testing reflected the presence of PET fibers. For a given blend, the first break of test samples was mostly consistent. Larger cracks propagated parallel to the application of the load. However, compared with conventional concrete, the fracture behavior was less brittle. The crack pattern also showed that the final fracture of the test pattern with PET fibers was less open, with some medium and microcracks also occurring. This demonstrates ductile failure of concrete mixes comprising PET fibers.

4.2 *Flexural Strength*

The results of the bending strength test are given in Figs. 7 and 8. PET had a significant influence on the flexural strength of the concrete as well as the compressive strength. With increasing PET fiber percentage, the flexural strength of PET concrete increases slightly up to 1.5% of the fiber content. The average increase in flexural strength was 7% compared to conventional concrete.

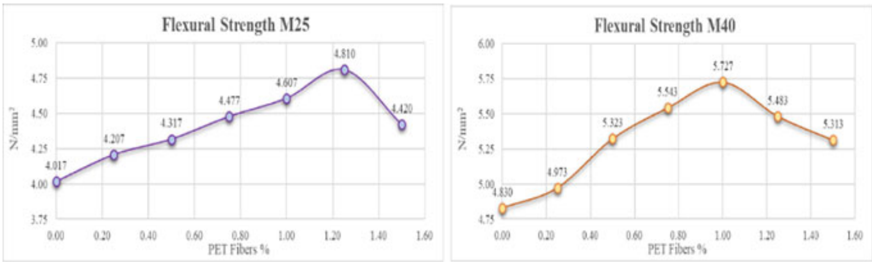

Fig. 7 Correlation between flexural strength and dispersion of PET fibers

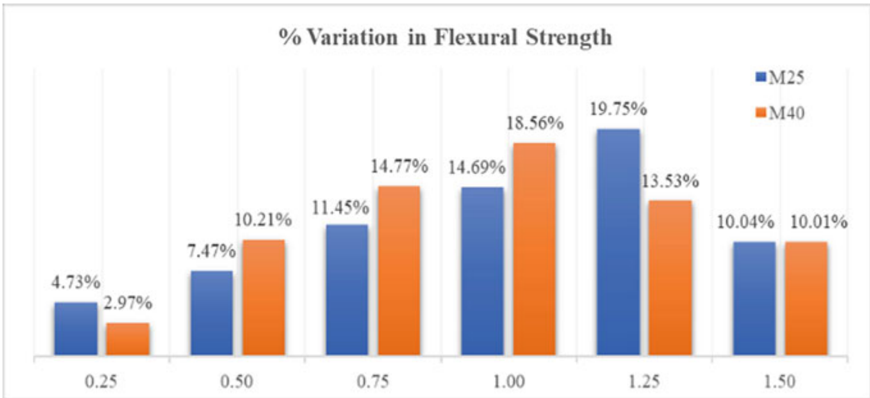

Fig. 8 Variation in flexural strength of different PET fibers

This result indicates that the flexural strength is highly dependent on the grade of the concrete mix. However, bending deformation was greatly enhanced by the addition of PET to concrete. Test results indicated that the flexural strength of fiber concrete continued to increase, reaching a maximum of 1.25% and 1% for M25 and M40, respectively, in contrast to the conventional concrete mix.

The M25 concrete mix showed a maximum strength increase of 19.75% at 1.25% fiber content and the M40 concrete mix showed a maximum strength increase of 18.56% at 1% fiber. Flexural strength increased in the range of 4.5–20% and 2.5–18.5% for M25 and M40, respectively.

Test results showed that the observed deflection was higher at a constant load rate due to the improved PET fraction. Concrete incorporated with PET fibers indicates a steady growth in deformation capacity with compare to the applied load. Initially, loading capacity is not suffered by the plastic fibers, but after the ultimate load to a deflection amount is reached, it is determined by the existence of plastic fibers in the concrete. PET has the ability to absorb the stresses that occur in beam test specimens at the time of bending deformation, and also help extend the specimen's deformation for a given load.

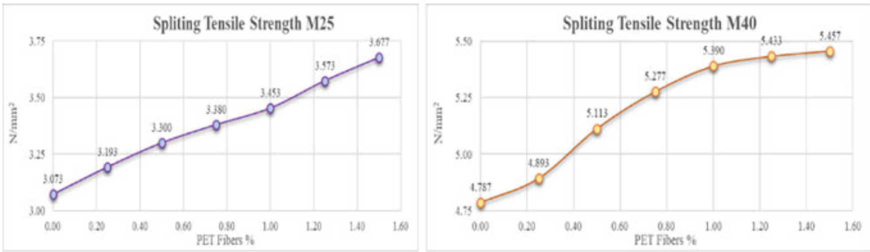

Fig. 9 Correlation between tensile strength and variations in PET fibers

The insertion of PET fibers was confirmed to improve the ductility of the concrete mix. The test specimen exhibited relatively good ductility behavior due to the presence of PET scraps. As the content of PET wastes increases, the deformation of the specimen increases and exhibits greater resistance to the tensile forces that occur in the beam specimen during bending testing. The presence of long fibers in the concrete mix improves cracking resistance due to the excellent adhesion of the fibers. Excellent adhesion also increased the ductility of concrete.

4.3 Splitting Tensile Strength

The inclusion of PET scrapes increased the splitting tensile strength by up to 1.5%. Indirect tensile strength was remarkably influenced by the incorporation of PET fibers. Plastic fibers are more resistant to cracking by minimizing the occurrence of microcracks. When long fibers were present, the concrete mix manifested preferable crack resistance due to the greater adhesion of the fibers.

Figures 9 and 10 show the performance of the tensile strength test. It might be seen that the resistance to rupture of the specimens increases with increasing PET content. The split tensile strength increased to 19.63% and 14% for M25 and M40, respectively.

5 Conclusion

Plastic, regardless of shape or type, is very tough task to get rid of it. Recycling of plastic scrape has not achieved sufficient treatment rates. Therefore, some advanced methods of using plastic waste have become highly recommended.

This study explored the idea of developing sustainable concrete by adding post-consumer PET as one of the materials. This has the dual benefit of minimizing the energy demands of concrete production and potentially serving as a waste management alternative.

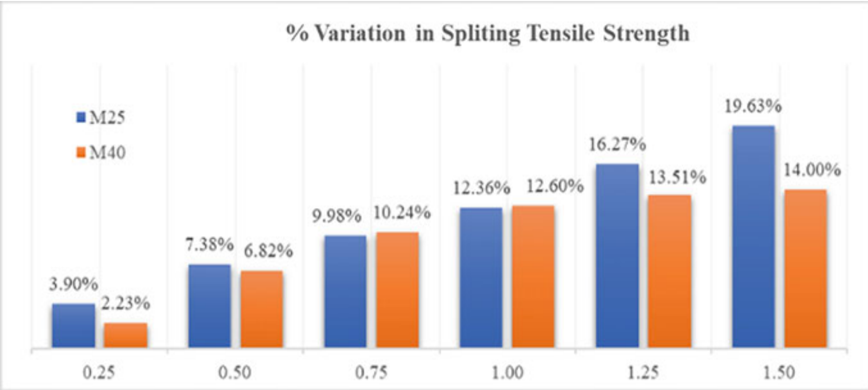

Fig. 10 Variation of split tensile strength with different PET fibers

The main objective was to find the amount of PET that should be included in the concrete mix. This study shows that the strength behavior of M25 and M40 concrete mixtures is somewhat similar. The following are conclusions based on the survey values;

- The use of PET resulted in some improvements in compressive strength, flexural strength, and cleavage strength, as well as improved ductility after peak stress at large elongations at a break in contract to the referred concrete.
- The insertion of PET wastes improved the crack resistance of concrete. The existence of PET substances increased the occurrence or generation of microcracks in the concrete and increased the ductility of the cement paste relative to the brittleness of the material. PET fibers help minimize cracking by properly holding the concrete material.
- Using PET fibers in concrete had no direct impact on strength.
- Using PET fibers till 1.5% increased the tensile strength, whereas adding PET fibers from 1% of concrete slightly decreased the compressive and flexural strengths.
- Concrete containing 1% PET was shown to be the best containment of PET waste, as shown by various experimental results.
- For concrete mix M25, the optimal outcomes for compressive strength, flexural strength, and split tensile strength are 12.19%, 19.95%, and 19.63%, respectively. Similarly, for concrete mix M40, the optimal values for the same are 6.10%, 18.56%, and 14.0%, respectively.
- As the proportion of plastic fiber waste expands, the density of the concrete mix decreases, making the structure more sustainable, lighter, and more durable.
- A study conducted to procure the answers of concrete incorporating PET waste fibers revealed the application of scrape plastic bottle fibers as a key component of a reliable process.

- Concrete with PET fibers have excellent chemical and water resistance, making it suitable for chemical hazard areas and near bodies of water.
- In fact, compared to conventional concrete, the heat of hydration generated is minimized, thus reducing the temperature rise of the concrete. This is the decisive advantage of PET concrete.
- Experimental results demonstrate the effectiveness of developing green concrete with PET in concrete, and the survey can provide a database of plastic waste in concrete available in each region.

Future trends concerning the use of PET scrape fibers in concrete are even more promising in non-concrete, construction-oriented uses that may also be suitable as a building material. Reinforced concrete should be checked to obtain the structural response of slabs, beams, and columns with different proportions of PET fibers in relation to the primary structural action.

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Predicting the Stock Market Prices Using Ensemble and Fbprophet Model

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Abstract Stock price prediction through machine learning is an emerging area of research. In the emerging economy, stock investment is useful for individuals and institutions for stabilising their income on investments. Many fund houses hire professionals to analyse the stocks. The machine learning models are more useful and effective than any other traditional techniques. However, many researchers have done price prediction based on various ML algorithms and techniques such as classification and regression. In this proposed work, we were comparing two main types of stock market analysis methods, technical analysis and fundamental analysis. For technical analysis, ensemble classification was used. More care has been taken on choosing the classifier to get more accuracy of prediction. ML algorithm decision tree, KNN and random forest have been used for creating ensemble models. Three ensemble classifiers are chosen such as AdaBoost, bagging and voting classifiers. For the fundamental analysis, we have chosen the Fbprophet price forecast with sentiment on stock from New York Times news for stock 'Apple'. The proposed ensemble models and Fbprophet model are compared to find the best on accurate predictions. Natural language processing (NLP), sentiment analysis technique is used for finding the stock sentiment as positive, negative or neutral. This sentiment value is compounded for each date and added as the additional feature for stock historical prices downloaded from Yahoo. From the experimental results, it is observed that voting-based ensemble classifiers are more efficient and have achieved the highest accuracy of 79.98%. This tells us for short-term market prediction technical analysis gives us better results than fundamental analysis.

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Keywords Natural language processing (NLP) · Decision trees · Random forest · KNN · Sentiment analysis · Fbprophet

1 Introduction

Stock market investments are challenging in real-world scenarios, as the price can be influenced by many factors such as news, financial data, country's economic growth, GDP data and many more. Thus, this domain is very challenging to analyse and make decisions. Though there are traditional methods such as technical analysis and its related tools are available, still this is challenging, and none of them will work efficiently all time. The market conditions are highly influenced by political stability, war situations, financial data release and economic growth, global market trends, etc. Traditional techniques follow the stock's historical price movement to predict the trend and forecast the prices. Fundamental analysis of stock includes company's annual performance, balance sheet data, return on investment, etc. Technical analysis depends on many tools such as moving averages and relative strength are most common amongst them. Though these techniques are followed by the investors, these techniques are not highly reliable to make decisions.

There were many techniques on ML, namely support vector machine classifier, Naïve Bayes, neural network classifiers, and regression models were applied to predict and forecast the prices. These techniques are effective in stock price predictions. However, more effective algorithms are to be proposed for this challenging industry. The challenges in this market are mainly due to the fluctuations of prices. Stock can behave violently based on news and trend flows; this may affect the financial institutions. Thus, the ensemble models are more preferred for price predictions; as this is the combination of more than one algorithm, each algorithm's decision can be combined and considered for the prediction. This is more effective than a single classification or regression algorithm.

Ensemble learning (EL) is the emerging area in many industries such as health care, traffic surveillance, agriculture, finance, energy and more. The ensemble learning gives better performance in all these industries, and data scientists widely use these for effective predictions. The volatility of the stock price has a negative impact on investment psychology. Though this volatility cannot be avoided, the stock price trends can be predicted effectively through EL methods.

The impact of social media amongst the people is high these days. The stock prices trends can be analysed from social media such as Twitter and Facebook and news portals. Social media plays a huge role in stock price movements, as these impact the small investors highly. The sentiment analysis of stocks on social media to be considered one of factors while making the stock price predictions.

The contribution of this paper is listed below.

(1) Proposed work analyses the stock named AAPL; for this stock, data is collected from yfinance
(2) Stock price forecast is proposed using fbprophet model

(3) The proposed work objective to analyse stock (AAPL) sentiment on social media data, New York Times news data is used for this study
(4) Historical price data is added with the sentiment feature, and stock price prediction is proposed
(5) Ensemble model based on KNN, decision tree and random forest is proposed with the AdaBoost classifier, bagging model and voting classifier
(6) Compare the implemented models and find the efficient one for stock price prediction.

In the following chapters, related work on stock price prediction is discussed. In Sect. 3, the algorithm implementation for stock price prediction based on fbprophet and ensemble models is discussed. In Sect. 4, the comparative study of results and discussions is done. In Sect. 5, work conclusion and stock price prediction further enhancements are discussed.

2 Literature Review

According to literature studies, stock price prediction is more reliable with machine learning or deep learning techniques than traditional approaches. Some of the existing ML and DL approaches are discussed in this chapter.

Stock volatility is predicted with the neural network hybrid model in [1] by author Wang et al. This study performed Dow Jones index prediction and data taken from Yahoo finance. The model is a proposed Conv layer, ReLU activation layer for feature fusion technique. Further, the author used the LSTM model and added results to feature fusion and a fully connected layer to get the output price prediction. Experimental analysis showed that the bag of words (BoW) convolutional neural network (CNN) model has achieved the highest accuracy around 64%. However, this accuracy can be improved for more accurate price prediction.

Stock crises or sudden fall in stock prices are unavoidable in certain situations like war situations or at the times of COVID. Stock crisis is referred to when the stock price fell more than 10% in consecutive days. This type of prediction is even more challenging than predicting normal price trends. Authors in [2] explain the crisis prediction using deep neural network algorithm and extreme gradient boosting. For this, NSE stock data is considered for the study. They applied hybrid attribute selection based on 42 input financial features. These features are completely based on the company's growth parameter, annual reports data. Experimental results proved that XGBoost performed more accurately than DNN.

Hyperparameter tuning on ML models is approached by many researchers; this gives effective price prediction for stocks considering its volatility. Authors in [3] described the hyperparameter tuning for eight different classifiers and regression models. Experimental results were performed and noted that support vector regression (SVR) and kernel ridge regression (KRR) are outperformed in price prediction. SVR used parameters such as kernel, C, epsilon for tuning, whereas KKR used alpha and kernel for tuning. The dataset used for the study is even company data taken from the Saudi Stock Exchange.

Sentiment of social media for particular stock may have a high impact amongst investors and traders. The sentiment is observed by these people for predicting the movement of the stock. There are numerous studies approaching sentiment analysis on social media for stocks. The author in [4] observed the sentiments on the stock forum. The author proposed collection of data from online stock forums and cleaned and processed. ML classifier GARCH-SVM is used for this study. This study has achieved accuracy of 81% in classification technique.

Stock price prediction in particular sectors is of interest to many researchers; in [5], the author discussed Taiwan Construction companies. The author developed a hybrid model for prediction and forecast the prices of Taiwan construction companies' stock prices. The hybrid model approached tuning the hyperparameters swarm and metaheuristic algorithms. There are five top construction company stock data from 2011 to 2017 taken for the study from Yahoo finance. On the experimental results, all the five stock prices are compared with the error metrics.

Gated recurrent unit network (GRU) is one of the promising algorithms for time series data studied by authors in [6]. This study used new articles related to S&P 500 indices from Reuters and Bloomberg news portals. The author used GRU and Stock2Vec models for evaluating the S&P 500 index sentiment. The study carried out for the data from 2006 to 2013 new articles. The proposed GRU technique has achieved accuracy of 66.32%.

Limit order book data is one of the useful information, which can guide the movement or trend of the stock. Limit order is the one, which shows interest on the stock as sell or buy limited by the users. The authors in [7] used handcrafted feature extraction for important features. The data is cleaned for unnecessary data provided by exchanges or brokers. The classifiers used are support vector machine, multilayer perceptron and single hidden layer feedforward neural network. The study concluded that the ML algorithms performed better in prediction stock price forecasting using Limit order book data.

Sentiment analysis on news and lexicon-based study was performed by authors in [8]. The authors studied information technology stock such as AAPL, Google and Microsoft stock price impact on S&P 500 index. Lexicon generation from news websites is done, and feature extraction is carried out with tokenization. Decision tree is used as the binary classification in this work. Decision tree has achieved high precision in stock forecasting.

It is inferred from the literature survey that there are a number of machine learning and deep learning models that were used for price prediction, sentiment analysis and price forecasting. These studies used either stock price or news data as the dataset for the implementation. Moreover, these data, on using combined, may give better results. Ensemble model with an ML classifier is more advantageous than other models.

3 Methodology

The proposed work is stock price prediction based on historical price movements and financial events using natural language processing and ensemble machine learning techniques. Machine learning algorithms such as KNN, decision tree and random forest used for price prediction; these algorithms are combined with three different classifiers AdaBoost, voting and bagging classifier models. The proposed work used stock historical price and forecast using the fbprophet model. Natural language processing is used for analysing the sentiment on new data collected from NYT.

Dataset Details

Dataset used for the proposed work is taken from yfinance.com for the stock named 'AAPL'. The stock-related news also downloaded from nytimes.com. The data collected from yfinance is the stock historical prices from January 2017 to December 2020 with following attributes in the dataset (Table 1).

One more dataset considered for the proposed work is new articles from New York Times publications. The web scraped data from api.nytimes.com can be used for web scraping data for news, articles, blog, brief, editorial data, analysis column data. The keyword used for data retrieval is 'apple inc'; this refers to the stock symbol 'AAPL'. The news articles are downloaded as json format. The monthly data collected from January 2017 to December 2020.

Data Exploratory Analysis

Data exploratory analysis is useful for data scientists to observe and analyse for further processing. In this proposed work, data exploratory analysis is done on the historical stock prices. The following figure shows the stock price movement from 2004 to 2020 for the stock 'AAPL'. The stock price trend can be clearly visualised from the below plot (Fig. 1).

Data Pre-processing

The data process helps in converting the data ready to give input to the ML models; in this work, the news articles collected from social media data to be pre-processed before giving as input. Natural language processing is used for processing the

Table 1 Dataset description

Variable name	Attribute description
Date	Trading date
Open	Stock open price
High	Stock high price on the date
Low	Stock low price on the date
Close	Stock close price on the date
Adj close	Stock adjusted close price on the date
Volume	Volume traded on the date

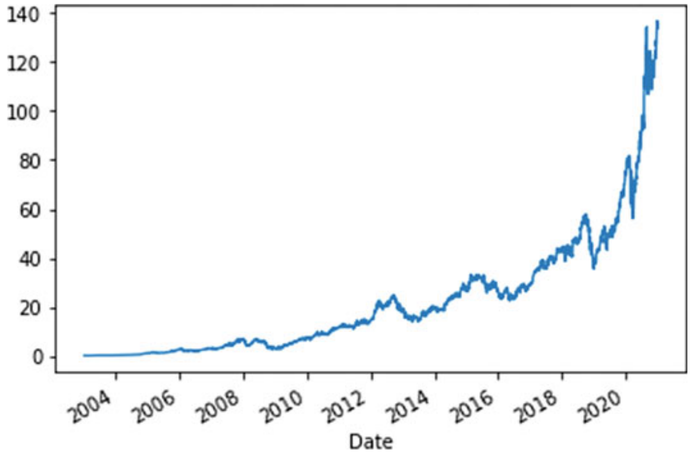

Fig. 1 Data visualisation of the stock AAPL from 2004 to 2020

collected data. Polarity value for each article is computed using SentimentIntensityAnalyser() function. The polarity values are categorised as positive, negative and neutral values. The sum of positive, negative and neutral values is named as compound values. The new attribute is added to the learning attributes of the stock historic dataset. Thus, the objective is to create the data considering the sentiments of social media about particular stock. The below plot shows the compounded value of sentiment score for the stock AAPL from the year 2017 to 2020. The blue line in the chart represents neutral; thus, the values plotted above and below represent sentiments as positive and negative, respectively (Fig. 2).

The proposed work is stock price prediction based on historical price movements and financial events collected from social media. The techniques such as ensemble learning and natural language processing are used for this study. The below figure

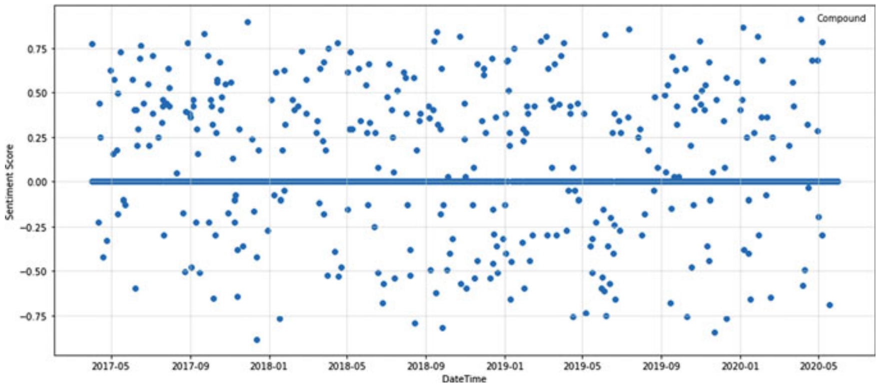

Fig. 2 Sentiment score for stock 'AAPL' from 2017 to 2020

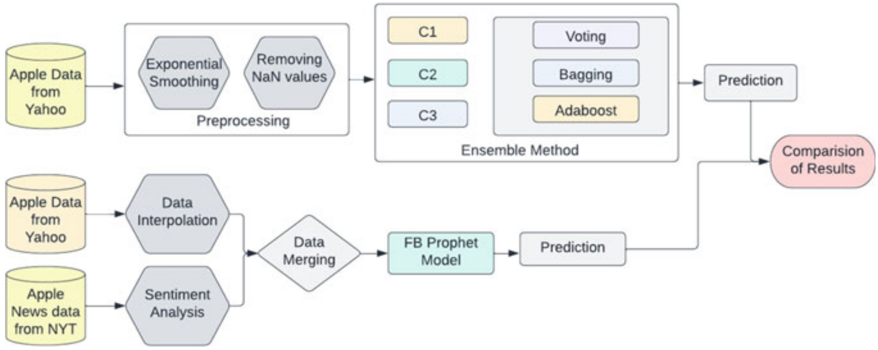

Fig. 3 Proposed architecture diagram for stock price prediction based on financial events and price

represents an architecture diagram of proposed work. It is shown as two phases. The first phase is data collected from Yahoo finance from 2017 to 2020 is pre-processed. Pre-process includes smoothing the exponential values, and null values are removed. The ensemble model using three classifiers C1, C2, C3 are KNN, decision tree and random forest is evaluated separately with bagging, AdaBoost and voting models. The prediction results are taken for comparative analysis and are further discussed in Sect. 4. The second phase of the work is stock-related news articles collected from NYT are processed for sentiment analysis, and historical data is taken; these two are merged together to get new learning data. The data is analysed by the fbprophet model, and stock price is predicted. The results are compared as shown below (Fig. 3).

Decision Tree Algorithm

The proposed work used a decision tree for AAPL price prediction by learning data from 2017 to 2020. The decision tree gets supervised learning data, here the historic stock prices. The close value of stock is the prediction values (y-variable). Closing price of the stock is constructed as leaves in the decision tree. Further steps of this algorithm are explained.

Input: Apple dataset from finance (1006 × 6) (Open-O, High-H, C-Close, L-Low).
Step 1: Get all learning attributes (O, H, L, C) values of stock from the dataset.
Step 2: Attribute selection computation done to get the best attribute.
Step 3: Subsets are generated with the give stock data.
Step 4: Best attribute amongst (O, H, L, C) is taken as best attribute.
Step 5: Repeat steps 3 and 4 for all subsets.
Output: AAPL stock closing price prediction.

KNN

The proposed work used KNN algorithm for AAPL price prediction. KNN was given input of AAPL stock data collected from Yahoo finance. The close value of stock

AAPL is the prediction attribute (y-variable). Further steps of this algorithm are explained.

Input: Apple dataset from finance (1006 × 6) (Open-O, High-H, C-Close, L-Low).
Step1: Read dataset using Pandas.
Step 2: Set the value for K as an integer.
Step 3: Each record in testset.
Step 4: Compute the distance between test data and training data using the Euclidean formula.
Step 5: Sort in ascending order by distance value.
Step 6: Top K records are selected.
Step 7: The predicted value of the test record is based on the frequent value of train data.
Output: Stock AAPL close price prediction.

Random Forest

Random forest classifier is implemented on the proposed APPL stock price prediction. Given the learning features such as stock open, high, low and volume traded with 1006 samples in the dataset, these 1006 data are split into subsets randomly by the algorithm. Random subset is used to build trees. The total number of attributes is 6; thus, a value which is less than 6 is taken by the algorithm for growing the tree.

Input: Apple dataset from finance (input attributes 1006 × 6).
Step 1: Split random subsets from 1006 records.
Step 2: Train the decision tree for individual subsets.
Step 3: Each individual tree predicts the data/prices from test data.
Step 4: Compute the stock price prediction.
Output: Prediction price.

AdaBoost

The proposed work used the AdaBoost classifier as one of the EL techniques. The classifier results of KNN, DT and RF are given as input for this ensemble model. It is carried out as a sequential process. One-level decision tree is made by this model called decision stumps. Incorrect classifications are given higher weight than correctly classified ones. The higher weights are given priority in further learning. This process repeated for less error.

Voting

In the proposed work, soft voting model is used. This model trains the KNN, DT and RF model and makes EL and predicts values based on probability computation. This method works based on the average probability of the predicted values.

Bagging

The proposed work used a third EL technique bagging model; this method is chosen as it reduces overfitting. This approach handles large datasets conveniently and also

Fig. 4 Price forecast for April to May 2020

maintains missing values accuracy. In this work, three base models, namely KNN, DT, RF are learned parallel for training data. All models are combined to get a final decision.

FBprophet model

Fbprophet model is specifically used for time series data to forecast. It fits the nonlinear data based on yearly, monthly and weekly values. Fbprophet model also handles missing values if any in the dataset. It handles periodic change and holidays effectively. The below plot is the fbprophet forecast for stock price AAPL for the month of 1st April 2020 to 1st May 2020 is forecasted (Fig. 4).

4 Results and Discussions

The experimental results of stock (AAPL) price prediction by fbprophet model and ensemble model have arrived. The implementation is done in Python with mandatory libraries. ML classifiers such as KNN, decision tree and random forest were used as base models for EL technique. EL models AdaBoost, bagging and voting were implemented on these three based models. The dataset collected in AAPL stock historical price from 2017 to 2020 as time series data and one more data NYT news articles also collected during the same period for keyword ‘apple inc’. Table 2 represents the evaluation metrics of the fbprophet model. Accuracy achieved in fbprophet model is 70.76%, MAE score 0.97, MSE score 1.2, R2 score 0.78, respectively.

With base models KNN, decision tree and random forest ensemble models are built, and the results arrived separately for each model. Table 3 shows results arrived

Table 2 Results of FBprophet model

Algorithm	Accuracy (%)
MAE	0.973
MSE	1.208
R-squared	0.7820
Accuracy	70.76

Table 3 Experimental results of ensemble model

Algorithm	Voting classifier accuracy (%)	AdaBoost accuracy (%)	Bagging accuracy (%)
KNN	74.15	74.15	74.15
Decision tree	76.90	78.58	77.41
Random forest	73.15	73.15	73.15
Ensemble	**79.98**	**77.63**	**77.13**

from each EL technique. Accuracy achieved in voting classifier is 79.98%; AdaBoost is 77.63%, and bagging model is 77.13%. From these results, it is observed that the voting model outperformed in price prediction.

Figure 5 shows the comparison of fbprophet model and ensemble model accuracy. Fbprophet model accuracy is 70.76%, whereas voting-based ensemble technique accuracy is 79.98%. This model has the highest accuracy than the other two ensemble techniques.

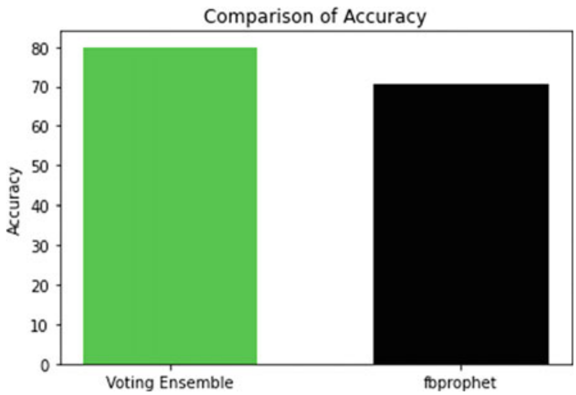

Fig. 5 Comparison of voting and fbprophet model

5 Conclusions

Stock price prediction is very challenging, due to its volatility in prices. There are many factors, which can affect the prices are financial events, corporate results, world market trends and many more. The proposed work stock price prediction from historical prices and financial events is carried out. There are two methods used for this prediction; one is the fbprophet model which combines the sentiment analysis values from NYT news articles. The second method is ensemble model bagging, voting and AdaBoost. The comparison of proposed work shows that the voting ensemble model outperformed the other models.

In future work, this work can be extended for deep learning algorithms and hybrid models. More specifically tuning the parameters in the deep learning LSTM model is of our interest. LSTM models are widely used for times series data prediction; thus, parameter tuning may give best results.

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A Review of Datasets for NLIDBs

Alaka Das and Rakesh Balabantaray

Abstract Natural language interface to database (NLIDB) is a research area that is gradually merging natural language processing (NLP) and data Sciences, specifically after the rise of deep learning. Traditional NLIDBs were built based on rules, syntactic and semantic grammars, statistical and ontology-based techniques and methods from NLP. Most of those systems usually were supporting controlled natural language queries (NLQs) where parsing error and ambiguities were manually handled by the users. As deep learning (DL) captures complex dependencies,human interventions is getting reduced. DL-based NLIDBs are again in focus and many recent NLIDBs got satisfactory performance by using sequence-to-sequence DL model and semantic parsing text-to-SQL datasets. These DL end to end models require huge, complex and cross-domain labeled dataset for exhaustive training. As none of the existing datasets for text-to-SQL tasks seems to be perfect, to meet the demand, new datasets are being produced in every couple of years. Though the role of dataset is very crucial for natural language interface, there are very few review papers focusing on datasets. This paper reviews the datasets used in different NLIDBs, discusses their importance and presents a summary report.

Keywords Text-to-SQL · SQL · NLIDB · Machine translation · Deep learning · NLP · Data set · Survey · Review

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1 Introduction and History

First attempts of language interfaces to databases appeared as early as the sixties. They were basically NL interfaces for expert systems. They were made for a specific domain and mostly for a single database (DB). Domain experts were manually creating specific datasets for these systems. It was very difficult to modify them for querying a different DB and almost impossible to port them to other application domains. Examples of such systems are LUNAR [49], LADDER [30] etc. In the mid-eighties, researchers were focusing on portability issues and efforts were made to develop generic interfaces that could be easily adapted to various databases. CHAT-80 [46] is a popular system from these times. In the 90s, focus was on different learning approaches. Despite the interest and numerous attempts, NLIDBs did not achieve the expected performance.

During the early years of this millennium, some semantic ontology-based techniques became popular. Ontology represents a set of entities and their relationships, constraints, axioms and the vocabulary of a given domain. In this approach, NL queries and a given ontology is provided to a NLIDB system that returns answers using one or more knowledge bases of the ontology. As users don't have to learn the vocabulary or structure of the ontology, these NLIDBs are domain-independent. Text retrieval engines, linguistic resources such as WordNet [36], DBpedia [62] and NLP Parsers such as Stanford Parser [34] support these NLIs. But these systems require human intervention for domain customization and they understand a defined subset of NL in a controlled or guided environment [59]. AquaLog [60], ORAKEL [61] or FREyA [25] are such systems for querying ontologies where controlled NL is used to balance ambiguity and expressiveness.

In the last decade, again NLP including NLIDBs are in focus specifically after advancements in machine learning and deep learning. In deep learning methods, from the raw data, machine automatically discovers the representations needed for detection or classification. Starting with the raw input, it has multiple levels of representations where representation at one level is transformed into a representation at a higher, slightly more abstract level following a general-purpose learning procedure. These transformations help the machine to learn very complex functions. DL methods are doing well for various tasks in NLP including NLIDB. Deep feed-forward networks or multilayer perceptron (MLP)s form the basis of many important applications such as convolutional neural network (CNN)s, recurrent network (RNN)s and long short-term memory (LSTM) networks. In almost all recent NLIDBs, LSTM networks are used as the encoders and decoders. These networks are the main building blocks of many recent NLIDB models [37].

Semantic parsing (SP) deals with the meaning of NL queries and maps them to meaningful logical forms or SQL queries. Almost all the deep learning NLIDBs are following semantic parsing technique. They are using semantic parsing datasets to get the schema information, natural language questions and corresponding SQL queries for training. Like traditional parsers, a semantic parser applies a context-free grammar and a set of reduction rules to token sequences to derive non-terminal symbols. In some NLIDBs, a sentence in NL is mapped to a logical form which represents its meaning. Various logical form representations like lambda calculi [21, 22], natural logics [23], query sketch [49] etc. may be used to transform the user's English description. Then these representations can be converted into database queries. In some other systems, from the NL question, SQL query is generated without any intermediate representations. Deep learning methodologies are converting the semantic parsing problem to a sequence-to-sequence learning problem achieving start-of-the-art performance.

Data driven complex deep learning methods tremendously depend on public datasets. That is the reason why work in this area couldn't proceed well till no large complex dataset was available [58]. Deep learning methods require a huge amount of training data and rely heavily on the underlying statistical distribution of the training data. Training also needs massive computing power and storage space. If the scale of training data is not sufficient, they often make terrible and unexpected mistakes that will never occur in humans because they abstract away many significant features. Recently, few large and cross-domain annotated datasets have been released consisting of a good collection of NLQs and their corresponding SQLs along with the under lying database to execute these queries. Since then, NLIDBs with deep learning-based models are in uprising focus.

Two datasets that were widely used in the past are ATIS [29] and GeoQuery [54]. ATIS and GeoQuery are small, simple and single domain datasets in comparison to few recently developed Semantic Parsing datasets for deep learning like Wikisql [55], Spider [53], SParC [83] and CoSQL [83]. Among them, Wikisql is the largest hand annotated semantic parsing dataset. It is large in terms of the number of queries and databases, but it contains only simple SQL queries on single database tables and queries consist of single SELECT clause and WHERE conditions. No GROUP BY, ORDER BY or JOIN are included. Hence these queries are much simpler as compared to actual user's queries. Spider is more complex than Wikisql. It covers all verities of SQL queries including join and nested query. Queries involve multiple tables and include clauses like ORDER BY, GROUP BY, etc. But the number of examples that contain complex clauses like GROUP BY is not enough to train the end to end text-to-SQL model for these clauses.

Both WikiSQL and Spider are designed to convert standalone NL questions to executable queries. In real life, many times people ask multiple interrelated questions. To handle these types of queries, the system must be able to sequentially process conversational requests to access databases. Very few datasets have the provision of mapping context dependent questions to structured queries. One such dataset that was widely used in the past is ATIS whose contextualized version includes series of questions from users interacting with a flight database. But ATIS is small and single domain dataset in comparison to few recently developed cross-domain Semantic Parsing in Context datasets like SParC and CoSQL. New datasets are being created to address different problem domains of NLIDBs.

The following table describes in brief some of the popular datasets in the chronological order of their development along with the NLIDBs that used those datasets. Some models were specifically designed for only one dataset; where as some generic

Table 1 Data set and NLIDB(s) that use the corresponding data set

Data set name and description	Example of some NLIDB(s) that use this dataset
1. US baseball league dataset (1961) [26]:—the database consists of the attributes like the date, place and other details of the baseball game in the American League for one year	**BASEBALL (1961)** [26]:—symbolic approach, pattern matching technique, domain specific, syntactic parsing method to converts NL to attribute-value pairs
2. Rock samples from moon by the Apollo missions (1972) [48]:—It consists of two data base files. One table consists of the details about the chemical, isotope and age analyses of the Apollo 11 samples. These details were collected from the reports of the First Annual Lunar Science Conference. The second file is a key phrase index to those reports. These files are provided by NASA MNC	**LUNAR (1972)** [48]:—Syntax-based system that uses Woods' procedural Semantics, domain specific, converts NL to symbolic expression of formal predicate Calculus
3. US-Navy ships database (1978) [44]:—It is a distributed RDBMS database from the Navy 3-M (Maintenance and Material Management) Database for Aircraft, Mechanics burg, PA. It consists of the details about aircraft maintenance and flight information for 48 A7 and F4 aircraft for a period of two years. It has around 40 tables where each table has 10 to 20 attributes such as date, serial number and type of aircraft, service details	**1. PLANES (Programmed Language-based Enquiry System) (1978)** [44]:—symbolic approach, pattern matching technique, uses relational calculus to convert NL query **2. LADDER (1978)** [30]:—Semantic grammar System that is DBMS portable. Uses LISP to convert NL query. Can process some elliptical (incomplete) inputs, attempts to correct misspelled word through user interaction. One of the first good NLDBI systems of 1970s. ambiguity was handled through user interaction
4. World geography database (1982):—It is a database of facts about world geography that contains the names of world's major countries (over 150 of them), oceans, major seas, rivers and cities. 'borders' represent all pairs of countries, oceans, or major seas that are adjacent; thus, representing relations. The database has over 850 tuples and a small vocabulary of English words sufficient for querying the database	**1. CHAT-80 (1982)** [45]:—It translates English questions into Prolog logical forms augmented with extra control information. These Prolog components can execute to produce the answer. Interactive NLI. It is among the best NLP systems in the eighties. Few NLIDBS used the code of CHAT- 80 to form the basis of their NLI (e.g., Masque/sql [56]) **2. Masque/sql (1993)** [56]:—Interface supports semiautomatic customization and NL portability. It can be easily configured for new knowledge-domains using the built-in domain-editor and it is DB independent
5. CHIP (1983):—This database contains information about processor chips like: the identification number of a chip, its manufacturer, its width in bits, speed in megahertz, cost etc.	**TEAM (Transportable English Access Data manager) (1983)** [27]:—It provides information about the DB through a system-directed acquisition dialogue using Lisp. Provides an excellent Interactive NL front end and a powerful way of relating the front end to an existing DB
6. ATIS (1990) [29]:—Air Travel Information System contains spoken questions about air travel, the written forms of these questions and the corresponding SQL queries. It has 1658 unique question sequences, 27 tables and 123 columns. The tables that are mostly used in queries to the database are: airline, airport, flight, fare, transport, etc. It is the one among a few datasets That maps both context independent and context dependent questions to structured queries	**PRECISE (2003–2004)** [40]:—Tokenizer tokenizes the question. Parser generates parse tree. Matcher generates valid mappings. Query generator generates SQL equivalence checker generates SQL queries for multiple distinct solutions, then user chooses the best among them. It provides controlled NLI. Parsing error and ambiguities are handled through user interaction. DBMS portable. It had 95.8% accuracy on ATIS data set and 100% accuracy on GEOQUERY for answering semantically tractable questions [38]. It reduces the interpretation of semantics in NL to a graph matching problem. Code available at [4]

(continued)

Table 1 (continued)

Data set name and description	Example of some NLIDB(s) that use this dataset
7. WordNet (1995) [36]:—WordNet is an online lexical database that contains nouns, verbs, adjectives and adverbs of English language in the form of synonym sets and semantic relations link the synonym sets. WordNet is a registered trademark of Princeton University which can be downloaded freely from [5]	1. **PRECISE (2003–2004)** [40] 2. **NLPQC (2005)** [43]
8.CINDI (1997):—CINDI is a virtual library developed at the Concordia University. It was developed to help the registration of digital resources and consequently in searching the bibliography	**NLPQC (2005)** [43]:—With the help of WordNet [36], semantic parsing is used to convert NL query to SQL. It is developed using C and ++. it can work with more than one database by tuning it to a given database during pre-processing. Code is available at [6]
9. GEOQUERY (2001) [54]:—is a database consisting of basic information about the U.S. geography that includes: the state, population, area, city, river, lake, mountain, etc. It was developed by the UT Austin group led by Prof. Mooney. The GEOQUERY has three parts: the database, the query language and the corpus. The database called Geobase consists of relational tables that contain basic information about the U.S. geography in Prolog format. geoqueries880 contains the training corpus that has 880 questions paired with their correct Prolog queries for training a semantic parser for the task and geoqueries250 contains the testing corpus that has 250 questions. Geoquery is a system that executes a given query in logical form [2]. Available at [7]	**1. PRECISE (2003–2004)** [40] **2. WASP (2006)** [47] **3. C-PHRASE (2010)** [37]:—It has an authoring tool through which a schema may be imported from any ODBC accessible database. It can edit the interface data dictionary. The NLI builds the semantic grammar interactively. Attained approximately 75 % recall given an arbitrary relational database. A state-of-the-art authoring system for NLIDB. Open-source code Available at [8] **4. ATHANA (2016)** [41] **5. COVER (2017)** [38]:—Here a simple domain specific lexicon automatically derives itself from the database instance and lexical resources from the user's question, a set of meaning representation language (MRL) expressions are generated and these MRL expressions are pruned from the constructed set using syntactic analysis and theorem proving. It is implemented in Python using NLTK. It can deal with aggregate operators, self-joining queries and sub-queries. It consolidates equivalent queries and considers only non-redundant and information bearing queries. Here the role of syntactic parsers is more isolated. Its performance is better than PRECISE on the GEOQUERY corpus
10. ROBOCUP (2006) [47]:—Its primary domain is robotic soccer. On a simulated soccer field, teams of agents compete in the ROBOCUP Coach Competition. Coach advice is given to them using a formal language called CLANG	**WASP (Word Alignment-based Semantic Parsing) (2006)** [47]:—learns a semantic parser given an annotated corpus using statistical machine translation with minimal supervision. Developed using Prolog. Portable front end language like English /Spanish /Japanese /Turkish. A huge number of annotated corpora is required to train it
11. DBpedia dataset (2007) [62]:—It has a huge multi-domain ontology derived from Wikipedia. DBpedia supports more than 100 languages. It has millions of information about around 2 million "things" like persons, places, music albums, films, images, Wikipedia categories and YAGO categories. It contains more than 1,600,000 links to external web pages, 180,000 links into other external RDF datasets	

(continued)

Table 1 (continued)

Data set name and description	Example of some NLIDB(s) that use this dataset
MusicBrainz Metadata of DBpedia dataset: MusicBrainz is a project to compile high quality audio metadata. The metadata format of MusicBrainz is not strictly a playlist format, but rather a format to describe collections of audio resources called albums. It defines a new namespace for Artist, Album, Track, Track Listing and Track Num. Fields are all Dublin Core and RDF defined [1]	**FREyA (Feedback, Refinement and Extended Vocabulary Aggregation) (2012)** [25]:—It is an ontology-based lookup model. Using Stanford Parser and heuristic rules Potential Ontology Concepts (POCs) are identified. It supports ad-hoc NLI including ill-formed queries and handles ambiguities and parser errors via user interactions. It learns from the query history. It is portable to work with different ontologies. The performance of the model is largely dependent on the ontology data
12.YELP (2011) [51, 78]:—This dataset consists of information about restaurant businesses and reviews related to these restaurants. It stores business, review, user and check-in data in separate JSON files. It includes over 158,000 reviews about almost 5000 restaurants and these figures are increasing day by day. Can be downloaded from [10]	**SQLizer (2017)** [50]:—It uses deep learning method to train a sequence-to-sequence neural semantic parser. From the query sketch, SQL query is generated using type-directed synthesis and automated repair. It is written using C++ and Java, uses Sempre framework [24], Stanford CoreNLP library [34] and Word2Vec tool [35]. It is database agnostic. Interface can be used for online conversion of files into SQL databases ([11]). Can't find out similarities for those terms for which similarities can't be computed using Word2Vec. Among the top k queries, the user decides which is the correct query. In 78% of the cases, the desired query is ranked in the top position and in 90% of the time the right query comes within top 5. Its sequence-to-sequence model suffers from the "order-matters" problem in the 'where' clause of the SQL query
13. IMDB database (2011) [79]:—The IMDB dataset was first proposed by [79]. The dataset consists of movie reviews of around 100,000 movies taken from the Internet Movie Database ([12]). Each movie review has several sentences	**SQLizer (2017)** [50]
14. MAS data set (2014):—It is the data set of Microsoft Academic Search (MAS) that contains bibliographic data for academic papers, authors, journals, conferences and universities. It contains 196 natural language queries. The MAS workload was designed by the authors of NaLIR from the Microsoft Academic Search data from its site [13]	**1. NaLIR (2014)** [33]:—MySQL is used as the RDBMS and Stanford NL Parser [84] as the dependency parser. It handles Controlled NLQs based on predefined grammar. It is an interactive NLIDB that assists the user to incrementally build complex NL questions. Queries may contain join, aggregation and sub queries. It is a state-of-the-art tool **2. ATHANA (2016)** [41] **3. SQLizer (2017)** [50]
15. FIN (2016) [41]:—FIN is a contribution of IBM. It has a complex ontology that is derived from real-world financial data from various sources. It is based on 75 concepts, 289 properties and 95 relations. FIN is much more complex than MAS GEO. Its SQL queries may include aggregations, joins, unions and nested sub queries. It was first used by ATHANA	**ATHANA (2016)** [41]:—NLQ is translated into Ontology Query Language (OQL) and then to SQL. Here several interpretations are generated and a ranking function chooses the best interpretation and executes. It permits ad-hoc queries and is DB independent. Resolves ambiguity based on translation index and domain ontology. Its performance in terms of precision and recall is very good on the GEO, MAS and FIN workloads
16. WikiSQL dataset (2017) [55]:—It is a semantic parsing dataset that consists of json files describing the content of database tables, 80654 NL questions and corresponding SQL queries. Here the annotation has been done manually. The SQL tables are extracted from 24241 HTML tables from Wikipedia. It is collected by crowd-sourcing on Amazon Mechanical Turk. The dataset is available for download at [14]. The dataset is split in such a way that each database only appears in one of the train, development or test set. This helps the systems to generalize to new domains	**1. SEQ2SQL (2017)** [55]:—It uses deep learning method to train a sequence-to-sequence neural semantic parser that automatically translates SQL queries from NLQs. It uses Stanford CoreNLP tokenizer [34], GloVe word embedding [39] and character n-gram embeddings [28]. It is trained using ADAM [32] and regularized using dropout [42]. Implementation uses PyTorch [3]. LSTM is used for encoding and decoding. It is a popular semantic parsing model that uses reinforcement learning enhanced attention pointer network model. But, its sequence-to-sequence model suffers from the "order-matters" problem. SEQ2SQL is proposed by the developers of WikiSQL [55]

(continued)

Table 1 (continued)

Data set name and description	Example of some NLIDB(s) that use this dataset
	2. SQLNet (2017) [49]:—Deep learning is used for training a sequence to set neural semantic parser to automatically synthesize SQL from NLQ. Its performance is better than the previous model Seq2SQL in terms of query-match accuracy and result-match accuracy. It avoids reinforcement learning and the order-matters problem by employing a sequence to set model with SQL sketch approach. Open-source code available at [15] **3. TypeSQL (2018)** [51]:—It is a text-to-SQL generator designed by modifying SQLNet. Here the NL question is pre-processed by type recognition. The words in the question are encoded and then the values for the slots in the SQL sketch are predicted using LSTMs. Here the hidden states of LSTMs are used. It is implemented in PyTorch [3]. It uses concatenated Glove [39] and paraphrase [46] embeddings. Code is available at [16] Few more references those use WikiSQL data set are:—[63–69]
17. Spider (2018) [53]:—Spider is a semantic parsing and text-to-SQL hand annotated dataset whose SQL queries cover clauses like GROUP BY, ORDER BY, JOIN, etc. unlike SEQSQL. It consists of 10,181 questions and 5693 unique SQL queries. It has around 200 databases with multiple tables on 138 different domains. It is smaller than SEQSQL in terms of number of questions but it covers more complex questions. Like SEQSQL, the train and test data sets do not overlap. Available at [17]	**SyntaxSQLNet (2018)** [52]:—Model decomposes the SQL decoding process into different modules to predict different SQL components. Encoder encodes table schema and path history and then they are fed as inputs to each module along with the NLQ. Its decoder manages a syntax tree network to address the complex and cross-domain text-to-SQL generation task. Decoder executes a collection of recursive modules using SQL generation path history and a SQL grammar. Model is implemented in PyTorch [3]. Each modules implementation is based on TypeSQL [51]. SyntaxSQLNet works better in dealing with complex queries and unseen databases than previous NLIDBs. Latest updates are available at [18] Few more references those use Spider data set are:—[70–77]
18. SParC (2019) [80]:—It is a cross-domain semantic parsing dataset that deals with context dependent NLQs. It has 4298 question sequences that consists of more than 12,000 questions annotated with SQL queries. The questions are obtained from user interactions with 200 databases over 138 domains. It is designed by modifying the Spider dataset to map context dependent NLQs to SQLs. The dataset is available at [19]	**1. CD-Seq2Seq (2019)** [80]:—This is a Seq2Seq model extended with the turn-level history encoder [81] to handle cross-domain text-to-SQL task **2. SyntaxSQL-con (2019)** [80]:—It is an extended version of SyntaxSQLNet with history input. The decoder of SyntaxSQLNet is modified to accept the encoded previous question as an additional input to design SyntaxSQL-con model The above 2 models are proposed by the developers of SparC [80]
19. CoSQL(2019) [83]:—It is a large-scale cross-domain conversational text-to-SQL corpus collected under the WOZ setting [82]. Similar to Spider, the corpus covers 200 complex DBs over 138 different domains. CoSQL contains 3007 dialogues where each dialogue matches to real-world interactions. Corpus contains many questions for which user clarification is required and there are questions for which SQL queries can't be generated. The dataset is available at [20]	**1. CD-Seq2Seq (2019)** [80] **2. SyntaxSQL-con (2019)** [80]

popular models used multiple datasets for comparison and analysis. Though a single table is not sufficient to represent every detail, it will be helpful to get an overall idea of the scenario (Table 1).

2 Conclusion

Starting from sixties, many research work has been done on Natural Language Interfaces. With the passage of time, technology is changing and many NLIDBs are providing promising results. But still, none of them has proved itself as a standard option for interfacing a database. An ideal NLIDB is expected to support ad-hoc NLQs, should be self-improving, should handle partially specified queries by storing query history, should handle parsing error and ambiguities through auto correction, the query construction should be automatic either following rules or through machine learning and it should provide multilingual/cross lingual support. Whereas the existing NLIDBs usually support controlled NLQs, has fixed capacity, does not support partially specified queries efficiently, parsing error and ambiguities are not completely handled by the system, query construction does not support multilingual interfaces. Hence to build an ideal NLIDB system is a major research challenge. As datasets play an important role in building efficient NLIDBs and very few work is done towards reviewing datasets, this paper focused on discussing about them.

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‘Mazoor Katta’ a Mobile Application for Daily Wage Labor Management

Rakhi Bharadwaj, Anoushka Mudkhedkar, Amogh Dixit, Ayush Ingle, and Fatima Khatib

Abstract Daily wage laborers face many problems getting work and struggle to make ends meet. They often travel from nearby towns and villages in search of daily work. To overcome issues like finding secure jobs and ensuring efficient work, we have implemented an idea to provide a common platform to the workers and employers, where the employer can upload job profiles and specifications on the platform and the workers would be able to view these work opportunities and apply to work. This application was developed using Flutter for frontend and Firebase and Cloud Firestore for backend. In this paper, we dive into the steps taken in planning and developing the ‘Mazoor Katta’ application.

Keywords Flutter · Firebase · Mobile application · Job applications

1 Introduction

Daily wage work is a concept wherein the workers work for a day and get paid for it at the end of it, i.e., one day at a time. This type of work does not promise that more work will be available in the future. They are usually hired by the day by an employer who requires help for a small amount of time.

In many cities of India, the workers gather at a market place also called ‘mazoor mandi’ in search of jobs. The employer visits the place and hires a few people

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according to their needs. But there has always been an issue of lack of job security as not all the workers will get a guaranteed pay at the end of the day. And especially after the COVID-19 lockdowns, the average monthly earnings of the daily wage workers have dropped from ₹10,000 per month to almost ₹6,000 per month. In that time period, the employment opportunities declined which caused many of the daily laborers to lose their sources of income. Even now, the workers travel several kilometers from their homes in hopes of getting a job for the day but sometimes do not.

We aim to develop a mobile application in various regional languages which will help the workers in securing daily jobs and also have a guaranteed pay according to the daily wages law.

2 Literature Review

Our application caters to the needs of daily wage workers and also the employers who want to hire them. Following are the papers and articles we have referred to for getting a proper perspective toward developing our application.

- Authors of 'WORKSAPP' [1] have implemented an Android application to find daily wage workers. Users can create user profiles using Google Authentication service and Facebook Graph API authentication service. Users and employers can post jobs and their requirements. Post creators can also track statistics of a post such as views on posts, likes and comments. Workers can click on the contact number and the email address of the employer to contact them. Users can create and modify posts whenever needed.

Instead of only focusing on the employer, we will also be paying attention to the daily wage workers and enhancing their job finding experience on the application.

- We observed an app called 'MyRojgaar' which too focused on cutting the middle man from the equation of employer and daily wage workers.[4] The main difference between that app and our app will be the time period given to accept the job. 'MyRojgaar' app offers a lesser time window to accept the job which is unlike our app.
- 'Labouradda' application intends to determine issues like correspondence gap, inaccessibility and inconsistency for the consumers while simultaneously expanding request, hours, days and worth of employability for the everyday workers [3]. How it works is that it uses GPS to track the job location and according to the requirements posed by the consumer, the nearest app-certified worker is sent to the site of work (Table 1).

Table 1 Summarization of literature

Application	Implementation	Limitations
WorksApp	Users and employers post jobs and their requirements	No facility to chat within the app, communication occurs through call/email
MyRojgaar	Users and employers post jobs and their requirements	Offers lesser time window for workers to accept the job
Labouradda	GPS tracks job, and nearest app-certified worker is sent to work site	More focus on nearest workers rather than requirements posed by the consumer

3 Technology

We have developed the application using Flutter (Version 2.10.4) and Dart (Version 2.16.2) for the Frontend and Firebase and Cloud Firestore for the backend. For the development of the project, we have used the Android Studio IDE (Version 2021.1.1 Patch 3).

Flutter is used for creating high performance applications which work cross-platform on a single codebase.

The database is delivered as a service by Firebase in real time. Therefore, data can be transferred quickly and conveniently to and from the database. It is therefore appropriate for developing mobile applications.

The amount of data stored in the database has no significant impact on data querying in Firebase. Instead, it is complicated by the number of outcomes returned by the query.

In the Firebase-Cloud Firestore’s data model, the data is stored in collections which contain documents which may contain other collections or hold the data in key-value pairs.

There are other alternatives to Firebase such as MongoDB, but due to its flexibility, excellent scalability and simplicity to synchronize with mobile applications, Firebase is preferred over MongoDB.

4 Features

After the thorough literature review, we better understood what features our application needed to have so as to deliver maximum ease of access and functionalities. Below are the functions we came up with.

Theapplication has 2 main interfaces, following is the feature workflow for each.

Employer:

- Make a profile on the application by entering the required details.
- Create the job profile specifying all the job details and the category.

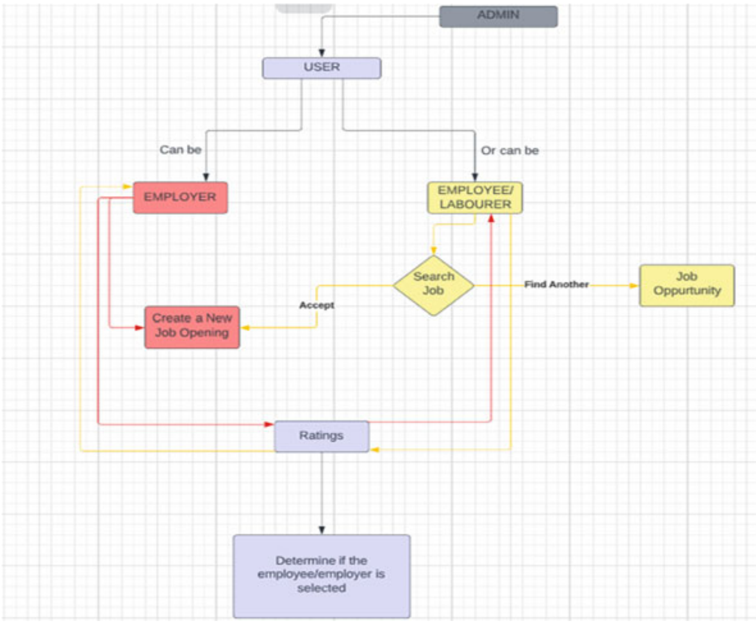

Fig. 1 Flowchart depicting the basic workflow of the application

- The workers who have applied for the job will be visible in a list format. Through this list, they can also view the worker's detailed profile.

  Worker:

- Make the profile and add the correct details to create the account.
- The homepage will have multiple job recommendations, and they would be able to view the job profile.
- The worker would be able to set up their profile.
- By applying for the jobs, the workers can procure them at the comfort of their homes and have an assured pay at the end of the day (Fig. 1).

5 Methodology

5.1 System Architecture

Thearchitecture of the Mazoor Katta application is separated into 3 layers:

- Presentation
- Business
- Data layer.

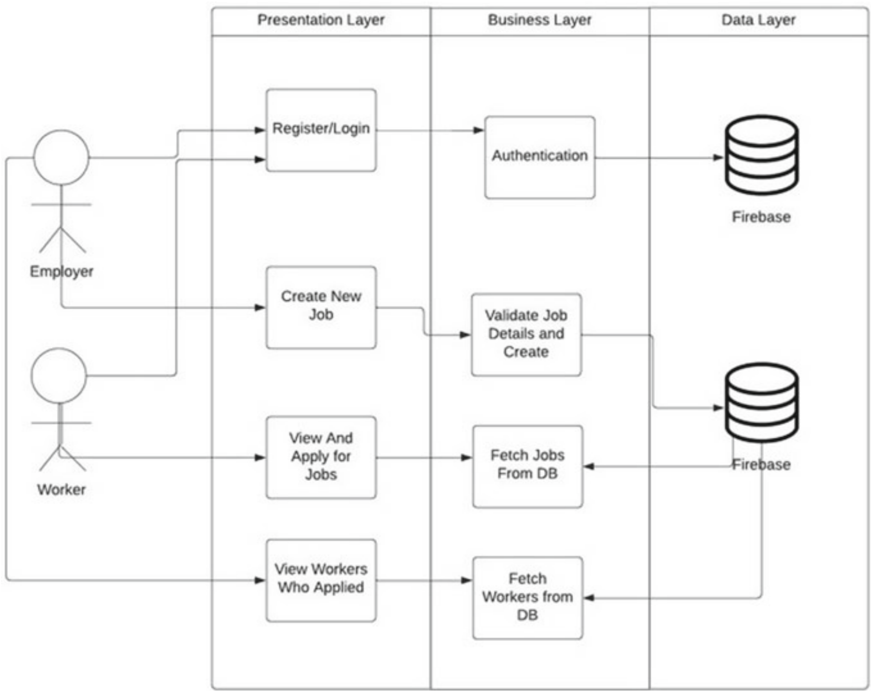

Fig. 2 System architecture of the application

The presentation layer of our application consists of all the UI and the views for the users.

The business layer consists of the sign in process and other computational functions which specify the way in which the job data, worker data fetched from the database is visible to the users.

The data layer consists of the Cloud Firestore database of our application, consisting of job, employer, worker and location information (Fig. 2).

5.2 *Modules*

The application has 3 modules which cater to 3 different user types as seen in the features. But according to the functionalities, the modules can be classified into (Table 2).

The **Job Creation** module starts right after the employer signs in, and in this, the employer can add all the job details—description, address, duration, wages, requirements, date and time, images(optional) and contact details. All this is stored in the specific job subcollection in the employer collection in Firebase.

Table 2 Modules in the code

Module Name	Description
Job creation	Creating the jobs (employer)
View workers	View the workers who have applied for the jobs (employer)
Category filter	Get open jobs list according to your profile (worker)
Distance filter	Get the open job list according to the location (worker)
View job Details	View selected job details(worker)
View employer	View the employer who has put up the job(worker)
Apply	Apply for a specific job (worker)

The **View Workers** module used by the employer to view the workers who have applied for the jobs the former has listed. The data is retrieved from the worker subcollection in the job subcollection in the employer collection in Firebase.

The employer can further view the entire detailed profile as well.

The **Category Filter** module retrieves and displays the job data in form of cards in a list view according to the matching of the keywords from the values inside of the requirement subcollection in the jobs and the skills subcollection in the specific worker subcollection.

In the future, we are going to add the **Distance Filter** module that will use the Google Maps Flutter plugin. The data from the location subcollection would be retrieved in real time and the plugin will be used to get the markers on the map in real time. Further the worker's location marker will be used to get its polyline coordinates (latitude and longitude) and the shortest distance algorithm would be implemented to calculate the path and the distance between 2 locations.

The **Apply module** starts implementing when the worker clicks on the apply button on the job details page which triggers the insertion of the worker id and other details into the application subcollection in the jobs subcollection present in the employer collection in Firebase. This data is then visible to the employer in the 'view workers' module.

5.3 Sequence Diagram

This diagram is used to demonstrate the process between a group of items in our application and how they interact together and in what order they occur (Figs. 3 and Fig. 4).

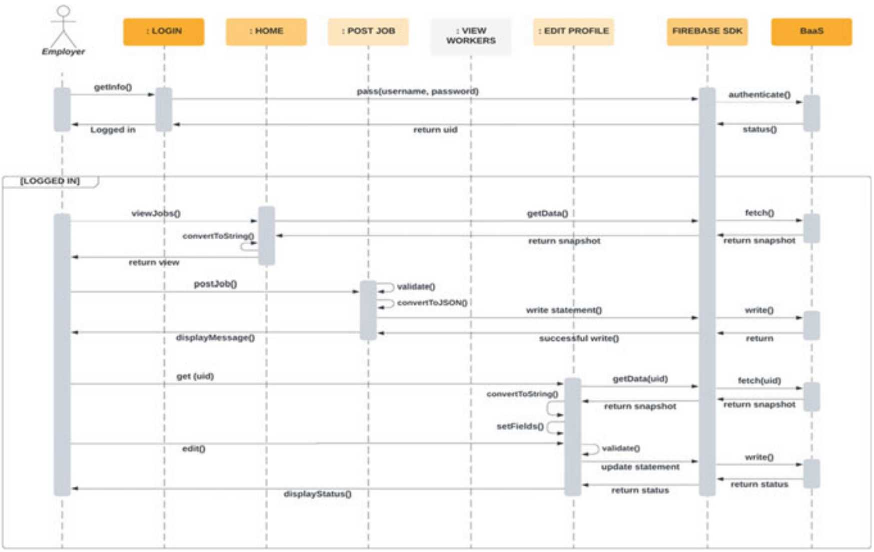

Fig. 3 Employer sequence diagram

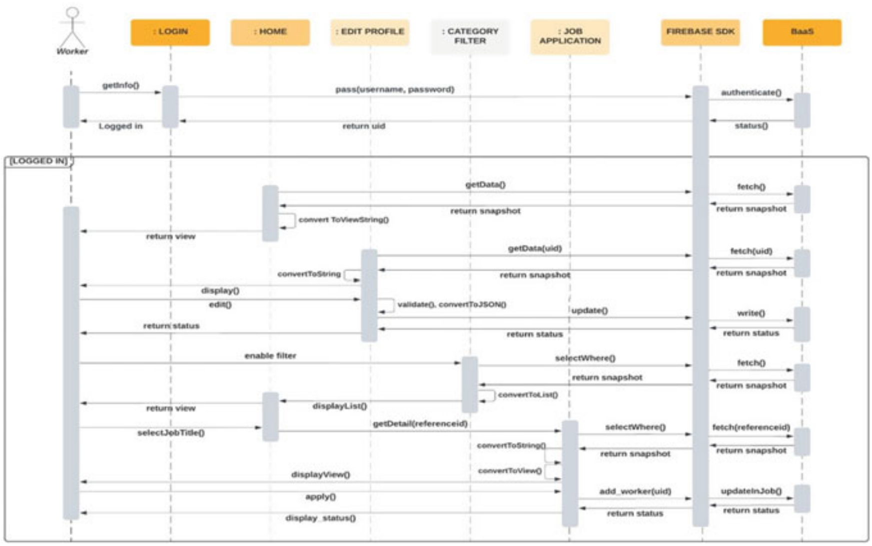

Fig. 4 Worker sequence diagram

5.4 Database Model

For the project ‘sign up’ and ‘login’ functionalities, we have used the Firebase inbuilt authentication by using the ‘firebase_auth’ plugin (version: 3.3.19), ‘firebase_core’ plugin (version: 1.17.1) and “cloud_firestore” plugin (version: 3.1.17).

And as for the database of the application, we have created 3 collections inside the Cloud Firestore: workers, employer and job_data.

- **Workers:** This collection contains the details of the workers inside the multiple documents. Fields from these documents are fetched in the form of snapshots when the view workers module is called.
- **Employer:** This collection contains the data of employers in the form of documents. Not only that but each employer document also contains a jobs subcollection containing all the documents having information about jobs posted by the employer.
- **Job_data:** Since firestore does not allow the fetching the selective data (i.e., only the job documents from all the employer documents) without writing extremely complex and time heavy queries, we have implemented a separate collection job_data which only stores the job title (String), description (String) and a foreign reference (Reference Key) to the actual document of that job containing the details.

This collection helps in getting all the available jobs in a list view inside the worker interface. When the list tile is clicked, it will fetch the job data from the employer document by passing the reference key as the document path (Fig. 5).

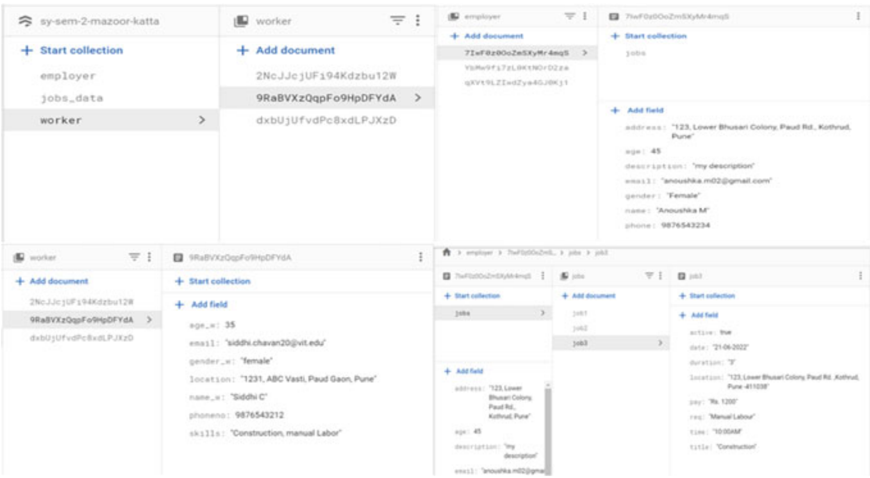

Fig. 5 Database collections

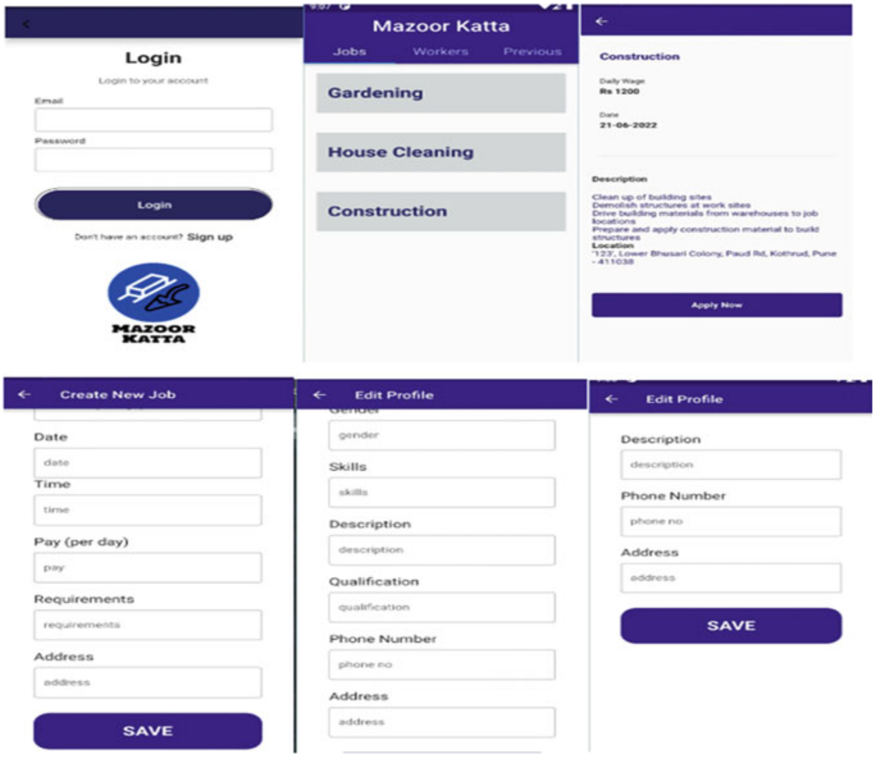

Fig. 6 UI screens

6 User Interface

After the implementationofthe project, following is the user interface (Fig. 6).

7 Results

As it was found that in recent times, because of the COVID-19 outbreak, the situation of daily wage workers worsened. Which is why, we thought of creating an application ‘Mazoor Katta’ which would aid the workers in finding jobs. We successfully created an Android application to solve the issue of job security and unfair pay for the daily wage workers.

To ease their situation, we used app development tools like Flutter, Dart and Firebase to develop an application which will provide a platform for both the employer and the worker to find each other thus eliminating the 'middle man' in the communication and providing an easy way to acquire work for the day. Also, this application allows keeping track of all the job and work histories of both the employer and worker.

8 Conclusion

In this study, we first studied and analyzed three different apps which focused on the same problem statement as we did. They were 'WorksApp' 'MyRojgaar' and 'Labouradda'.

'WorksApp' was a more employer focused app. There was no scope for the employees to interact with the app.

'MyRojgaar' provided a very less time window in which the employees could apply for the job and lastly the 'Labouradda' app focused on the nearest employees rather than the employee skill.

These studies implied that there had to be an app which could provide a common platform for both employees and employers to interact with each other. This is exactly what our application 'Mazoor Katta' focused on. Providing a platform where the employers could post job openings and the employees could select the preferred job offer out of the vast number of jobs made available by the employers.

This paper goes through the literature we have referred to and how we have devised our solution for the problem based on our findings. It also encapsulates the architecture and working of the system and how we can further enhance it.

9 Future Scope

We plan to take this project further by implementing the Google Maps API's polyline coordinates to compute the distance between the location of job and the address of the user and filtering the database to only show the user the jobs near them.

We also think it would be beneficial to implement a 2-way chat window for better communication between the worker and the owner without any third-party interference.

For further developments, users could track statistics of their created posts such as views, likes and comments. Workers could add their Aadhar number and verification details such as Ration Card/Voter Id/License No. They could also upload a video resume on their profiles. The application could be integrated with online payment gateways such as Google Pay API, RazorPay and Paytm in order to accept payment cards. The application could also be monetized by adding an email subscription form to get more engagement, running in-app advertisements or offering both free and paid versions.

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Improving the Efficiency of High-Performance Free-Space Optical Communication Channels in Various Weather Conditions

Sergey V. Zhilin, Vladimir V. Arkhipenko, Elena S. Basan, and Mariya G. Shulika

Abstract Free-space optical communication channels are a type of communication system that uses open space to transmit information carried by light. Often, these communication channels are used for groups of unmanned aerial vehicles. Various atmospheric phenomena can weaken the quality of the transmitted light signal. In this paper, we investigate a method to improve the efficiency of high-performance free space optical communication channels in different weather conditions: clear sky, fog, rain, and snow. The existing free-space optical communication technology, a system using dense multiplexing (DWDM) and one input and one output (SISO), was considered. One of the proposed improvements is the use of many sources of receiving and transmitting signal. The analysis of the impact and attenuation on the free-space optical network in different weather conditions has been carried out. The study was based on the use of the optisystem simulation software toolkit, which simulates different attenuation weather conditions in two types of systems. A comparison between SISO and MIMO systems is made from point of view of quality factor when used in several types of atmospheric phenomena. The suggested system shows budding results in terms of capacity and received signal quality. It is possible to increase the indicators along the length of the transmitted signal by 33.6% in dense fog conditions, in heavy rain grow by 63.89%, and in heavy grow by 35.21%.

Keywords Free-space optics (FSO) · SISO system · MIMO system · Dense wavelength division multiplexing (DWDM) · Signal attenuation · Clear sky · Fog · Rain · Snow

1 Introduction

Systems based on optical communication channels (OCS/FSO) have become a technical revolution in free space communications. In recent times, FSO has been considered suitable for high-speed signal transmission because it depends on light emission

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for signal transmission. Such systems have several advantages over radio frequency communication systems due to the high bandwidth of FSO, which is an important characteristic for mobile communications, including radio frequency communications. FSO is deprived of the need to obtain a license to use the spectral frequency. In addition, the RF system is less secure compared to the FSO communication system.

FSO works in the near infrared (IR) range, which indicates online-of-sight technology. A modified beam of infrared or visible light is sent to FSO through the atmosphere [1]. There is also an alternative to the IR range—the ultraviolet (UV) range. But in the UV range, the waves are almost completely absorbed by the atmosphere [2]. In the UV range, in contrast to the IR range, there are physical factors that significantly affect the construction and operation of communication systems [3]. FSO faces the problem of attenuation due to object obstructions and weather conditions [4]. Atmosphere and weather conditions such as fog, rainy weather, and snowfall are the main causes of signal absorption and scattering. In addition, obstacles in the form of birds or insects cause interrupt the transmitted optical signal [5, 6]. In [7], it is proposed to use several transmission sources between the stations, that is, to use the well-known multiple-input–output method (MIMO) to reduce the weakening. A technology for combining laser beams for a multi-beam FSO system is also proposed, which alleviates problems arising from weather attenuation (absorption and scattering) and losses that occur in the received side due to losses in the detector [8].

In the context of this study, it is important to propose the method of transmitting an optical signal that would allow it to use it for groups of unmanned aerial vehicles (UAVs). It is necessary to propose a method that will extend the distance to transmit an optical signal and provide its quality the same throughout the transmission. BPL groups that are considered as a cyber-physical system are critical to the quality of data transmission. Firstly, UAVs must be constantly obtained and transmitted telemetry to properly evaluate the position. Secondly, it is important to receive managing commands to achieve goals. The optical communication channels are struck by many natural factors that worsen them. At the same time, it is more difficult for the attacker to attack them, and in this attractiveness for cyber-physical systems. Thus, it is necessary to consider the possibility of improving the cash signal in various environmental conditions.

2 Data Transfer Technologies

The development of wireless communication laid the foundation of new high-performance methods of data transmission. The first classic and simplest option for using one transmitting and one receiving antenna is shown in Fig. 1. In terms of terminology, such system is called SISO—Single Input Single Output. FSO system using SISO signal transmission is more sensitive to atmospheric attenuation due to weather influences and interruptions due to hurdles such as birds and insects. WDM is used to improve the transmission quality of the FSO by allowing power scaling

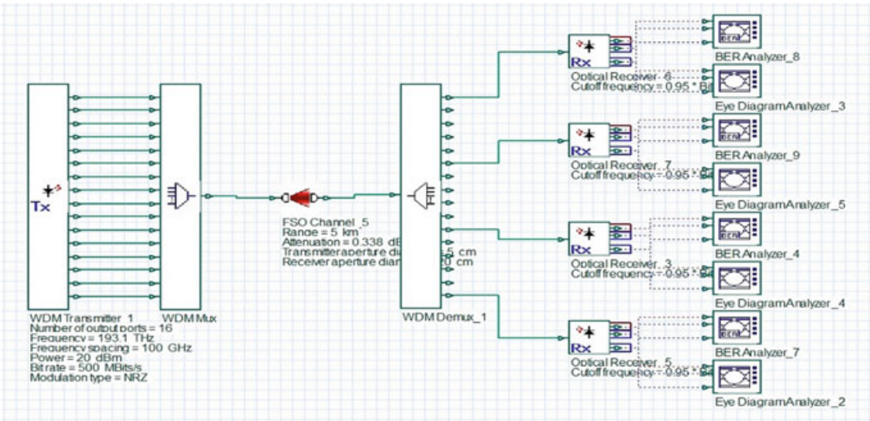


Fig. 1 DWDM-SISO modeling

and increasing the speed and bandwidth of the links. WDM has gained its popularity around optical fiber communication systems. There are two types of WDM: (CWDM) coarse and (DWDM) dense—classified depending on the distance between the channels.

In addition, WDM is a method in which, by using various wavelengths, you can use several optical communication channels within the same data transmission medium. WDM is a counterpart to frequency division multiplexing (FDM), but using wavelengths or frequency range is the main difference between the two methods [4]. The demultiplexers located on the receiving side of the WDM communication system recover the data. WDM allows the use of protocols with characteristics, including those with different speeds of fast data transfer [5, 9], which is an important condition when using measures to improve the data transmission system.

3 The Influence of Weather Conditions on Free-Space Optical Communication

The biggest problem for implementing free-space optical communications is weather attenuation, which occurs due dispersion and absorption. Particles of water and carbon dioxide are the main reasons of signal adsorption. Wherein, various environmental conditions, such as rainy weather, haze, significant cloud cover, and snowfall, are the main causes of optical scattering in free space. Scattering causes part of the beam to deviate from the desired direction. The weather attenuation expression is given in formula (1):

$$A_{\text{atm}} = \exp(-\alpha L), \tag{1}$$

where A_{atm}—general attenuation, α—total coefficient of attenuation, and L—length of transmission path. The total coefficient of attenuation is calculated in accordance with formula (2).

$$\alpha = \beta\alpha + \beta s, \tag{2}$$

where $\beta\alpha$—coefficient of absorption attenuation, βs—coefficient of scattering attenuation. FSO uses such opportunities of using waves that modification of assembly power is impossible, and absorption consumes the same [10]. The overall attenuation coefficient is found by the formula (3):

$$\alpha = \beta s. \tag{3}$$

3.1 Attenuation in the Fog

In this study, we consider fog as an accumulation of particles of vapor, water, smoke, ice, or all together, which usually forms near the earth's surface. At the same time, one of the main reasons that degrade the quality of data transmission over optical communication channels is the formation of fog [11]. The limitation of the traditional way of calculating fog attenuation depends on the particle size radius. As a rule, it is difficult to determine what size the particles are [5]. Therefore, calculating the attenuation value for an optical communication channel, as in Eq. (4), becomes a rather difficult task:

$$\beta_s = \sum_{i}^{n\max} \left(n_i * Q_i \pi r_i^2\right), \tag{4}$$

where β_s—attenuation of scattering, n_i—distribution of particles, Q_i—dissipation efficiency, r_i—particles size radius.

To improve the calculations, the need to consider the particle size is eliminated, and only the quality factor and the visibility range in fog conditions are considered. Let's define that atmospheric visibility is such a distance to the object, when the violation of the proportion of the image is approximately five percent of the original image, considering its proximity. [12]. The visibility range is calculated at a wavelength of 550 nm, which corresponds to the highest solar spectrum intensity. Attenuation depending on the range of visibility was calculated in accordance with Eq. (5) [5, 13]:

$$W_{\text{FOG}} = \frac{10\log(v\%)}{v\,\text{km}} \left(\frac{\lambda}{\lambda^o}\right)^{-q} = \frac{13}{v} \left(\frac{\lambda}{550}\right)^{-q}, \tag{5}$$

where W_{FOG}—weakening in fog (dB/km), v—visibility range (km), q—the relative content of particles of various sizes in the rock, regardless of composition, depending on the level of atmospheric transparency, λ—transmitted signal wavelength (nm), λ° = 550 nm designates the standard of visibility of the wavelength corresponding to the maximum solar spectrum intensity. q is calculated in Eq. (6):

$$q = f(x) = \left\{ \begin{array}{cc} 1.6 & v > 50 \times 10^3\,\mathrm{m} \\ 1.3 & 6 \times 10^3\,\mathrm{m} < v < 50 \times 10^3\,\mathrm{m} \\ 0.585v^{1/3} & v < 6 \times 10^3\,\mathrm{m} \end{array} \right\}. \tag{6}$$

3.2 Attenuation in the Rain

The scattering of rain is different from a pure atmosphere. The radius of raindrops after precipitation is in the range of 100–1000 μm, and is much larger than the FSO standard wavelength. As a result, the laser can pass through raindrop particles with minimal scattering effect [14]. The model used to calculate rain attenuation depends on the speed of the rain, the number of raindrops, and their size. Attenuation increases linearly with increasing rain speed. The mean value of the rain speed rises with the increase in the size of the raindrops [15]. The attenuation due to rain is given in Eq. (7) [16]:

$$W_{\mathrm{rain}} = 1.07R^{\frac{2}{3}}, \tag{7}$$

where W_{rain}—weakening in rain (dB/km), R—the speed of which it is raining (mm/h).

3.3 Attenuation in the Snow

Snow pieces are generally larger than raindrops and introduce attenuation into the optical signal that is greater than the effect of rain. The literature reports that the diameter of snow pieces can reach 20 mm or more. This is the main reason for the failure of the communication channel with a narrow laser beam [13]. In addition, the size of the radiated and accepted signal is affected by the size of snowflakes and the rags of snow, as well as how the beam passes through the snow [17]. During the snowfall due to the presence of obstacles, the signal is attached, which depends on the intensity of the snowfall and the speed of the snowflakes [18]. Attenuation is modeled based on the classification—wet and dry snow—and is calculated according to Eq. (8):

$$A\,\mathrm{snow} = \mathrm{mS}^n, \tag{8}$$

where A snow—snow attenuation (dB/km), S—snowfall speed (mm/h), (m, n)—determines the parameters that determine the type of snow activity. These values can be calculated accordingly (m, n) for these types:

- for wet snow: $m = 1.023\,(10^{-4}\lambda) + 3.785;\ n = 0.72,$
- for dry snow: $m = 5.42\,(10^{-5}\lambda) + 5.495;\ n = 1.38.$

Based on the results of calculating the coefficients, it can be determined that a decrease in the quality of data re-prose through optical channels most increases with dry snow. With damp snow, attenuation is observed, but to a lesser extent.

4 Improving the Efficiency of FSO in Various Weather Conditions

Figure 2 shows the developed hybrid MIMO system using multiple transmitters and receivers, which consists of three main parts: a transmitter, a channel, and a receiver.

The transmitter contains a transmitter of 16 subsystems and a WDM multiplexer (WDM Mux). From Fig. 2, you can see that in this scheme there is a component that is located behind the multiplexer. It is called splitter. The branching component is used to generate multiple laser beams from a single source. Each laser beam created after the branching corresponds to another branching component. To increase the power of the optical signal, the laser beams generated by the second splitter are combined in an adder and transmitted to the FSO channel.

The transmitter uses the power of about twenty decibel-milliwatts. The frequency of the light source is 193.1 THz, and the distance between optical channels is 100 GHz. The transmitting and receiving apertures are 5 cm and 20 cm, respectively, and the data rate is 500 Mbps. The FSO channel consists of 4 × 4 MIMO technology, with different attenuation depending on weather conditions. The following

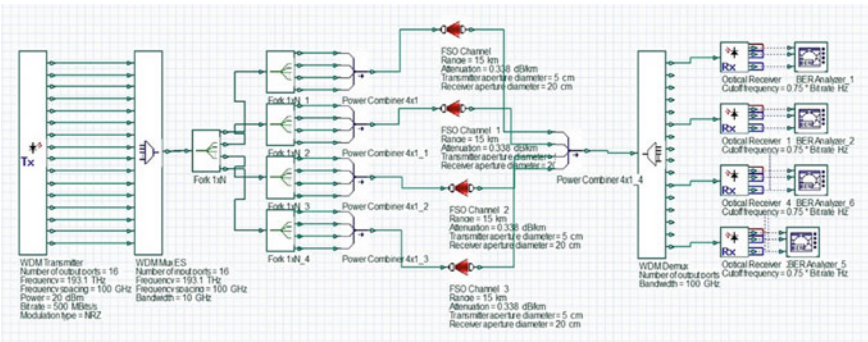


Fig. 2 MIMO simulation model

components are part of the receiver. The power adder is used to combine the transmitted optical signals and then input into the WDM DE demultiplexer, after which the demultiplexing process starts. Then the signal is sent to an optical receiver. The BER analyzer is used to calculate the bit error rate of the received signal. The quality factor of the resulting signal depends on the weather and is calculated due to a decrease/increase in the distance between the components of the optical communication channel. The quality coefficient is related to BER as shown in Eq. (9):

$$\mathrm{BER} = \frac{\exp\left(\frac{-R^2}{2}\right)}{R\sqrt{2\pi}}, \tag{9}$$

where BER—bit error coefficient of the received signal, R—reception coefficient of the receiving signal.

The model was verified using the simulator optisystem [19]. The proposed system is also compared with a conventional DWDM-SISO system, considering atmospheric turbulence under different weather conditions [20, 21].

4.1 FSO Efficiency in Clear Weather and Fog

We will compare the systems: DWDM-SISO, DWDM-MIMO—in fog conditions and in conditions where the conditions do not interfere with the passage of the signal. In this study, a mathematical model was used to calculate weakening based on different visibility ranges (Formula 5). For mild fog, visibility is 50 m > v > 500 m, which is defined as a weakening of 26 dB/km. For thick fog, the visibility is v > 50 m, which is defined as a weakening of 260 dB/km.

Figure 3 shows plots of quality coefficients versus distance using: (a) a DWDM-SISO and (b) a DWDM-MIMO systems in the conditions of the presence of fog and in the absence of obstacles in the sky. Simulation results are following. Clear sky attenuation is 0.338 dB/km. In the traditional DWDM-SISO system, the ICC is reached at 4728 m, and in the proposed DWDM-MIMO system, the ICC is reached at 14334 m. Light fog attenuation is 7.743 dB/km. In the traditional DWDM-SISO system, the ICC is reached at 1490 m, and in the proposed DWDM-MIMO system, the ICC is reached at 2553 m. Mild fog attenuation is 26 dB/km. In the traditional DWDM-SISO system, the ICC is reached at 691 m, and in the proposed DWDM-MIMO system, the ICC is reached at 1051 m. Thick fog attenuation 260 dB/km. In the traditional DWDM-SISO system, ICC is reached at 122 m, and in the proposed DWDM-MIMO system, ICC is reached at 163 m. This means that the MIMO system increases the length of the transmission path by 33.60%.

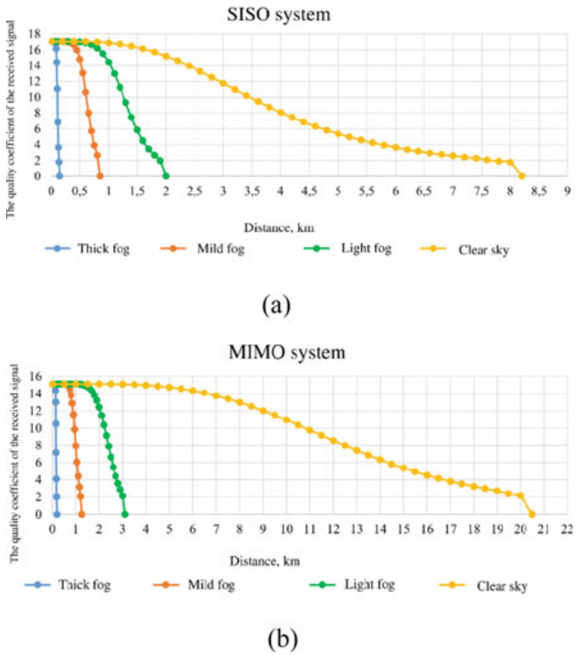
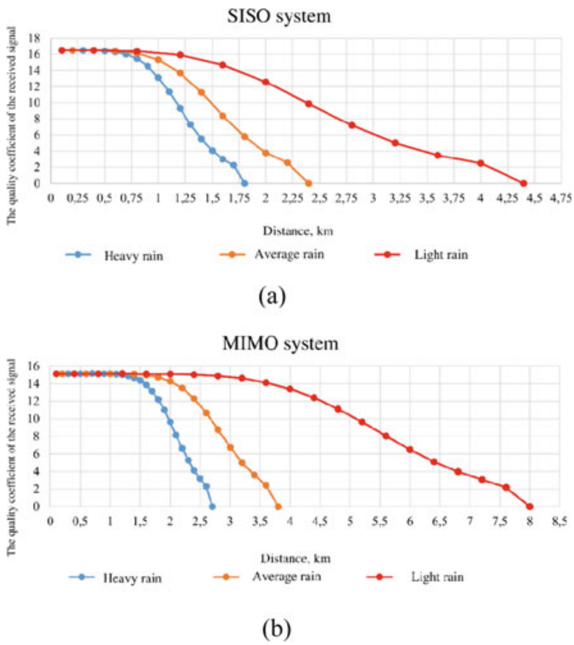


Fig. 3 Dependence of quality coefficient on distance when using: **a** a DWDM-SISO and **b** a DWDM-MIMO systems in the conditions of the presence of fog and in the absence of obstacles in the sky

4.2 FSO Efficiency in Rainy Conditions

The capacity of the traditional DWMD-SISO system and the proposed hybrid DWDM-MIMO system in three rainy weather cases (light, average, and heavy rain) is considered. The weakening in cases calculate by the formula (7), which depends on the intensity of the rain and the wavelength of the transmitted optical signal. In conditions of light rain, the approximate speed is 2.5 mm/h. With medium rain, the approximate speed is 12.5 mm/h. With heavy rain, it will be approximately 25 mm/h. [17]. Figure 4 shows plots of quality factor versus transmission distance using (a) a DWDM-SISO system and (b) a DWDM-MIMO system in rain conditions. Simulation results are following. Light rain attenuation is 1.988 dB/km. In the traditional DWDM-SISO system, the ICC is reached at 3021 m, and in the proposed DWDM-MIMO system, the ICC is reached at 6140 m. Average rain attenuation is 5.8444 dB/km. In the traditional DWDM-SISO system, the ICC is reached at 1782 m, and in the proposed DWDM-MIMO system, the ICC is reached at 3086 m. Heavy rain attenuation is 9.29 dB/km. In the traditional DWDM-SISO system, the ICC is reached at 1371 m, and in the proposed DWDM-MIMO system, the ICC is reached at 2247 m. This means that the MIMO system increases by 63.89% of the transmission path length.

Fig. 4 Dependence of quality coefficient on transmission distance when using: **a** DWDM-SISO system and **b** DWDM-MIMO system in rainy weather conditions



4.3 FSO Efficiency in Dry Snow Conditions

The performance of the DWMD-SISO system and the proposed hybrid DWDM-MIMO system are evaluated in different weather conditions with dry snow. Dry snow attenuation is calculated based on Eq. (8), which expects on snow speed (S). This work considers three types of dry snow conditions: light, average, and heavy, which are defined based on the average snow speed. The speed of snowfall changes depending on the type of snow. If dry, not very intense snow is observed, then the speed is estimated at 2.5 mm/h. If there is an average snow intensity and it is dry, then a speed of 5 mm/h is observed. With intense snowfall, the speed can reach 10 mm/h [17]. The weakening of the optical signal can be calculated according to Formula (8) knowing the speed of snow. Figure 5 shows quality factor versus path length plots using (a) a DWDM-SISO system and (b) a DWDM-MIMO system under snowy conditions. Simulation results are following. Light dry snow attenuation is 19,356 dB/km. In the traditional DWDM-SISO system, the ICC is reached at 684 m, and in the proposed DWDM-MIMO system, the ICC is reached at 1316 m. Average dry snow attenuation is 50,654 dB/km. In the traditional DWDM-SISO system, ICC is reached at 440 m, and in the proposed DWDM-MIMO system, ICC is reached at 627 m. Heavy dry snow attenuation is 131,835 dB/km. In the traditional DWDM-SISO system, the ICC is reached at 213 m, and in the proposed DWDM-MIMO system, the ICC is reached at 288 m. This means that the MIMO system increases the length of the transmission path by 35.21%.

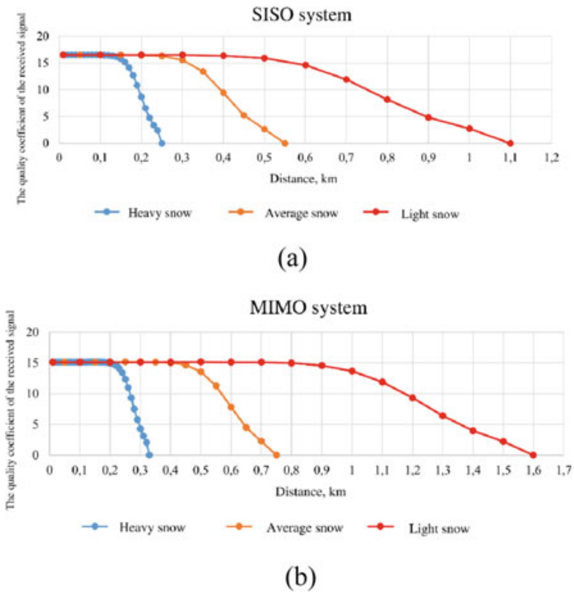


Fig. 5 Dependence of the quality factor on the length of the transmission path using: **a** DWDM-SISO system and **b** DWDM-MIMO system in snowy weather conditions

The obtained results are presented in Table 1, which demonstrates a significant improvement in the use of the proposed system compared to the traditional DWDM-SISO system for free space optical system. As the results, the quality coefficient decreases as the length of the transmission path increases. It has to do with damping. However, the proposed system can transmit a signal over a greater distance with better quality in all weather conditions. It's achieved using MIMO technology. The MIMO technology used creates redundant transmission paths that help overcome obstacles, while DWDM allows to improve the possibility of increasing the number of transmitted signals.

Table 1 Comparison of DWDM-SISO and DWDM-MIMO systems at maximum transmission length under various weather conditions

Weather	SISO (m)	MIMO (m)	Improvement (%)
Clear sky	4728	14,334	+ 203.17
Light fog	1490	2553	+ 71.34
Mild fog	691	1051	+ 52.09
Thick fog	122	163	+ 33.6
Light rain	3021	6140	+ 103.24
Average rain	1782	3086	+ 73.17
Heavy rain	1371	2247	+ 63.89
Light snow	864	1316	+ 52.31
Average snow	440	627	+ 42.5
Heavy snow	213	288	+ 35.21

5 Conclusion

Although the FSO has major benefits, including high data transfer rate, security, and capacity, it in trouble, especially due to different weather factors. The problem of using optical channels is quite existing. This problem is important in the conditions of use of unmanned aerial vehicles (UAVs) as a reserve communication channel. UAVs can be attributed to cyber-physical systems (CFS), in turn, for the CFS, an important factor is the use of reliable communication channels to transmit telemetry and control commands. In this article, modeling and testing of various data transmission systems on optical communication channels were carried out. Modeling various weather conditions occurs. Considering the worst weather conditions causing high attenuation, the path length: with a heavy fog attenuation of 260 dB/km, increases by 33.6%; attenuation in heavy rain 9.29 dB/km increases by 63.89%; at attenuation in conditions of heavy dry snow 131,835 dB/km increases by 35.21%. It is worth highlighting the advantage of the proposed system. It can be used in locations with harsh weather conditions such as heavy fog, heavy rain, snow, and dust storms. Unfortunately, in the case of UAV systems, it is necessary to consider not only weather conditions, but also the vibrations that occur during the flight of the UAV. In addition, the wind has an influence not only on snow and wind, but also on the UAV itself. All these factors can worsen the transmission. The use of optical communication channels is possible when solving the tactical problems of the UAV groups. When the UAVs are not far from each other, within direct visibility. The main channel of communication is still to be considered a communications radio channel. At the same time, several UAV tasks are essential, which should be performed in the radio mode of silence. In the future, it is planned to simulate optical communication channels in vibration conditions and a hustling of wind, which can shift the source and receiver.

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Comparative Analysis of Social Media Creditability Assessment Using Machine Learning Approaches

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Abstract Social media and its regular use is an important part of our life. It is regarded as one of the most crucial information sources in comparison with traditional ones. Among, Twitter has become one of the most popular social media platforms for communicating news, ideas, and emotions. The detection of the news creditability is an important analysis. In this paper, we proposed machine-based news social media creditability assessment and comparative analysis of predicted results using of the various algorithms. Finding new features which will use for predictive analysis and to improve performance of classifiers is one of the credibility detection challenges. Naive Bayes (NB), support vector machine (SVM), K-nearest neighbors (KNNs), random forest (RF), and decision tree (DT) were applied over Fake News Net, LAIR, and SemEval datasets for the purpose of analysis assessment. SVM-based creditability assessment provides good results using Fake News Net dataset. SVM gives accuracy (72%) and (70%) for Naïve Bayes for the same dataset. Using both types of features and a stack classifier, we were able to attain the best results. Performance is measured by different measurements accuracy, precision, recall, and $F1$-score.

Keywords Credibility detection · Machine learning · Social media credibility · Credibility framework · Social media datasets · Naïve Bayes · Support vector machine

1 Introduction

Currently, over social media, huge amount of content is created. People read, write, and tend to believe the content reactions accordingly. The exactness of information in the content is necessary which not mislead the people. Data mining and extraction of useful information are a challenge. Credibility is decided by classifying the information into credible and non-credible information [1, 2]. Content is defined by

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the user's perspective and understanding, and it may contain variable percentages of information. The challenge of extracting the correct information from a narrative, post, blog, tweet, or microblog is difficult [3]. Incomplete, unreliable, contradictory, and invalid data create uncertainty in the predictions. All of this content deceives then users, and it may have led to an incorrect opinion, thinking or decision based on it. It leads to inaccurate opinions, reasoning, and decisions. The credibility of news content is determined, i.e., whether it is fake or real. Therefore, it is necessary to specify the material that will be examined for credibility. If information's reliability is not evaluated, it is possible that it will spread inorganically. Spam, unethical marketing, clickbait, Fake News, and attractive content with irrelevant information are all examples of this type of content [2, 4].

Machine learning is great demand for the various kinds of predictions and analytics. Nowadays, machine learning is used in various sectors like health, agriculture, education, engineering, government, smart cities, and vehicles industries for prediction of the various solutions and analysis of the various problems. In social media, machine learning will help to solve the problem of user identification, detection, or its behavior analysis [5, 6]. Making sense [7], rumors detection [8, 9], Arabic content analysis [10], and identify creditability are a complex problem in social media [11]. It is very important in the social media to prevent unauthorized users and detection of Fake News. Over Twitter, news creditability analysis is an important part which can be solve using the machine learning-based approach. The supervised-based machine learning approaches will help to asses and predict news creditability [7]. So we have proposed and stated analysis of news credibility assessment and analysis in this paper.

2 Literature Review

To enhance the social media news credibility, various machine learning techniques have been proposed by various authors which are discussed here.

In the duration of year 2019–2022, various articles presented literature and research on information credibility, Fake News detection, and trust in social media content. Another phase centers on the posts entitled NEWS, classifying it as true/false, which create assumption and challenge for the identification. Use of multiple classifier such as SVM, decision tree, decision rule, and Bayesian networks on the noted information for the classification of the news [12]. A framework to detect credibility of social media datasets was presented, and the technique is quite good in assessing the credibility of the datasets to detect negativity in posts on social media but lacks to explain how it can be implemented programmatically with multiple datasets and check their credibility [8]. Public shamming on Twitter using SVM technique is presented [9]. This technique is quite good in detecting public shamming, but analysis and use over multiple dataset are stated.

Some researchers applied the features centered on the content and social networking features, with machine learning classifiers: SVM, random forest, Naïve

Bayes, MaxEnt, CRF, and found CRF achieved the highest precision and $F1$-score [13]. It was noticed that tweets get fast responses from the public, who frequently express suspicion and doubt about rumor tweets [10].

Sections 1 and 2 describe the introduction and related work. Proposed system model is presented in Sect. 3. Experimental results and discussion based on the proposed approach are presented in Sect. 4. Conclusion drawn based on the experimental results is presented in Sect. 5.

3 Methodology

The methodology used for the assessment of news creditability presented in this section. The use datasets, preprocessing of data, and creditability assessment model with comparative assessment are briefly presented. The methodology elaborates use of supervised machine learning for classifying the dataset and analyze news creditability in the percentage. Initially, preparation of the dataset for classification, followed by preprocessing, accessing multiple datasets, then perform the training and testing of dataset. Finally, machine learning-based methods are applied to detect creditability.

3.1 Multiple Dataset Collection

The dataset is an important component for the machine learning approaches. We have referred three different datasets for news creditability assessment which are downloaded from standard Twitter online repositories. Mainly, LIAR, Fake News Net, and SemEval are downloaded and used for this work. Initially, these datasets are stored in stored on local system for assessment. After preprocessing, those are trained and tested and finally used for machine learning-based approach. Multiple datasets are used to identity different types of tweets creditability and comparative analysis of predictions.

3.2 Preprocess Multiple Datasets

Preprocessing is important for the accurate results predictions and analysis of the data. In the Twits news data, unwanted errors are there which are to be cleaned using preprocessing. Further, we removed stop words, and then lexicon analysis was performed. We then keep only grammar words and rearrange the datasets for assessments. Tweet preprocessor will help to removal of stop words, digits punctuations tokens, and adding it in cleaned dataset for further processing. Many times raw data contain redundant and problematic content which require preprocessing. Our preprocessing module cleans, and only grammars words are used for the assessment.

3.3 Assess Multiple Datasets

Main aim of the preprocessing is to prepare best dataset which will used to machine learning approach for greater result and high performance. In assess multiple dataset module, we fetched and rearranged datasets. Then using train–test module, dataset is converted into training and testing sub-datasets. We have divided datasets into 80 and 20% for training and testing. After successful conversion of training and testing datasets, we have applied machine learning-based approaches for news data creditability predictions.

3.4 Proposed System Architecture

The overall creditability assessment process and architecture is presented in Figs. 1 and 2, respectively. The main aim of the paper is to present machine learning-based approach for creditability assessment and comparative analysis of the predictions. The datasets and preprocessing part of the architecture are presented earlier in the section methodology. Analysis and assessment are based on conducting various experiments on dataset using the different algorithms like random forest, SVM, and Naïve Bayes.

We applied five traditional machine learning classifiers and compared the performance of the models. The models are support vector machine (SVM), random forest (RF), logistic, Naïve Bayes (NB), random forest (RF), and *K*-nearest neighbors (*K*NNs) to find the best one approximately to 0 and activation standard deviation close to 1. We have presented algorithmically flow of the Fake News dataset assessment using SVM and NB in this paper (Algo 1). The result gain from these algorithms is high as compared other; therefore, they are presented and discussed here.

Initially, using FetchTweet() function, the data are fetched for the purpose of assessment. After successfully fetching tweets, the number of words are counted for preprocessing process. CleanTweets() and RemoveStopwords() functions were used to clean the dataset and remove all kind obstacles present for future accurate predictions. Accuracy and performance of the system are depend on the preprocessing of

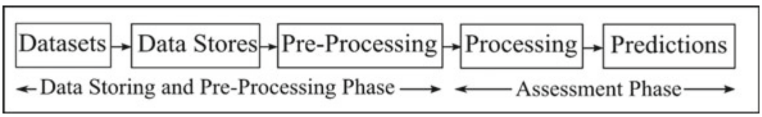

Fig. 1 Creditability assessment process

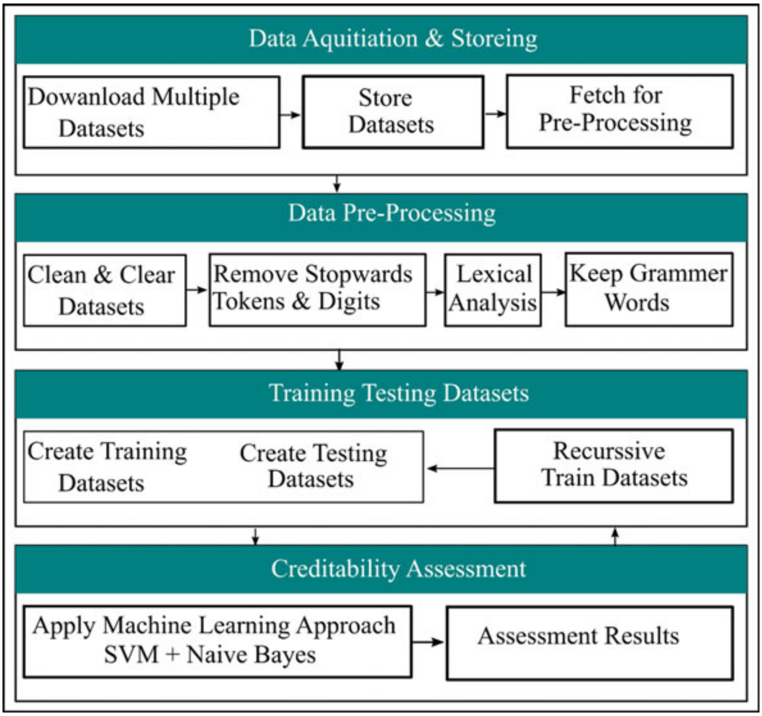

Fig. 2 Schematic representation of system architecture

the data so these functions help better for increasing accuracy and performance. Then, training and testing datasets are generated using train–test functions. The training of the dataset is using both algorithms svm.fit(train) and nb.fit(train) performed. After successfully training both algorithms, they are tested using testing dataset to check the prediction accuracy and performance of the system. The detail evaluation and performance measures are discussed in Sect. 4.

4 Results and Discussion

We compare the outcomes of SVM, NB, and other machine learning algorithms separately to see which one performs the best. The Naïve Bayes results for the Fake News dataset are presented in Table 1. We have evaluated precision, recall, $F1$-score, and support measures for both algorithms. In addition, results are presented as fake and real with accuracy in this paper.

The graphical representation of the results using Naive Bayes algorithm is presented in the Fig. 3. Accuracy for the same is 72% as shown in Table 1. SVM algorithm results graphically presented in the Fig. 4. Accuracy for the same is 70%

Algo 1 Algorithmic flow for Fake News dataset assessment

Classifier	Statements
1.	procedure ASSESS-FAKE-NES
2.	tweets[] = FetchTweetsFromTwitter()
3.	tweetsCount = tweets.length()
4.	if tweestCount == 0 then
5.	for i = 0; i < tweetsCount; i++ do
6.	cleanTweets(tweets(i))
7.	removeStopwords(tweets(i))
8.	extractFeatures(tweets(i))
9.	end for
10.	lCount = readFakeNewsDataset()
11.	if lCount > 0 then
12.	train = CreateTrainingDataset()
13.	SVM = svm.SVC()
14.	SVM.fit(train)
15.	NB = MultinomialNB()
16.	NB.fit(train)
17.	Else
18.	Fetch Fake News Dataset first
19.	result ← Exit procedure
20.	end if
21.	test = createTestingDataset()
22.	predictionsSVM = SVM.predict(test)
23.	predictionsNB = NB.predict(test)
24.	Else
25.	Repeat Step 2:
26.	end if
27.	View Fake News dataset classification
28.	end procedure

Table 1 Naive Bayes results for Fake News

Measures	Precision	Recall	$F1$-score	Support
Fake	0.70	0.75	0.72	240
Real	0.74	0.70	0.72	250
Accuracy	–	–	0.72	490
Macro avg	0.72	0.72	0.72	490
Weighted avg	0.72	0.72	0.72	490

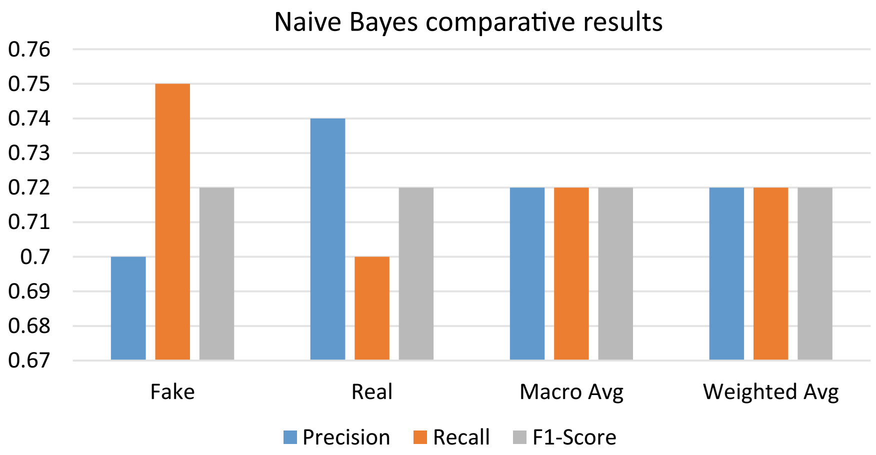

Fig. 3 Comparative results of NB algorithm

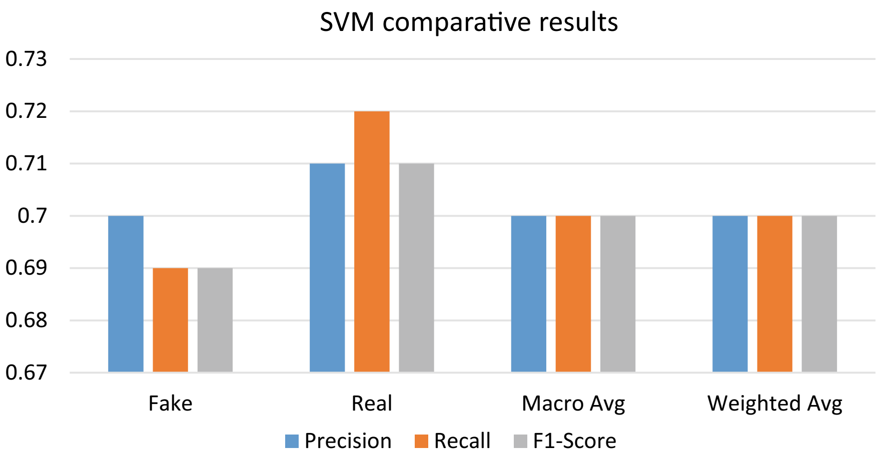

Fig. 4 Comparative results of SVM algorithm

as shown in Table 2. The comparative results of various algorithms are presented in Fig. 5. The Naive Bayes and stacked model give better accuracy as 72% and 71%, respectively, as compared to other machine learning algorithms (Table 3).

5 Conclusion

In this paper, we have presented and evaluated accuracy and performance using machine learning approaches for the dataset of Twitter. The user creditability is

Table 2 SVM results for Fake News

Measures	Precision	Recall	$F1$-score	Support
Fake	0.70	0.69	0.69	240
Real	0.71	0.72	0.71	250
Accuracy			0.70	490
Macro avg.	0.70	0.70	0.70	490
Weighted avg.	0.70	0.70	0.70	490

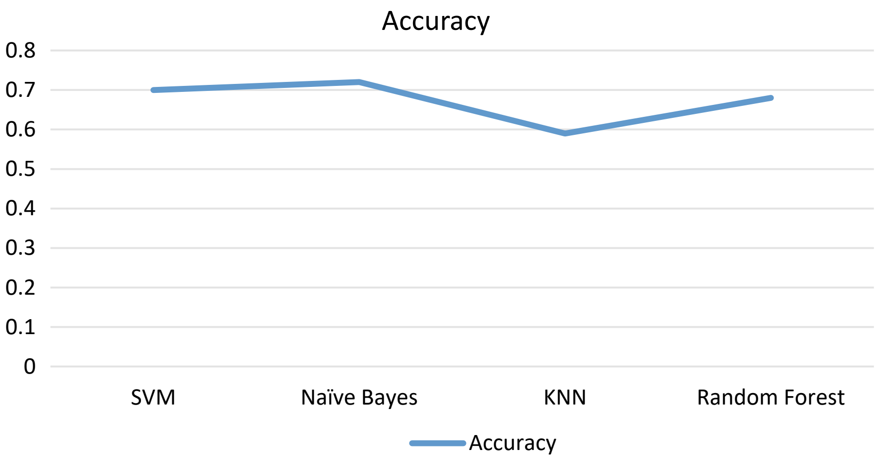

Fig. 5 Comparative results of machine learning models

Table 3 Comparative results for stacked classifier

Classifier	Accuracy
SVM	0.70
Naïve Bayes	0.72
KNN	0.59
Random forest	0.68
Decision tree	0.58
Stacked model	0.71

assessed using SVM and NB algorithms for Fake News dataset. The fake and real tweets were analyzed for the multiple dataset using multiple machine learning algorithms with multiple datasets. The Naïve Bayes and SVM give more accuracy for the Fake News dataset which is presented in this research. In addition, stacked model gives better performance 71% as compared to other models. Naïve Bayes also gives good results for the Fake News creditability assessment. Using multiple machine learning approaches, we have assessed creditability and compared their results.

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Mid-Air Gesture for Hand Control System Using Leap Motion Robot

B. C. Kavitha, B. Philip Delapierre, P. Venkata Vikas, and Shaik Thohid

Abstract This paper proposes the design of a model that enables a communication between human hands and the robotic module. This is performed by human–machine interaction which is the interface between people and computers. For this, a leap motion controller is used, a device that can be able to sense and track hand gestures. The direction of the robotic module is controlled by human hand gestures in three directions based on cartesian co-ordinate system. The performed hand gestures are observed through leap motion controller and translated into commands through which the robotic module is controlled. Here, a mobile robot on four wheels is designed which has the ability to detect obstacles during its mobile movement.

Keyword Leap motion controller · Gesture recognition · Obstacle detection

1 Introduction

Over the years, researches has been carried out to enhance the interaction between human and computer. As a result, due to the advanced development in the research of robotics, hand recognition system has eliminated the use of wired communication, analog joysticks, and mouse control. The existing method in the process of tracking system includes vision-based and gyroscope or accelerometer-related tracking system. Optical devices like leap motion controller, Microsoft Kinect Sensor, and Camboard PICO are examples of vision tracking systems [1–3]. Both systems have equal advantages and disadvantages. Vision-based system has interference to users like eye gazing and head gestures. It may result to the possibility of focusing objects around the targeted objects and may results to wrong manipulations. On the other side, the non-vision-based system has not the ability to provide 3D co-ordinates of the hand movements and may lead to errors.

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The sensor used for hand tracking in this project is leap motion controller. An optical hand tracking device manipulates digital objects and can capture the movements of hands with an unparalleled accuracy [4, 5]. The Leap motion sensor is designed in a way that it has two infrared camera modules and three infrared LEDs in order to track the hand movements roughly through a distance of about 1 m. The viewing range for this sensor is roughly 60 cm above the device. The light intensity emitted by the LEDs is then transferred to the host computer via USB cable where the sensor data are read and manipulated.

Despite the availability of various tracking sensors like Microsoft Kinect, the purpose of using leap motion controller in this project is low cost when compared to other available hand tracking sensors and is specially designed for tracking hand movements. Apart from that, it has library availability, accuracy for the application used, and is lightweight and portable. The design of both hardware and software of this sensor and the above-mentioned features are the reasons for the selection of leap motion controller [6, 7].

In this paper, a key strategy is proposed using this sensor (1) To enable communication between the hand and the robotic module. (2) To control the robot through simple hand gesture in required direction. (3) To detect the obstacles lying during the mobile motion of the robot. The design, implementation, working, and results are discussed in the following sections.

2 Related Works

Gesture recognition has led to the design of various models like robotic arm and anthropomorphic gripper to perform hand gestures. Each model has its own drawbacks. Certain limit positions have been set for the movement of the arm which performs limited movements in certain directions. In case of anthropomorphic gripper, the model has been intended to perform grasping movements on particular objects.

In [8], the authors proposed a human–robot interaction using an augmented reality interface. It is based on a system that recognizes hand gestures extracting features of coordinates thereby predicting the complete hand model. The length, angle, and angular velocity features are extracted, trained, and accuracy is checked.

In [9] a head-gesture-based control robot is proposed. The designing of a hand less interaction with the robot providing gestures like eye gazing and head movements that are to be performed in a virtual environment. Comparative analysis is carried out for robotic manipulations. This system has a disadvantage of having the possibility of focusing objects around intended target objects which results to wrong manipulations when head gesture is performed.

Jackowski et al. [10] propose a gesture recognition system for controlling a virtual hand. It includes a design of a virtual hand gripper with fingers that tends to perform gripping action through commands. The test was experimented by gripping on a particular object like screw spanner. Evaluation of efficiency of the gripping process is performed on the object, its functionality aspects are observed, and control strategies are carried out. It has a drawback of performing the action on particular objects.

In paper [11], the authors proposed a human–robot interaction via pointing gesture navigation. This model focuses on the manipulation of the robotic arm that tends to perform the natural gestures by means of hand pointing indication. The concept of linear HRI is used to control the robot by hand gestures. It focuses on a concept that improves the efficiency and functionality of the performed natural hand gestures. The implementation phase of the gestures is carried out in virtual environment.

Vision-based hand gesture recognition was proposed in [12]. The proposed paper presents a hand-free vision-based eye gazing technique for human–robot interaction which focuses on objects need to be focused according to eye movements.

In this paper, the physical movements of the hands are sensed by Leap motion device and then transferred to Zigbee TX through wireless communication in serial data. The data are received by the receiver to Arduino UNO and writes a program to the driver circuit for serial communication. The DC motors are in turn controlled by the driver circuit. The gesture recognition behind leap uses the reflected IR signal by the integrated LEDs which converts the physical motions of the hand movements like velocity, orientation, direction, and distance to digital data. The gesture recognition requires simple hand movements in Forward–Backward-Left–Right and is sensed accurately. The mobile motion of the robotic module can be interrupted by any obstacle detected, and is indicated by LED.

3 Proposed Work

The leap motion controller is peripherally connected to a PC or laptop placed facing upward. The hand gesture movements are sensed by the leap motion sensor, and the values are derived by the performed movements as shown in Fig. 1.

The direction of the movement is controlled by right-hand cartesian system in three motions, namely, X, Y, and Z. The values are then transferred to the computer port and are then converted into serial data through Python. The serial data are transmitted through the transmitter wirelessly through Zigbee wireless sensor network. These data are received by the receiver on the robotic module and are transferred to the Arduino microcontroller through the UART protocol which is used for device-to-device communication. Two 100 rpm DC motors are interfaced to the Arduino, which are controlled by the driver circuit and accordingly the robot module is driven.

4 Results and Discussion

This section presents the results of the proposed method of control of the robotic module technique is based on performed hand gestures, and the priority of the

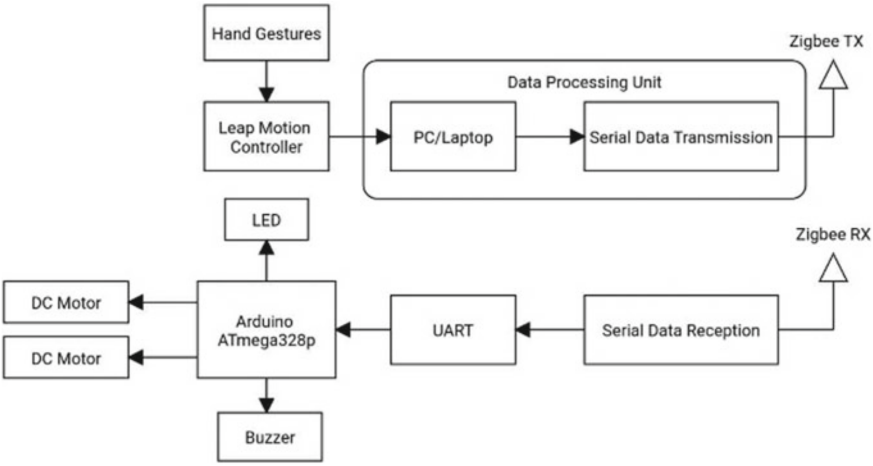

Fig. 1 Block diagram of the proposed method

proposed model is proved through the analysis of the proposed method seems to be performing the desired movements with good accuracy.

Step 1: The Leap software 'Windows Powershell' is opened. The preliminary commands are specified as shown in Fig. 2. E.g., the location of the code for the software to read (D:) and the name of the file.

Step 2: After the above step is completed press 'Enter'. Now the leap motion controller starts reading the values as indicated in Fig. 3. The hand gestures are

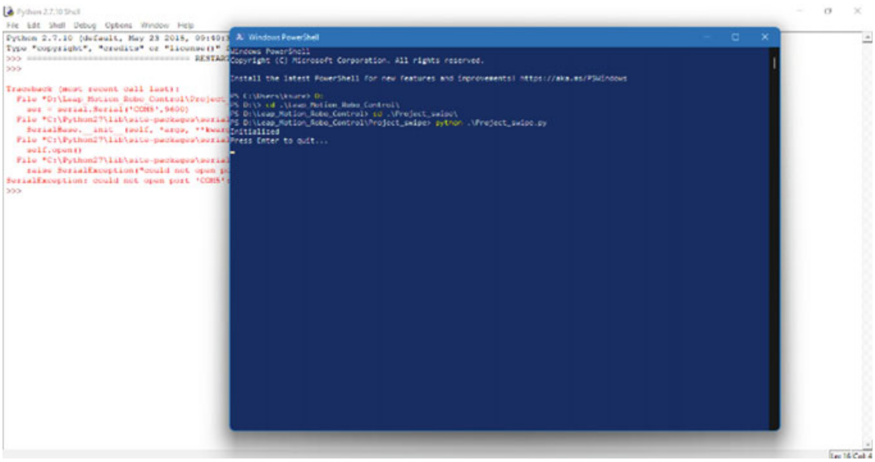

Fig. 2 Initial set-up of leap motion software

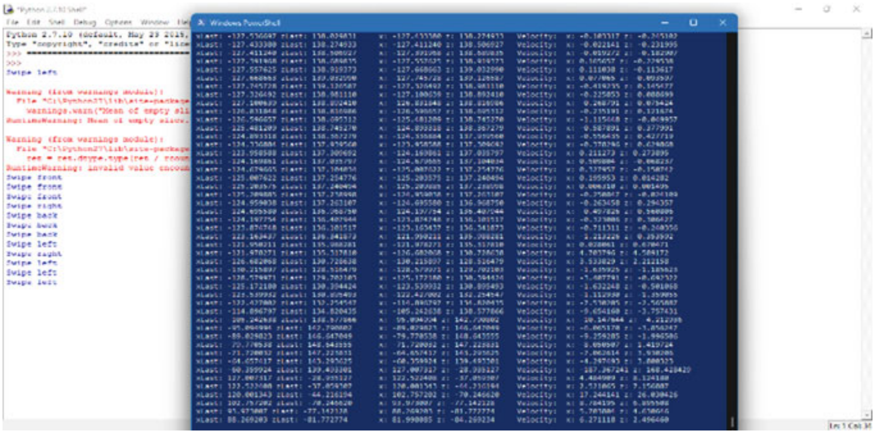

Fig. 3 Processing of data

performed in front of the leap sensors which in turn converts the gestures into frame values.

Step 3: According to performed hand gestures in each directions, the software indicates in which direction the hand gesture is performed as can be seen in Fig. 4. For e.g., Swept front, swept back, swept left, and swept right.

After the completion of the above steps, the processed commands are then transmitted by Zigbee TX which in turn is received by the receiver on the robotic module (see Fig. 5). These commands are read by the microcontroller, and the robotic module is set to perform the desired movements according to the hand gestures in four directions, namely, front, back, left, and right.

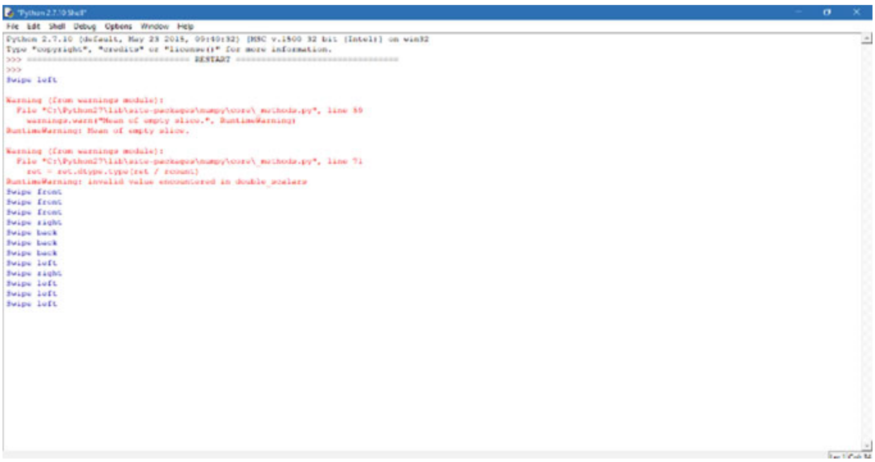

Fig. 4 Recognition of commands

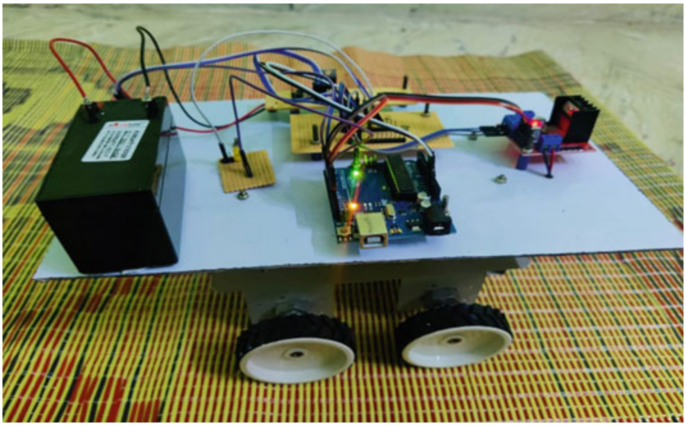

Fig. 5 Design of hardware model

5 Conclusion

The work changed into test that is viable to carry out a teleportation thinking of the layout and development of robotic control the usage of leap motion sensor mechanism. For the development of the involvement of the robotics in the society in the coming days, it is better to approximately sketch out how robots engage to produce a natural interplay. This helps humans to sort out an innovative technique to control the robot just through the natural action gestures for the humans to communicate with the robot in an efficient way. Concerning to future works, it is simply recommended using processes of avoiding of vehicle collision many of the limbs, and a strong stability module to works that technique helps and manages the frame work of robots through less interpretation.

6 Future Scope

This paper focuses on controlling of the robotic module in four directions through four hand gestures. In the future, this model can be developed into a mobile robotic arm or vision-based system which has interference to users like eye gazing and head gestures. For e.g., developing a vision based tracking system by focusing on a desired direction in which the module should move and with head gesture to control the robotic arm on the module. This concept will open doors to more opportunities in the field depending vastly on this gesture recognition through this proposed idea.

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Controlling Wheelchair Based on Brain Waves for Paralyzed People

B. C. Kavitha, D. Sai Sathrughna, V. Chaithanya Sai, A. Nuthan Abhiram, and M. Sujatha

Abstract This venture investigated the advancement of a mind-controlled robot utilizing cerebrum PC associations (BCI). BCIs are structures that can sidestep customary channels of correspondence (i.e., contemplations) give straight correspondence and control in the human psyche and genuine devices by persistently translate assorted cases in frontal cortex development into orders. These orders can be utilized to work a compact robot. This undertaking will likely foster a robot that can help outwardly disabled individuals in their regular routines by doing certain labor that would otherwise be done by others. This paper basically focuses on mind wave signals. Millions of linked neurons make up the human cerebrum. Considerations and excited emotions are examples of connections between these neurons. As stated by the human thoughts, this will change, resulting in distinct electrical waves.

Keywords Brain computer interface · Neurosky mind wave · EEG · Wheelchair

1 Introduction

The possibility in PCs being compelled by the person psyche for quite some time been explored and researched. Cerebrum PC connection point is basically a correspondence method that permits people and PCs to speak with each other. Mind cues act as the essential vehicle for this correspondence. An exceptional mind cue is made in the cerebrum for every human development or action like strolling, hearing, chuckling, sobbing, playing, etc. This mind cue, otherwise called an activity potential, corresponds to the movement that is being finished. Interfacing the cerebrum to a PC permits truly impaired people or those with engine hardships to attempt an assortment of exercises, working on their personal satisfaction and giving them more prominent

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autonomy [1]. Different mind cues connected with different exercises have been found in the writing and are generally ordered into the accompanying classes: (1) The alpha musicality (8–13 Hz), (2) Beta rhythms (more than 13–30 Hz), (3) Gamma rhythms (30–100 Hz or more) (4) Delta beats (up to 4 Hz) Theta rhythms (4–8 Hz) (6) Mu beats (8–13 Hz). These inspirations may be recorded by partner sensor to the noodle of frontal cortex. The information caught/got by adding cathodes to these focuses can then be handled and analyzed to decide or decipher the genuine movement directed. Numerous BCI frameworks have been proposed throughout the course of recent many years, with most of them zeroing in on applications, for instance, 1D and 2D mouse pointer headway control, wheelchair control, speller frameworks, and mechanical control. Mind prompts have likewise used in PC games. Mind prompts have in like manner been utilized in PC games. A kind of EEG signals utilized in BCI applications can be used to organize the applications [2].

Despite extensive research, BCI still has numerous drawbacks, including high hardware reliance, low accuracy, the need for subject training, and expensive implementation costs. Furthermore, the majority of BCIs have been endeavored and tried using information accumulated from ordinary patients. At the point when these advancements are utilized by crippled people or those with engine challenges, we might get various results.

2 Literature Survey

Individual Authentication Using Brainwaves (EEG) and Maximum a Posteriori Model Adaptation were introduced in [3], which concentrates on the utilization of cerebrum movement for individual validation in this examination. Past examination has demonstrated that every individual's mind wave design is extraordinary and electroencephalogram (EEG) might be utilized for fingerprint distinguishing proof [4, 5]. EEG-based fingerprint is an original report region that they expect will prompt new exploration headings and applications later on. Nonetheless, moderately little exploration has been led around here, with the accentuation for the most part on individual recognizable proof as opposed to individual authentication. Person confirmation looks to acknowledge or dismiss an individual guaranteeing a personality by matching biometric information to a solitary layout, though individual ID tries to match biometric information to all passages in a data set. A measurable structure in view of posterior model adaptation was proposed, which has been effectively used to speaker and face validation and can deal with just a single instructional course. To exhibit the capability of innovation, they run extreme exploratory reenactments using many tight train/test methods. They likewise show that there are a few mental errands that are more fitting for individual validation than others.

Subtle biometric system based on electroencephalogram analysis was presented in [6], where highlights gathered from electroencephalogram (EEG) accounts have been demonstrated to be unmistakable enough between members to be utilized in biometric applications. They exhibit that biometry in view of these accounts gives a remarkable strategy to vigorously validating or distinguishing people. They offer in this work a speedy and subtle validation framework that just requires two front facing anodes alluded to one more embedded at the rear projection. Besides, the framework has a multistage combination plan, which further develops framework performance. The execution investigation of the framework given in this work depends on an analysis with 51 subjects and 36 intruders, which yielded an equivalent mistake rate 3.4%, which means a genuine acknowledgment rate 96.6% and a misleading acknowledgment rate 3.4%. Noticed presentation estimations beat the discoveries of past investigations on comparative frameworks.

Subject identification using electroencephalogram (EEG) signals during imagined speech [7] was proposed, which looks at the possibility of identifying which person produced electrical brainwave signals during imagined speaking. Electroencephalogram (EEG) signals were gotten from six worker members who envisioned expressing one of two syllables, /ba/and/ku/, at shifted rhythms without doing any unmistakable exercises. After preprocessing the EEG information to eliminate curios and commotion, coefficients are recovered from every terminal's sign and connected for subject ID utilizing a direct SVM classifier. Due to the high between subject varieties, the members were related to 99.76% precision, demonstrating an unmistakable potential for utilizing envisioned spoken EEG information for biometric ID. Besides, the point distinguishing proof seems, by all accounts, to be versatile to changing factors like envisioned syllables and rhythms. The recommended method was additionally tried on a freely open information base of EEG signals relating to Visual Evoked Potentials to survey its relevance on a more extensive number of members, and recognizing 120 patients with 98.96% accuracy was capable.

3 Proposed Methodology

The inventive developments of this decade represent a tremendous achievement in the advancement of humanity. Various devices have been developed as tools to deal with human life through research and innovation, particularly for persons with exceptional requirements, who have limitations in carrying out their day-to-day tasks. A wheelchair's major duty is to assist individuals who have brief or long-term aggravations in the engine structure in getting back on their feet. Individuals with impairments can move their wheelchairs entirely on their own utilizing the Brain PC Interface (BCI) via mental surges of EEG signals. Most significant plus of EEG readings is the confusing example of brain function may be preserved in a few periods after the improvement is provided [8]. EEG signals may be used to decide mind work, sluggishness, oxygen levels in the cerebrum, and analyze specific neurological sicknesses, for example, epilepsy [9]. Nonetheless, with this attention on the utilization of mental waves, you can really wish to operate a wheelchair, which most people would regard to be typical to be used for the incapacity. The evaluation of thought waves, as well as the supporting research, has been completed. In light of existing PC interfaces, research on electroencephalogram (EEG) signals only regulates the development of the wheelchair forward, right, left, or in reverse. Furthermore, there is a recommended BCI step plan for ordering the electric wheelchair test system. The human cerebrum is comprised of millions of connected neurons. Considerations and passionate moods are discussed as examples of communication between these neurons. As shown by human concerns, this example will change, resulting in distinct electrical waves. A strong limitation will likewise give an amazing electrical sign. This high amount of electrical waves will be seen by the mind wave sensor, and the information can be changed over to bundles sent through far off media. The level analyzer units (LAU) and Mind wave head set as shown in Figs. 1 and 2 will get the crude information from the mind waves and will concentration and cycle the sign utilizing the MATLAB stage. The control requests will then, at that point, be sent to the robot module for handling.

The advancement is of the accompanying includes the accompanying methodologies. In the initial segment eye flicker timing and greatness for quite some time are removed likewise, willful numerous squints from crude EEG wave along are isolated from normal flickers, additionally various degrees of consideration and contemplation levels are recorded and examined. In the second part consideration, contemplation levels as well as eye squints derived from crude EEG are planned through basic sign handling to control yield extent.

The World Health Organization characterize, a wheelchair as 'a gadget giving wheeled versatility and seating support for an individual with trouble in strolling or moving about'. Accordingly, the reason for a wheelchair is to work on private portability [10–12] as demonstrated in Fig. 3.

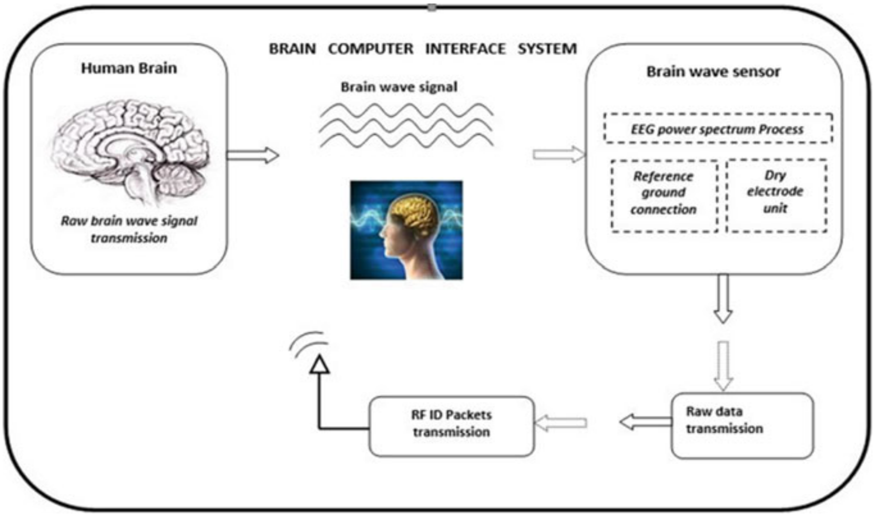


Fig. 1 Proposed block diagram

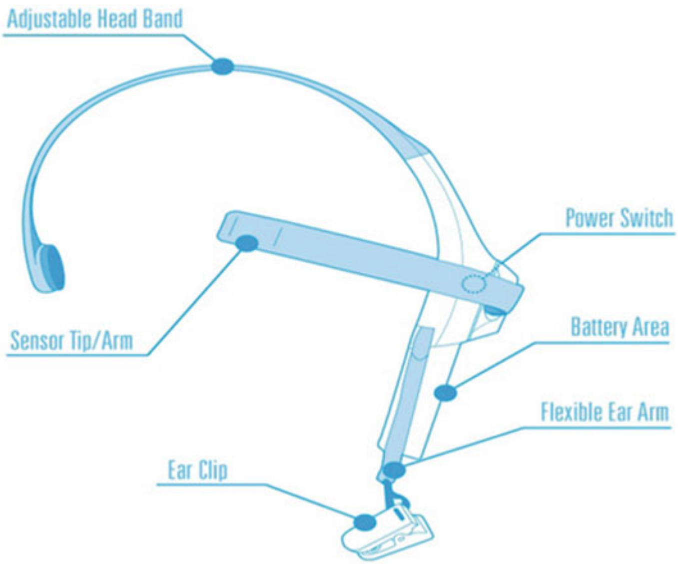


Fig. 2 Mind-wave headset

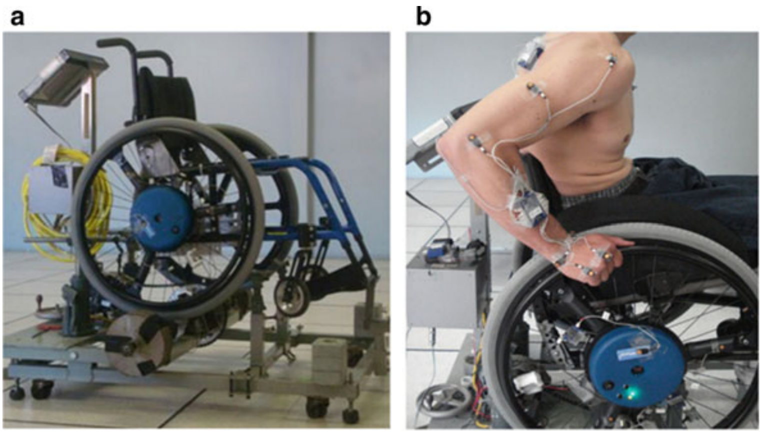
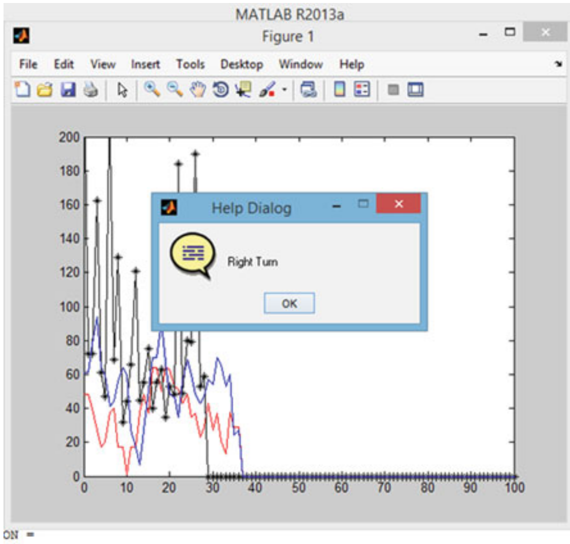


Fig. 3 Wheel chair

4 Results and Discussion

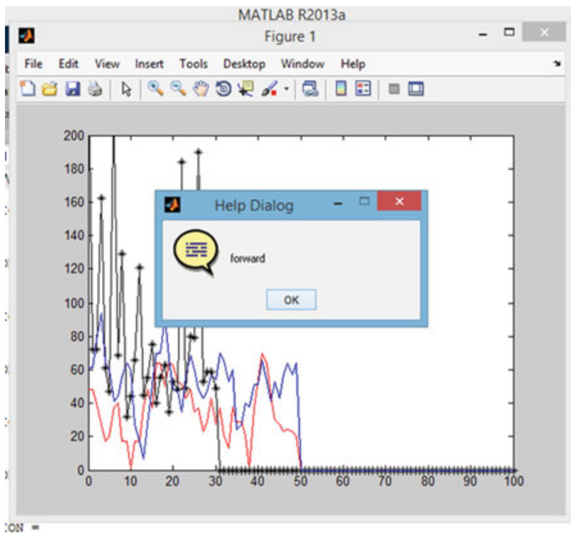
Put on the Neurosky mind wave headset. Pair the Bluetooth dongle connected to the computer system with the mind wave headset. When the person want to turn right, he needs to concentrate on the movement and needs to give one eye blink, when it reaches to value range, it will turn right as indicated in Fig. 4.

Fig. 4 Right turn



When the person wants to move forward and needs to concentrate on the movement, when it reaches to attention value range, it will move forward as shown in Fig. 5. Similarly, when the person want to turn left, needs to concentrate on the movement and needs to give one eye blink, when it reaches to value range, it will turn left as in Fig. 6.

Fig. 5 Forward



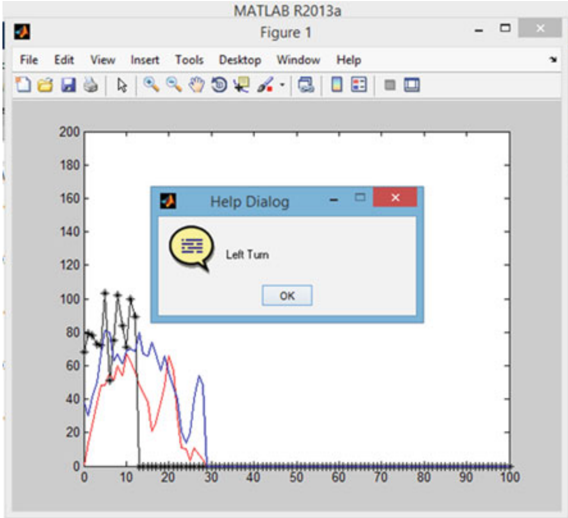


Fig. 6 Left turn

5 Conclusion

In this paper, brain computer interface was introduced as a human–machine interface type and possibility of using Neurosky mind wave headset was explored. Neurosky mind wave headset was introduced as a non-invasive solution for monitoring brain activities of the central nervous system. Arduino microcontroller was presented for easy software interconnection which helps to interface brain-computer based on Neurosky mind wave headset. The simulation of the brain wave signal acquired from the Neurosky mind wave indicates that the attention and meditation levels decreases or increases with respect to emotional state. Natural blink were also separated from multiple blink. Interestingly, Brain-computer interfaces have opened a broad area of research while cutting across its application in intelligent smart home network, where it can set the input for setting parameter.

6 Future Scope

Cerebrum PC interface (BCI) is a state of the art innovation relevant in numerous areas, and the above methodology can be carried over to controlling the movement of the robot in the direction in forward, backward, left, and right side. The combination of blink and attention data along with visual neurofeedback can be utilized for control of robotic module.

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Monitoring Urban Growth Using Land Use Land Cover Classification

Srivarshini Nalla, Madhumitha Totakura, Deekshita Pidikiti, and K. Pranathi

Abstract The rise in population hastens changes in land use as well as land cover, increasing threat to natural resources. Monitoring and measuring land use land cover (LULC) changeover vast areas is crucial to study climate change patterns and in natural resource management. This paper examines changes in Vijayawada's urban growth over a period of six years (2016–2020) using the Google Earth Engine (GEE) cloud-based platform by classifying LULC changes. The NDVI and NDWI indices were used to accurately collect training points of 'crop land', 'water bodies' land cover classes, respectively. The random forest (RF) supervised classification technique was used to classify the LULC in the research area. Landsat-8 surface reflectance data was utilized for the LULC categorization between 2016 and 2020. 'Water bodies', 'Crop Land', 'Built up', 'Bare Soil', and 'Shrubs' were the five land use classes developed. For the years 2016 and 2020, the overall accuracy was 80.55% and 91.78%, and the kappa coefficient is 0.73 and 0.88, respectively.

Keywords Google earth engine (GEE) · Land use land cover (LULC) · Random forest (RF)

1 Introduction

Urban sprawl, land degradation, or the transformation of agricultural land to shrimp farming are often hallmarks of rapid changes in land use and land cover, particularly in developing nations. The local and/or regional environment is profoundly affected by these kinds of changes, which ultimately affect the global environment.

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1.1 Basic Definitions and Backgrounds

Satellite Remote Sensing. It offers higher temporal resolution images and lower costs to monitor land-use changes [1].

Google Earth Engine. GEE, an open-source cloud-based platform used for simple satellite imagery processing offers remote sensing data that can be loaded within the platform and has a JavaScript API with many in-built functions offering high performance to perform machine learning tasks.

Urban Growth Monitoring. Analyzing the difference between a state and phenomenon of an object at different periods of time by using remote observation. This remote sensing data from multiple time periods are used in growth monitoring to determine and/or describe LULC changes.

1.2 Problem Statement

Urban sprawl, the inefficient use of resources, and the inadequate allocation of infrastructure initiatives are seen as major threats to sustainable development. Monitoring land use and land cover changes is used in the study to identify such sprawls that can be effectively managed. The ongoing and current study of LULC is an essential component of any area's sustainable development efforts.

2 Review of Literature

A cloud-based platform called Google Earth Engine provides enormous amounts of remote sensing data and a powerful JavaScript API to perform machine learning tasks making it a high-performance computing engine that can quickly and easily compute satellite images. Since GEE has an extensive set of capabilities, it is often used for viewing the satellite imagery, maps, and terrain for LULC-based research [2]. Using cloud computing techniques, Gong et al. [3] created a model of global land cover at 30 m. For 15 years, Midekisa et al. [4] used the GEE platform to map locations all over Africa. Kolli et al. [5] employed an RF classifier to map land use changes around Kolleru Lake in India. Rahman et al. [6] used accuracy levels to study the performance of RF and SVM on the classification of urban and rural areas in Bangladesh. For Bhola, they were able to achieve a maximum SVM accuracy of 96.9%, and for Dhaka, they were able to get a maximum SVM accuracy of 98.3%.

In most of the studies above, GEE is being used to analyze LULC changes, monitor water resources [7], time series analysis, and determine temperature's role in climate change. In terms of time, storage, and memory, GEE is subject to some computational constraints. A great deal of the available research compares LULC classifiers. Only a

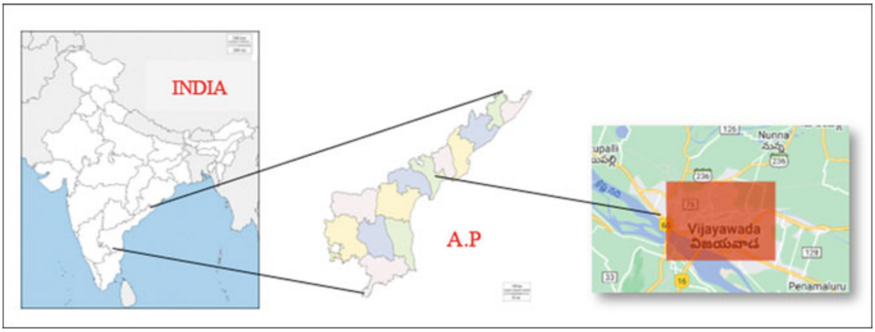

Fig. 1 Location map of Vijayawada city, India

few studies have done LULC mapping on large areas using machine learning methods available in GEE.

In current study, urban sprawl of Vijayawada city within a time span of four years (2016–2020) has been inspected by using RF algorithm in Google Earth Engine.

3 Data and Methods

3.1 Study Area

Vijayawada (16° 30′ 22.227″ N 80° 38′ 52.855″ E), located in the capital region of Andhra Pradesh, is the second largest city in the state (see Fig. 1). This is the administrative center of NTR district. Within the Eastern Ghats, there are hills referred to as Indrakeeladri Hills surrounding the city, and is situated on banks of river Krishna. In addition to being one of India's fastest growing urban areas, it is the state's commercial, political, cultural, and educational capital.

According to 2001 census, the gross density per square kilometer was 13,600 [8]. For present study, a rectangular area of 57.46 km^2 has been selected as the region of interest. For feature collection nearly 200 training points were placed over the entire study area from the satellite image having cloud cover less than 10%.

3.2 Data

Landsat-8 surface reflectance Tier 1 dataset was used in current investigation, which was atmospherically corrected. Because of cloud cover, only about 10% of the overall datasets was considered for each year, and those images were blended into a singular frame using median filter. Landsat-8's entire band set was used to classify the images.

Landsat uses pixels as the analytical unit: one pixel represents 30 m × 30 m. The LULC is classified into five major categories: water bodies, croplands, bare soils, shrubs, and built-up areas. Water bodies were rivers and ponds, while cropland was considered vegetation.

3.3 Methodology Flowchart

As shown in Fig. 2, this investigation was conducted according to a methodological flowchart. Our categorization process was based on orthorectified pictures with the least cloud cover. In addition to removing cloud shadows and cloud cover, the satellite data was also imported into GEE. Cloud mask was used to remove polluted pixels from all accessible pictures. Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI) indices were added to identify and correctly place the vegetation and water training points, respectively [9]. The entire collection is converted into a single image by assigning a median value to each pixel. To perform LULC classification, high-resolution Google Earth images were used to create 234 training points and 28 training polygons for five land use classes. All training points and polygons were spread across the study area for correct classification by RF classifier. Feature collection tables were created based on this training data in the GEE. To train the classifier, we used a random forest algorithm available in GEE.

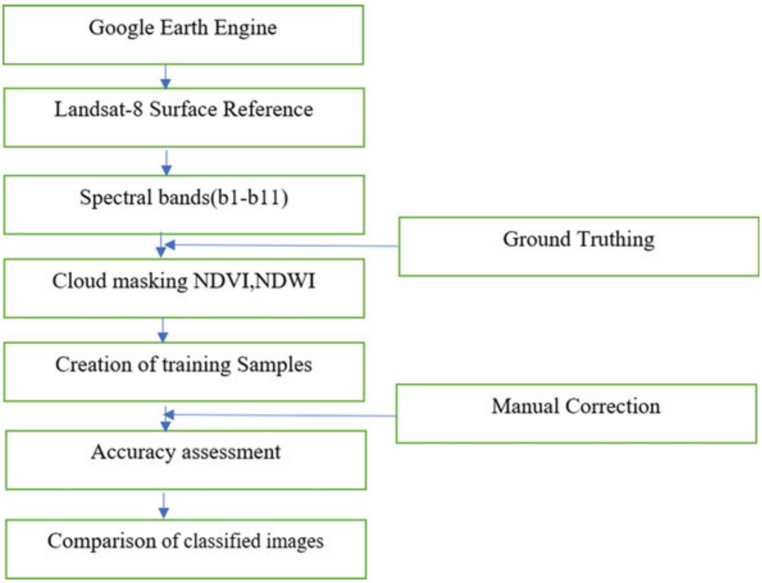

Fig. 2 Methodology of LULC supervised classification in GEE

3.4 Description of Random Forest Classifier

With the "Classifier" package available in Google Earth Engine we perform supervised classification on the traditional machine learning algorithms namely, support vector machine (SVM), random forest (RF), and classification and regression tress (CART). The most commonly used classifier is random forest [10], which employs many classification and regression trees to create an ensemble classifier. By randomly selecting training datasets and variables, Random Forest generates multiple decision trees. The classifier's performance can be assessed, and the generalization error is estimated using non-training samples at the internal level. The number of parameters and trees, both of which are user-defined parameters, are the two most essential input components for random forest.

4 Accuracy Assessment

After the classification was finished, an accuracy assessment was performed using machine learning algorithms to analyze the categorized images and to determine if they are correct. There is a separation between the training datasets and the validation datasets. 80% of the entire dataset were utilized for training, while the remaining 20% were used for testing. In the Google Earth Engine, confusion matrices are used to validate and then rate picture categorization accuracy. Additionally, confusion matrix, user accuracy, and producer accuracy can be utilized to evaluate the class-level performance of a given classifier. Overall accuracy (OA) is the most extensively used metric for estimating accuracy [11]. The following formulae are used to compute the overall accuracy (OA) and kappa coefficient (k):

$$\mathrm{OA} = (P_c/P_n) * 100 \tag{1}$$

where correctly classified pixels were given by P_c and P_n represents total number of pixels in the image.

$$k = (po - pe) / (1 - pe) \tag{2}$$

where po represents relative observed agreement among raters and pe represents hypothetical probability of chance agreement.

5 Results and Discussions

As a result of pre-processing and supervised classification, the final classified images were obtained, and layout wasvdone in QGIS (see Fig. 3). Land use patterns in

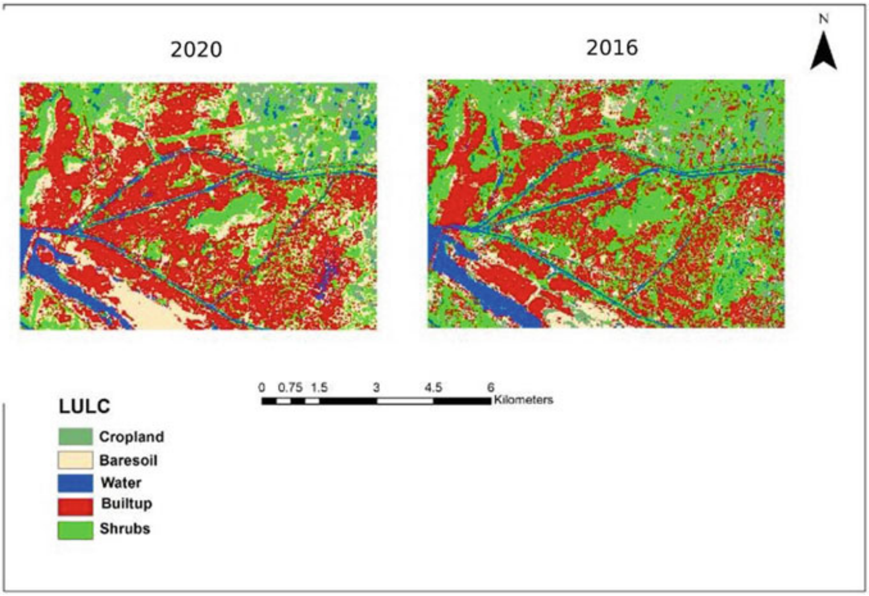

Fig. 3 Land use land cover maps of Landsat-8 surface reflectance pictures for the years 2020 and 2016

the study area are illustrated by these images. Urban construction is shown in red, agricultural area is shown in dark green, water is shown in blue, bare soil is shown in cream, and shrubs are shown in light green. The accuracy of the classification was verified using ground truth data. As shown in Table 2 in 2016, Vijayawada's classification accuracy was 80.55%, while in 2020 it was 91.78%. A regional LULC classification of Vijayawada city is shown in Fig. 3. Since this is an initial study of small scope, it is necessary to test the accuracy of digital interpretation results.

5.1 LULC Change Dynamics

A total of 57.46 km^2 was considered as study area in which all the land cover classes were classified. The area in km^2 of each individual class can be seen in Table 1.

The Vijayawada city has experienced expansion of bare soil and built-up regions rapidly in the span of just four years (2016–2020). But due to the cloud cover, some classes are misclassified as others especially in the year 2016. In the year 2016, the area of crop land was 7.71 km^2, which was reduced to 4.97 km^2 in 2020 which means there is a decrease of 35.41%. Similarly, the percentage of decrease in water is 17.20%, and built-up area has shown an increase of 19.27%. These changes are plotted as a bar chart and displayed in Fig. 4.

Table 1 Area of each land use land cover class in 2016 and 2020

S. No.	Land use classes	Area of 2016 (km^2)	Area of 2020 (km^2)
1	Crop land	7.7103	4.9797
2	Bare soil	5.9193	13.9203
3	Water	4.8087	3.9816
4	Built up	21.1797	25.2612
5	Shrubs	21.0348	12.5100

Table 2 Overall accuracy and Kappa coefficient values obtained in the years 2016 and 2020

Year	Classifier	Overall accuracy (%)	Kappa coefficient (km^2)
2016	RF	80.55	0.73
2020	RF	91.78	0.88

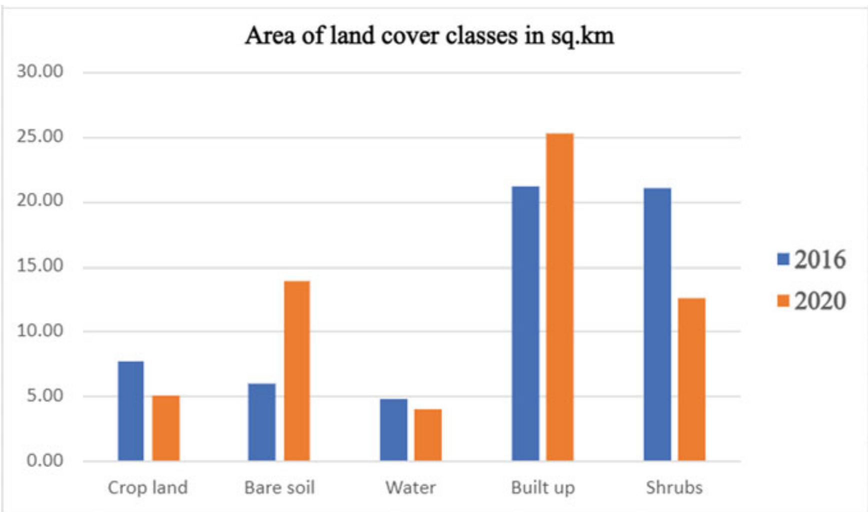

Fig. 4 Changes in area of land cover classes

The best-performing model is determined by the overall accuracy (OA) and the Kappa coefficient. Table 2 displays the results. In every example, the RF classifier was able to attain an accuracy of better than 80%.

6 Conclusion

A four-year period (2016–2020) was used to study the urban growth of Vijayawada. Landsat-8 surface reflectance tier 1 satellite images of 2016 and 2020 are used for this study. The study area covered 57.46 km^2. LULC images are developed in Google Earth Engine. At all stages, accuracy exceeded 80%, which is satisfactory but can be improved by altering the dataset or algorithm which are present in Google Earth Engine. Without the implementation of suitable environmental management plans for the urban area, this rapid expansion in built-up and bare soil regions at the same time as depletion in crop land and water bodies may have major environmental repercussions.

7 Future Scope

Creating more accurate maps is always essential. For this, there are number of classification methods and classifier techniques available in GEE that we can try. Future scope is to expand the territory of our current study area by trying different classification techniques that GEE offers and sharing the results obtained with town planners and local authorities to take steps toward sustainable development projects.

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An Empirical Analysis of Different Classifiers on COVID-19 Vaccination Data

Sonithoi Ningombam, Arindam Roy, and Pradip Debnath

Abstract During the COVID-19 pandemic, there are no other ways to communicate the whole world rather than connected through social media especially Twitter platform to share information. It is challenging to read through and comprehend everything that has been posted on Twitter about the COVID-19 vaccines. It is a fortunate that many advances such as machine learning (ML) methods and natural language processing (NLP) techniques are used to analyze the tweet, and we can observe the sentiments of the tweets that will reduce the human effort and could easily be classified tweets into their respective classes. In this study, we focus specifically on tweets about COVID-19 vaccination which have been gathered between March and April of 2022. We aim to explore the overall sentiments relative to COVID-19 vaccination, inclusive of how the sentiments are mainly concerns and evolved. To perform the empirical analysis, we use five machine learning classifiers, viz. decision tree, support vector machine (SVM), *K*-nearest neighbor (KNN), logistic regression, and Naïve Bayes classifiers and bidirectional encoder representations from transformers (BERT) model on the collected dataset. Among competent approaches, sentiment analysis based on the BERT model gives the highest accuracy.

Keywords COVID-19 vaccination · Classifiers · Sentiment analysis · BERT

1 Introduction

The world has undergone chaos and insecurity for the past few years because of the COVID-19 pandemic. India being one of the most affected country, people have suffered a lot. In the second quarter of 2020, the active cases of COVID-19 had ascended to a sky-high (WHO) [1]. To control the pandemic, the Government of India (GOI) imposed lockdowns in different phases throughout the country [2]. Despite

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imposing restrictions, there was spread of disease, and to prevent this situation, the GOI started campaigning for vaccination on 16th January 2021. As we know that the integral part of preventing any infectious diseases is vaccination. Two types of vaccines were made available among the Indians by the GOI, i.e., Covidshield, a vaccine produced by Oxford-AstraZeneca, and Covaxin vaccine produced by Bharat Biotech [3].

With the advancement in technology and virtual world, people use to connect and express emotions more in social media. Similarly, during the COVID-19 pandemic with the help of social media platforms, citizens from different countries share their opinion and emotion about the situation. The use of social media plays an important role in vaccine acceptability to the people allowing them to express thoughts and ideas. Social media platforms such as Facebook, Twitter, and Instagram use real-time data, and these are the examples how people show their expressions publicly. During this pandemic, people spend more time on social media. The Twitter platform is employed by various users and notions on political ideas, information spreading, that is consider to play an important role in society development [4], and 300 million active Twitter user [5].

The present study has been performed to visualize the sentiment score of Indian Twitter user's tweets and to single (out) the most influential positive and negative ideas about COVID-19 vaccination. It reflects the overall state of mind of people about the vaccinations that were campaigned by the GOI. Social media sentiments mean opinions, thoughts, and attitude, toward any situation shared by the public regarding any issues. So in this study, it will focus on certain hidden sentiments behind the reaction on social media by people as it can be easily access to express in this situation. Globally, people can connect through micro-blogging sites as a medium of exchanging the opinions, moments, and perspective field of vision. While communicating over social media, sentiments of the people are also exposed. As one of the world's largest social networking platforms, the proposed study collects tweets about the COVID-19 vaccination to analyze people's sentiment.

The structure of the paper is organized as follows. Section 2 explains the related works, Sect. 3 explains the suggested system design. Section 4 describes the experimental outcomes. Section 5 conclusions.

2 Related Works

In recent days, research on social media analysis has gained traction, and many researchers have been working on social media sentiment analysis. Several research has been counseled and spell out on COVID-19 vaccination tweets that were uploaded in Twitter [6] to analyze the sentiments of the people using LSTM and Bi-LSTM. In [7], examine the side effects of the COVID-19 vaccines, collected the data from March and April 2021, and 189,888 tweets were chosen for their studies, used LDA topic modeling for analyzing the sentiments of Indian citizens. Nezhad and Deihimi [8] analyzed Iranians' views toward COVID-19 vaccination, as well as the sentiments of retrieved tweets, were analyzed using CNN-LSTM model. Sattar and Arifuzzaman [9] investigate opinion of USA citizens toward vaccines by collecting approximately 1.2 million tweets during the month of April–May, 2021. Their experiment result shows positive response which is the majority among the vaccinated people. Also, by using time-series forecasting, it estimates how many people will be vaccinated within a specific period of time predicts within a specific period of time. Shamrat et al. [10] studied emotions on the Moderna, Pfizer, and AstraZeneca vaccines that are made to fight COVID-19. An extracted tweet from Twitter is used to discuss the sentiment toward vaccine types by using KNN classifier. They concluded that people have more surpassing positive sentiment contra Pfizer and Moderna vaccines with a rate of 47.29 and 46.16, respectively, as compared to the AstraZeneca vaccine with 40.08. Aygun et al. [11] collected the Twitter data related to vaccination and vaccine types for the countries like USA, Canada, France, Turkey, UK, Italy, Spain, and Germany and created two new datasets (English and Turkish). They used BERT model to conduct the sentiment analysis on the dataset created. Neme and Attila [12] develop RNN model for classifying the emotional analysis based on coronavirus and COVID, also compared TextBlob model and RNN model. Charlyn et al. [13] also examined the sentiments toward the COVID-19 vaccine in Philippines, conforming to positive, neutral, and negative polarities. RapidMiner (RM) search Twitter operator collects and codifies English and Filipino language tweets. In their work, Naïve Bayes classifier employs to assort the sentiment of the nation toward vaccination and achieved accuracy of 81.77% through RM operators. Singh et al. [14] data from inhabitants of Gulf countries who had received the COVID-19 vaccination via Twitter have been studied. Using machine learning (ML)-based methodologies, the proposed method appropriately stresses the Gulf region's specific concerns with COVID-19 vaccination. The obtained data were filtered and tokenized using ratio, TextBlob, and VADER to examine the extracted sentiment. The sentiment scores are classified into positive and negative using the suggested LSTM approach.

3 System Design

This section designs a system that will collect the Twitter tweets peculiar to the COVID-19 vaccination and highlight the positive, negative, and neutral of sentiment in the text. We retrieve the tweet data from Twitter using Tweepy library and save that data in the csv file format. Most of data retrieve from Twitter are unstructured data. Figure 1 shows the conceptual framework of system design for sentiment analysis. The following sub-section will briefly explain each steps involve in Fig. 1.

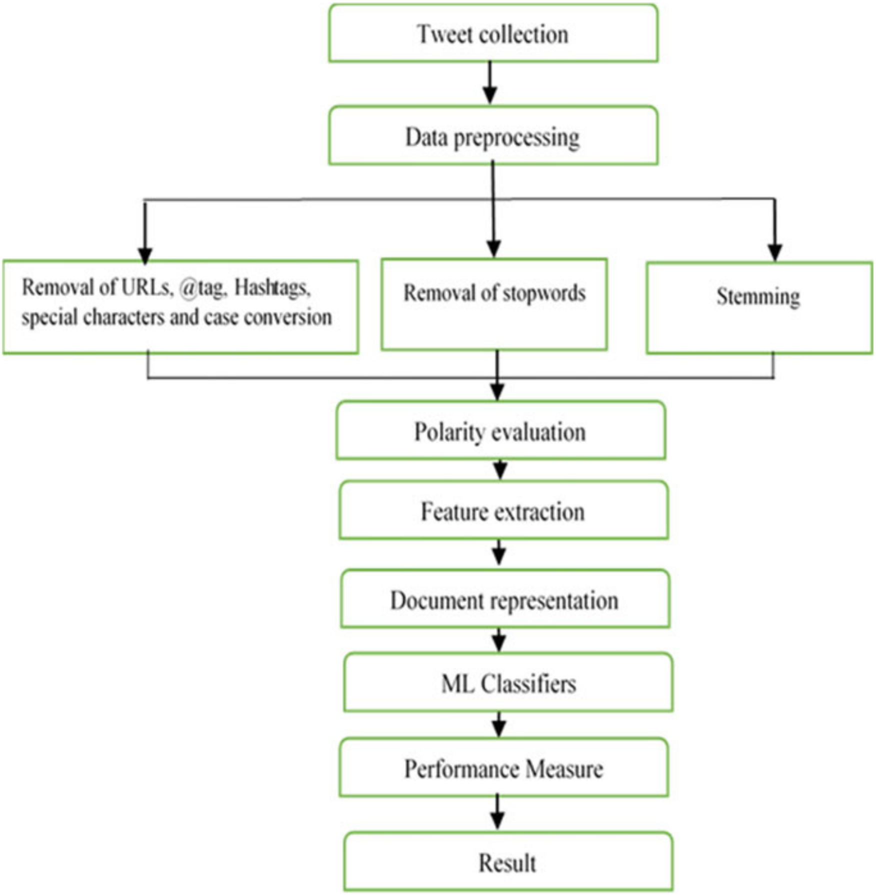

Fig. 1 Framework of the proposed system

3.1 Tweet Collection

In order to collect the tweets regarding COVID-19 vaccination, Twitter developer account was created, then API key, consumer key, consumer secret key, consumer key, and API secret key are activated. Thus, performed the authentication process successfully. The dataset consisting of 28,629 tweets was collected from Twitter using Tweepy library regarding COVID-19 vaccination.

3.2 Data Pre-processing

Data pre-processing is one of the most crucial ascends in any NLP task. Most of the data available on the social media are unstructured and full of noise in form of html mark-ups, hyperlinks, etc. Basically, pre-processing is the trials that cleans the raw text data. Text pre-processing includes various approaches that convert raw text into an explicit structure [15].

- **Removal of URLs and lexical analysis**: URLs are removed since they add no value to the analysis of the tweet, and the entire text is converted it in to a stream of smaller units known as tokens. Word separators were also regarded as spaces between words. Punctuations (such as dot (.), hyphen (−), comma (,), and so on) and special characters ($, &, @, %, and so on) have almost no meaning when we analyze the text, so they are removed. Uppercase to lowercase conversion.
- **Removal of Stopwords**: The words that do not convey much information in natural language like is, am, the, etc., are stopwords.
- **Stemming**: Process reduces the inflected words to stem (base form).

3.3 Polarity Evaluation

Employing TextBlob as sentiment analysis tools, the gathered tweets are specified as positive, negative, or neutral [16]. In this studies, we utilized TextBlob to calculate the subjectivity and polarity of the tweets. Each polarity assigns a number from -1 to 1 based on words that is used and shows that the negative score indicates the negative attitude, positive scores indicates positive attitudes, and zero indicates the neutral sentiment which is laid out in Fig. 2. Then, Fig. 3 shows the number of positive, neutral, and negative representation of sentiment. 6179 tweets are neutral polarity, 6116 tweets are positive polarity, and 2214 tweets are negative polarity. Figure 4 exhibits the tweets' percentage in each sentiment. As shown in figure, 36.0% tweets are positive, 48.3% tweets are neutral, and 15.8% tweets are negative.

3.4 Feature Extraction

It plays an important role in sentiment analysis. A large number of important features can be extracted from collected tweet dataset. Bag of words (BoW) [17] is one of the front leading methods in the feature extraction. In this work, we also used BoW.

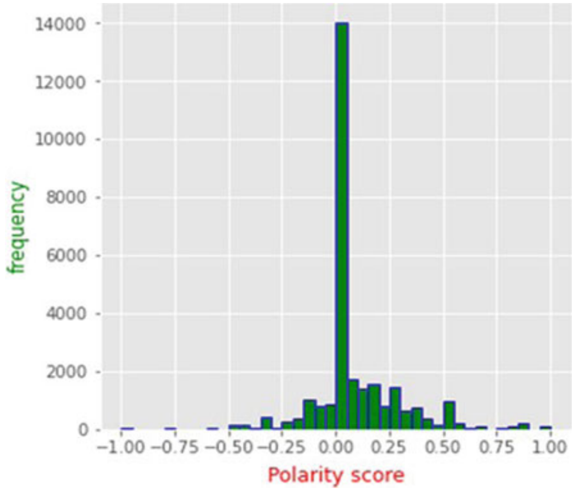

Fig. 2 Tweet polarity score diagram

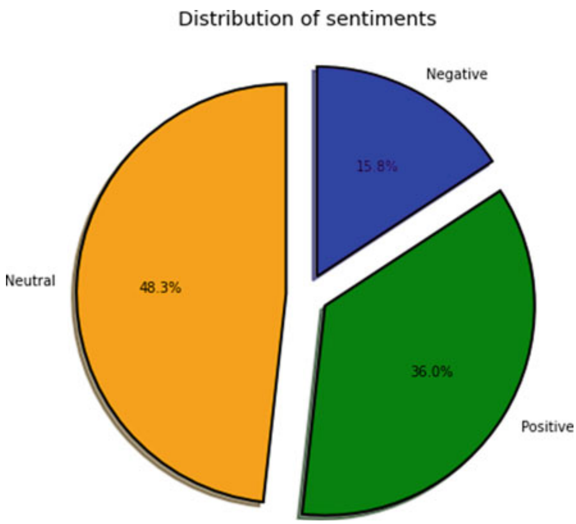

Fig. 3 Distribution of sentiments

3.5 Document (Words) Representation

We cannot able to use the extracted features directly to the machine. It needs to transform it into numerical form. For this purpose, we use two term weighting scheme, namely term frequency (tf) and term frequency-inverse document frequency (tf-idf). Term frequency (tf) is simply the count number of term occurrence in the document. Inverse document frequency measures how much the word is important in the corpus [18, 19].

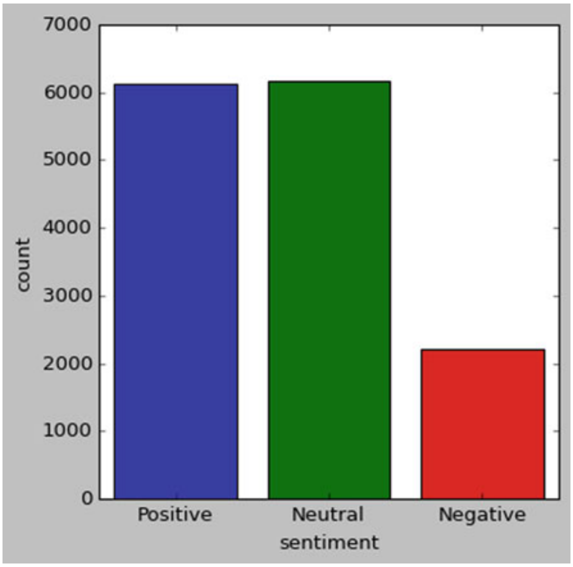

Fig. 4 representing the number of positive, neutral, and negative sentiment

3.6 Machine Learning (ML) Classifiers

In this experiment, we have used five classifiers, namely support vector machine (SVM) [20, 21], Naïve Bayes [22], logistic regression [23], decision tree [23, 24], and *K*NN [25] classifiers into two representation models (tf and tf-idf). We have also used BERT [26] which is an transformer-based machine learning method, to perform the sentiment analysis of the collected data.

3.7 Performance Evaluation Metrics

It is necessary to validate the outcomes of our experiments. For this, we used four evaluation metrics, namely

Accuracy: $\frac{\text{True Positive (tp)}+\text{True Negative (tn)}}{\text{True Negative (tn)}+\text{False Positive (fp)}+\text{True Positive (tp)}+\text{False Negative (fp)}}$

Precision: $\frac{\text{True Positive (tp)}}{\text{True Positive (tp)}+\text{False Positive (fp)}}$

Recall: $\frac{\text{True Positive (tp)}}{\text{True Positive (tp)}+\text{False Negative (fn)}}$

F-score: $F1 = 2 \times \frac{(\text{Precision}*\text{Recall})}{\text{Precision}+\text{Recall}}$

4 Results and Discussion

For this empirical analysis, we used a total of 28,629 tweets which is collected during the period of March–April, 2022 from the Twitter using Twitter API. After pre-processing, we get a total of 14,509 tweets which are classified into three categories by using TextBlob. We classify these three categories [positive (Pos), negative (Neg), and neutral (Neu)] in accordance with value of polarity score. To evaluate performance of ML classifiers, the dataset is split into two parts for training and testing. Perhaps, the testing data were obtained using the proffer method, which entails allocating 25% of the original dataset to model testing and 75% to model training. A total of 3628 tweets out of 14,509 are used for testing. In this experiment, we use five classifiers, viz. SVM, Naïve Bayes, KNN, decision tree, and logistic regression classifiers. As machine learning can give a better result than the manual labeling since it takes time while labeling the datasets. The results of the experiments are given in the following tables. In each tables, we are considering the performance metrics (precision, recall, and F-score) for each category. Table 1 shows the performance analysis of different classifiers using count vectorizer. It considers only the term frequency of each features. In this representation model, SVM classifiers outperform than other classifiers in term of accuracy and average $F1$-score value. The performance of other classifiers is still goods except the KNN classifier. Table 2 shows the performance analysis of different classifiers using the BoW representation model with Tf-idf (Fig. 5).

SVM classifier dole out the apical accuracy of 85% and average $F1$-score of 79% followed by logistic regression classifier. KNN gives the worst performance result among them. BERT is a deep learning model based on transformers that every output element is connected to every input element, and the weightings between them are calculated dynamically based on their connection [26]. To analyze the sentiment of the collected data, we employ the BERT model. Table 3 shows the experimental result of sentiment analysis using BERT. It could achieve an approximately 98% of accuracy and 97% of average $F1$-score.

Table 1 Performance analysis of different classifiers using count vectorizer

ML classifiers	Accuracy (%)	Precision			Recall			$F1$ score		
		Neg	Pos	Neu	Neg	Pos	Neu	Neg	Pos	Neu
Logistic regression	85.45	0.81	0.88	0.85	0.62	0.88	0.94	0.70	0.87	0.89
SVM	86.30	0.82	0.89	0.85	0.66	0.86	0.94	0.73	0.87	0.89
KNN	52.12	0.81	0.94	0.47	0.17	0.18	0.99	0.28	0.30	0.64
Naïve Bayes	72.46	0.96	0.69	0.77	0.04	0.86	0.84	0.07	0.76	0.80
Decision tree	80.2	0.69	0.78	0.81	0.56	0.78	0.91	0.62	0.80	0.85

Table 2 Performance analysis of different classifiers using Tf-idf vectorizer

ML classifiers	Accuracy (%)	Precision			Recall			$F1$-score		
		Neg	Pos	Neu	Neg	Pos	Neu	Neg	Pos	Neu
Logistic regression	84	0.90	0.82	0.84	0.52	0.88	0.91	0.66	0.85	0.87
SVM	85	0.88	0.83	0.84	0.55	0.87	0.92	0.68	0.85	0.88
KNN	50	0.87	0.96	0.46	0.14	0.14	0.99	0.24	0.63	0.24
Naïve Bayes	72	0.96	0.69	0.77	0.04	0.86	0.84	0.07	0.76	0.80
Decision tree	76	0.60	0.79	0.78	0.50	0.76	0.85	0.54	0.77	0.82

Fig. 5 Word cloud representation of tweet

Table 3 Performance analysis of sentiment analysis using BERT

	Accuracy (%)	Precision			Recall			$F1$-score		
		Neg	Pos	Neu	Neg	Posi	Neu	Neg	Pos	Neu
BERT	98	0.96	0.98	0.99	0.93	0.99	0.98	0.95	0.99	0.98

5 Conclusions

The work done in this paper makes a comparison of different classifiers performance on the collected tweets. Each classifier gives different performance results. In general, the performance results of sentiment analysis depend on many factors such as pre-processing, the way of representing the features, i.e., document representation, ML classifiers, etc. In this experiment, we found that BoW representation with tf gives better performance results than Tf-idf because the size of collected dataset is small and BoW with tf works well on small dataset. We also performed the comparison of BERT's performance with two baseline representation models, in which we use count vectorizer and Tf-idf vectorizer. The experimental results shown that the accuracy of BERT is higher than other two methods used by different classifiers. That is, the model using BERT is highly predicted the various sentiments correctly. We could also conclude that most of the peoples are having positive sentiments about COVID-19 vaccination followed by neutral thoughts. Very few people are having extremely negative thoughts about COVID-19 vaccination. This study additionally provides a method and means to examine public opinion around vaccination and comprehend how persons are attempting to adapt to their mental conditions throughout this unusual period. The dataset content and the time over which the collected data have limitations of this exploration, since it was collected for the month March–April 2022 only. It will be an intrigue to collect the data for longer period of time for further study.

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Steganography in Colour Images with Proposed Arnold Chaotic Map and Optimized Curvelet Transform

Sanjay Nipanikar, Rohini Nipanikar, and Mahesh Kulkarni

Abstract Steganography seems to be the process of concealing secret information within a non-secret file or communication to prevent discovery; this hidden information is then retrieved at its destination. Steganography could be used in conjunction with encryption to conceal or safeguard data. As a result, numerous researchers have concentrated their efforts in this field in order to offer safe data transfer. In addition, we proposed a unique strategy called steganography in colour pictures with proposed Arnold chaotic map and optimized curvelet transform which has two working stages: image embedding and image extraction. In the first stage, the 3-level DWT with curvelet transform is being used to embed the original picture with a watermarking image which uses self-improved Aquila optimization (SIAO) to get the better performance by optimizing the scaling factors. During the embedding phase, in the scrambling process, proposed Arnold chaotic map is used to scramble the image. In the second stage, the water marks get extracted from this water marking images by inverse 3-level DWT. Consequently, secret image was generated by applying inverse Arnold chaotic map transforms on the cover image. The performance of proposed work is compared over the other conventional models like existing Aquila optimizer, cat swarm optimization, spider monkey optimization, poor rich optimization, etc., which shows that our proposed steganography technique has greater performance.

Keywords Steganography · Image embedding · Arnold chaotic map transform · 3-level discrete wavelet transform · Self-improved Aquila optimization

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1 Introduction

Although data hiding technologies have been around for a considerable time, their relevance has lately grown. The primary cause seems to be a rise in data transmission via the Internet as well as social networking sites. Although cryptography has been the most extensively utilized technology for data concealment, steganography has getting prominence [1]. Steganography was derived from the Greek terms Steganos (covered) as well as Graptos (secret) (writing). Steganography has a physiological and biological genesis [2]. Steganography seems to be the act of concealing a hidden little multimedia data within a much bigger multimedia information including an image, text, file, and perhaps video [3–6]. Multiple applications notably relied on 3 spatial domain picture steganography methodology: LSB, PVD, as well as CRT [7]. When considering a steganography strategy, three predominant needs should be regarded: embedded capability, imperceptibility, as well as security. Picture steganography strategies were often categorized into spatial domain methods but also frequency domain framework depending on the process of information embedding. The former is dependent on direct pixel intensity alteration, has more embedding capabilities with minor picture quality reduction, but is vulnerable to statistical assaults [8, 9]. Recently, researchers developed enhanced methodologies including the least significant bit (LSB) [10, 11], pixel value differencing steganography (PVD) [12–14], particle swarm optimization-dependent steganography [15], and many others. Although their approaches have advantages, they also have drawbacks such as being vulnerable to steganalysis, being less secure, causing premature convergence, and offering poor local search performance. As a result, we developed a unique and high-performance approach. The following are the principal contributions of our proposed Steganography technology.

2 Literature Review

Arshiya et al. [1] developed a picture steganography technique which can operate with cover images in a multitude of formats. This approach primarily predicated on the notion of picture elements and can be applied to cover images in JPEG, bitmap, TIFF, as well as PNG formats. It is the first steganography tactic which can function with numerous cover picture formats. Furthermore, techniques such as capability pre-estimation, adaptive segmentation methods, as well as information spreading were used in this article to integrate secret data with boosted security. This suggested approach is evaluated for robustness to steganalysis, and the findings are promising. Importantly, comparison findings for the suggested technique for three alternative cover image formats were quite encouraging.

Chanil et al. [2] suggested a new 1D chaotic framework system to address the disadvantage of restricted chaotic behaviours as well as homogeneous key sequence distribution. The results demonstrated that this approach beats the prior techniques, with an exceptional effectiveness against statistical analytic assaults.

Sabyasachi et al. [3] suggested a tactic that merges cryptography with steganography. The signature picture data is held concealed in the cover picture by using sender's as well as receiver's private keys, and the data is extracted from the stego picture using only a public key. This method could be utilized for authentication scheme, message integrity, and including non-repudiation.

Rajeev et al. [4] introduced a unique colour picture steganography framework in the AMBTC compression area employing grey invariant. Except the previous approaches, the suggested methodology integrates the secret data within a compressed colour picture whilst preserving grey pixel values. This suggested approach first divides every colour element of a cover picture into non-overlapping blocks of the same size, after which the two least complicated blocks with the least variation were compressed utilizing dynamic AMBTC compression. To retain the grey pixel rates, the pixel levels of the more complicated colour block were changed depend on the intensity values on the rebuilt compressed units. As a consequence, the suggested approach can minimize the size of the colour image by embedding a large quantity of information whilst maintaining grey pixel values.

Ashraf et al. [5] recommended an innovative information concealing strategy for picture steganography depending on individual visual features employing adjustable least significant bits (LSB). Two alternative approaches are being utilized. Initially, the human visual system possesses variable sensitivities to RGB colour channels, allowing for a distinct quantity of bits for each colour channel. Furthermore, photographs generally concentrate on their centre zone, allowing the secret message to be hidden utilizing a spiral path beginning from the image's perimeter and heading to its centre. By using basic LSB substitution strategy, both strategies are employed to improve the aesthetic appeal of the stego picture. This method allows for the concealment of a larger secret message having lesser actual visual effect/distortion.

3 Proposed Method

As the Internet had evolved into a channel for delivering sensitive information, the security of the transmitted data has become a key consideration. Image steganography had developed as a premier data concealment tool that ensures data transmission security. For that reason, we have developed a novel technique, named steganography, **in colour images with proposed Arnold chaotic map transform and optimized curvelet transform**. Our proposed scheme will have two key phases: (a) proposed embedding as well as (b) proposed extraction. Figure 1 shows the architecture of proposed work.

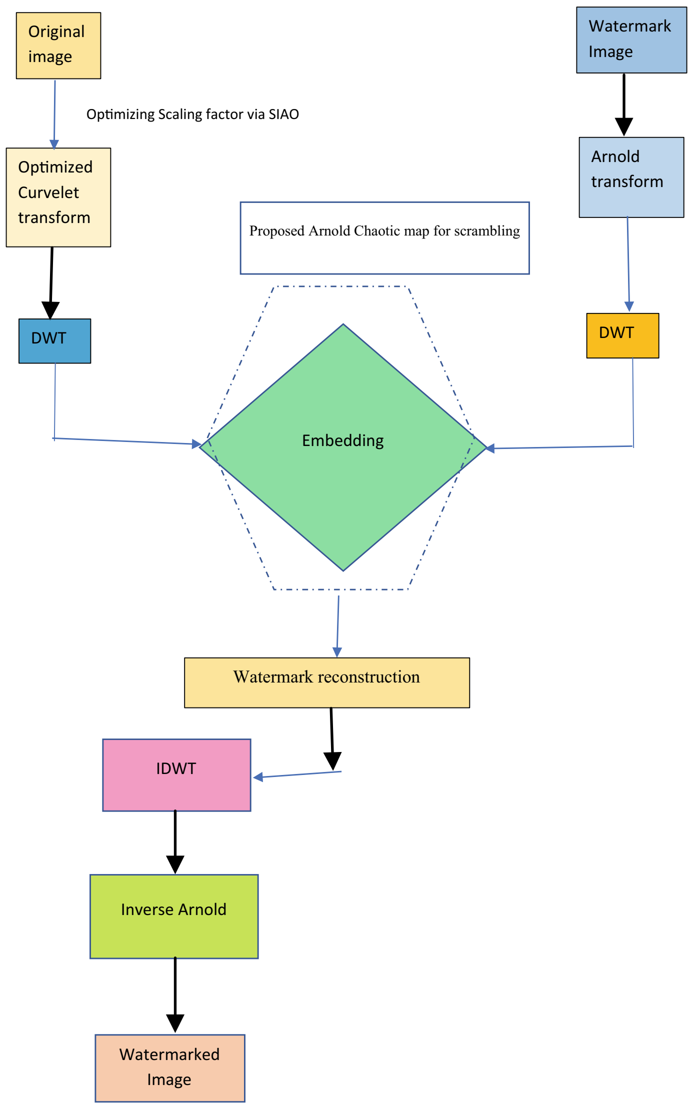

Fig. 1 Architecture of proposed model

(a) **Proposed embedding**

The practice of inserting the watermarked picture or secret picture into the original cover image has been termed as watermark embedding. Initially, the original cover as well as secret pictures were sent into this embedding step, and also the secret image's size was changed depending on the cover image size.

3.1 Optimized Curvelet Transform

The curvelet transform seems to be a multiscale transformation, just like wavelet, having structural components keyed by scale as well as position attributes. It has directional attributes, as opposed to the wavelet transform, and also the curvelet pyramid comprises components with a large degree of directional specialization. Furthermore, this curvelet transform would be centred on an anisotropic sizing concept that differs greatly from the wavelet's isotropic scaling. The components follow a specific scaling principal S in which the length of a frame element's support as well as its width were connected by the relationship width $\approx$ length^2.

Here, the scaling principle is optimally tuning by the new SIAO. Optimization procedure is given in the subsequent section.

An original cover image was denoted as I^o, and water mark or secret image was denoted as I^w.

Execute the curvelet transform to I^o during the embedding phase.

$$\text{Then} \quad I^o = I_c^o = \mathrm{CT}\big(I^o\big) \tag{1}$$

The selection of scales count in the curvelet transform is indeed a crucial task that is optimally chosen in our work by employing the self-improved Aquila optimization, which would be briefly discussed in the following section.

The three-level discrete wavelet transform (DWT) is then performed to the same curvelet-applied picture I_c^o to produce the LL, HL, LH, as well as HH bands.

3.2 3-Level Discrete Wavelet Transform

Discrete wavelet decomposition (DWT) seems to be a numerical methodology for decomposing a picture hierarchically. This DWT divides the signal into two portions depending on frequency. The greater frequency portion provides data on the edge elements, whereas the low-frequency section is divided into high as well as low-frequency portions again. Because the human eye has become low sensitive to variations in edges, higher frequency elements were typically employed for watermarking. Throughout double-dimensional scenarios, we do the DWT mostly in vertical motion initially, then by its horizontal plane. Daubechies wavelet was used in our work. There might be four sub-bands after the initial decomposition level: LL1, LH1, HL1, as well as HH1.The preceding level's LL subband gets utilized as the input for every successive decomposition step. The DWT is deployed to the LL1 band to accomplish 2nd stage decomposition that decays the LL1 band into four sub-bands: LL2, LH2, HL2, as well as HH2. The DWT is applied to the LL2 band to accomplish third tier decomposition that decomposes this band into four sub-bands—LL3, LH3, HL3, as well as HH3. The decomposed elements of the host as well as water mark pictures were multiplied by k then added.

The secret or water mark picture I^w is scrambled utilizing Arnold map during this embedding procedure. Arnold maps, sometimes referred as "cat maps", are a sort of nonlinear map that is presented as follows:

$$\begin{bmatrix} p_{i+1} \\ q_{i+1} \end{bmatrix} = \begin{bmatrix} 1 & b \\ a & ab+1 \end{bmatrix} \begin{bmatrix} p \\ q_i \end{bmatrix} \bmod N, \tag{2}$$

here, (p_i, q_i) indicates the pixel location even before exchanging, whilst (p_{i+1}, q_{i+1}) represents the changed pixel location. The Arnold map generally stated to as a generalized Arnold map after stretching that is specified as

$$\begin{cases} p_{i+1} = p_i + \mathrm{by}_i \bmod 1, \\ q_{i+1} = aq_i + (ab+1)q_i \bmod 1 \end{cases} \tag{3}$$

Equation (3) generates chaotic sequences $\{p_k\}_{k=0}^{\infty}$ as well as $\{q_k\}_{k=0}^{\infty}$ that seem to be nonperiodic, nonconvergent, and pseudorandom, with variables, b, p_0 and q_0. The map's greatest Lyapunov feature exponent was $\mu = 1 + \left(\left(ab + \sqrt{a^2b^2 + 4ab}\right)/2\right) > 1$. And it is the mapping which is really in a chaotic state for attributes. We are using an improved chaotic Arnold map for scrambling.

Proposed Arnold Algorithm for Image Scrambling

Input: P_I (plain image), g, h;

Output: C_I (Scrambled image)

(1) Read the image P_I and get its size $N \times N$;
(2) Let img $= P_I$ and C_I be a zero image with the same size of P_I;
(3) For each row y and column z, do:
(4) As per the proposed logic, Y and Z, is calculated as in Eqs. (4) and (5)

$$Y = (1 - 2|v| + bw) \bmod N + 1 \tag{4}$$

$$Z = (g(1 - 2|v|) + (gh+1)w) \bmod N + 1 \tag{5}$$

(5) $C_I(Y, Z) = \mathrm{img}(y, z)$;
(6) Return

After scrambling, curvelet as well as 3-level DWT decomposition were applied to this scrambled water marked picture.

$$\mathrm{WMI} = K * (LL2) + Q * (\mathrm{WM2}) \tag{6}$$

WMI denotes the water marked image, K and Q are the scaling factors, LL2 signifies the low-frequency component of the level 2 decomposed cover image, and WM2 is the lower frequency element of the water mark image. After embedding the cover image with water mark image, 3-level inverse DWT is applied to watermarked image coefficients to generate final secured water marked image.

3.3 Watermark Extraction

First, 3-level DWT being performed to the watermarked picture and cover image that breaks down the image into sub-bands. The watermark is then retrieved from the watermarked picture utilizing the alpha blending process. The restored picture is provided by accordance per the alpha blending equation

$$\mathrm{RW} = (\mathrm{WM1} - K * \mathrm{LL3}) \tag{7}$$

where RW denotes the lower frequency approximate of the restored watermark, LL3 denotes the low-frequency approximate of the original picture, whilst WMI seems to be the low frequency approximate of the watermarked picture. Following the extraction procedure, the watermark image coefficient subsequently subjected to a 3-level inverse discrete wavelet transform to produce the resulting watermark extracted picture.

3.4 Self-improved Aquila Optimization (SIAO) for Optimal Scaling Factor

In our work, we employ self-improved Aquila optimization (SIAO) in curvelet transform to optimally select the scale's count. Here, AO is enhanced in its logic to speed up the convergence rate and also avoid local search problems, which was lagging in existing model.

Aquila optimization (AO) seems to be a population-dependent approach that replicates the Aquila's behaviour whilst hunting by displaying the behaviours of every phase of the hunt. Such optimization procedure starts with the development of candidate solutions (A), as shown in Eq. (8), which are created probabilistically between the upper (UB) as well as lower bound (LB) of the specified issue. For every iteration, the best-obtained resolution was identified as the approximate optimum solution.

$$A = \begin{bmatrix} f_{1,1} & \cdots & f_{1,m} & f_{1.\mathrm{Dim}-1} & f_{1,\mathrm{Dim}} \\ f_{2,1} & \cdots & f_{2,m} & \cdots & f_{2,\mathrm{Dim}} \\ \cdots & \cdots & f_{i,m} & \cdots & \cdots \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ f_{N-1,l} & \cdots & f_{N-1,m} & \cdots & f_{N-1,\mathrm{Dim}} \\ f_{N,1} & \cdots & f_{N,m} & f_{N,\mathrm{Dim}-1} & f_{N,\mathrm{Dim}} \end{bmatrix} \tag{8}$$

where A seems to be a collection of present possible solutions produced at arbitrary via Eq. (9), A_l indicates the decision values (positions) of the lth solution, N signifies the candidate solution's (population) overall count, whilst Dim signifies the problem dimension size.

$$A_{lm} = \text{rand} \times (\text{UB}_l - \text{LB}_m) + \text{LB}_l, \quad l = 1, 2, \ldots, N \; m = 1, 2, \ldots, \text{Dim} \tag{9}$$

If RAND is just a random value, LB_l would be the lth lower bound, whereas UB_m seems to be the given problem's lth upper bound.

This AO method replicates Aquila's hunting habit by displaying the activities of every phase of the hunt. As a consequence, AO algorithm's optimization operations have been split into 4 approaches: choosing the search area by greater soar with vertical stoop, uncovering inside a diverge search area through contour flight with short glide invasion, exploiting inside a converge search area through limited flight with slow deceleration invasion, as well as swooping through walk as well as grab prey. Depending on this scenario, the AO technique can switch between exploration to exploitation stages utilizing distinct behaviours: If $t \leq \left(\frac{2}{3}\right) * T$, the exploration stages would be stimulated; or else, the exploitation stages would be conducted. We described Aquila's behaviour as a numerical optimization paradigm that determines the optimum solution given certain restrictions. The following is a mathematical formula of the AO.

Step 1: Expanded exploration (A_1)

The Aquila recognizes the prey region then picks the optimal hunting location by greater soar with the vertical stooping during first technique (A_1). Here, the AO extensively explores the search region from a higher altitude to discover where the prey is. This Aquila great soar's behaviour with the vertical stoop was numerically predicted as seen in Eq. (10).

$$A(t+1) = A_{\text{best}}(t) \times \left(1 - \frac{t}{T}\right) + (A_M(t) - A_{\text{best}}(t) * \text{rand}), \tag{10}$$

Here, $A_t(t+1)$ would be the solution of the preceding iteration of t produced by the initial search technique $(A_1).A_{\text{best}}(t)$ represents the best answer achieved till the lth iteration, which indicates the probable location of the prey.

In our self-improved AO,

$$A_1(t+1) = A_{\text{best}}(t) \times \left(1 - \frac{t}{T_{\max}}\right) + (A_M(t) - A_{\text{best}}(t) * r1) + \text{Brownian}\,(P_b)\,\text{motion} \tag{11}$$

$$P_b = \frac{1}{h\sqrt{2\pi}} \exp \frac{\left(-(\text{dimension} - \text{agent})^2\right)}{2h^2} \tag{12}$$

$$h = \sqrt{\frac{T}{N}}, \quad N = 100 * T\ T = 0.01$$

This expression $\left(\frac{1-t}{T}\right)$ has been utilized to regulate the count of iterations in the extended search (exploration). $A_M(t)$ signifies the mean value of the previous strategies linked at the tth iteration, as computed by Eq. (13). RAND represents a number between 0 as well as 1. The constants t and T reflect the present iteration and the maximal count of iterations, correspondingly.

$$A_M = \frac{1}{N}\sum_{l=1}^{N} A_l(t), \quad \forall m = 1, 2, \ldots, \text{Dim} \tag{13}$$

where Dim would be the problem's dimension size whilst N indicates the count of alternative solutions (population size).

Step 2: Narrowed exploration (A_2)

When the prey region gets located from a great soar in the second way (A_2), the Aquila circles over the targeted prey, makes the land, and afterwards strikes. This is known as contour flying with short glide assault. In this stage, AO closely searches the target prey's chosen region in readiness for the assault. The algebraic representation of the Aquila contour flying with short glide attack is given in Eq. (14)

$$A_2(t+1) = A_{\text{best}}(t) \times \text{Levy}(D) + A_R(t) + (y - x) * r2, \tag{14}$$

where $X_2(t+1)$ has been the solution of the following iteration of t produced via the second search technique X_2. Levy(D) would be the levy flight distribution product, whilst D represents the dimensional area.

In our proposed work, the $r2$ value is take using gauss map.

$$x_{k+1} = \begin{cases} 0 & x_k = 0, \\ \frac{1}{x_k} \bmod (1) & \text{otherwise} \end{cases} \tag{15}$$

Equation (16) can be used to compute Levy(D).

At the lth iteration, $A_R(t)$ would be a random solution picked from the range [1, N].

$$\text{Levy}(D) = s \times \frac{\lambda \times \sigma}{|\beta|^{\frac{1}{\delta}}} \tag{16}$$

Here, "s" represents a constant value set to 0.01, and λ and β are random integers ranging from 0 to 1. σ can be computed utilizing Eq. (17).

$$\sigma = \left(\frac{\Gamma(1+\delta) \times \mathrm{sine}\left(\frac{\pi\delta}{2}\right)}{\Gamma\left(\frac{1+\delta}{2}\right) \times \delta \times 2^{\left(\frac{\delta-1}{2}\right)}} \right) \tag{17}$$

where δ denotes a fixed constant value of 1.5. In Eq. (14), the variables y as well as x were utilized to represent the spiral form in the search, and they will be determined as follows.

$$y = r \times \cos(\theta) \tag{18}$$

$$x = r \times \sin(\theta) \tag{19}$$

where

$$r = r_1 + U \times D_1 \tag{20}$$

$$\theta = -\omega \times D_1 + \theta_1 \tag{21}$$

$$\theta_1 = \frac{3 \times \pi}{2} \tag{22}$$

For a specified count of search cycles, r_1 picks a range between 1 and 20, as well as U represents a small value set to 0.00565. D_1 comprises of numeric integers ranging from 1 to the length of the search area (Dim), and ω is a tiny value set to 0.005.

Step 3: Expanded exploitation A_3

When the prey region is precisely selected as well as the Aquila is prepared for landing and assault, the Aquila descend vertically with an initial strike to find the prey response in the third technique A_3. This technique is known as low flying with gradual descending assault. AO uses the specified region of the target to come near to the prey and strike.

Step 4: Narrowed exploitation A_4

In the fourth approach A_4, once the Aquila moves closer to the target, it assaults it over the land using random motions. This technique is known as stroll and grab prey. Finally, AO assaults the victim at the last spot.

3.5 Solution Encoding and Objective Function

In our work, we have optimized the scaling factor by the utilization of self-improved Aquila optimization, and the fitness function (PSNR) has been calculated. The objective function is expressed as in Eq. (23). The solution passing to the proposed SIAO

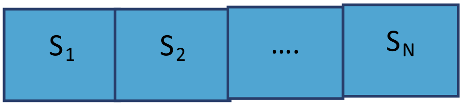

Fig. 2 Solution encoding

is illustrated in Fig. 2.

$$\text{Obj} = \max(\text{PSNR}) \tag{23}$$

3.6 *Expected Outcome*

The proposed work was implemented in MATLAB. The performance of proposed work is compared over the other conventional models like existing Acquila optimizer, cat swarm optimization, spider monkey optimization, poor rich optimization, and lion optimization with respect to MSE, PSNR, NAE, NCC, and SSIM, respectively. The sample image results are given in Fig. 3.

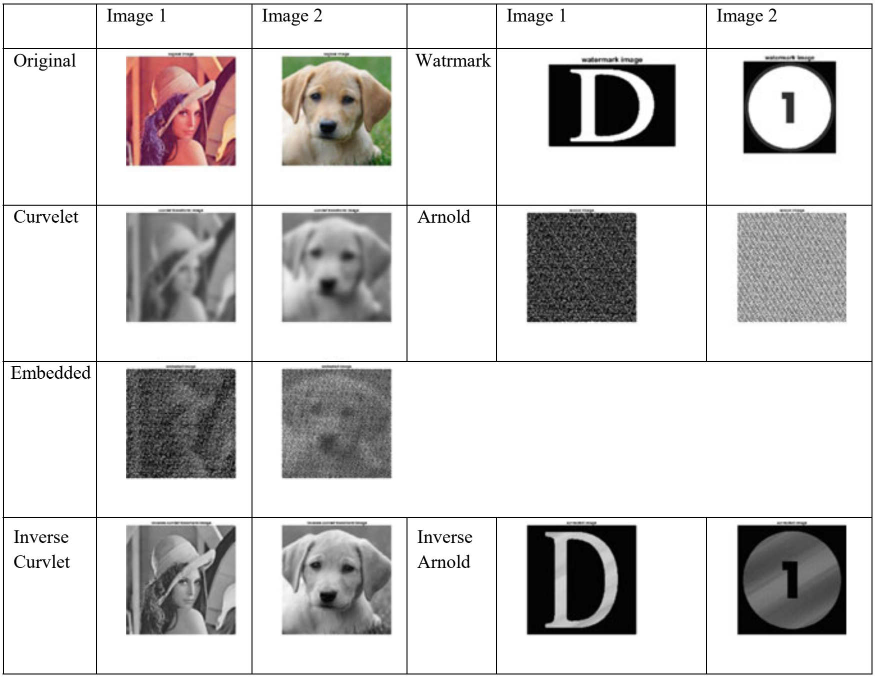

Fig. 3 Sample image results

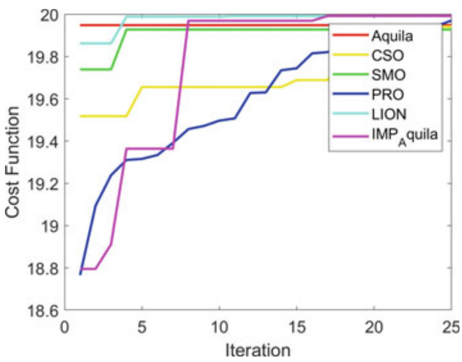

Fig. 4 Convergence analysis

3.6.1 Convergence Analysis

The obtained graph says about the fitness defined in the proposed work (maximization of PSNR) (Fig. 4). The graph shows the convergence of proposed work on the defined fitness with high value that is in the range of ~ 19.6, where the other models have shown poor convergence towards the fitness defined. This has been taken for different iterations from 0 to 25. In the initial iterations, the convergence of the model is very low, and in the mid of 5–10th iterations, the model (SIAO) gives its better convergence that reaches above 19.8. In the iterations between 20 and 25, the proposed model has shown the peak convergence. This proves how the improved contributions indulge in the watermarking.

3.6.2 Performance Analysis

Table 1 shows the performance of proposed work over other models with respect to the optimization algorithm, as it is the key role to enhance the performance. Using the proposed improved Acquila optimizer, the proposed work shows its better performance of watermarking. This has been proved with the error measures and PSNR value. The proposed work has attained high PSNR value that is of 20.493, whereas the remaining models have shown its poor performance. Similarly, least error has been obtained by the proposed model, particularly, ranges with 0.002, whereas the remaining models show high error rate. Similar results show in NAE measure as well.

This table shows the performance of proposed work with and without optimization strategy. As the model incurs the optimization strategy as the major tool on enhancing the watermarking performance, the proposed self-improved Acquila optimizer has shown its performance on watermarking, which is revealed with respect to high PSNR value (20.493). Here, it is clearly proved that the work without optimization has obtained degraded performance with respect to less PSNR value. Similarly, all the remaining error measures as well. This differentiation has shown the impact of optimization in this process (Table 2).

Table 1 Performance analysis

Method	PSNR	MSE	NAE	NCC	SSIM
Aquila	13.449	0.01121	0.89995	0.77992	0.78737
CSO	14.472	0.008857	0.79995	0.80437	0.79194
SMO	15.632	0.006781	0.69996	0.82882	0.79662
PRO	16.971	0.004982	0.59996	0.85328	0.80139
Lion	18.555	0.00346	0.49997	0.87773	0.80615
SIAO	20.493	0.002214	0.39998	0.90219	0.81077

Table 2 Performance with and without optimization

Method	PSNR	MSE	NAE	NCC	SSIM
Proposed without SIAO	13.449	0.01121	0.89995	0.77992	0.78737
Proposed with SIAO	20.493	0.002214	0.39998	0.90219	0.81077

Table 3 Statistical analysis

	Aquila	CSO	SMO	PRO	Lion	SIAO
Best	19.948	19.518	18.795	18.766	19.862	19.739
Worst	19.948	19.941	19.992	19.97	19.992	19.928
Mean	19.948	19.708	19.744	19.606	19.975	19.905
Median	19.948	19.656	19.969	19.63	19.992	19.928
SD	1.09E−14	0.13155	0.41234	0.31611	0.042637	0.062672

3.6.3 Statistical Analysis

As the optimization models are stochastic in nature, the models are allowed to run for several times, and the final outcomes are determined with respect to the statistical scenarios like best case scenario, worst case scenario, mean, median, and standard deviation. This results has been determined with respect to PSNR (Table 3). Here, it is shown that the proposed work has obtained high PSNR particularly in the best case, mean case. The range of the obtained PSNR value is 19.9, where the remaining models have reached minimum value when compared to the proposed model. Altogether, this has been proved that the proposed work is more significant in watermarking.

3.7 Conclusion

We proposed a unique strategy called steganography in colour pictures with proposed Arnold chaotic map and optimized curvelet transform which has two working stages:

image embedding and image extraction. In the first stage, the 3-level DWT with curvelet transform was being used to embed the original picture with a watermarking image which uses self-improved Aquila optimization (SIAO) to get the better performance by optimizing the scaling factors. During the embedding phase, in the scrambling process, proposed Arnold chaotic map was used to scramble the image. In the second stage, the water marks get extracted from this water marking images by inverse 3-level DWT. Consequently, secret image was generated by applying inverse Arnold chaotic map transform on the cover image. The performance of proposed work is compared over the other conventional models like existing Aquila optimizer, cat swarm optimization, spider monkey optimization, poor rich optimization, etc., which shows that our proposed steganography technique has greater performance.

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Block Chain Driven Intelligent Communication System for IoT

Ravinder Singh Madhan, Randeep Singh, and Pradeep

Abstract Several real-world applications, such as smart transportation and smart cities, are being industrialised by the Internet of Things (IoT). The Internet of Things (IoT) presents a number of difficulties that can be addressed with blockchain technology. In this review paper, they look at how blockchain technology can be used in conjunction with the Internet of Things (IoT). Block chain-based intelligent communication systems for IoT will be examined in this study. First, we introduce IoT and analyse some of its drawbacks. After that, we give a brief introduction to blockchain. Each block in the blockchain is linked to those that came before it, creating a decentralised ledger. Cryptographic hash code, block contents, and the previous block's hash code are all contained in each block. In the Internet of Things (IoT), BC serves as a mechanism for securely storing and transmitting data between IoT nodes. BC is a safe and open technology that anyone can utilise. Secure communication between IoT nodes is essential for the IoT. The BC for IoT could be able to assist in enhancing the safety of communication. From 2016 to 2022, this article undertakes a comprehensive assessment of 51 reference papers in the subject of blockchain.

Keywords Blockchain · Internet of things (IoT) · Cryptography · Security · Communication

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1 Introduction

The Internet of Everyone is a way of connecting peripherals and humans through the exchange of information about things (IoE). Smart homes, smart vehicles, and intelligent automobiles are all examples of peripherals that can engage each other in conversation. Using the Internet of Things (IoT) to improve manufacturing efficiency is possible in a wide range of industries. The appropriateness of blockchain technology for usage in a variety of areas, like finance, data security, agriculture, and health inside Things on the Internet (IoT), could be emphasised enough. Using a hash function, data blocks are connected together to form a chained (time stamps and links to the preceding block are part of cryptographic construction). Smart contracts are programmes that are utilised in the public blockchain for securing transactions and are kept in the public blockchain of the blockchain [1]. Accuracy, latency, centralization, plus security, and privacy are all issues that can be addressed by integrating Blockchain with AI. In blockchain technology, the transactions are stored in a database with a cryptographically signed hash value. Consequently, AI algorithms also are utilised to address issues of accuracy, latency, privacy and security, or centralization. Again, for Internet of Things, a cloud service used for massive data processing with the help of blockchain, the decentralisation attribute allows for automatic and quick data validation in blockchain networks. Delivering efficient and reliable IoT data from IoT applications in a decentralised manner at the fog layer requires an IoT network security architecture. It overcomes the problem of IoT network centralisation. Various modern technologies, such as blockchain thinking, use AI in everyday life [2, 3]. Decentralised artificial intelligence, such as smart machines and other objects, will permeate every aspect of human existence. For maximal data collection, a confluence between AI and IoT is the best way to go. As the device layer integrates blockchain and artificial intelligence, DL techniques blockchain based are provided to provide reliable data for IoT such as in the field of healthcare, connected home, smart agriculture, or intelligent transportation. For Internet of Things (IoT) data, it delivers great accuracy while also having a fast response time [4]. In various sectors, such as medicine, autonomous sensing devices, autonomous car driving, and culinary, studied intelligent machines that minimise the need for human work. What distinguishes intelligence from artificial intelligence (AI) is the capacity to contribute one's gathered knowledge in order to tackle complex problems. According to a research by McKinsey [5]. By 2030, the market for artificial intelligence (AI) will have grown to a value of 13 trillion US dollars, according to current market study. Artificial intelligence (AI) and A new method for safely and reliably sharing information without the intervention of a third party has been developed using blockchain technology. For IoT applications, it can also make autonomous decisions. Among the most important new technologies which have accelerated the pace of innovation across Blockchain, AI, and thus the Internet of Things (IoT) have become increasingly important to a wide range of companies in recent years (IoT).

There are many worries about privacy and accuracy, as well as latency and centralization, when using Blockchain with AI in IoT applications. This essay solves these issues by merging Blockchain and AI. A Ledger Intelligent IoT Architectural style to AI is proposed that utilises a Blockchain-enabled decentralised cloud, blockchain-based distributed fog networks, blockchain-based distributed edge networks, and peer-to-peer networks will converge at the device level and overcome recent issues. Internet of Things (IoT) secrecy are once again front of mind issues for many people (INTERNET OF THINGS), which is expanding at an exponential rate as it moves toward 5G technologies like Smart Cities or Smart Homes or e-Health or Distributed Intelligence. Decentralised networks connect IoT devices. As a result, employing currently available conventional security measures in IoT node communication is quite difficult. For transactions between IoT devices, they just use BLOCKCHAIN (BC) technology. An IoT network's data blocks are stored in a distributed, publicly accessible shared ledger that is decentralised, distributed, and open to the public. The public ledger's data is self-maintained thanks to a topology called peer-to-peer. The BC is indeed a system that uses a block to communicate between IoT nodes. There is a network of blocks, and each device has a unique identifier. Integrated with the Internet of Things and the Cloud, the blockchain function together. The BC will transform IoT communication in the future Reyna et al. [6].

1.1 Blockchain

This decentralised ledger uses cryptography to encrypt each block's hash value and timestamp, which are all stored in a distributed ledger called a blockchain. Digital ledgers that are distributed, decentralised, and open to the public, such as blockchains, are used to record transactions. There is no way for a third party to modify a record because each block has a unique cryptographic value and is owned by the preceding block. Blockchain technology encrypts all transactions and verifies each one with a hash value. For each transaction, the ledger contains a copy of its value in the form of blocks. Decentralised, distributed, safe, and trusted data sharing are all possible with Blockchain Salah [7]. The current block's smart contract code is linked to the previous block's decentralised storage, allowing it to store enormous amounts of data decentrally. Internet, sensors, and knowledge are indeed the three main pillars of a Internet of Things (IoT). The Internet of Things (IoT) refers to devices that are constantly sending and receiving data across a network.

1.2 Internet of Things (IOT)

The Internet of Things (IoT) is an altogether new communication paradigm has revolutionised the study of remote measurement and management operations. Farooq et al. [8]. An overview of IoT-based distant control systems that could potentially solve societal problems in healthcare, environment, connected home, transportation, the military, farming, solid waste disposal, smart metres, surveillance and consumer asset tracking, national grid, vehicular communications network, and pilgrim monitoring is presented in this study. An Internet of With the Internet of Things (IoT), several industries, including healthcare, the army, and even solid waste management are benefiting. Despite its revolutionary nature, the Internet continues to evolve, making it impossible to escape for anybody. Machine-to-machine communication is the future of the Internet, instead of human–human or human-device communication, due to the Internet of Things (IoT) (M2M). The purpose of this research is to provide a comprehensive overview of the Internet of Things, including the technologies that enable it and the sensor systems that are used in it. It also discusses the IoT's six-tiered design and the associated major problems.

2 Review of Literature

2.1 IOT Blockchain Framework

Haber and Stornetta [9]. In 2017 and 2020, IoT device privacy and security garnered too much attention. Several papers will be published between 2017 and 2020. It was written by Stuart Haber and W. Scott Stornetta on how to exchange a document privately without preserving any data on the moment service. Satoshi Nakamoto introduced the concept of blockchains to the world; however, he was not the first person to create a blockchain [10]. As a result of his work, a blockchain was created by connecting the blocks in a chain. Alphand et al. [11] the "IoTChain" was presented by the authors as a way to authenticate information sent between IoT nodes. They've developed an algorithm for exchanging data across the Internet of Things and blockchains. As depicted in Fig. 1, the authorization element of a IoTChain framework is the focus of this research. Benaida M. and Alam T. are the authors of this article [12]. Using MANET, for the Internet of Things, the authors researched how to have a strong influence devices to the cloud while still ensuring data transmission security. Alam and Benaida [13] when it comes to providing secure connection to IoT devices, the internet-cloud framework represents an excellent option. An IoT node's reliability in communicating with other nodes is represented by a middleware architecture in cloud-MANET architecture provided by the authors.

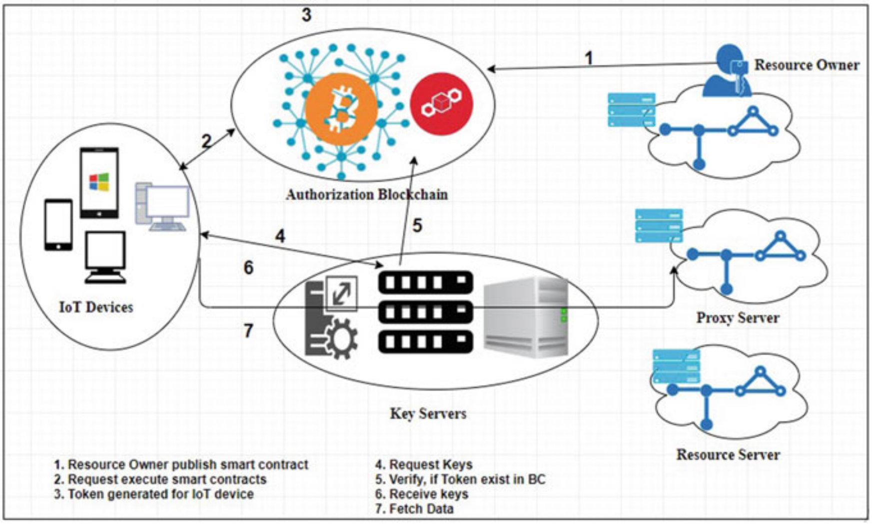

Fig. 1 IoT chain framework. *Source* https://www.researchgate.net/publication/330826270_Blockchain_and_its_Role_in_the_Internet_of_Things_IoT

2.2 The Role of BC (Block Chain) in IoT (Internet of Things)

Gubbi et al. [14] with the Internet of Things actual objects can share their data via a diverse network. The following are the various types of Internet of Things (IoT).

Physical Things: In the IoT, each connected object has a unique identifier. Internet of Things (IoT) devices can talk to one another and exchange data.

Gateways: The gateways are indeed the devices that act as a link between the actual world and the cloud, ensuring the network's connectivity and safety.

Networking: It's used to manage data flow and find the quickest path between IoT nodes.

Cloud: To store or compute the data, it's used here.

A chain of record as the BC is maintained by devices connected to a network. Digital ledgers are used to store and distribute information about blocks. Figure 2 depicts an IoT network where the BC secures communication. Private, public, or consortium blockchains each have their own unique set of attributes. The suggested IoT Blockchain platform's conceptual framework is depicted in Fig. 2. In order to create a multi-layer blockchain architecture, the networked IoT devices, Edge IoT nodes (CHs), client application nodes, external data storage, and IoT servers are coordinated in the peer-to-peer blockchain-based network. By these criteria alone, it appears that blockchain technology has an advantage over traditional centralised storage systems.

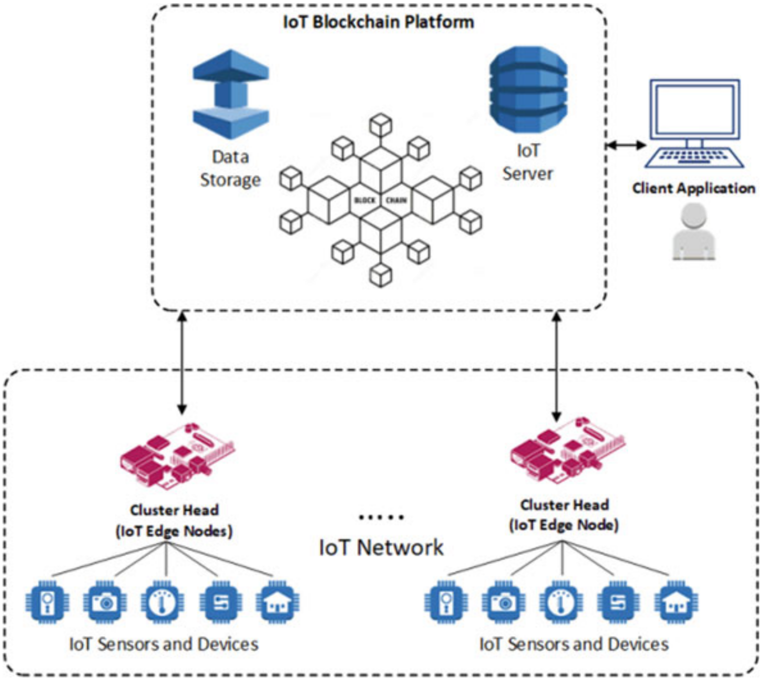

Fig. 2 Role of block chain in Internet of Things (IoT). *Source* hyperledger fabric blockchain for securing the edge Internet of Things [Houshyar Honar Pajooh]

Blockchain-based IoT applications can be built on any of the platforms listed below. IOTA: "Next generation" It's important to note that the terms "blockchains" and "Internet of Things" are used interchangeably (IoT). This platform allows for high data security, high transaction speeds, and high block validity while consuming a less amount of energy. There are no longer any issues with blockchains as a result.

IOTIFY: As a web-based IoT solution for blockchains, it allows custom apps to reduce their constraints.

iExec: Blockchain-based open-source software is exactly what it sounds like: open source. Your apps may take advantage of the benefits of decentralised cloud computing more easily thanks to this tool.

Xage: To boost automation and protect information, it is a secure public blockchain for the Internet of Things (IoT).

SONM: Secure cloud services are provided by a decentralised blockchain-based fog computing platform. It's now possible for anyone and everything to interact in real time, securely, privately, and authentically thanks to the Internet of Things (IoT) and blockchains. When these new technologies are integrated, the current world will be transformed into a world where machines interact without human intervention at various stages. Framework's aim is to provide secure data in a timely manner to an appropriate destination. Billions of IoT-connected devices might be tracked and coordinated using the BC. This would allow for transaction processing, failure resolution or elimination, and the creation of a customizable ecosystem for running physical things on the BC. BC protects user data by implementing hashing techniques in chunks of data.

2.3 *Challenges on Internet of Things*

Jindal et al. [15] describe how sensors, actuators, or software systems are combined into a variety of products (smart objects) that are capable of detecting, acquiring, and acting on information about its immediate physical environment. IoT's unique qualities bring the following research difficulties.

Figure 3: Internet of Things (IoT) consists of perception layer, communication layer and industrial applications.

Heterogeneity of IoT: There are a vast variety of devices, communication protocols and data types in IoT systems. Many other challenges stem from heterogeneity in additional to compatibility, privacy, and security.

Complexity of networks: The Internet of Things (IoT) is made up of a wide range of communication and networking technologies. In terms of network protocols, NFC, Wifi, WirelessHART, Sigfox, LoRa, and NB-IoT are now only a few examples. A

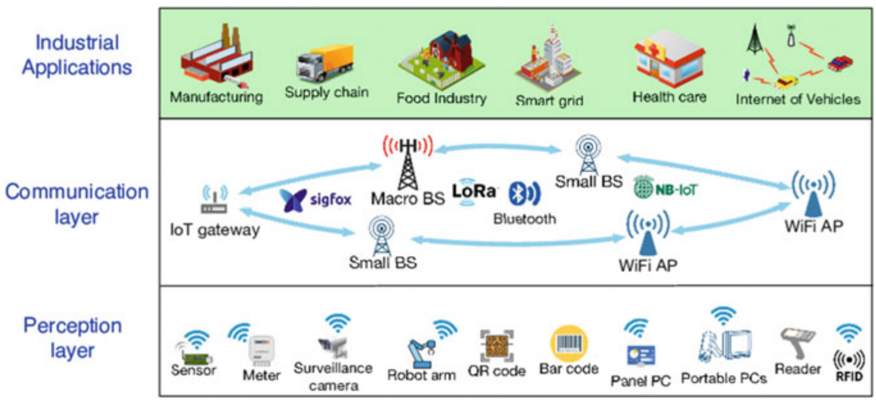

Fig. 3 Blockchain-composite layer. *Source* https://www.researchgate.net/publication/333446530_Blockchain_for_Internet_of_Things_A_Survey

variety of network services can be found on each of them. The communication ranges of LPWAN technologies, such as 6LoWPAN and Wireless HART, are sometimes limited (e.g., less than 100 m).

Poor interoperability: Having the ability to exchange, consume, and cooperate on data is what we mean when we talk about IoT interoperability. As IoT networks spread and IoT systems become more diverse, it's becoming increasingly challenging to transfer data among different enterprises, strategic centres, and IoT systems. As a result, interoperability in the IoT is problematic.

Resource constraints of IoT devices: The computational power, storage capabilities, and battery life of several Internet of Things (IoT) gadgets limit their usefulness. Included in this category of RFID tags are passive tags, which do not require any form of battery power since they can only take power from RFID readers or even the environment. Lu et al. [16]. Additionally, IoT devices are more exposed to malicious assaults as a result of the dearth of resources they possess.

Privacy vulnerability: The privacy of IoT data must be protected if it is to be properly utilised. Data privacy is challenging to manage in the IoT due to its decentralisation and complexity, including its variety. As a result, cloud computing is becoming more popular as a means of integrating Internet of Things (IoT) devices with cloud computing resources. IoT data may potentially be compromised if it is uploaded to third-party cloud servers, which are prone to IoT privacy breaches Zhou et al. [17].

2.4 Blockchain for 5G Beyond in IoT

Future networks, including such 5G-beyond and 6G, will be important in the development of core blockchain infrastructure. Several research issues must be answered before blockchain technology is merged with IoT, although it shows promise for IoT. Figure 4 demonstrates how blockchain might benefit 5G beyond networks from a communications, network, and computing management perspective. They're laid out in further depth here.

- **Blockchain for Communications**

Mobile data traffic's increasing demands are forcing 5G communication technologies to improve resource management. Radio spectrum, for example, is a critical resource [18]. The auctioning of radio spectrum and the sharing of available spectrum are two common methods of radio spectrum management. In the most recent speech, that is evident [19] J. Rosenworcel, a commissioner of the for 5G and beyond (6G), the

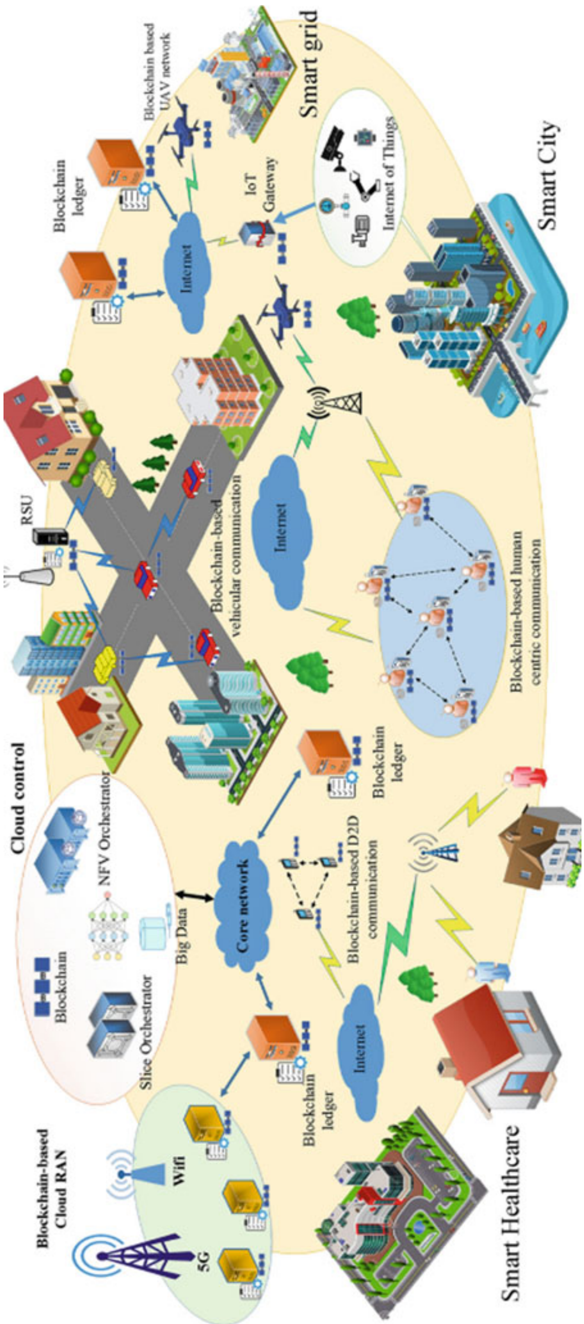

Fig. 4 Blockchain for 5G beyond networks in IoT. *Source* https://sci-hub.se/, https://doi.org/10.1016/j.jnca.2020.102693

Federal Communications Commission (FCC) has said that blockchain technology might be employed to create dynamic spectrum regulation that is secure and reliable [20, 21]. A central intermediary isn't needed for 5G beyond networks, which saves money in the long run by making transactions more secure and traceable [22] illustrates the benefits of radio frequency cooperation in terms of trust, consensus and cost reduction by leveraging blockchain technology. Moreover, Kotobi and Bilen [23] ensure spectrum sharing in wireless systems between main and cognitive users using a blockchain-based mechanism. By preserving anonymity while sharing network conditions with various IoT nodes, blockchain could assist to improve spectral efficiency through traffic optimization [24]. Blockchains have the ability to supply users with the best mobile services in addition to managing radio airwaves. Fragmented heterogeneous networks are common in 5G networks, for example. In order to provide seamless access between networks, blockchains constructed on top of the network level can aid in network integration. As a result, smart contracts can drastically reduce operational costs by automating the provisioning and agreement process between network providers and subscribers the work of indicates that what It is possible that operating nodes could benefit from a blockchain-based system. Service providers will benefit from the combination of blockchains with big data analytics in the future.

- **Blockchain for Network Management**

IoT device distribution has lately found a suitable solution in software-defined networking (SDN). However, it is shown that SDN centralization can also lead to a single point of failure. As a result, conventional SDN hardware (such as gateways) is unable to perform computation-intensive analysis of the data flow. It is possible to solve the issues with SDN by utilising blockchain technology in conjunction with SDN. For example, the work of presents an IoT SDN infrastructure based on a secure blockchain. It has been determined that the flow rule table can be updated securely and without the use of an intermediary using a blockchain-based system. Additionally, blockchain can aid in the safety of network administration and visualisation of network functions (NFV). In particular, it is shown in to ensure a secure, unchanging, auditable, and non-repudiation platform for NFV, the use of blockchain technology has been included into it. An architecture model was also created for this study, and it was tested. The emergence of network slicing technologies, in addition to SDN and NFV, the ability for networks to adapt to changing functional and performance needs is brought to bear. Blockchains can be used in a wide range of industries, as discussed in Section IV. It is common practise to use only one blockchain for applications like digital currency, whereas businesses may use multiple blockchains for various purposes. Each of the following: ERP, PLM, MES, and CRM have their own dedicated blockchains. In mobile edge computing, using network slicing, blockchain applications can meet a variety of objectives.

- **Blockchain for Computing Management**

As a result of the lack of processing power on IoT devices, data is routinely transmitted onto external servers for further analysis. Using a pure cloud computing model results in a lot of network traffic congestion and significant delay, as well as a lack of context and privacy, thereby impeding Internet of Things (IoT) growth. In recent years, mobile edge computing (MEC) Cloud computing is being supplemented by offloading computing tasks from faraway server to MEC servers often situated at IoT gateways, Wi-Fi APs, Mega BS, or Micro BS, which are closer to the user. For situationally, latency-critical, and computing-intensive applications, local MEC servers can be substituted for remote cloud servers. This will improve response time and privacy protection. Due to its capacity to establish trust in a decentralised manner, blockchain technology was used in numerous fields. Many concerns must be addressed before MEC could be implemented in BCoT. Mobile edge servers, on the other hand, typically lack the computing power and storage capacity of cloud servers. The main memory, storage capacity, and network connectivity of mobile network edges are all heterogeneous. Consequently, mobile edge servers are unable to meet the computational demands. While a mobile server may be unable to solve the blockchain consensus challenge, a cloud server can. Due to the importance of providing blockchain services, it is necessary to examine how mobile edge computing or cloud computing may be coordinated.

3 Conclusion

To better understand how blockchain technique can be implemented to the Internet of Things, we've written a review paper. When we talk about blockchain and the Internet of things, we reference to papers like this one. Let's start by giving a brief introduction to an Internet of Things as well as the blockchain technology. After that, we'll talk about the BC's or the Internet of Things's functionality. We'll go over some of the research problems that blockchain provides for next-generation networks in the part after this one. We're going to keep looking into how blockchain and the Internet of Things might be used in the future. A blockchain-enabled IoT system employs a network diagram throughout this time. In a distributed ledger architecture, IoT system identification, authentication, and data flow are all seamless. Instead of relying on a third-party authority, IoT devices can use a secure and trusted blockchain to exchange data. Sensor data can be managed and recorded using blockchain, which minimises the repetition of malicious data. IoT devices can be immediately identified on the blockchain, allowing for analytics and troubleshooting of linked devices and their information.

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Face Recognition-Based Automated Attendance System for Educational Institutions Utilizing Machine Learning

Al Mahmud Zayeef and Rana Jyoti Chakma

Abstract Face recognition technology, defined as the process of detecting and verifying individuals' identities via image processing techniques in computer vision, has become increasingly vital in today's technologically and digitally evolved world. Automating the attendance system with face recognition software eliminates inefficiencies like tampered records, proxies, and security risks. This paper proposes incorporating facial recognition technology, Haar Cascade classifiers (Li et al. in ICEMI 2017-Proceedings IEEE 13th International conference on electronic measurement and instruments, vol 2018-Janua, pp 483–487), and the Local Binary Pattern Histogram (LBPH) (Ahmed et al. in 2018 International conference artificial intelligent big data, (ICAIBD 2018), pp 144–147) machine learning approach can be used for identifying faces to create a secure and reliable solution for automating attendance systems. The proposed method produces more accurate results than any other algorithms used earlier. Compared to existing algorithms, the suggested system showed better results, reliability, and robustness in accurately recognizing faces. Its facial recognition accuracy is 87%, and the false-positive rate is only 7%. The system can also reliably identify a person who has undergone unintentional changes in their appearance, such as growing a beard or putting on spectacles.

Keywords Automated attendance system · Face recognition · Local Binary Pattern Histogram · Machine learning

1 Introduction

The conventional method of recording attendance at many educational institutions is time-consuming and burdensome for instructors, who must manually call out students' names, which may take up to 10 min out of the entire session. In addition to that, there is the possibility of attendance by proxy. Because of this, several educational institutions have integrated biometric identification systems like RFID,

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iris scans, fingerprint readers, and more. These queue-based methods may be more time-consuming and intrusive than alternatives.

Face recognition is a simple, non-intrusive biometric feature. The facial recognition procedure has two phases: (a) face detection and alignment (localization and normalization) and (b) feature extraction and matching. However, the existing conventional facial recognition processes have a high false-positive rate and don't encourage people to use them much.

We propose a facial recognition system that applies a threshold to reduce false positives. We utilized Haar Cascade [1] and LBPH [2] to recognize and identify faces. This paper demonstrates that the facial recognition-based attendance system proposed is effective and can automatically record the presence of an enrolled individual at a given location. The proposed method also maintains a log file to record each user's entry regarding a universal system time. This innovative technology is more efficient than prior, traditional methods.

2 Literature Review

Several studies have discussed the use of biometrics to track attendance. In [3], the authors proposed an automatic attendance system as a model. This model demonstrates how Facial Recognition and Radio Frequency Identification (RFID) collaboratively detect authorized individuals as they enter and exit the classroom and keep records of faces, identification numbers, and entrance and departure times via the Real-Time Clock (RTC) module.

The fingerprint system in [4] is used to track students' attendance. Biometric sensors scan fingerprints and extract features. Students must walk to the hardware device or pass it to other students to register their enrollment during class, which might be distracting.

The paper's authors [5] have designed and implemented an iris biometrics-based attendance system. In the beginning, everyone must register their data and the iris template. Afterward, the device will record attendance by snapping a photo of each student's iris and comparing it to a database of similar images. A web-based application is served as the prototype. This approach has the problem of being vulnerable to external factors.

Researchers in the paper [6] have used DNN, PCA, and LDA algorithms, Support Vector Machine (SVM) classifier, CNN, and SVM classifier to identify students' faces. With a database of eleven photos, they could get an accuracy rate of 86 percent. The frames from the students' videos were taken out and stored in the database.

The authors of [7] have proposed a facial recognition-based attendance system using Viola-Jones Algorithm, HOG features, and SVM classifier. Scale, illumination, and posture were examined in real-world circumstances. Quantitative research was conducted using MATLAB's Graphical User Interface (GUI) and Peak Signal-to-Noise Ratio (PSNR) data.

In [8], the authors introduce a facial recognition attendance system that utilizes deep learning. This study discusses how to construct a facial recognition component using learning techniques. It has been discovered that a high degree of accuracy may be achieved with fewer facial photos.

In [9], the authors have suggested a face recognition-based attendance management system combining 2D DWT-PCA with *k*-NN classification. The *k*-NN algorithm with Euclidean distance recognizes students from photographs or videos, and IP cameras, PCs, or laptops may automatically detect each student's presence or absence and identify them inside their course group.

3 Methodology

Our proposed methodology intends to construct a facial recognition-based attendance system that will give a low false-positive rate by identifying and storing photos of unknown individuals. The Haar Cascade algorithm [10] begins by amassing many positive and negative pictures to train the classifier. After then, it is utilized to detect human faces. The technique used to detect faces consists of four components: feature selection, necessary image processing, AdaBoost training, and a cascade classifier [10]. Local Binary Pattern Histogram (LBPH) is the most often used approach in computer vision, image processing, and pattern recognition; it is suitable for feature extraction since it depicts the texture and structure of an image. The Local Binary Pattern Histogram (LBPH) technique is a straightforward approach to face recognition that can identify both the front and side faces [11].

3.1 Workflow of the System

The suggested technique for face recognition consists of four modules: one for picture capture, one for feature extraction, one for training a classifier database, and one for classification.

Initially, the image acquisition module collects the face datasets. Then, using a feature extraction module, several essential characteristics are extracted. These facial traits assess facial landmarks that include information about a person's identity. The classifier is then taught to recognize faces in the next step. Finally, the system identifies a person's face and retrieves their information from the MySQL database.

3.2 System Architecture

Initially, this system will use the camera to capture input photos. Then, pre-processing will happen by converting the color image to grayscale. The Local Binary Pattern

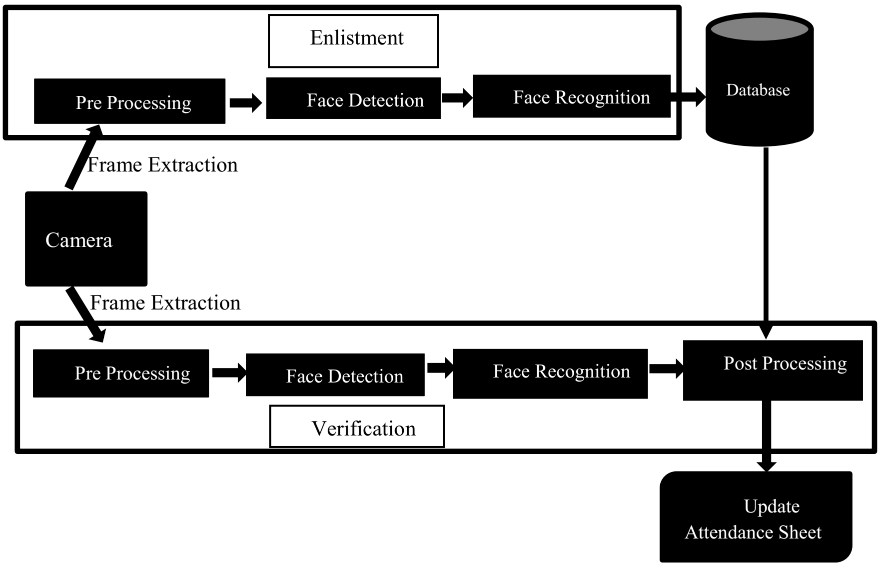

Fig. 1 Face recognition attendance system architecture [12]

will recognize the face after the Haar Cascade classifier has identified it. Next, the algorithm will match the face with trained ones and check every student's face in the database. Attendance is marked "PRESENT" on the datasheet if it matches; otherwise, attendance is marked "ABSENT" on the datasheet. The attendance sheet will then be automatically updated. Figure 1 [12] depicts the steps of this suggested system.

3.3 Algorithm of the System

The Haar Cascade learns from many positive and negative samples, where a positive sample contains an object of interest, and a negative sample contains anything else. Afterward, it detects human faces in photographs. And Local Binary Histogram recognizes the face. And, then face matching happens by comparing with the trained dataset.

The step-by-step algorithm [13] of our smart attendance system is given below:

Steps:

1. Capture an input image.
2. Transform the color image to a black and white version.
3. Identifying faces with the assistance of the Haar Cascade classifier.
4. Face recognition using LBPH.
5. Matching faces with trained ones.

6. Check every student's face.
7. If it is verified, the datasheet shows "PRESENT."
8. Mark "ABSENT" if it doesn't match.
9. Generate a report.
10. Update attendance.
11. Proceed to step 6.

4 Implementation

The whole implementation process can be divided into four stages as described below:

- Dataset creation process
- Face detection process
- Face recognition process
- Attendance update process

4.1 Dataset Creation Process

In this process, before taking photos for the dataset, all students must register and give appropriate information. Faces will be extracted from live-streaming classroom footage during each session. Identifying faces and linking them to photos inside the dataset will be possible. Spreadsheet will monitor the student's attendance if a match is found.

4.2 Face Detection Process

Images of pupils are captured using a web camera, and the Haar Cascade algorithm detects the capture and placement in a snap. The separation of facial objects from the image is the pre-processing of a human look. Each student will be photographed from multiple angles and with various gestures. Cropping creates a Region of Interest (ROI) for subsequent identification. The cropped photographs are then resized. The next phase converts RGB photos to grayscale.

These photographs will be in a student-named folder. This application uses OpenCV's detect Multiscale module, which creates a rectangle around an image. Scale factor, minimum neighbor count, and minimum size are considered. The scale factor parameter in each picture scale defines how much an image should be shrunk down. The MinNeighbors parameter specifies the minimum number of neighbors necessary for each candidate rectangle, and minSize specifies an object's minimum size.

4.3 Face Recognition Process

Local Binary Pattern Histogram (LBPH) is this system's strategy for face recognition. Using the LBPH technique, which can be implemented in various ways, the collected characteristics are fed into a classifier that recognizes or categorizes the face. The machine learning classifier is constantly monitored as the system compares the test photo to the pictures in the database. The specified model is executed in two stages: registration and testing. The collection of data, pre-processing of data, and characteristics extraction are all involved at each location. After the picture test and the image dataset have been appropriately registered and tested, an image classifier is utilized to order them. It's possible that as image processing advances, the input image will be rescaled to incredible proportions, and the detector will be set to a fixed size.

The LBPH algorithm is used to determine the best features in a picture. This approach is more straightforward because it describes the image inside the dataset locally and compares the result to each image within the dataset. It outperforms other algorithms in various situations and lighting. The Local Binary Pattern Histogram (LBPH) provides a picture that highlights the image's qualities better. It incorporates the sliding window principle, radius, and neighbors.

It is possible to break the process of identifying a person's face into three components. Preparing data for training, training the face recognizer, and making predictions are part of the process. Photographs in the dataset will be utilized as training data for the machine learning algorithm, and they will be assigned an integer label corresponding to the student they are given. Face recognition is then conducted on the photographs that have been collected. Before proceeding, a list of local binary patterns (LBP) for the entire face is formed. After converting LBPs to decimals, all decimal histograms are created [14].

The technique of obtaining a feature histogram for each image is shown in Fig. 2.

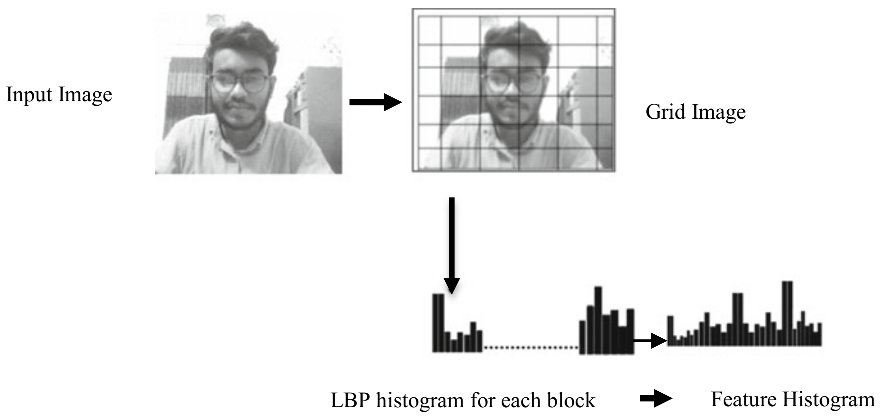

Fig. 2 Feature histogram

After the operation, each training image has a histogram. Later in the recognition process, the student's label is determined by comparing the face's histogram to previously computed histograms.

4.4 Attendance Update Process

After face recognition, the recognized faces are logged in Spreadsheet. In contrast, other faces will be reported as absent, and a list of absentees will be generated.

5 Results and Discussion

This technique uses Haar Cascade classifiers and the Local Binary Pattern Histogram (LBPH), which produce more accurate results than any other methods. Compared to existing methods, the suggested approach showed better results, reliability, and robustness in accurately recognizing faces.

The percentage of accuracy of face recognition utilizing the LBPH and Haar Cascade classifier on our dataset is shown in the following Fig. 3, where we conducted the test with 100 photo samples, and the result showed that face recognition accuracy is about 87%. In our evaluation, we considered the following metrics: False Positives, False Negatives, True Positives, and True Negatives. The formula for calculating the face recognition accuracy rate is as follows: (Number of True Positives + Number of True Negatives)/(Total Number of Faces) * 100.

A distance of 1.5 m with the lights on is ideal for this system to recognize a sample. However, certain circumstances, such as expression diversity, disorientation, and a change in illumination performance, limit the identification rate of the system.

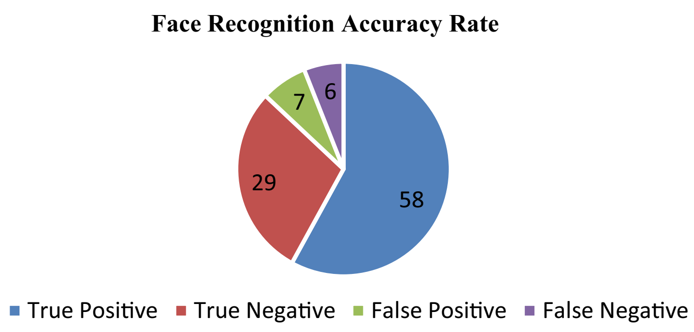

Fig. 3 Face recognition performance evaluation

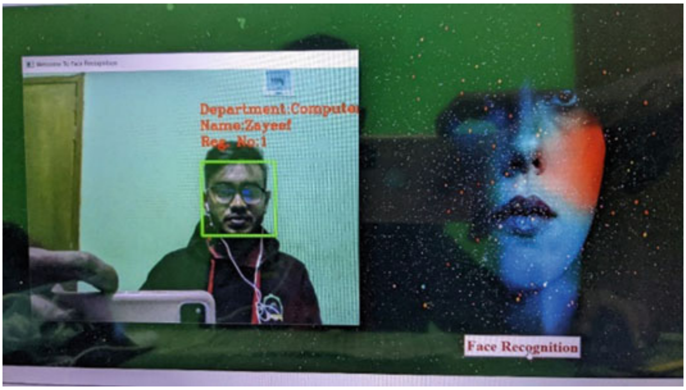

Fig. 4 Face recognition result

A common problem with the Haar Cascade method is that it frequently provides false-positive results. By synthesizing additional training instances for Haar Cascade classifiers, we can increase their ability to identify unfamiliar individuals. The system performs well on the facial expression variation test, except when the face is tilted left or right. The face recognition result is shown in Fig. 4.

6 Recommendations and Conclusion

Utilizing face recognition to track attendance may save a lot of time and work in situations when recording the attendance of many participants is necessary. An automated system in this situation will replace the manual attendance system, which will save both time and money while being efficient and quick. This method will drive to digitize a classroom. The face recognition accuracy of our innovative attendance system is approximately 87%, with a false-positive rate of about 7%. Furthermore, it can correctly identify a person who has made unintentional changes, such as wearing glasses or growing a beard. There are other areas in which this work could be advanced. We identified areas for improvement when working on the system, such as overcoming distance constraints, lack of brightness, and false-positive rates. We can add a GSM module so that students can receive SMS alerts about their attendance in the future.

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Segmentation of Gujarati Handwritten Characters and Numerals with and Without Modifiers from the Scanned Document

Sanket B. Suthar, Devanshi S. Shah, Heli K. Shah, and Amit R. Thakkar

Abstract Gujarati is more challenging to understand than other languages because of its curves, encompassing of modifiers, and usage of joint characters. So, to make it convenient in reading the Gujarati language, systems like OCR are used. Optical character recognition (OCR) also referred to as text-recognition. Day by day, the use of OCR technology is increasing worldwide to convert either handwritten text or printed text from a required image virtually to machine-readable text. So great effort has been laid into the literature for Gujarati OCR. The accuracy of the OCR devices for isolated *handwritten Gujarati* characters depends upon the genuine segmentation of characters. This paper focuses on box segmentation and character image extraction using Python language and experimental analysis using convolutional neural network (CNN) has been carried out on some of the well-segmented newly generated *handwritten Gujarati* characters and numerals dataset which includes 10 consonants, 5 vowels, and 10 handwritten numerals. As a result, 350 images for each 490-characters including consonants, vowels, numerals, and modifiers are extracted.

Keywords Optical character recognition (OCR) · Gujarati character recognition · Convolution neural network (CNN) · Recognition · Gujarati character and symbols · Handwritten numerals · Printed character classification

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1 Introduction

The process of character segmentation is a process, which breaks down the image of multiple characters into sub-images of individual symbols [1]. There was a long ago dream of researchers to fabricate a device which can read text documents written in a language [2]. And as there is an increase in facilities worldwide, all may travel either from one state to another or from one country to another. In this kind of traveling, travelers may come across the language barrier. This research paper work is based on offline Gujarati handwritten character recognition. Offline handwritten character recognition is useful because it can recognize multiple characters in an image of handwritten text [3]. Images of handwriting, unlike printed texts, are difficult to split into characters. Early methods attempted to compute character segmentation hypotheses by executing a heuristic over-segmentation and then rating groupings of segments. To resolve such type of problems like language barriers, researchers are able to develop an OCR system which can read the text document. This technology has advanced much since 1996. The technologies of today are capable of providing OCR accuracy that is almost perfect. Although there are numerous OCRs created for many languages, OCR for Gujarati languages still does not produce good results especially for handwritten characters. One of the decision stages in an OCR system is character recognition. OCR is conjuring up the problem of data extraction from printed or handwritten text from scanned documents or an image file. Two types of OCR systems are found: offline and online. Nowadays, the use of OCR applications is increasing for reliability in the face of language barrier. It can be useful to: (1) blind people for converting the text to speech, (2) for visitors to convert one language to another for people coming from different states or countries, signature verification, vehicle license-plate recognition, check truncation system, etc. In all above-mentioned areas, it requires high recognition accuracy, lesser complexity, and a consistent performance in the recognition system. Thus, in this research, a well-segmented dataset of newly generated Gujarati handwritten base characters, modifiers, and numerals is collected that contains 36 consonants, 13 vowels, and 10 handwritten numerals on which experimental analysis has been done. In experiments, variations in the datasets such as size, boldness, noise, and angles are also taken into account. The proposed method achieves a character recognition rate of 82.01% and a numeric recognition rate of 86.80%. Globally, digitalization is becoming more prevalent today. As a result, many crucial documents are scanned and either shared with or saved for later use. For this purpose of scanning, many applications are used in cellphones like Cam Scanner, Microsoft Office, etc., where option of OCR is also added. The flow of the paper is organized as mentioned below: Sect. 2 describes the background and survey of Gujarati script, Sect. 3 describes the datasets collection process, Sect. 4 describes the method and steps required for image, line, and character segmentation, i.e., methodological analysis, Sect. 5 describes the CNN training model and describes the future of OCR, and Sect. 6 is about results obtained after segmentation. After these sections, there is discussion about conclusion and discussion related to future work and references.

2 Background of Gujarati Script

Gujarati is an Indo-Aryan language spoken mostly by Gujaratis and native to the state of Gujarat. Gujarati is a ceremonial language spoken by residents of Gujarat as well as students in union tertiary institutions in Dadra and Nagar Haveli, Daman and Diu. Gujarati is the sixth most widely spoken language in India, with 5.54 crore speakers accounting for around 4.5% of the country's total population as of 2021. Base letters, modifiers, compound characters, vowels, and numbers are all used in Gujarati. Compound characters are created by combining base characters and modifiers.

Base characters of Gujarati language, which are handwritten as shown in Fig. 1.

There is no distinction between upper and lowercase in Gujarati. However, it is a common feature of the Gujarati language that all characters are written by touching the page's upper line. There are additional vowels, as indicated in Fig. 2.

To modify the base characters, there exist modifiers which make compound characters (modifiers + base characters = compound characters). Modifiers like maatras, kanas, rasvai, dirgai, etc., are attached at any one side of the base character from four sides. Modifiers and compound characters are shown in Figs. 3 and 4, respectively. Combination of all types of characters as mentioned above can make a word and by combining words there can be formation of sentences.

Fig. 1 Gujarati base characters

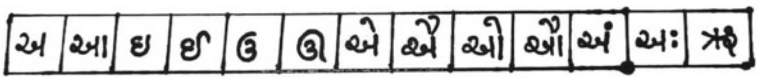

Fig. 2 Gujarati vowels

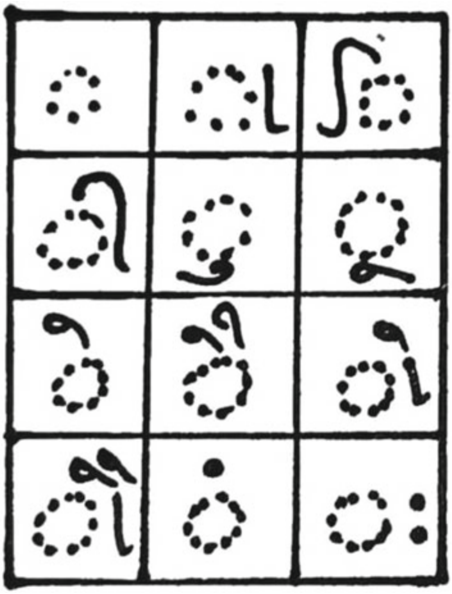

Fig. 3 Modifiers

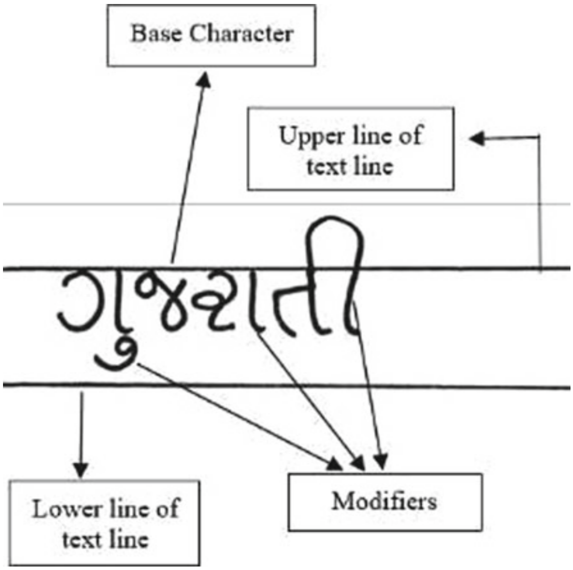

Fig. 4 Compound characters

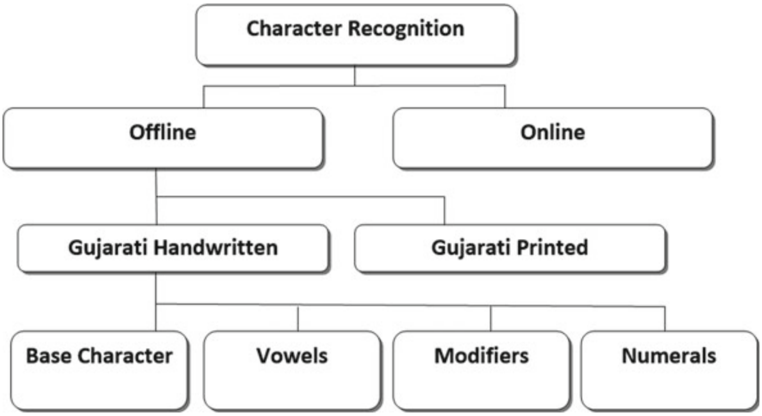

Fig. 5 Flow of datasets collection

3 Dataset Collection

The contents of handwritten document pages for the suggested datasets were authored by persons of various ages. Document pages for datasets in the research were collected by requesting many people to write textual contents of base characters and modifiers available in Gujarati language. Writers insisted on using different color pens with different kinds of thickness and writing inside the four edges of the box. The main concern was to get characters with more variations with varieties such as broken characters, blurry characters, noisy characters, and characters with different thickness so that machine can be trained with higher accuracy at the time of CNN training model. No other restrictions were intruded on the writer. Moreover, datasets were collected from various places like school, colleges, neighbors, offices, etc. In the task of collecting datasets, a total of 150 men and 120 women were engaged. The flow of datasets collection is shown in Fig. 5.

4 Methodological Analysis

To build the device like OCR, there are various steps that should be followed for handwritten Gujarati isolated characters. There are three main steps to be followed in segmentation of handwritten characters are (1) image acquisition, (2) preprocessing, and (3) segmentation. These steps can be understood properly by the flow of the segmentation process mentioned in Fig. 6.

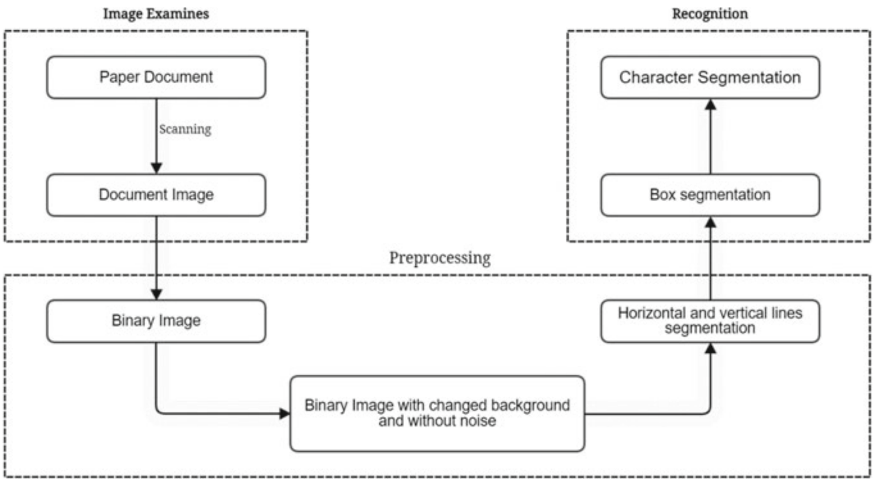

Fig. 6 Flowchart of segmentation

4.1 Image Acquisition

Scanning for required text

To interpret the required text from a document into convenient language, it becomes necessary to convert the text of the required document into a digital image. This piece of work can be performed either by a hand-held phone scanner or by flatbed scanner.

4.2 Preprocessing

Because machines only understand binary language, it is one of the procedures for converting grayscale images to binary images. It aids in distinguishing text from backdrop so that isolated characters may be correctly identified.

Binarization

Binarization is done by thresholding by setting intensity value in pixels either greater than or less than the threshold value. If the threshold value is greater than the pixel value, characters of the image are forced to turn black. But if the pixel value is found to be greater than threshold value, then characters of the image are forced to be turned white. The following Fig.7 shows the binarized image.

Background and Color Change

The color of the background can be explicitly changed by applying the concept of bitwise_not because it inverts the bit of the operand.

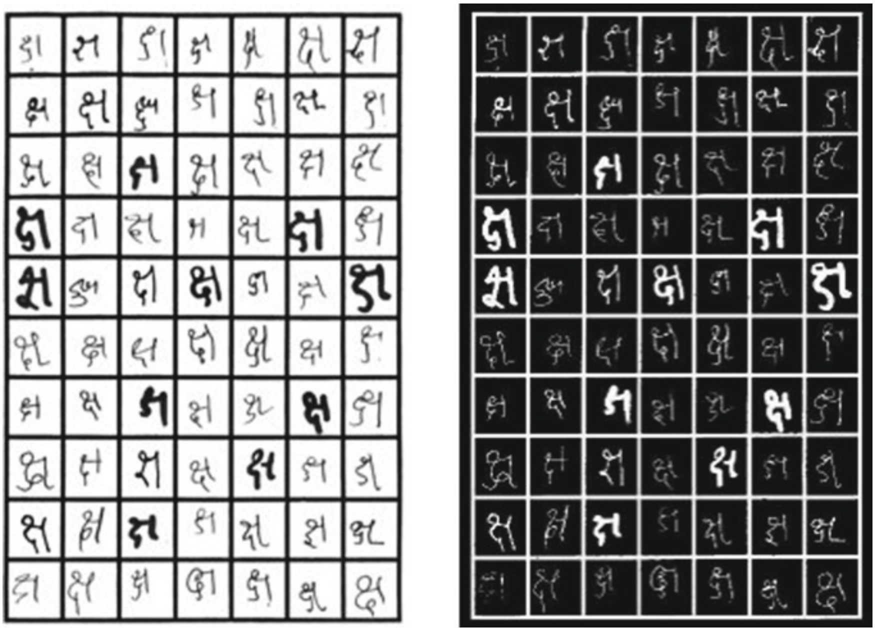

Fig. 7 Binarized image of scanned image

Noise Detection

Noise can be churned out at the time of scanning or printing. But noise can be removed using the technique of low-pass filter. This filter removes noise at maximum level. Image of text can be seen with presence of noise as shown in Fig. 8.

4.3 Line Segmentation

The segmentation is the process in which an image is converted into different parts of either equal or unequal division.

Vertical Line Segmentation

The vertical line segmentation is the part of the box, which contains the complete vertical part where endpoints of lines would be at coordinates of x-axis and y-axis. Where coordinates of x-axis differ, but coordinates of y-axis remain same.

After scanning the image, the input image can be segmented vertically by assigning white pixels in each row. The uppermost row of the image is where white pixel is found for the first time. After finding the uppermost row, it continues scanning the next row after the current scanned row. This process continues until a row with no white pixel is found.

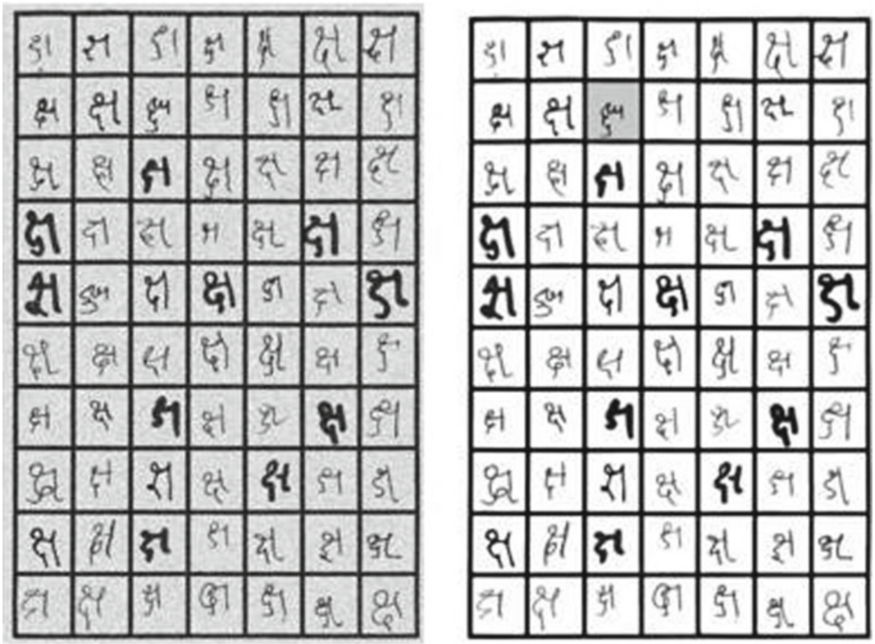

Fig. 8 Noise removal in input image

The segmented image of vertical lines can be seen in Fig. 9.

```
img_temp1 = cv2.erode(img_bin, vehicle_kernel, iterations=3)
verticle_lines_img=cv2.dilate(img_temp1, verticle_kernel, iterations=3)
cv2.imwrite("verticle_lines.jpg", verticle_lines_img)
```

Output:

See Fig. 9

Horizontal Line Segmentation

The horizontal line segmentation is the part of the box, which contains the complete horizontal part where endpoints of lines would be at coordinates of *x*-axis and *y*-axis. Where coordinates of the *y*-axis differ, but coordinates of *x*-axis remain same. After scanning the image, the input image can be segmented horizontally by assigning white pixels in each column. The uppermost row of the image is where white pixel is found for the first time. After finding the uppermost row, it continues scanning the next row after the current scanned row. This process continues until a row with no white pixel is found.

The segmented image of vertical lines can be seen in the following Fig. 10.

Code:

```
img_temp1=cv2.erode(img_bin, horizontal_kernel, iterations=3)
horizontal_lines_img=cv2.dilate(img_temp1, horizontal_kernel, iterations=3)
cv2.imwrite("horizontal_lines.jpg", horizontal_lines_img)
```

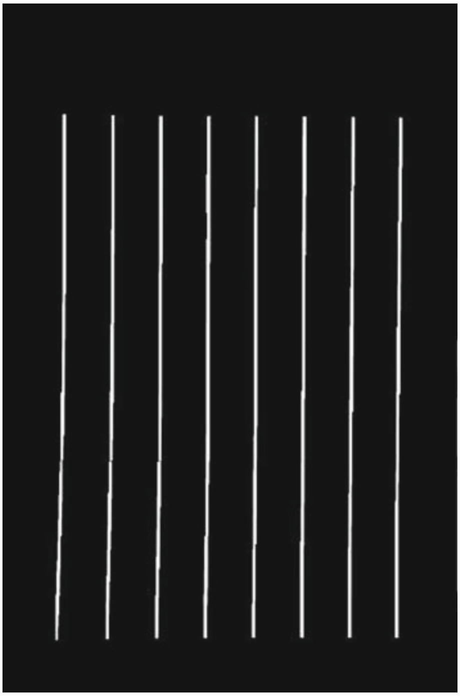

Fig. 9 Vertical segmented line

Output:

See Fig. 10.

4.4 Box Segmentation

The boxes are bounded by vertical and horizontal aligned axes. Boxes are either found in square rectangle shape, which is the simplest shape in planar. Boxes can be represented by four points of two types, which contain the minimum and maximum coordinates for both axes.

By combining Figs. 9 and 10, it is possible to obtain boxes without data without any type of noise. So, the boxes can be detected accurately. Box segmentation image can be seen in Fig. 11.

5 Proposed CNN for Character Recognition

Convolutional neural network (CNN) is a form of artificial neural network that is specifically made to process pixel input and is used in image recognition and

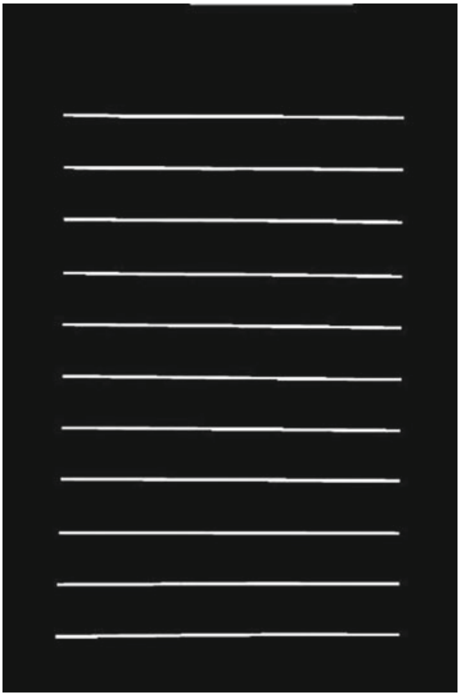

Fig.10 Horizontal segmented lines

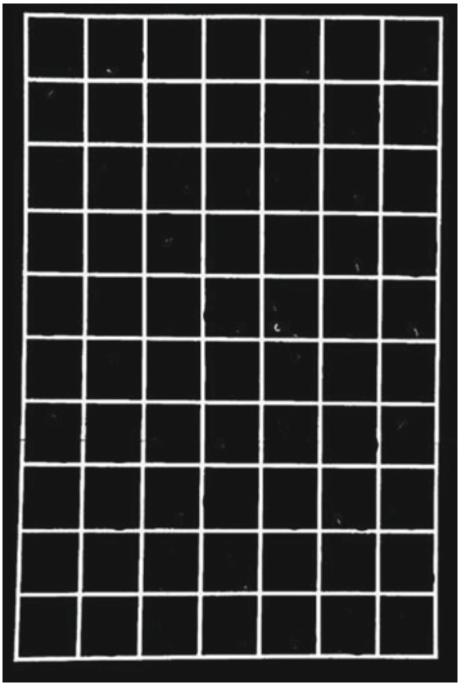

Fig.11 Extracted boxes

processing. It is a mathematical construction composed of three layers: (1) convolutional layer, (2) pooling layer, and (3) fully connected layer. The first two layers, i.e., convolutional and pooling extract features from the collected datasets. And the third layer, i.e., fully connected layer is used to extract features into the output. The CNN working can be well understood by the following Fig. 12.

Bunch of filters are applied in convolution layers to extract featured data. Then, the pooling layer is used to reduce the potency to prevent the problem of computational speed and overfitting. Later, the max pooling layer divides each convolutional layer into sub-fields and holds value at its max. Neurons of each layer are connected with each other to extract the image in the output with accuracy at its maximum. Higher the accuracy of the output extracted, higher will the well-trained model [4]. So, using CNN concept machines are given intelligence artificially like humans to make machines capable enough to distinguish between particular characters and numerals in chosen regional language. In this research, CNN model has been trained for Gujarat language in handwritten form. For now, some of the characters and numerals are taken into consideration for applying in CNN training. The size of extracted box images is 28×28, and the epochs 100 are taken into consideration for CNN training model. The accuracy of characters and numerals is as mentioned in Table 1.

After undergoing all processes and CNN training, the construction of OCR can be taken into consideration. OCR helps to convert the scanned image of a document into the digital text. OCR neglects light focused areas by considering it as background and examines text, which is with the dark focus. Later, preprocessing is done for removing extra lines, boxes, spots, etc. Further, texts are decomposed into some features such as loops, lines, and intersections. Then, as per the nearest best match, it extracts the text digitally from the image. Then, some OCR also does post-processing where the extracted data is converted into computerized form and creates the new file, which can be comparable with before scanned document and after scanned document. The flow of the working of OCR can be seen in Fig.13.

6 Results

After applying the proposed segmentation approach on the scanned A4 size grid document, the total number of images extracted as a result are 1,71,500. This 28×28 size .png file format image is further trained using CNN model specially designed for Gujarati character and numerals recognition. The total of images are considered for training 1,20,050, validation 25,725, and testing 25,725. The training, validation, and testing are computed for class-wise computation of character images (Fig. 14).

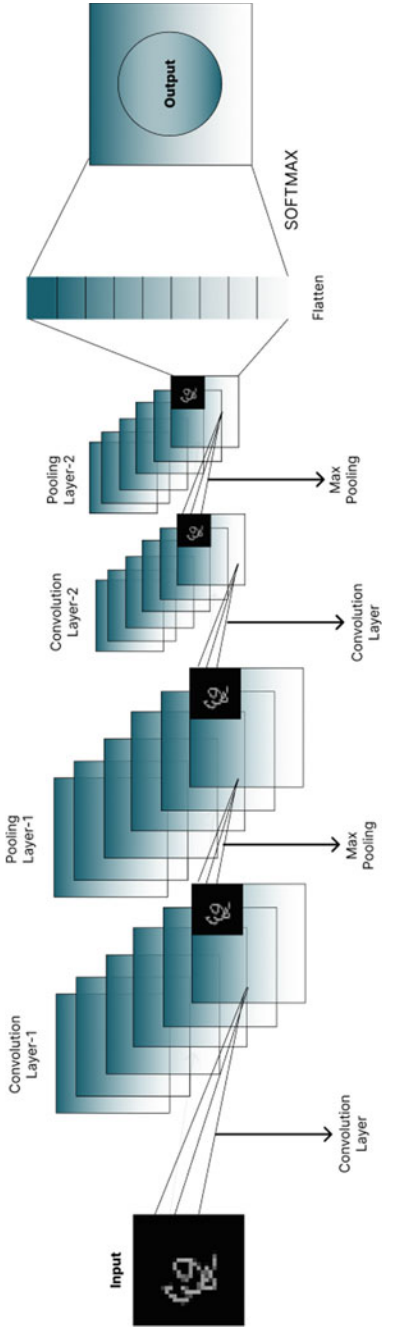

Fig.12 Architecture of proposed CNN

Table 1 Accuracy of extracted dataset for Gujarati characters and numerals

Types of datasets	Dataset	Image size	Accuracy (%)
Characters	12,600 (350 for each character)	28 × 28	82.01
Numerals	3500 of each numeral	28 × 28	86.85

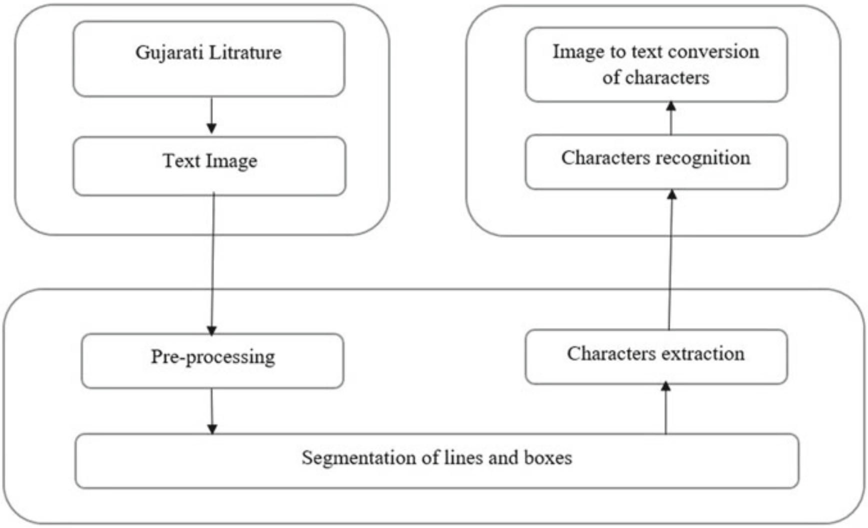

Fig. 13 Flow of OCR working

Fig.14 Extracted datasets

7 Conclusion and Future Work

Segmentation of handwritten Gujarati characters has been implemented in this research article. The segmentation procedure can be useful in the development of a state-of-the-art OCR system. Due to the presence of modifiers, curves and circles in Gujarati language, the script becomes very difficult to recognize. So, the machine must go through a number of processes and algorithms like image acquisition, preprocessing, etc. So that isolated images can be extracted through segmentation. Till date, the total number of extracted images are 1,71,500 successfully. And some of the characters and numerals are trained using CNN training models. Finally, CNN does the classification in order to evaluate how well recognition on the prepared dataset performed. The proposed model achieved 82.01% and 86.85% accuracy for Gujarati characters and numerals, respectively. The future goal is to train the CNN model for joint characters by taking different sizes of extracted images.

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Crop Yield Prediction and Climate Change Impact Assessment Using Machine Learning Technology in Agriculture

Anshul and Randeep Singh

Abstract India's economy is heavily reliant on agricultural output growth and related agro-industry products, as the country is predominantly agrarian. Machine learning techniques can be used in agricultural production in an effort to do further research. For the most part, agriculture serves as India's economic backbone by producing a significant portion of the country's exports. The weather has a significant impact on crop output. Climate change implications on the sector can be forecasted using empirical data. A yield crop technique that combines a semi-parametric modification of a neural network is able to incorporate complicated nonlinear interactions in elevated data, known as cross-sectional heterogeneity. This study was conducted to review the work related to predicting crop yield and the effects of climate change using machine learning technology in agriculture.

Keywords Agriculture · Machine learning · Climate change impacts · Regression analysis · Time series analysis

1 Introduction

As a result of agriculture's reliance on weather, global climate change will have a greater impact than on most other economic sectors [1]. Impacts of this type and scale will be determined by changes in the climate system and crop yields in relation to the weather. This research focuses on weather forecasts for the future yield. Models that accurately predict the effects of climate change on agriculture, as well as other environmental and economic outcomes, are critical for developing mitigation and adaptation policies. The use of deterministic, physical crop models for yield modelling in climate change impact assessments accounts for a significant percentage of this effort [2]. To better understand how plants respond and how they can adapt, these models use comprehensive representations of the plant's anatomy

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[3]. Even so, statistical models often beat them when it comes to forecasting on wider spatial scales [4, 5]. Schlenker and Roberts [6] analytical models show a strong link between poor crop performance and extreme heat. Classical econometric methods have been used in these approaches. Crop models and statistical models have recently been combined in recent work in various ways by including the output of crop models in statistical models [7], and statistics models can be parameterized using insights from agricultural systems [8, 9]. Parallel to this, advances in machine learning (ML) have been made during the last several decades. Since the goals of ML are different from those of traditional statistics, ML is philosophically unique. Prediction of outcomes rather than inference into to the structure of the mechanical processes that generate those results is a major focus of this research. We are not interested in unsupervised ML, which seeks to find structure in data that has not been labelled. Deep neural networks, also known as semi-parametric neural networks, can be used in conjunction with parametric statistical models (SNN). The SNN has the best out-of-sample predictive performance of any crop yield modelling framework currently published. The SNN outperforms traditional neural networks in terms of statistical efficiency by drawing on prior knowledge of significant occurrences and the classification determines that link them to the outcome. Adding a neural network to a parametric model allows it to capture dynamics which are either missing or insufficiently described in parametric models. Layer one of the network is composed of linear regression specifications culled from yield or climate modelling research literature (Fig. 1). When used in conjunction with the existing parametric algorithms or neural networks that are completely nonparametric, the methods described in the next section improve efficiency and performance even more. This method provides a framework for enhancing prediction skill for just any neural network which has a prior understanding of an information process that may be encapsulated by a so does influenced by site theory and/or expertise. Climate change severity can be affected by the yield model that is used.

Impact projections, with yield declines of more than 16% between SNN or OLS projections in some of the worst scenarios also, while in less severe situations, OLS forecasts show yield improvements in several northern areas; however, this projection is mostly absent from SNN projections. As a final point, the SNN's confidence interval for mean forecasts is substantially narrower than the comparable OLS regression, signifying more precision in any particular weather scenario.

1.1 Role of Deep Learning in Agriculture

Human brain structure is depicted in artificial intelligence (AI) through deep learning, which is a fundamental aspect of AI. In order to enhance learning, neural networks with hidden layers are commonly used as the structure of deep learning. As a result, we all have a nagging question: why do we need artificial intelligence in agriculture? The primary reason for this is that entire world is heavily dependent on the diversity of life on the planet. Agriculture plays the most important role in preserving biodiversity.

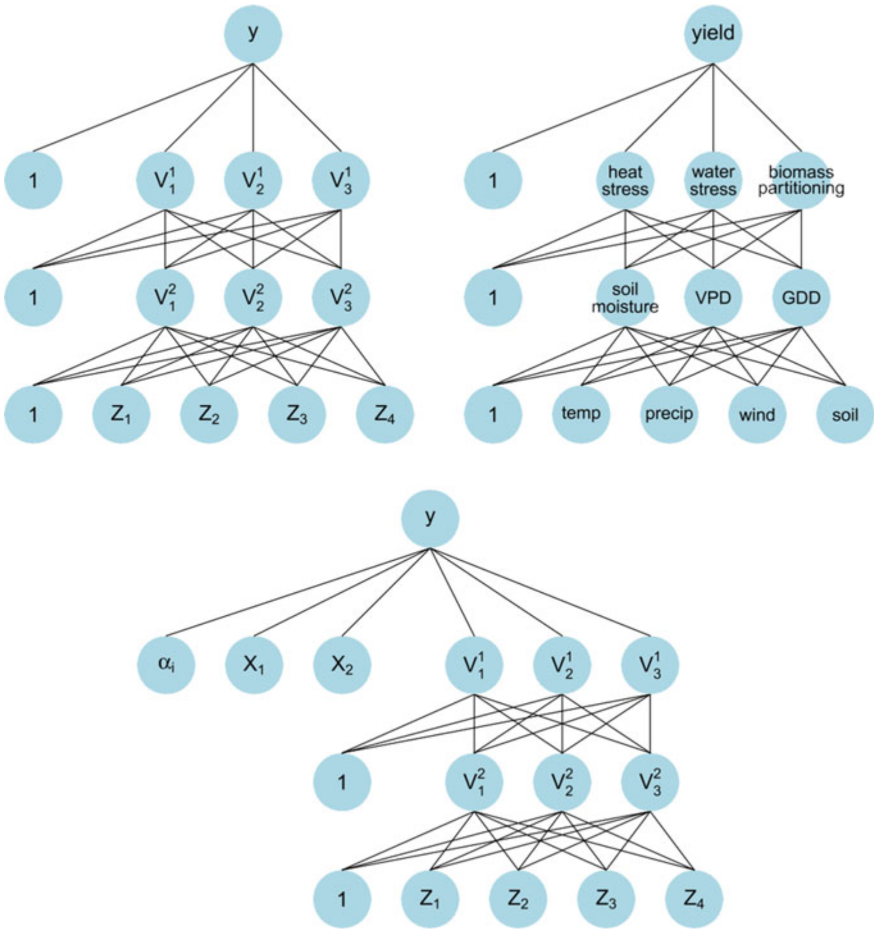

Fig. 1 Schematic drawing of a (semi-parametric) neural network [10]

The world's living species rely on agricultural goods and trash as a source of nutrition Ferentinos [11]. In order to maintain the ecological cycle's equilibrium, changes and difficulties in agriculture have the biggest impact on humans and the rest of the biosphere. IoT-controlled drone systems and AI-enabled harvesting robots were also used to monitor the harvesting process in conjunction with deep learning. As a result, the field's size was automatically determined. The harvesting of crops was carried out using a mix of machine learning and the Internet of Things [12, 13].

1.2 Identification of Crop Yield

Crop yield depends on disease diagnosis because fewer plants are infected, which means better yield. In the early days, the sickness of the crop was mostly identified manually. New diseases emerged as a result of environmental change as the transmission of information was slowed from generation to generation. A single point of access to all of the relevant information proved extremely challenging for agricultural workers. In agriculture, it would be extremely beneficial if we could have some sort of automated system. From this perspective, deep learning has a significant impact on plant identification and disease detection. Convolutional neural network (CNN) is a type of deep learning technique that can be used to identify infected leaves. It was used to train a computer system to recognise 25 different plant species by photographing their leaves at various stages of development. In the same part, medical experts determined the cause of the problem and recommended the best course of action Boukhris et al. [14]. The importance of region-based deep convolutional neural network (*R*-CNN) in plant disease identification is critical, as it helps pinpoint the precise location of the sick part and so facilitates a more precise diagnosis Grinblat et al. [15]. It is possible to prevent the spread of plant diseases if the underlying causes of disease can be identified. Temperature and other environmental elements such as insects have a major impact on plants. The farmers would benefit more if the infections were discovered before they had a chance to cause harm. Climate change, pests, and insects are to blame for the fungal and bacterial illnesses. Plants and pests can be identified using CNN's deep learning technology, which uses neural networks. It aids farmers in spotting plant diseases that are spreading rapidly and so minimises agricultural damage Barbedo [16]. Climate, temperature, rainfall, green index, soil texture, and nutrients all play an important influence in crop production prediction. Deep learning approaches will provide a prediction value based on environmental inputs. Classification or regression predictions are two options. It is possible to classify crop growth in order to determine which classes it belongs to. Classes such as well, middling, and under-grown are examples. Regression, on the other hand, provides a numerical approximation. Percentage yield estimate can be calculated using these data. It is possible to find a technique for predicting crop yields by using a variety of different types of neural networks in combination with deep learning Jones et al. [17].

1.3 Agriculture's Effect on Global Warming

The long-term weather systems that characterise various parts of the world are changing due to human-caused global warming. Short-term (daily) fluctuations in temperature, air, and/or rainfall are known as "weather". Crop quantity and quality, rate of growth, photosynthesis and transpiration prices, moisture availability, as well as other aspects could all be impacted by climate change in agriculture. Global food production is predicted to be directly impacted by climate change. Many crops' lifespans can be shortened and their yields reduced if the seasonal mean temperature rises. Climate change will have an immediate impact on crop production in locations where temperature are already near to their physiological maximums. It is also possible that changes in plant physiology due to human-caused climate change will have an impact on food production. Climate change's negative effect on agriculture and agriculture's major cause of climate change will have a significant influence on food production, which could jeopardise food security, necessitating the implementation of specific agricultural policies to tackle the problem. A global danger to food security and nutrition is posed by climate change. The greenhouse effect is causing an increase in temperature as a result of rising levels of greenhouse emissions in the atmosphere. The worldwide average temperature is expected to climb by 2 °C by 2100, resulting in significant economic loss just at global level. Plant growth and productivity have improved due to enhanced photosynthesis as CO_2 concentrations rise, but this effect is countered by rising temperatures, which increase crop respiration and evaporation and transpiration, pest invasion, and weed flora shifts. Crop longevity is also reduced. The soil microbial population and its enzymatic activity are also impacted by climate change.

2 Review of Literature

2.1 Machine Learning Techniques in Agriculture

Artificial Neural Network

Crane Droesch [18] for example, the artificial neural network is composed of artificial neurons (ANN). It is inspired by human brain's natural processes. Supervised learning is an illustration of what this entails. After initial training, neural networks may anticipate future data patterns, such as meaningful solutions to issues, even if the input is inaccurate or incomplete, for example. Until enough data is accumulated, the accuracy of ANN improves. The core concepts of ANN complexity can be adopted by them even if they are not aware of it. Any operation can benefit from ANN's ability to infer relationships between input and output.

Khoshnevisan et al. [19] for estimating potato production in Iran, artificial neural networks (ANNs) were utilised to construct energy output or greenhouse gas emissions (GHG) depending on input energy. Face-to-face interviews were conducted with 260 farmers. As a result, a wide range of ANNs were created and evaluated based on their forecasting abilities using the input impedance. An estimated 83,723 kilojoules of energy was used in the production of potatoes, with an associated energy output of 83,059.

Ornella et al. [20], electricity, chemical fertiliser, and seed were the most important factors in energy use. Efficiency and productivity in the utilisation of energy were evaluated. Potato's total GHG emissions and output energy were best predicted using an ANN design with structure. The optimal topology had a probability value ($R2$) of 0.98 for potato production energy and 0.99 for total GHG emission, as indicated in the graph (Fig. 1). Web-based intelligent systems built using Java and SQL were utilised to assess tomato crop symptoms using classification algorithms and several optimization techniques. The tomato is by far the most widely produced vegetable crop in the world. Everywhere in the world, it is grown for its raw or fresh use and processing purposes by farmers' markets or in their kitchen gardens. The tomato crop specialist conductive system was designed by a group of computer engineers, programmers, and designers who collaborated with a recognised agriculture scientist and specialist in the field of tomato production. As part of the professional arrangement, the applicant will be able to receive good guidance on numerous topics such varieties, pest and disease symptoms, cultural practises, and mosaic of tomato fruits and plants in a message. An expert system allows the client to communicate with the system while it is running in the background. Ask the question of the client, and the client must respond. Upon receiving a response from the client, the expert system will recommend and demonstrate its control measures for all of the threats. Tomato crops commonly use a knowledge expert system that recognises various diseases, pests, and variations. When utilised for breeding maize, machine learning (ML) algorithms have shown themselves to be effective which can be used in quantitative methodology, such as linear mixed models, which are currently more widely accepted. New genotypes can be released more quickly using ML, a contemporary technique.

Kujawa and Niedbała [21], ML is currently being used for a variety of strategic purposes in maize breeding, as well as for quantitative trait locus mapping heterotic group task for popular genome-wide selections. The evolution of genotypes suited to a worsening environment, particularly drought, has made corn, together with rice and wheat, among the most important grains in the world and a main source of energy for humans. These crops must be cultivated in marginal land under changing climatic conditions. A simulation tool for fall wheat crop management was studied using advanced machine learning and simulation approaches in this study. Prior to the development of a simulation tool, agricultural production plant engineers faced a challenge in devising methods that were distinct from those now in use. As a result, a novel exploration assistance system was built that is based on reinforcement learning and genetic algorithm techniques, which can be used by the user to expedite a wide range of solutions and fascinating strategies.

Neural networks can be used in the modelling process because they can automatically discover complicated correlations between data. The advantages of neural networks over multiple regressions were discussed. There is no need to select a different variables in the data when using a neural network to select the independent variable. As with multiple regression, there is no requirement to offer a model function. A neural network can uncover factors of a more sophisticated nature. Thus, a model with the greatest degree of accuracy can be created. In the presence of noise, the data is more resilient. For estimating agricultural yield, we examined the presentation using three different types of multivariate modelling methodologies. A soil conductivity metre was used to gauge the top soil depth, and soil fertility was examined on a 30 m grid. In 1993 and 1994, they used statistics on corn and soybeans. The harvest yield was recorded at the end of the season. Randomly generated train and test datasets were used in the neural network's construction. As input factors, they used topsoil depth, phosphorus, potassium, salts, organic matter, and magnesium saturation to estimate the corn yield.

Information Fuzzy Network with Crop Yield

Bilal et al. [22] to predict crop yield by neural network, sensing and other parameters were studied. The versatile neuro-fuzzy inference system was used by them (ANFIS). ANFIS takes as inputs the moisture content of the soil, the biomass beneath it, and the organ of the repository. It just has one output stage, i.e. yield, and is looking for a single number. There is also the issue of remote sensing data that do not keep pace with time when it comes to forecasting yield. It is therefore necessary to use a limited number of previous seasons in order to generate a model for predicting future values. One year is left out of the equation, but the rest of the data is used. Our estimate is compared to the output of year that is not included in the calculation. Based on population estimates provided by the Hellenic Sugar Industry, FINKNN was used to forecast the amount of sugar produced. Nearest-neighbour classifier FINKNN using typical interruption-supported convex fuzzy sets as metric lattice input. They found that FINKNN provided superior forecast accuracy on this impact and analyse the wide range of possibilities and potential services offered by these techniques. They also noticed that as a result of the problem. Fuzzy interval numbers (FIN) can be used to interpret a population of measurement data, thus they began developing algorithms to generate FINs from this data. A lattice theory metric gap opened up among FINs with discretionary funds FINKNN's analogous measures are the result of shaped membership activities.

While developing an agriculture web-based decision-support system, fuzzy modelling was employed to clear up any confusion that might have arisen as a result of climate change on Malaysia's agricultural fields' high production and crop arrangement. The heterogeneity of data necessitates the use of decision algorithms classifiers to arrive at data synthesis decisions, which is why progeny tests require data synthesis decisions to be made. Data on the region's rainfall patterns and soil structure, combined with allotment data that takes full advantage of the region's inadequate data, will help researchers achieve their goals. This study's advancements include the development of new algorithms and research into the classification of plant materials. This researcher then focused on experimental results that could allow for offers sustainable in plant material breeders through the achievement of policies for decision-making in agricultural management.

Fuzzy cognitive maps (FCMS) have been used to build and forecast methods for apples using an aggressive, effective group (Red Chief). As a tool for causal cognition and influence on influential processes, FCMS are great for the design of such systems. For their clarity, elasticity, and adaptability to a wide range of situations and user comfort, they have a lot of power. They classify apple production based on the methods they employ. They all have one thing in common: they create an attitude towards complex systems that is effective in terms of interpretation and can be used to anticipate new scientific discoveries. For determining apple yield, they have settled on a data driver with nonlinear FCM capability access to the data. Using the approved technologies, they built and modelled the FCM system in order to produce accurate production forecasts and crop management. For example, soil characteristics such as organic material (OM), potassium (K), calcium (CA), conductivity (EC), phosphorous (P) and zinc content, and other edges illustrate the cause effect or weighted affinity between soil parameters and production in an advanced FCM design. When it comes to predicting yields, the FCM training algorithm was found to be superior than the other methods. Olive farming in Andalusia has benefited from the development of a decision-support system and a fuzzy logic data system. A prototype tool was developed to aid Canadian farmers in determining crop selections. Gathering all the required information and data has been particularly tough for crop production this season. Farmers should be allowed to submit statistics on crop performance as well as provide information on the conditions in which crops grow, they said. The information gleaned from such reports can be used to provide general information about the performance of various crops and the conditions which best support them.

Crop Yield-Based Decision Tree Cropping

Nodes, branches, clearly values, strategies, payoff distribution, certain equivalents, and the rollback procedure are all part of decision tree models. There are three types of nodes plus two types of branches in this graph. The square represents a point at which a decision must be made. A decision node serves as the hub from which all of the decision branches branch out. A payout value, result value, and endpoint value is a phrase used to describe the value assigned to each terminal node. Each terminal value is used to calculate the decision-making sequences. Developing a decision tree method requires two steps: first, the development of a big decision tree, followed by a pruning stage that involves shrinking the tree and removing overfitting data. As shown in Fig. 2, the classification tree provided is a pruned version of the decision tree described [23, 24].

Aditya Shastry et al. [23, 24], a number of variables come into play when making a prediction like this. Agronomic variables like as nitrogen delivery and weed management were utilised in conjunction with machine learning algorithms such as neural networks and decision trees to construct yield mapping and anticipate yields. They conclude that accurate predictions can be made using artificial neural networks. Decision tree algorithms were used to model soybean productivity. They had gathered data on the Bhopal district's climate between 1984 and 2003. Evaporation rate, temperature, highest relative humidity, and rainfall totals were all taken into account along with the crop's soybean yield. An approach based on information and two assumptions, Interactive Dichotomizer3 (ID3), was used. Relative humidity has been revealed to have a significant impact on soybean crop output by induction tree analysis. In order to understand how climate affects soybean yield, we created a decision tree. The classification rules depicted in the decision tree are derived from the if-then-else rules (Fig. 2). Relative humidity has a significant impact on soybean productivity, and various principles have been developed to aid in the prediction of low and high

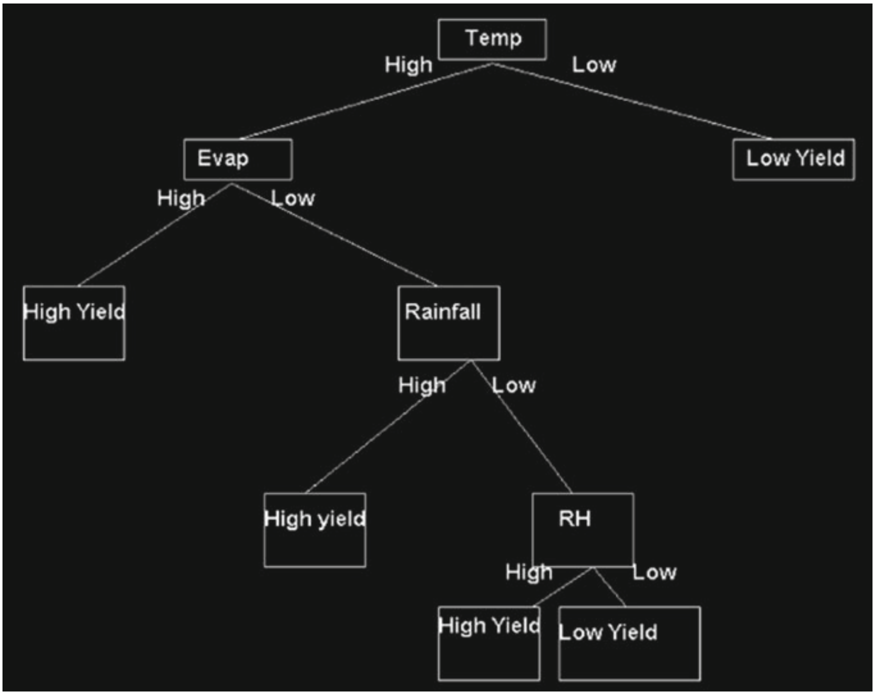

Fig. 2 Decision tree for influence of climatic factors on soybean yield [23, 24]

soybean yields. Only the higher or lower yields can be predicted, but how much yield is actually produced is unknown.

There has been a significant decline in agricultural output due to India's climate diversity over the previous two decades. In order to make marketing or storage decisions which are more convenient for farmers and policymakers alike, it may be beneficial to anticipate crop production well in advance. Concurrent industries can benefit from forecasts that just do not take into consideration the weather because they do not take account the weather. When it comes to forecasting crop yields, this course has produced Crop Advisor, a user-friendly website. The most ecological environment parameter just on yields of specified crops in the targeted Madhya Pradesh district is determined using the C4.5 approach. You can use the software to see how different weather variables affect crop yields. Using this method, it is impossible to account for additional agro-input characteristics that could affect crop output. Each field in time and space has its own unique set of input parameters.

2.2 Crop Yield Prediction: A global Need

Bali and Singla [25], agriculture is a vital component of any nation's overall growth. Research into sustainable agricultural practises, or methods that might boost crop yields without harming our planet's natural resources, is being prompted by both the world's expanding population and the sudden shifts in climate and soil conditions. Crop yield predictions for the current growing season that are accurate and timely can be a significant first step in this approach and help shape any agricultural policy. Global organisations such as the European Commission's Research Centre (JRC) have been established to monitor agricultural resources (MARS). Crop yield predictions and monthly bulletins on predicted yields are provided by the CAP for the entire world by this organisation. Providing countries with food insecurity with early warnings of crop shortages or failures is an important contribution to improving global food security. Real-time data like weather observations and forecasts, remote sensing data like soil maps, crop attributes, and administrative regions are used as inputs to the system that creates this information. Crop conditions are recreated with the help of these data inputs. The yield numbers are updated on a regular basis Cedric et al. [26].

2.3 Techniques for Predicting Crop Yields via Machine Learning

Kamir et al. [27], prior to harvest, accurate, and timely yield forecasts are critical. Researchers have traditionally struggled to precisely anticipate yields because of the study's inclusion of several nature-based components. Machine learning is showing signs of progress and has a bright future ahead of it. The following section discusses the use of different machine learning approaches for the prediction of crop yields for various crop kinds. [*] The vector support model was used to estimate wheat crop yield. Nine basic learner models and half as good models were among the many that were put to the test. The results revealed that SVR had the great learning efficiency among the nine models, whereas ensemble models did not report much progress in accuracy despite a significant rise in cost. Additionally, as the amount of training data increased, so did the performance of all models.

Zhang et al. [28], soybean phonological growth can be predicted with more accuracy using a calendar-day technique. Machine learning techniques including such artificial neural networks (ANN), *k*-nearest neighbours (kNN), or regression were used to build the prediction models. KNN and/or ANN had accuracy values that were satisfactory. Plant vegetative growth stages were predicted using regression models.

Kogan et al. [29] in order to see if wheat crop yields can be predicted using remote sensing. Based on weather-related parameters, an empirical logistic model was created and MODIS and CGMS were evaluated. For 2010, the CGMS system was the most accurate, whereas all three methods predicted the same for 2011.

Ahamed et al., data mining techniques were used to investigate the impact of various environmental (weather) criteria, such as biotic variables or production area, on crop yields in various local government areas. For the purpose of predicting agricultural productivity, a variety of classification approaches (such as linear regression, KNN, and neural networks) were employed, including the clustering technique. Neuronal network models are superior to other systems (statistical, metrological, simulations, agri-technological, and remote satellite-sensed) in a study by Lamba and Dhaka [30].

Kim and Lee [31] in Iowa State, researchers used four machine learning approaches to analyse remote sensing data to predict corn yield (SVM, RF, ERT, and DL). As a method for evaluating yield, machine learning techniques fared well, particularly deep learning (DL), which produced more stable findings.

Bose et al. [32], a spike neural network was used to analyse crop productivity from remote sensing data. Six weeks before harvest, a 9-feature model was used to predict yields with a 95.4% accuracy, a 0.236 t/ha average inaccuracy of prediction, and a coefficient of correlation of 0.801.

Pantazi et al. [33], wheat yield fluctuations were examined using continuous multilayer soil derived from satellite photos of crop growth. Three machine learning techniques were utilised to evaluate the performance of counterpropagation artificial neural networks (ANNs), XY-fused networks (XFNs), and supervised Kohonen networks (SKNs). Cross-validation yield prediction generated a yield of more than 91% for the low yield class, which is highly significant in the light of the complex interaction between controlling features and the yield, according to results. Accuracy rates of 70% and 83% were achieved for the average and high-yielding classes, respectively. SKN, CPANN, and XYF were all tested, and SKN was found to be the most accurate at 81.65% compared ANN models to multiple linear regression analysis in terms of prediction capabilities and performance. Results showed that ANN consistently gave better predictions than the linear regression model, with respect to accuracy.

Chlingaryan et al. [34], we looked at a number of machine learning strategies for predicting remote sensing data yields. Reviewers have been debating machine learning techniques for yield prediction for the last 15 years. Comparison of random forest versus multiple linear regression models for crop yield prediction was done by Jeong et al. [35]. Random forest models outperformed all other models in every performance metric. All test scenarios yielded between 6 and 14% of the roots mean square errors (RMSEs) when using an RF model, while the values ranged from 14 to 49% when using an MLR model. RF was found to be an effective and beneficial method for predicting yields on a regional and global scale, as demonstrated by the study. In addition to climate, soil contributor to agricultural production variance.

Gandhi et al. [36], the WEKA software application was used to carry out the analysis. When it comes to plant growth research and agricultural yield estimates, remote sensing has recently demonstrated tremendous potential. On the basis of precise yield maps, precision farming relies.

Mishra et al. [37], according to my investigation, it appears that it is an accomplished research area that will continue to increase in future. Farm crop forecasts are improved by integrating computer science with agriculture. Additionally, this technique aids in the dissemination of knowledge about crops, such as how to boost yields. Decision tree algorithms, linear regression, and artificial neural networks are the algorithms employed. The main drawback is that there is no defined process to follow.

Nishit et al. [38], farmers will profit from this paper's ability to accurately estimate crop sequences and maximise yield rates, according to the authors. It is possible to use machine learning in agriculture for everything from prediction and diagnosis and crop simulation to analysing different irrigation methods. There are two types of algorithms used: neural networks and SVMs. The drawback is that the exact precision is not stated.

Vishnu Vardhan and Ramesh [39] that this method provides several linear regression methods that may be used to existing data, therefore allowing for the verification of the information that has been collected. Multiple linear regressions are the algorithms employed. The drawback is that less precision is achieved.

Raorane and Kulkarni [40] believe this method will be useful in determining rainfall and investigating why yields are lower. Regression analysis is the method employed. The problem here is that there is no precise method to follow.

3 Conclusion

Based on the meteorological input factors, the current study revealed the possible application of data mining methods to estimate agricultural yields utilising using deep learning techniques. Nowadays, an increasing variety of agricultural machine learning approaches is required, which can analyse a wealth of data currently information from different sources in order to identify the hidden information. Crop forecasting is made easier because to the application of computer science in agriculture. ANN, decision trees, or artificial neural networks, information fuzzy network, and machine learning techniques for crop yield prediction have been investigated and found the following findings.

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Transformation of Data Flow Diagram (DFD) to Petri Net

Veena Jokhakar and Tejas Shah

Abstract A system model can be developed and designed using data flow diagram (DFD) in a system development life cycle (SDLC). DFD is a set of graphical diagrams with different levels for specifying, constructing, visualizing and showcasing the transformation of flow of data to model a system. Though not obsolete, DFD is used in defining and specifying the functional requirements of a system in a graphical view. Although formalization and semantics consistency is missing in traditional DFD representation. In this paper, we focus on transformation of DFD into Petri net representation to represent the system in a more systematic way. Hence, we quote a need for translation DFD to Petri net. The translation into Petri net is based on the abstract syntax of DFD. DFD level 1 and level 2 types of diagrams are transformed into Petri net, as context level diagrams do not represent transition of data flow between processes.

Keywords Data flow diagram (DFD) · Petri net · Formal semantic

1 Introduction

Engineers need a system to be planned, analyzed and developed in a most cost effective way, requiring less effort and less time of development considering various aspects and methodologies like DFD, Unified Modeling Language specifically for computer science and similarly Petri net in mathematics. Although, there is still a need to refine the same for better understanding and modeling.

The paper presents a model of simulating level 1 of DFD. The processes/events of DFD of any system are simulated through Petri net in an elegant manner. The primary goal of this paper is to propose a Petri DFD model to the researchers and practitioners, who are actively involved in the work areas of modeling and analysis

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of industrial types of systems. The model describes the transformation process of level 1 type of DFD into Petri net. In this paper, we focused on the simple Petri nets, although other types of Petri nets also exist that are in various contexts of the application driven developments. A case study of the train ticket reservation system is included to illustrate the transformation of DFD into Petri net.

The paper is divided into following sections: (1) Introduction, (2) Petri Net, (3) Data Flow Diagram, (4) Related Work, (5) The Petri DFD Model and (6) Conclusion.

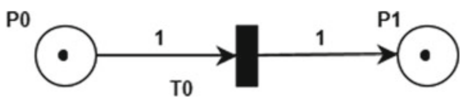
2 Petri Net

In the field of computer science, there has always been a need to develop a complex system with operational risks. Trial and error method is no longer feasible due to the time and fund constraint. A Petri net can be used as a modeling tool, analysis and simulation tool as well. It is provided with graphical visualization to easily represent the system's run time behavior with the support of mathematical aspects. As a result, one can get to significant conclusions about the system without engaging in extensive experiments. Carl A. Petri, who in 1962 developed a mathematical instrument resembling a net for the study of automata communication, Petri net derived its name.

One of the many mathematical modeling languages for the description of discrete event systems is a Petri net, also known as a P/T net (place/transition). A Petri net is "a directed bipartite directed graph, in which the nodes of the graph represent transitions (i.e., system's discrete events), places (i.e., conditions) and directed arcs (which enables pre- and post-conditions for transitions firing)" [1, 2]. A Petri net (PT net) can be described in its most basic form by a transition together with its input and output locations. The places are depicted pictorially by circles and transitions as bars or boxes. The preconditions and transitions of any event can be represented by input (output) places. The availability and release of resources are represented by input and output places, respectively. By rule, an arc cannot connect two places or two transitions. A place can contain a non-negative integer set of tokens as input and represented as a black dot. The number of tokens present in each place determines the state of a classical Petri net. An example of a Petri net is shown in Fig. 1. This sample Petri net is created using Platform Independent Petri Net Editor (PIPE) tool [3].

This sample Petri net shows transition from $P0$ to $P1$ with transition $T0$. A transition gets enabled and fired if input of 1 token is transferred from $P0$. This transition also produces one token which is transferred to $P1$. A Petri net graph is a 3-tuple (P, T, W) combination where P symbol denotes a finite set of places, T is a finite set

Fig. 1 Simple Petri net



of transitions; N is a multiset of arcs. A non-negative integer is assigned to arc as multiplicity (or weight); a mapping M: $S \rightarrow N$ is a marking process wherein places are provided with a number of tokens or weights.

$$W : (P \times T) U (T \times P) \rightarrow N$$

To enhance the DFD modeling of a system, a Petri net theory can be applied to include formal semantics. As both the concepts are modeling of a system with visualization, value based semantics will be an added advantage to represent the business process of the system. A combination of Petri net with DFD makes DFD implementation with semantics and execution of processes more efficient.

3 Data Flow Diagram

As a part of system analysis, one of the important modeling concepts is the data flow diagram of different levels. Data flow between external entities, processes and data stores is illustrated using data flow diagrams [4]. Authors in [5] stated data flow diagrams as an efficient tool which express relationships between different components of a system. Tao and Kong in [6] mentioned DFD as a sound technique for representing and specifying functional requirements of a large system.

To draw and depict DFD of a system, there are mainly two styles of standardized symbols used in the literature [7, 8]. This paper uses Gane and Sarson symbols as described in [7]. The process takes input or generates output by processing and changing flow of data and can be considered as a business activity. The data stores hold data generated from process or serve as a source input which is to be given to process of DFD. The data flow is a path going from and to processes and data stores which hold collection of data. The external entity can be a person, end user, actor which consumes or gives input to DFD. As shown in Fig. 2, a level 1 DFD is depicted with external entity E1 which transfers data with process 1 and then process maps to data to update the sample data store DB.

This context level diagram includes external entities, system boundaries and flow of data between entities of a system to be designed [4]. To show the interaction and flow between various main processes of a system, a context diagram is further decomposed into the lower-level diagram which is level 1 DFD. In fact, the process in level 1 is decomposed into many processes to form level 2 and so on. Generally, DFD cannot show syntax and semantic errors in the processes of a system. As mentioned

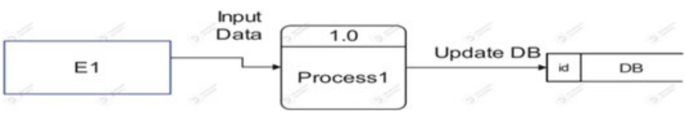


Fig. 2 Sample level 1 DFD

in [6], DFD can have syntax errors due to issues in connection between data flow and other components. A set of syntax errors can be easily detected in DFD as verification of connections and data flow transformations need to be checked [7]. The use of Petri net provides an elegant solution for semantic formalism to DFD.

4 Related Work

Many researchers have presented their work to convert business process modeling (BPM), Unified Modeling Diagram (UML) and other workflow processes into respective Petri net models.

A visualized DFD with a Petri net was represented in [9] with high-level semantics. A formal procedure and specification of transforming activity diagram to Petri net is mentioned in [10]. Authors in [11] designed a simulator of BPMN using colored Petri net approach. A meta model of business process simulation is derived in this approach. A software package is developed for transforming BPMN into a Petri net automatically using XML for m files of business process models [12].

To automate the process of consistency check between context level and level 0 DFD, authors presented a set of syntax and semantic rules in [13]. A tool is developed to check consistency while drawing DFD. Automatic translation of statecharts and sequence diagrams of UML into stochastic Petri net is covered in [14]. GSPN components are composed to transform sequence diagrams into analyzable Petri net. Activity diagrams with statecharts are modeled with labeled generalized stochastic Petri net (LGSPN) in [15]. Accounting information system (AIS) is modeled and documented using a Petri net model for simulation. Authors have compared flow charts with Petri net for accounting information systems. [16]

It can be seen from the above work that researchers have proposed different techniques for converting a particular modeling technique into different Petri net models depending on requirements. The work of visualizing DFD into Petri net is not specifying the level 1 conversion into Petri net model. In this paper, formal semantics are given to the process of level 1 or level 2 DFD transformation into Petri net.

5 Petri DFD Model

5.1 Petri DFD Model Components

As we have discussed in the previous section, the improvements needed in DFD to convert it into Petri net may end up in the added advantage of the Petri net and DFD to model a system. Petri DFD model consists of certain symbols for representation

Table 1 Components of DFD and Petri net used in transformation

Components of DFD	Symbols of DFD	Components of transformed Petri net	Symbols of transformed Petri net
External entity		Place	
Process		Transition	
Data store		Transition	
Data flow		Arc	

as described in Table 1. Here, the DFD symbols for external entity, process, data store and data flow and their equivalent symbol transformation are represented.

5.2 *Case Study of Train Ticket Reservation System*

Level 1 DFD of a system

In this paper, a case study of level 1 DFD of train ticket reservation is considered. The proposed model has considered level 1 of the train tickets reservation system as depicted in Fig. 3. The main processes of ticket booking include login, search train, make reservations, check ticket history and cancel tickets. A process of booking a ticket from passenger login to successfully booking a reservation is depicted in Fig. 3 as level 1 DFD. To create the level 1 DFD, Edraw Max tool is used.

Process of DFD and Transitions of Petri Net

A transformation process to add semantics from DFD of process to relevant transitions of Petri net is shown in Table 2. The transitions inclusion is a combination of processes and data store of a train ticket reservation system.

Place-Transition of Petri DFD Model

Places of Petri net transformed from external entities and transitions which are going to be fired are illustrated as shown in place-transition Tables 3, 4 and 5.

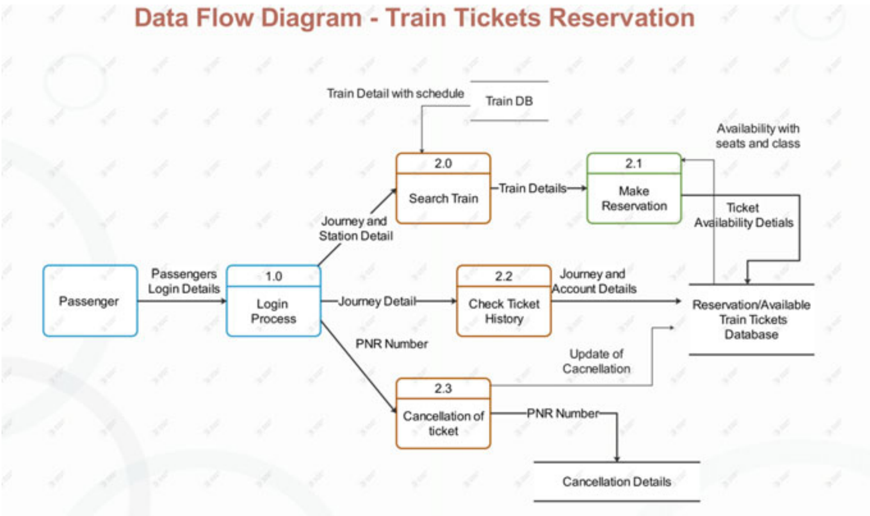


Fig. 3 Level 1 DFD of train ticket reservation

Table 2 Processes and transitions for train tickets reservation Petri DFD model

Process	Name	Transition	Name
$P0$	Passenger login	$T0$	Search train
$P1$	Searched	$T1$	Check ticket history
$P2$	No train found	$T2$	Cancel ticket
$P3$	Checked	$T3$	Perform reservation
$P4$	Not checked	$T4$	Cancelation and refund
$P5$	Valid	$T5$	Make payment
$P6$	Invalid		
$P7$	Correct data		
$P8$	Incorrect data		
$P9$	Ticket booked		
$P10$	Ticket not booked		
$P11$	Canceled		
$P12$	Not canceled		

Table 3 Place-transition PT1

Name of process	Passenger login
Input	PID, password
To process	Search train, check ticket, cancel ticket
Description	To login the passenger
Transitions to be fired	$T0$, $T1$, $T2$

Table 4 Place-transition PT2

Name of process	Search train
Input	Source and Dest city, journey date
To process	Make reservation
Description	To search a train for specific journey
Transitions to be fired	$T3$

Table 5 Place-transition PT3

Name of process	Make reservation
Input	Passenger detail, journey detail, class detail
To process	Data update in train ticket reservation DB
Description	Make a reservation of ticket with payment process
Transactions to be fired	$T5$

Petri Net Design of Level 1 DFD

A transition of a process from one state to another is marked net with a black dot that is enabled at a marking if each arc and also shown in Table 6. Each transition originates at a place which carries at least one token. A transition produces and consumes one token when its states are enabled as an immediate firing process.

It can be seen from the above table that, when firing occurs for a particular transition, it will transfer it into respective processes. Multiple states of the processes can be identified from the above table data, e.g., $T1$ transition of search train passes controls to two states: $P3$ or $P4$ (searched or no train found).

In this case study, a transition will be enabled in a marking from a set of transitions $T0$ or $T1$ or $T2$, when at least one token from inhibitor place $P0$ transfers to input arc. Then, an enable transition will be in fired state and takes an atomic action to consume one token from multiple input places and generates one token which is provided as input to a specific place.

Table 6 Transition firing

Petri net firings	$P0$	$P1$	$P2$	$P3$	$P4$	$P5$	$P6$	$P7$	$P8$	$P9$	$P10$	$P11$	$P12$
$T0$		•	•										
$T1$				•	•								
$T2$						•	•						
$T3$								•	•				
$T4$												•	•
$T5$										•	•		

Table 7 Process inputs to transitions

Petri net firings	$T0$	$T1$	$T2$	$T3$	$T4$	$T5$
$P0$	•	•	•			
$P1$				•		
$P5$					•	
$P6$						
$P7$						•

Table 7 shows impacts of the transaction enabling process when a particular process of Petri DFD inputs a token and enables a specific transition. Here, it can be seen that a process can have their state transfer from multiple concurrent available transitions. But at a time only 1 transition gets enabled, e.g., a process $P0$ (passenger login) may provide token input to $T0$ or $T1$ or $T2$ to enable any one of them.

Status of Petri Net Before T0 Fires

Figure 4 shows the state of a Petri net before firing of a transition. Here, the place $P0$ (passenger login) is using a token for input to be given to either transition $T0$, $T1$ or $T2$. Here, we have used weight 1 in arc to enable a transition with token input (1 token) coming from the process. When one of the concurrent transitions gets fired, it also produces a respective token and transfers it to a particular process. This the stage when Petri net has not yet fired any transition from initial enabled place to other places. The initial source of process $P0$ is passenger login which has one token which is used to enable any one transition out of 3 concurrent transitions.

Status of Petri Net After T0 Fires (T0 Enabled)

Figure 5 is a sequence of transitions from $T0$–$T3$–$T5$. Here, the transition starts from the initial place $T0$: login with weight 1 through place $P1$: search train operation to

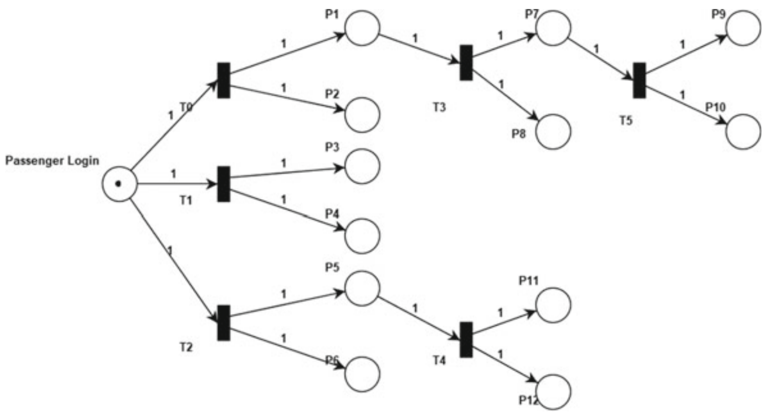


Fig. 4 Petri net before $T0$ fires

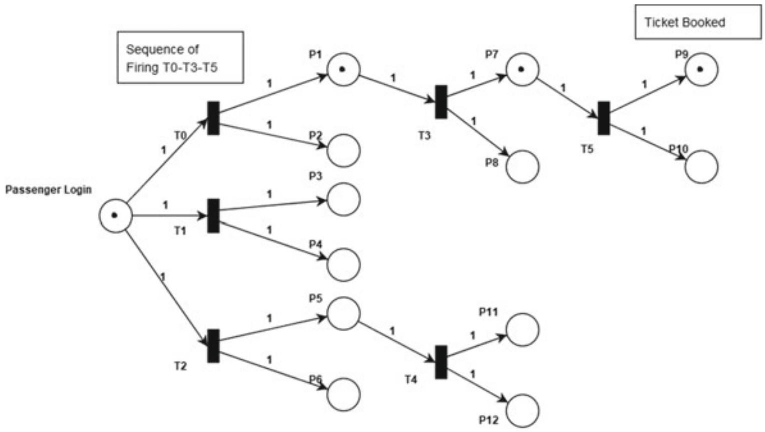


Fig. 5 Petri net after $T0$ fires

transition $T3$: cancel transition with weight 1 to the transition $T0$ with weight 1 that finally transits to palace $P7$: correct data that reach back to transition 5: make payment.

Hence, we see that traditional DFD lacks the display of the changes in the state during the processes and thus does not give the count of transitions that has taken place to execute a certain scenario required. This paper shows transition from well-known DFD to Petri net to cover points like transitions and processes that makes the diagram more understandable for complex systems.

6 Conclusion

The formal semantics of DFD level 1 provides insights to developers for developing modules with execution sequence. The Petri DFD model represented in this paper adds sequence of process execution with semantics. The case study of level 1 DFD of railway tickets reservation system is considered, and the respective Petri net model is designed. In the future, this model can be extended using colored Petri net with tokenized value for transformation of data flow from one process to other along with firing of transitions.

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Investigating OTT Subscription Intention Antecedents: A Review of Online Entertainment Motivations

Ritika Rani Sharma and Pallabi Mishra

Abstract Digitization has impacted every industry in a positive manner and media and entertainment industry is no exception to this. However, there has been a dramatic shift in the digital entertainment consumption for people during COVID-19 pandemic. Watching content on OTT has become an integral part of our urban life. With the outdoor entertainment options being closed because of the pandemic, people have resorted to OTT services for their entertainment needs. There is a shift in the consumer behaviour after the digital disruption, more so, in the younger generations who have developed a tendency to demand instant access to the content at all times and at all places. Content consumption across media channels, devices and demographics is also on the rise. The present paper examines the motivations behind choosing an OTT service and the challenges ahead for the service providers.

Keywords Streaming services · Online entertainment · Digital content · Over-the-top (OTT) · Customer satisfaction

1 Introduction

COVID-19 pandemic has brought many firsts in our lives. Right from switching our work to online mode, schools and colleges transitioning to online mode for providing education, and all necessities being brought to our home through technology. In the midst of satisfying the basic needs, a major shift has been witnessed in the world of entertainment. Few years ago, before the arrival of Netflix, Amazon Prime, Hotstar and all other over-the-top (OTT) service providers, at-home entertainment was dominated by television and rented CDs/DVDs. It took a pandemic and lockdown

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for us to witness this spurt in consumption pattern for entertainment in streaming mode with Internet as a medium.

Digitization has revolutionized the entertainment industry in a way that more choice and variety are available to customers than ever before. Consumers are exposed to HD channels, broadband and also value-added services (VAS) such as entertainment, gaming and video-on-demand (VOD) services provided by OTT service providers as well.

The most popular OTT players in India are Netflix, Amazon Prime, as well as the online options for all traditional channel houses, such as Hotstar, Voot, Zee5, SonyLIV and many other national and international players. One of the largest OTT service providers Netflix has been able to build upon the popularity of the shows like House of Cards and Sacred Games streamed exclusively. Netflix has been able to successfully operate as the top OTT service provider globally. It has established its branches in more than 130 countries. The Indian streaming platform, Disney's Hotstar, has a record to its credit of 18.6 million users watching an OTT event simultaneously. According to Business Insider Report (2021), In India, there are 353 million OTT users and 96 million active paid subscriptions. This translates to a penetration of about 25.3%. India has become one of the fastest-growing OTT markets with a CAGR of 28.6%.

1.1 Development and Usage of OTT Services

The unique feature of OTT services is that the customers can watch content anytime, anywhere and on any device [1]. Consumers are looking for good content for entertainment and as well as educational purposes. As per the latest reports, Indian viewers watch television for 3 h 44 min every day, on an average. Television watching is considered more of a community experience and a ritual as most of the households in India are single TV households. Segmenting the users based on their viewing choices and designing programs accordingly has always been a daunting task for TV broadcasters. With the increasing trend of exclusive watching and cheaper data/handsets at the customer's perusal, the switching rates of viewers have increased. Also, the overall time spent on media consumption is even more. Many scholars have also investigated the user motivations for adopting OTT services. (e.g. [2]).

As per Neilsen Indian Readership Survey by Neilsen (2019), 75% of households have a colour Television, whereas 91% have mobile phone. It is interesting to note that while there is one television in a household on an average, mobile phones are often more than one in a single household. Each member of the family has their own phone (smartphone in 50% of the cases). Also, almost 60% of the Internet users in India are young people, followed by housewives and elder people. Out of all mediums used to access Internet, smartphone is the primary medium (as per BCG Consumer Insight survey). This phenomenon is leading to increased demand for a single person viewing experience and has opened many new avenues for content providers to curate specific content keeping in mind the demography of a single individual accordingly.

There is an emergence of an umbrella model widely known as "TV Everywhere (TVE)". In this model, the aggregation of television programming is provided by a cable operator or MVPD at no cost to the consumer. The only authentication required here is that the online user needs to be an MVPD subscriber also. Also, viewers are segmented basis of the content that the program provides. Haeden et al. [3] and Rust & Alpert [4] have mentioned about ten program types in their research. These are serial drama, action drama, psychological drama, game show, talk or variety, movies, news, comedy, sports and other.

1.2 War of Content

In the era of so many entertainment options for consumer, the phrase "content is king" is totally apt. This phrase has been coined by Bill Gates in an iconic speech back in 1996. "Content is where I expect much of the real money will be made on the internet, just as it was in broadcasting". We are witnessing this statement to be totally true in the recent times. The situation has been more complex these days with immense amount of content available to the audience to choose from. Both the viewers and the content providers have evolved preferences. The means and nature of the content provided have also seen a dramatic shift. The service provider which provides the richest and the most engaging content for the user becomes the preferred one. Users who know English have already been bitten by the digital wave. The next step for the service providers is to capture the rural audience who speak regional languages.

The demand for regional content has been on a rise with the availability of cheaper handsets and affordable Internet data plans offered by companies like Reliance Jio. Hindi, which is considered to be India's unofficial official language has garnered its dominance when it comes to regional content in India. According to a report, more than 50% of the user base in India speak a language other than English. The user base for regional language has grown at a CAGR of 41% between a 5-year span of 2011 and 2016 and has reached 234 million. This is expected to grow by 18% CAGR to reach 536 million by 2021 versus English which is expected to grow at 3% CAGR to reach 199 million by 2021. According to reports, by the year 2021, the user base who speak regional languages will account for 75% of the country's total Internet users. The industry heads have already caught the digital wave. OTT service providers such as Voot, offer content in many regional languages such as Kannada, Marathi, Tamil, Bangla and Gujarati.

Digital entertainment companies like Netflix and Amazon offer subscription-based video-on-demand (SVoD) services. SVoD service providers are basically content aggregators. They aggregate engaging and entertaining video content offered by other entertainment companies and sell it to consumers on subscription basis. In order to stay ahead of the competition and to ensure customer engagement and loyalty, these service providers have recently started providing exclusive and original video content.

Motivation for OTT adoption intention

There have been various researches earlier on adoption intention and consumer purchase behaviour for innovations in digital media. The topics covered range from social networking sites (SNS), Internet of things (IoT) and also self-service technologies (SST). However, there is limited study on the digital adoption of OTT and the impact of various factors that lead to subscription of an OTT service by a consumer. Geographically defined studies in India indicated that content superiority, system quality and service differentiation had a positive impact on perceived value by the customers, which in turn influenced their purchasing intentions and subscription renewal intentions positively. The findings from another research include that the attributes of perceived ease of use, perceived ubiquity and time savings are expected from the IoT devices, along with other factors such as utilitarian, social and hedonic values [5]. In another paper, the authors have analysed the impact of customer engagement and quality of service provided on the willingness to pay or subscribe to the said OTT service [6].

The impact of OTT industry on the telecom industry has also been studied by authors [7]. They have discovered the factors of cost, content, availability, convenience, Internet penetration and mobile phone penetration, user experience, features and net neutrality regulation that play an important role in the adoption of OTT services. However, there is still a lack of comprehensive research available to examine the underlying motivations for a user to subscribe to OTT SVoD service.

Barriers for OTT video consumption

For any new technology, there can be both positive and negative dispositions at the same time. It calls for further research including such adoption models. Regarding studying the independent influence of each barrier on for adoption of a new technology, there have been numerous researches [8–11]. Ram and Sheth's model [12] has been considered by most of the researches. According to them, the barriers can be classified into two major types, practical barriers such as value, use and risk barriers and psychological barriers such as image and tradition. The easy access to freely downloadable pirated content also plays a major role in hindering subscription for OTT streaming services. The content-sharing ecosystem has proven to be a disrupting factor in the traditional perspective on Internet privacy. The reasons for supply of such pirated content can be beyond the reasons of making money [13]. Many users also rely on the freely downloadable pirated content ignoring the attached privacy issues. Since there is a lot of exclusive OTT content, this could be one of the reasons for such inclination towards pirated content [14]. Another factor could be affordability and access to the exclusive content [15].

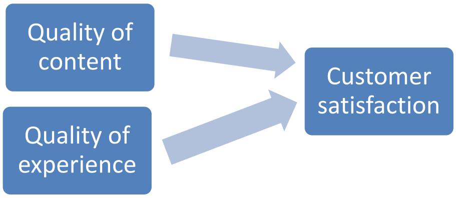

Fig. 1 Conceptual model

2 Research Gaps

Most of the researches on OTT subscription intention have been done in the western context since the content was primarily focused on native English-speaking countries. However, with the increasing demand for regional exclusive content in OTT in India, this research becomes relevant in the Indian context. India is one of the biggest revenue-generating nations for most of the OTT service providers like Netflix, Amazon Prime, Hotstar and Voot. Our existing research is largely focused on studying the impact of "Quality of Content" and "Quality of experience" provided by OTT players and customer satisfaction (Fig. 1).

With the support of existing literature, we have devised a conceptual model which indicates that customer satisfaction is dependent on quality of content and quality of experience. The criterion here is customer satisfaction and the predictors are quality of content and quality of experience. We have conducted a pilot study with data collected through primary survey.

3 Research Objectives and Methodology

For the purpose of this research, we have selected two important attributes which have an influence on customer satisfaction for OTT service providers, namely quality of content and quality of experience. Quality of content comprises of various attributes like the amount of content, exclusivity, regularly updating the content as per the likeliness of the audience. Quality of experience includes operating ease, user experience, audio and video quality and rate of breakdown.

3.1 Research Objectives

Based on the factors identified above and the literature review, we have formulated the objectives for this study as follows:

1. To examine the perception towards OTT subscription intention factors such as quality of content and quality of experience.
2. To explore the relationship of these factors with customer satisfaction.

3. To identify the major factors influencing customer's OTT subscription intention. The above-mentioned objectives serve as a framework for this study.

3.2 Research Hypotheses and Methodology

The following hypotheses were formulated by us for this study:

1. H1: Quality of content has an impact on customer satisfaction.
2. H2: Quality of experience has an impact on customer satisfaction.

4 Data Analysis and Interpretation

A pilot study was conducted with 102 respondents. The data was systematically compiled and sorted so as to ensure proper and meaningful computation and analysis.

The following tables show the demographic profile of the respondents.

Table 1 shows that majority of the respondents are female with ages 17–26 and are currently residing in East India. Majority of the respondents are pursuing graduation.

Table 1 Demographic profile

		Number	Percentage (%)
Gender	Male	48	47.1
	Female	54	52.9
Age	Below 17	3	3
	17–26	84	82.3
	26–34	12	11.7
	Above 34	3	3
Location	East India	78	76.4
	South India	9	8.8
	Central India	3	3
	West India	3	3
	North India	9	8.8
Education	Graduate	6	5.9
	Post-Graduate	30	29.4
	Pursuing Graduation	60	58.8
	Other	6	5.9

5 Conclusion

The OTT world has witnessed a tremendous growth across the globe over the past few years. The COVID-19 pandemic further accelerated its growth. The service providers have been witnessing positive growth for showcasing popular content. However, the real battle remains in improving and improving the user experience. Companies like Netflix and Spotify have been providing personalized recommendations for users using data analytics. Also, seamless transition between platforms on different devices (TV to mobile to laptop/tablet, etc.) would also play a major role in getting loyal customers. With the lockdown being lifted in some places, the total time spent for at-home entertainment will probably decrease as consumers will look for entertainment options outside their homes. All the OTT service providers must focus on providing a better and differentiated experience to customers in order to get the revenues flowing.

5.1 Managerial Implications

Through this research, we aim to contribute useful insights to academicians, researchers as well as other stakeholders. From the academic point of view, this research can serve as a base for brainstorming on multiple factors responsible for OTT service adoption and also help in conducting further research in this domain.

This research can be used by business organizations. The model proposed in this study can be used and tested with other variables in order to gain a better understanding of OTT subscription intention of consumers. This will help in generating relevant content and experience standards to enhance customer satisfaction for OTT viewing experience. Some new entrants in the OTT market may benefit from the model proposed in this study and work on their content and user experience beforehand to gain competitive advantage.

5.2 Limitations

- As the backbone of OTT is Internet, this makes it accessible everywhere. However, this study is limited to the state of Odisha, India. There is a scope for expanding this research to other states across India as well so as to get better insights.
- This study focusses on two aspects related to OTT subscription intentions, i.e. quality of content and quality of experience. Some other factors such as subscription cost involved, customer engagement and perceived enjoyment, can also be explored to enhance the scope of this research.

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Analogizing the Role of IoT and Data Analytics for Smart Irrigation and Aquaculture

G. Maria Joyce and J. Shiny Priyadarshini

Abstract In the present scenario, the stupendous growth in population and the shift toward technical advancements to meet the human facilities is the need of the hour. It also reflects in the rapid increase of enormous usage of smart devices with various specialized sensors. Smart farming is an emerging trend in the field of agriculture. The dual role of Internet of things (IoT) and data analytics (DA) in smart farming are highlighted here with efficient sensors embedded with data analytics. In this paper, the benefits of IoT sensors have been identified and how the combination of IoT and DA is enabling smart agriculture has been emphasized and proven. An empirical data analysis which provides future trends and opportunities is tabulated and analyzed with graphical representations. The goal is to focus on features that reduce the labor and supervision required for the consumer to a feasible extent.

Keywords Smart farming · Smart Aquaculture · Sensors · Internet of things · Data analytics

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1 Introduction

The Smart Farm—Irrigation and Aquaculture—project is part of the wider Smart Farm project [1]. Smart Farm is an IoT-based application that measures and monitors the temperature, humidity, moisture, water level, water quality, and water temperature of a farm. Smart Farm Irrigation is an IoT application that allows users to monitor temperature, humidity, and soil moisture and warn the user through notification. This system continuously updates the sensor data, which are saved in the database. Smart Farm Aquaculture is another part of IoT application that allows users to monitor water level, water quality, and water temperature that notifies the user through notification. This system continuously updates the sensor data, which are saved in the database [1, 2]. This application simplifies the day-to-day process of farm maintenance and monitoring for agricultural employees. This project is divided into four parts. The first part is to connect all of the IoT components and sensors to collect data. The collected data are then saved in the database.

The next part is to transfer the data from database to an application. If there is any change in monitoring or detection, the user will be notified by the admin through the notification. The fourth part is to clean the duplicate values and preprocess the missing values with their mean values [3, 4]. Then the preprocessed data are used to perform data visualization.

1.1 Existing Work

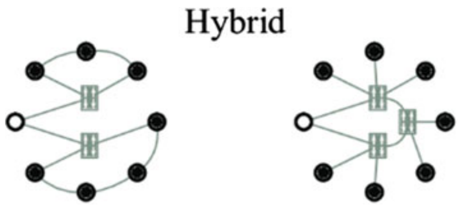
Adi et al. [1] presented a study on machine learning and data analytics for the IoT using neural computing and applications. Elijahet et al. [2] presented the usage of various technologies and usage of smart appliances in the field of agriculture. Masek et al. [3] presented the highlights of measuring the water quality for goldfish aquaculture. Atitallah et al. [4] suggested the deep learning algorithm to develop and build the smart cities for future. Dagar et al. [5] focused on IoT in smart farming and agriculture. Bhagat and Kumar et al. [6] have presented a survey paper on Role of Internet of Things in Smart Farming. Yang et al. [7] presented the various development modes, technologies security, and privacy challenges used in smart agriculture.

2 Proposed Methodology

This paper focuses on the automation of farming with IoT sensors. Further, the results are extemporized and analyzed with data analytics. Figure 1 depicts the various sensors and different stages used for agricultural automation.

Fig. 1 Various sensors and stages in data analytics

Fig. 2 Hybrid networking



3 Role of Networking in IoT

Topology plays the key role in the virtual setup of smart devices. It mainly deals with the components that are interconnected with each other.

In this paper, the physiological structure that is used to construct IoT components is mesh and hybrid as they are mainly used in WAN implementations where fast communications are possible emphasizing easier configuration [5–7]. These topologies result in high reliability, scalability, and effective speed with flexible communications. Figure 2 depicts the structure of hybrid networking.

4 IoT and Data Analytics for Irrigation and Aquaculture

4.1 IoT Devices

DHT 11

DHT 11 is the digital humidity and temperature sensor. It can detect humidity levels ranging from 20 to 90% RH and temperatures ranging from 0 to 500° C. DHT11 is small in size with operating voltage from 3 to 5 V. The maximum current used while measuring is 2.5 mA.

NodeMCU ESP8266

NodeMCU ESP8266 is an open-source Internet of things (IoT) hardware platform with built-in Wi-Fi. This device allows us to communicate directly with live servers. It's a board that looks like an Arduino and is used to connect to the cloud in real time. The general-purpose input/output (GPIO) of the NodeMCU is accessible, and the API documentation includes a pin mapping table. D0 (GPIO16) can only be used to read and write GPIOs.

Soil Moisture

A passive electrical component with two terminals is used for limiting or regulating the flow of electric current in electrical circuits. The Soil moisture sensor measures the volumetric water content of the soil. The two probes allow the electric current to pass through the soil and according to its resistance, measure the moisture level of the soil. It measures the tension between the soil particles and water molecules. It also contains a potentiometer to measure the threshold value.

MQ-2 and DS18B20 Sensor

The MQ-2 is also known as the gas or smoke sensor. It detects smoke, LPG, alcohol, and methane. It contains a sensing material whose resistance changes when it comes in contact with the gas.

DS18B20 device is used to measure temperature. It is a one-wire programmable temperature sensor from maxim integrated. The communication of this sensor can be done through a one-wire bus protocol which uses one data line to communicate with an inner microprocessor.

Ultrasonic Sensor

It is an instrument that measures the distance to an object using ultrasonic waves. Transmitters convert electrical signals into ultrasound, and receivers convert ultrasound into electrical signals.

Turbidity Sensor

It measures the amount of light that is scattered by the suspended solids in water. As the amount of total suspended solids in water increases the waters turbidity level, cloudiness or haziness increases.

Integration of DHT 11, MQ-2, Soil Moisture, Turbidity, Ultrasonic, and DS18D20 sensors

In Smart Farm, users can easily monitor the farm from any location at any given point of time. The user can also view all the processes of the divided subcategories indulged in farming. If there are any changes in the farm, such as a decrease in temperature, humidity, water temperature, water level, water quality, moisture of the soil, and also detection of smoke, distance, and motion for animals, the user is immediately notified so that the problems can be easily resolved. It reduces the manual work and time. An admin can keep track of everything that's happening and also control the access of each process.

The Smart Farm has been divided into two parts such as Smart Farm Irrigation and Smart Farm Aquaculture. Smart Farm Irrigation focuses on soil and chicken monitoring. In soil, it monitors the soil moisture, temperature, and humidity of the atmosphere and notifies the user. In chickens, it monitors the temperature and humidity and detects if there is smoke in the chicken coop. If the temperature goes below, the LED lights will be turned on automatically, which produces heat energy so that it warms the coop. All sensor values are saved in a real-time database, where they are analyzed and data visualization is performed. These three parts of the Smart Farm are monitored and controlled by an IoT-based application.

Data analytics is the science of analyzing raw data to make conclusions about that information. It is a process of inspecting, cleaning, transforming, and modeling data with the goal of discovering useful information, suggesting conclusions and support decision-making. Figure 3 depicts the entire structure of smart irrigation and aquaculture.

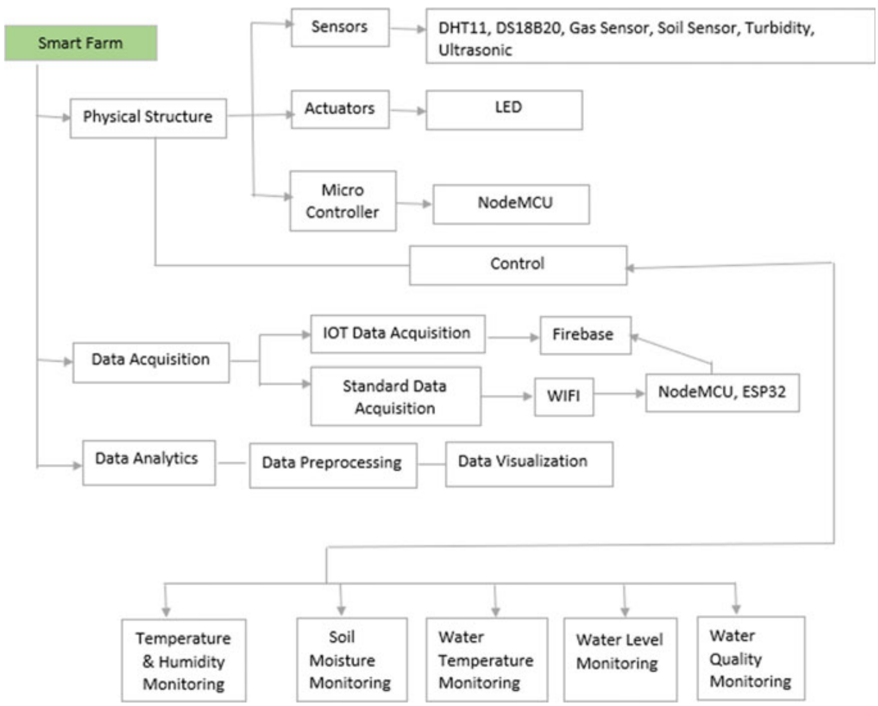


Fig. 3 Automation of smart farming and aquaculture

5 Simulation Results

Data preprocessing and data analysis have been performed for a period of 90 days. Figures 4, 5, 6, 7, 8, and 9 depict the results that are captured and presented for a period of ten days. The rise in temperature and humidity in particular day is depicted in Figs. 4 and 5. At this point of time, a notification will be sent to the user indicating rise in temperature and humidity. Figure 4 depicts the histogram readings of temperature and humidity.

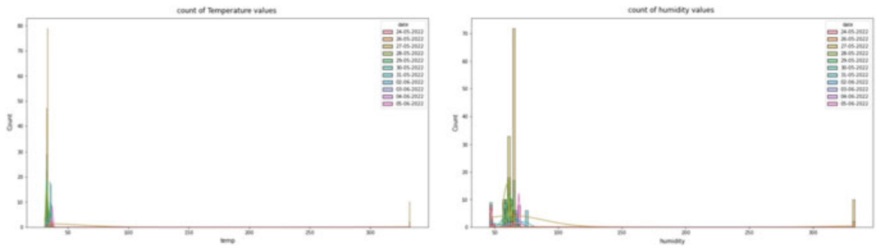


Fig. 4 Histogram for temperature and humidity

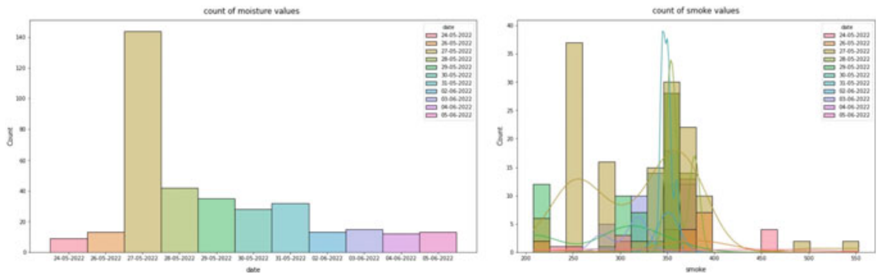
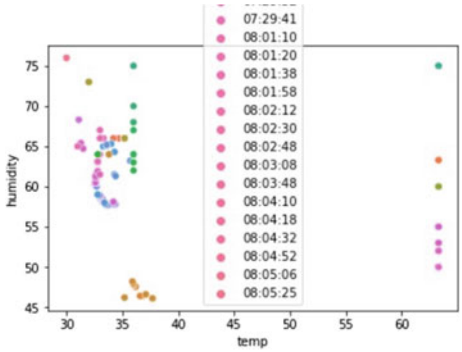


Fig. 5 Histogram for smoke and moisture

Fig. 6 Scatter plot for temperature and humidity



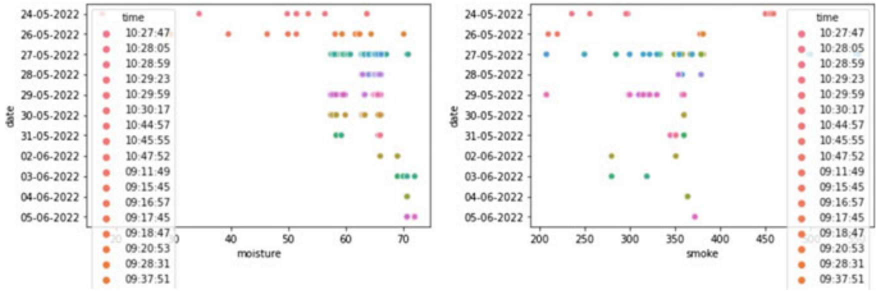


Fig. 7 Scatter plot for smoke and water temperature

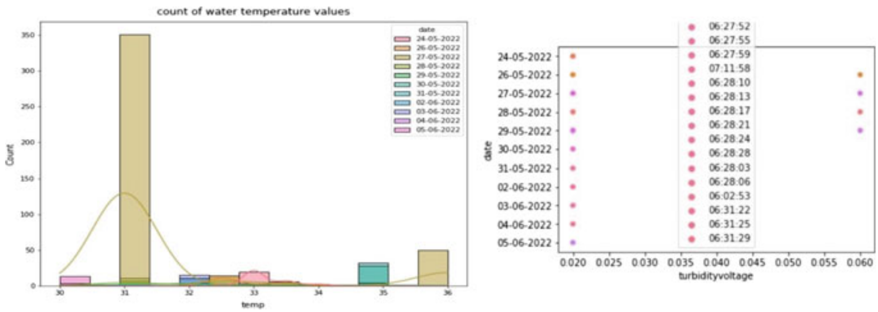


Fig. 8 Scatter plot for water level and water quality

Figure 5 depicts the smoke and moisture readings through a bar graph. Increase in smoke will be notified through a bursar alarm. Moisture readings are monitored and maintained based on plant requirements.

Figures 6, 7, and 8 show the scatter plot readings taken for temperature, humidity, smoke water temperature, water quality, and level. Figure 9 shows the scatter plot and bar chart for water quality and turbidity. All the readings were captured in real-time scenarios and stored in the database as shown in Fig. 10.

6 Conclusion

Thus, in Smart Farm the users can easily monitor the farm from any location at any point of time. The changes in the farm, such as a decrease in temperature, humidity, water temperature, water level, water quality, moisture of the soil, and also detection of smoke, distance, and motion for animals are monitored periodically with uniform

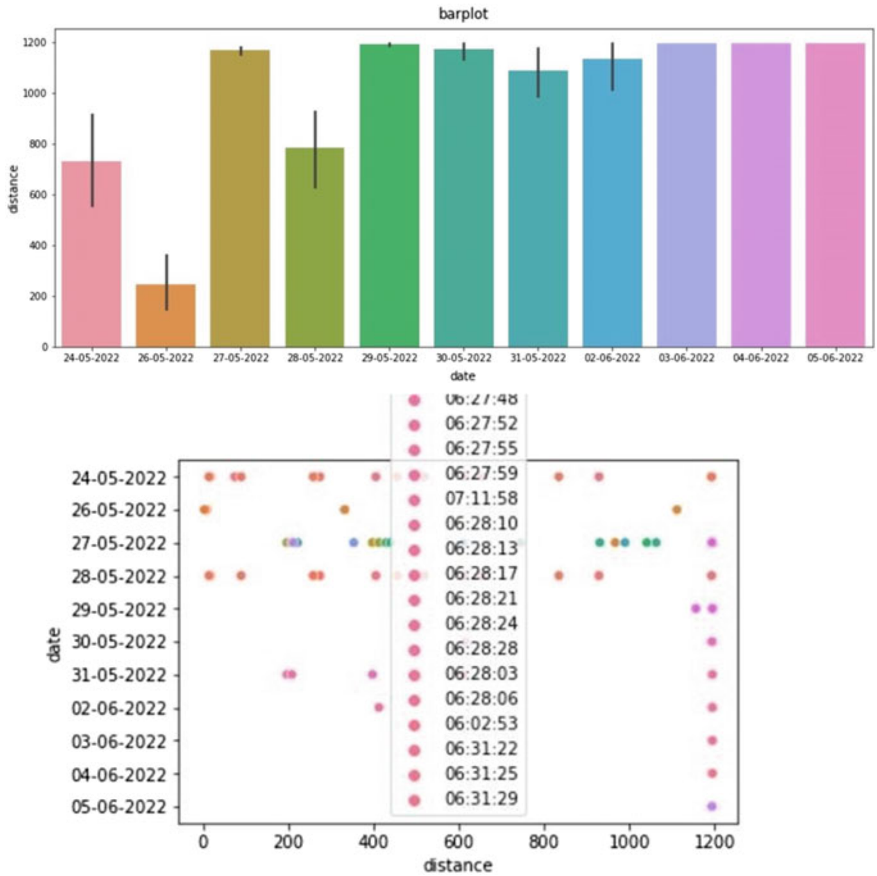
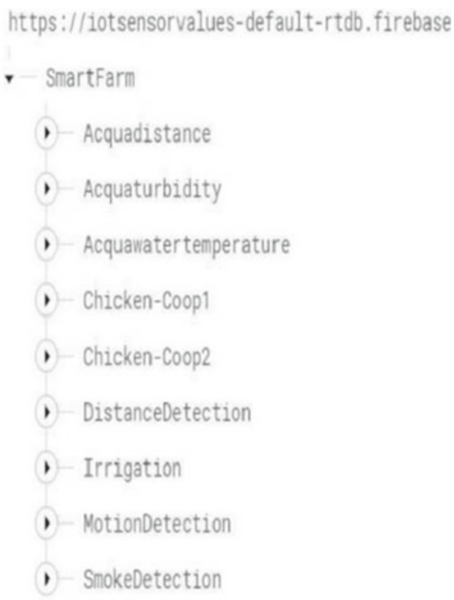


Fig. 9 Scatter plot and bar chart for water level and turbidity

time intervals. It reduces the manual work with immediate notification and solution. The sensor values are saved in a real-time database, where they are analyzed and data visualization is performed. Thus, two major categories of Smart Farm are monitored and controlled by an IoT-based application. For future analysis, results can be further extended and improvised for data analysis and prediction.

Fig. 10 Database



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Air Quality Index Prediction of Bangalore City Using Various Machine Learning Methods

Aadarsh Sathinarayan Nair, Sangita Khare, and Amrita Thakur

Abstract Air pollution is a severe problem in the present time whose implications are getting more dire with each passing day. In India alone, over 1.6 million people have died due to air pollution and its related factors in 2019. To clearly understand air pollution, we need to identify the primary factors contributing to it and to try and predict the conditions in future. Therefore, the assessment and forecasting of air quality is crucial. The Air Quality Index (AQI) is the standard measure of air quality and is calculated based on the average concentration of particular pollutants over a set time interval. Prediction models obtained using eight different Machine Learning methods are created to predict the AQI levels using the pollutants data obtained from India's Central Control Room for Air Quality Management of Bangalore City over the past 10 years. The prediction models were for their accuracy using evaluation metrics such as Root Mean Squared Error, Mean Absolute Error and R^2, and the best performing models were determined. From the metrics, it is found that Stacking Ensemble, XGBoost, Random Forest and Decision Trees perform the best, with Stacking Ensemble performing the best in terms of R^2 and RMSE with R^2 value of 0.991 and RMSE value of 6.353, whereas Random Forest has the lowest MAE value with 1.415. The models showing features importance also found that carbon monoxide (CO) and PM2.5 are the most important factors to the AQI.

Keywords Air quality index · Machine learning · Air pollution

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1 Introduction

Air pollution is a very serious pollution in the present day with studies showing that it is only worsening with time. In India alone, over 1.6 million people have died due to air pollution and its related factors in 2019 [1]. According to studies, the air pollution levels are set to rise by over 15% in the next 2 years. Therefore, to have a better understanding of the present pollution levels and also that in future, Machine Learning models can be applied to data available. Understanding the factors linked to air quality and predicting its trajectory in future using these models will help in the understanding of the problem and aid with improving and applying countermeasures. Machine Learning is very useful in the prediction of the air quality as it is a common approach for prediction problems [2–4].

Additionally, Bangalore being one of the fastest growing cities in India makes the understanding of air pollution in the area more crucial. Therefore, the Machine Learning models will be primarily focused on the data from Bangalore with secondary focus on other metropolitan cities in India.

In India, the Central Pollution Control Board (CPCB) monitors air quality data throughout the country. It is done by creating and monitoring stations all throughout the country. These stations track a variety of pollutants including but not limited to particulate matter (PM2.5 and PM10), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and others. Air Quality Index (AQI) is the measure commonly used by government bodies to measure air pollution using concentration of these pollutants. An increase in AQI refers to worse conditions and increased pollution.

2 Literature Review

Liang et al. [5] explore the application of Machine Learning models on air pollution data of 3 regions of Taiwan collected over a period of 11 years. A variety of models such as Artificial Neural Network (ANN), Support Vector Machine (SVM), Random Forest, Stacking Ensemble and AdaBoost are created on this data. The performance of these models was checked using RMSE, MAE and R^2. The results showed that Stacking Ensemble performed the best for RMSE and R^2 but AdaBoost performed the best using MAE.

Amuthadevi et al. [6] apply Machine Learning models such as multilevel regression, ANN, Neuro-Fuzzy and DL-LSTM on Indian Meteorological Data over 5 years. The accuracy is checked using RMSE and R^2. It was found that from all the models tested, DL-LSTM performed the best overall.

Abhilash [7] and Darekar [8] used a Time Series Analysis-based approach to analyse the air pollution data. Darekar [8] used time series models such as SARIMA, VAR, VARMA and ARFIMA which were modelled using Kaggle data on the air pollution levels of both Bangalore and Delhi. The SARIMA model was found to have performed the best with others trailing not too far behind. Abhilash [7] used the

ARIMA model to analyse the air pollution data consisting of SO_2, NO_2 and PM10 values. Both the PM10 and NO_2 were found to fit well with the plot due to it being stationary. Since the rest is non-stationary, the plot doesn't fit too well but intervals and trends are found.

Both Ma et al. [9] and Mallegowda et al. [10] used XGBoost models to model the data where Jun used data from USA containing 171 factors which were considered, whereas Mallegowda used Meteorological data from India. Additionally, Mallegowda also created a web application around the results from XGBoost model.

Kumar et al. [11] use a clustering method, namely Expectation Maximization (EM) clustering to analyse the air quality data around Bangalore. The data obtained contained pollution data from 10 Central Pollution Control Board of India (CPCB) controlled monitoring stations throughout Bangalore. An analysis is done from the data and clustering, and location-based inferences are made from these results. It also highlights the major pollutants among the same.

Soundari et al. [12] use the data from CPCB and apply Gradient descent boosted multivariate regression to predict the air quality. The model created was found to have an accuracy of 95% when tested.

Liu et al. [13] apply Support Vector Regression (SVR) and Random Forest Regression (RFR) for prediction. In this work, the AQI is predicted in Beijing, China, using data collected over 5 years. Nitrogen oxides (NO_x) concentration in an Italian city is also predicted using a publicly available data set spanning the length of one year. RMSE and R^2 were the accuracy metrics used. SVR was found to be performing better when it came to the AQI prediction but RFR performed better when it came to the prediction of NO_x data.

Castelli et al. [14] forecast the pollutant levels and then the AQI levels are predicted using Support Vector Regressor. A radial basis function (RBF) kernel was used to obtain the most suitable results from the data set. Hourly data from California, USA, over a period of 2 years was used. A very accurate model is built from the data and results were produced with an accuracy of around 94%.

Jyothi et al. [15] analyse the air pollution in 3 different cities in Kerala, India, using the value of Air Quality Index. 3 pollutants are taken, namely, SO_2, NO_2 and PM10 over a period of 1 year from 6 different monitoring sites across 3 districts in Kerala. The AQI is calculated, and seasonal variations and trends across the 6 monitoring sites are analysed and compared.

Thakur [16] assesses the Air Quality of Bangalore by checking the values of SO_2, NO_2 and PM10 and also analyses the major contributing factors to the pollution. The study found that SO_2 and NO_2 are under control but the PM10 values are rising. Transport sector was also found to be a major contributing factor for the pollution caused.

Binsy and Sampath [17] use data collected to create MATLAB visualizations to get an initial picture of the situation. Then, the data collected in intervals of 5 min is used to create a regression analysis model using linear regression. The prediction from this regression model is found to have a RMSE value of 0.83.

Niranjan and Rakesh [18] use real-time analysis of air pollution and implement an air purification system which compliments the pollution readings. The purification is done by implementing the processes through a Raspberry Pi for ease in configuration and lower power consumption. Depending on the air quality, the system works effectively to purify the air in a smaller scale but has limitations in terms of power and portability while scaling up.

From this, we realize that air pollution is a large-scale problem where advances in the area of Machine Learning have been implemented. Clustering, classification, prediction and time series analysis all have been implemented using a variety of different data sets all over the world.

In this paper, eight different approaches are taken for the prediction of the Air Quality Index with a data set obtained from the Central Pollution Control Board (CPCB) having data over a period of 10 years to understand which approach is most effective.

3 Algorithms and Models to Be Used

3.1 Support Vector Machines

Support Vector Machines (or SVMs) are one of the most commonly used Supervised Machine Learning models used. They can be used for both regression and classification. SVMs operate on the basic principle of constructing hyperplanes forming boundaries between classes. When used to perform regression, Support Vector Machines are called as Support Vector Regressors (or SVRs).

SVMs work by finding a hyperplane in n-dimensions to either classify or perform regression on the data points. The number of dimensions (n) depends on the number of features provided to the machine. When the data isn't linearly separable, a kernel trick is used by mapping these nonlinear points onto a high-dimensional feature space. Kernel functions such as polynomial, Gaussian Radial Basis Function (RBF) and sigmoid are used to convert the nonlinear inseparable data into distinct separable ones.

When it comes to regression, there are some changes from the method used for classification. Support Vector Regression (SVR) uses the same main features as used for classification. When used for SVR, an additional parameter epsilon known as the margin of tolerance is used. Since the idea of the SVR remains the same, it will try and minimize the error creating the hyperplane which maximizes the margin keeping in mind the available tolerance of the system.

3.2 Multiple Linear Regression

Linear Regression is a Machine Learning technique used for modelling one dependent response value and one or more independent exploratory variables. When the number of independent variables is more than one, it is called Multiple Linear Regression (or Multiple Regression). It is done by fitting the independent variables into a line in n-dimensions with the dependent variable, where $(n - 1)$ is the number of independent variables. The model assigns weights or importance to each of the dependent variables to work towards the independent variable to be predicted.

Since the number of independent variables is greater than one, multiple regression can be considered to be an extended version of the ordinary least squares (OLS) regression method.

Linear Regression and by extension Multiple Linear Regression works best when some assumptions are followed by the data set. These assumptions are

- Linear relationship exists between the target class and the features: The model will find it difficult to form a linear relationship if none exists.
- Small or no correlation between the independent variables: If there is a high correlation between the variables, it'll prove to be difficult to find the true relationship between the independent and dependent variables. This is due to being unable to tell which of the correlated variables are actually influencing the target class.
- Normal distribution of error terms: Linear Regression assumes error terms which follows normal distribution pattern. Deviation from this will cause difficulty in finding coefficients.

3.3 Decision Tree

Decision Trees are one of the most commonly used Supervised Machine Learning models which can be implemented for both classification and regression purposes. Decision Tree models perform these tasks in the form of a tree structure with a root, interior (or decision) and leaf nodes. The root and interior nodes contain features and splits of the data set, while the leaf nodes indicate the outcome or result. It does this by breaking down the given training data set into smaller subsets while developing the tree structure by a similar increment.

Decision trees however can sometimes perform poorly in the case of regression and may overfit if not accounted for properly. Therefore, other models such as Random Forest may be preferred.

3.4 Random Forest

Random Forest is a Supervised Ensemble Machine Learning method. It can be used for both classification and regression. Ensemble learning is a method which uses multiple learning algorithms to obtain better performance than if 1 was used. Random Forest is a type of bagging learning technique. Bagging is an ensemble learning method used to improve accuracy and performance of the method by running many training scenarios in parallel.

In the case of Random Forests, a collection of decision trees is used. Decision trees work by breaking down the data set into smaller and smaller subsets in a tree structure. Finally, a tree will be formed with decision nodes and leaf nodes. Decision nodes contain 2 or more branches with values for the attributes tested, whereas the leaf nodes contain a value for the target attribute. As mentioned earlier, Decision Trees often face the problem of overfitting especially when used for regression.

Random Forest creates and trains a given number of Decision Trees in parallel during the training period.

If used for classification, the output of the Random Forest would be the one selected by the most number of trees. When used for regression, the output of each of the decision trees is averaged and considered as the result. The overfitting problem often faced by Decision Trees is corrected on by using Random Forest.

3.5 AdaBoost

Adaptive Boosting (or AdaBoost) is an Ensemble Machine Learning method. It is a type of boosting ensemble method. Boosting is an ensemble method used to reduce bias and variance. Boosting is a method which attempts to build a strong classifier from a series of weak classifiers. Firstly, a model is built from the training data and then assigns equal weights to all the data points. It then modifies the weights to give higher prevalence for those incorrectly classified. Therefore, these points are given higher importance in the next model and so on and so forth until an acceptable error threshold is reached.

AdaBoost can also be used to combine strong base learners such as complete Decision Trees instead of just stumps producing an even more accurate model. However, this is very power intensive and may take more time to train.

When outliers are present in the data, the model starts to train itself to rectify it to predict accurately which will be leading it to erroneous situations. Therefore, the data set needs to be thoroughly processed to remove any outliers or noise.

3.6 XGBoost

Extreme Gradient Boosting (or XGBoost) is a boosting type ensemble learning method. It works by creating models to predict the errors generated by the prior models. The models are then combined together after training to create the final model. Like most other models, it can be used for both regression and classification purposes.

Compared to AdaBoost, XGBoost works better in data sets where noise may be present. It is also generally faster when compared to AdaBoost. It also has more hyperparameters which can be tuned for improving accuracy and to prevent problems such as overfitting.

3.7 Stacking Ensemble

Stacking Ensemble, as the name suggests, is an Ensemble Machine Learning method. It combines 2 or more base Machine Learning models to create a new model which should have a better performance than the base models. Therefore, Stacking Ensemble can be used for both classification and regression tasks depending on the base models used. Stacking Ensemble has some differences from the other ensemble methods, namely bagging and boosting. It differs from boosting as the models used are all different to each other. And the difference from bagging is that a single model is used to find the best results rather than having a series of models that follow each other.

Stacking Ensemble uses 2 types of models for creating the final model, namely base models and a meta model also alternatively referred to as level 0 and level 1 models, respectively. A portion of the data set is used by each of the base models to train them and their results are compiled. Then the meta model works on the remaining portion of the training set to determine how the models can be combined most efficiently for maximum accuracy.

Since Stacking Ensemble models generally perform better than the base models used within them, they are a very popular model used in Machine Learning. Alternatively, the interpretation of the model is difficult and we can't find the relative importance of each of the factors contributing to the model for either classification or regression.

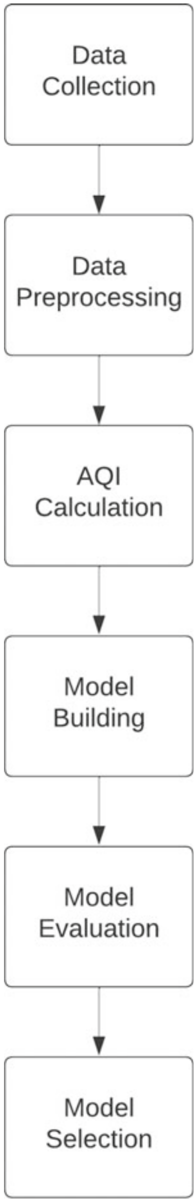
3.8 Artificial Neural Networks

Artificial Neural Networks (or ANNs for short) are computational models which perform similar to the network of neurons found in animal brains. Similar to the biological neural networks, ANNs have interconnected neurons called nodes. The connections between these nodes are called edges. These nodes and edges contain a weight associated to them in the network as well as a bias value which is added during the calculation process. The 1st layer in this network is the input layer and the last one the output layer. The layers between the input and output layers are called hidden layers. The number of hidden layers determines the complexity of the network. Different layers can be used to perform different functions as the need arises. It depends on the training of the network.

ANNs are trained by examples which set or modify the weights given to each node and edge. Activation functions are given to the nodes to bring about a nonlinearity to make it more adaptable. Some activation functions are sigmoid, ReLU and tanh.

ANNs are quite robust to noise and also have good fault tolerance. However, the functioning of ANN makes it so that behaviour of the network and importance of the features cannot be explained.

Fig. 1 Schematic for proposed methodology



4 Implementation Methodology

The implementation done consists of data collection, data processing, model creation and performance evaluation. All the models created and explored in this study are done using Python programming language and Jupyter Notebook A methodology diagram showing the flow of the process is shown in Fig. 1.

4.1 Data Collection

Throughout Bangalore, there are 10 air monitoring stations, collecting a variety of readings and air quality measures. Since the time period set for data collection was 10 years, many of these stations weren't suitable due to the lack of information in the earlier years. Therefore, 3 stations, namely BTM Layout-CPCB, Kadabesanahalli-CPCB and Peenya-CPCB were considered for the basis of this study due to data availability. The data from these stations is obtained from the website of Central Control Room for Air Quality—All India. It contains daily averages of 21 parameters including pollutants such as NO_2, SO_2 and CO and other factors related to the air such as air pressure, velocity of the wind and others.

4.2 Data Preprocessing

For the sake of this study, only the concentration of the pollutants was considered; therefore, the remaining parameters were disregarded. According to Central Pollution Control Board (CPCB), the pollutants required for calculation of the AQI of a place are PM10, PM2.5, NO_2, SO_2, CO, O_3 and NH_3. These pollutants are considered for analysis, and the remaining parameters present in the database were dropped [19]. Furthermore, across the 3 separate data sets, the number of values present for NH_3 and PM10 present was under 15%; therefore, those 2 pollutants were also disregarded and the remaining 5 pollutants taken for the study.

Out of 3652 days taken, the number of days each pollutant had null values is as given in Table 1.

As observed from the table, there are quite a few missing values inconsistently spread across the 3 stations. This may be due to any number of factors from sensor malfunction to routine maintenance. Therefore, to get the minimum number of null values, an aggregate data set was created by taking the daily average values of the pollutants across the 3 stations according to availability. After this, any missing values still present were filled in using the column average for each of the pollutants across the aggregated data set.

After this, the AQI is calculated using the guidelines as per CPCB [19]. The subindices of the pollutants are calculated first using the formula

Table 1 Number of missing values in initial data set

Pollutant	Station		
	BTM layout	Peenya	Kadabesanahalli
PM2.5	1605	1352	1412
NO_2	548	340	566
SO_2	545	466	740
CO	262	1107	1141
O_3	525	3231	613

$$I_i = I_{\mathrm{LO}} + \frac{(I_{\mathrm{HI}} - I_{\mathrm{LO}})}{B_{\mathrm{HI}} - B_{\mathrm{LO}}} * (C_i - B_{\mathrm{LO}}) \tag{1}$$

where

C_i Value of concentration of the pollutant
B_{HI} Upper end breakpoint
B_{LO} Lower end breakpoint
I_{HI} AQI value corresponding to B_{HI}
I_{LO} AQI value corresponding to B_{LO}.

The AQI value will the maximum subvalue among all of the pollutants considered

$$\mathrm{AQI} = \max(I_i) \tag{2}$$

where I_i is the subvalue of each of the pollutants.

After the calculation of the AQI, the completed data set for the model building is obtained.

4.3 Performance Evaluation

For the evaluation of the performance of each of the models built, 3 commonly used evaluation metrics are used, namely the coefficient of determination (R^2), Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) The formulae for calculation of these metrics are as follows:

$$R^2 = 1 - \frac{\sum_{i=1}^{n} (P_i - A_i)^2}{\sum_{i=1}^{n} A_i^2} \tag{3}$$

$$\mathrm{RMSE} = \sqrt{\left(\frac{1}{n}\right) \sum_{i=1}^{n} (P_i - A_i)^2} \tag{4}$$

$$\text{MAE} = \left(\frac{1}{n}\right)\sum_{i=1}^{n}|P_i - A_i| \tag{5}$$

where P_i = Predicted Value and A_i = Actual Value.

4.4 Model Building

For the purpose building the models, a 70:30 test train split is used.

Support Vector Regression The hyperparameter tuning of Support Vector Regressor showed that the linear kernel function performed the best for the training and testing of the model providing the best metrics when compared to other values. The model's performance was also the best when epsilon was set as 15. When tested using these hyperparameters, the evaluation metrics of the model were found to be,

R^2 = 0.899
RMSE = 21.243
MAE = 13.949

Decision Tree Regression The best evaluation metrics were found with the criterion being squared error and max depth being none so the tree builds itself until all values are taken into consideration

The evaluation metrics after testing were found to be,

R^2 = 0.9883
RMSE = 7.297
MAE = 1.548

Decision Tree is also one of the models created which shows the relative importance of each of the inputs, hence, the importance of this model created is as shown in Fig. 2.

Random Forest Setting the number of trees in the forest to be 300 is found out to be a good balance between the training time and the accuracy. Changing either of the 2 makes the model either slower to train or lower in accuracy. Using these parameters, the trained model was found to have the following evaluation metrics on the test data,

R^2 = 0.988
RMSE = 7.326
MAE = 1.415

Random Forest can also show importance of the inputs as the output is aggregated by each of the Decision Trees in the model. The relative importance is as shown by Fig. 3.

AdaBoost For the tuning of the AdaBoost regressor model, the base estimator is taken as Decision Tree Regressor and the number of estimators to be 20. Increasing

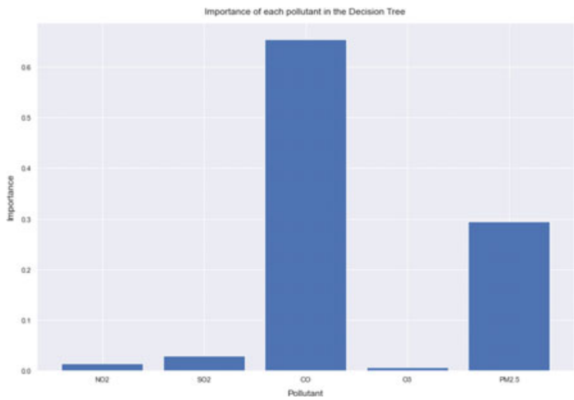


Fig. 2 Relative importance of the decision tree

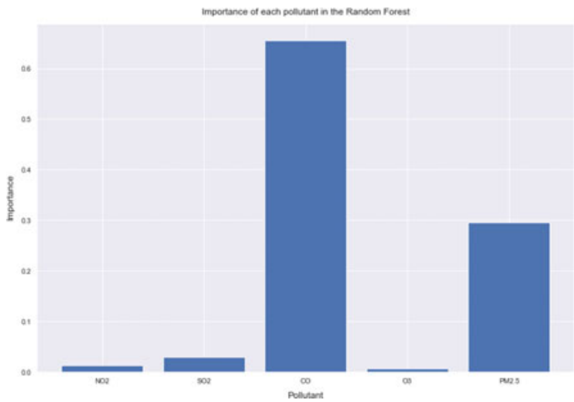


Fig. 3 Relative importance of the random forest

the number of estimators showed very similar performance and decreasing worsened the performance. The metrics obtained after training and testing this model are found to be,

$R^2 = 0.847$
RMSE = 26.345
MAE = 21.777

XGBoost The metrics from the model were found to be good when the base model was set as gbtree which is a Gradient Boosting in the type of a tree structure and the number of estimators in the model to be 100. The metrics obtained from these hyperparameters are,

$R^2 = 0.9896$
RMSE = 6.867
MAE = 2.509

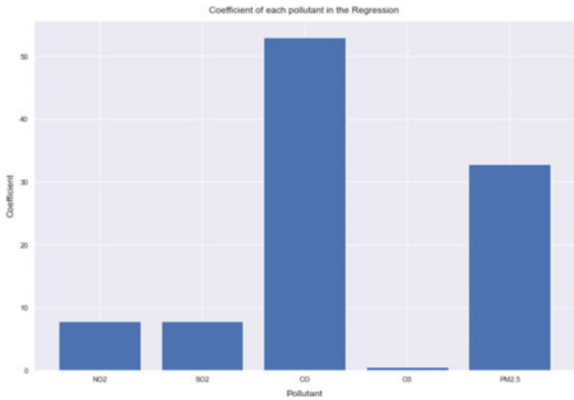


Fig. 4 Coefficients of linear regression

Linear Regression Linear Regression was found to preform fairly well with the data set even when trained and tested with the default parameters. The evaluation metrics which are produced from this are,

$R^2 = 0.903$
RMSE = 20.964
MAE = 14.198

We can also find out the coefficient of each of the features used as an input. This can be used to understand the positive or negative correlation of that input with the dependent output value. The coefficients of the model created are as shown in Fig. 4.

Stacking Ensemble Various combinations of meta and base models were tried out and it was found that kNN Regressor, Support Vector Regressor and Decision Tree Regressor as the base models and Linear Regressor being the meta models performed the best from the metrics observed. The metrics obtained from this model were,

$R^2 = 0.991$
RMSE = 6.353
MAE = 3.012

Artificial Neural Network The parameters were tweaked gradually to find the best values. The optimal parameters which does not have a large training period are found to be one with 5 inputs, 2 hidden layers of 5 nodes each and 1 output. The model was trained for 200 epochs with batch size 5. The loss function used was mean squared error and the optimizer "adam". The metrics of this model were found to be,

$R^2 = 0.978$
RMSE = 10.008
MAE = 6.39

Table 2 Table of evaluation metrics of ML models

Model	R^2	RMSE	MAE
SVM	0.899	21.423	13.949
Linear regression	0.903	20.964	14.198
Decision tree	0.9883	7.297	1.548
Random forest	0.9882	7.326	1.415
AdaBoost	0.847	26.345	21.777
XGBoost	0.9896	6.867	2.509
Stacking ensemble	0.991	6.353	3.012
ANN	0.978	10.008	6.39

5 Results

All the evaluation metrics of the built models are given in Table 2. These are the metrics found after hyperparameter tuning was performed.

Additionally, Decision Tree model, Random Forest Regressor and Linear Regression models can show the relative importance (coefficient in the case of regression) of each of the parameters used to build the model. These importance are shown by Figs. 2, 3 and 4. From these, we find that carbon monoxide (CO) has the highest importance in the models with PM2.5 being the next highest. We also find that ozone (O_3) has the least importance among these models.

6 Conclusion and Future Scope

6.1 Conclusion

Data was collected from 3 different air monitoring stations across Bangalore for a span of 10 years. The AQI calculation was done using the concentrations of the major pollutants as per CPCB guidelines. Eight different Machine Learning models are trained and tested using different hyperparameters. The evaluation metrics used were R^2, RMSE and MAE. Across the 8 models, Stacking Ensemble with kNN, Decision Tree Regressor, Support Vector Regressor and Linear Regression was found to perform the best in terms of both RMSE and R^2 with values of 6.353 and 0.991, respectively. XGBoost was found to perform the next best in terms of R^2 and RMSE. In terms of MAE, Random Forest Regressor performs the best with a MAE value of 1.415, while Decision Tree Regressor performed the next best. AdaBoost was found to under perform which may be due to some amount of noise present in the data set. We have also found that for the models which can convey importance of the features, that carbon monoxide (CO) has the highest importance in the models with PM2.5

being the next highest. We have also found that ozone (O_3) has the least importance among these models. Since CO and PM2.5 has the highest importance, steps should be followed to control the concentrations of these pollutants to bring down the Air Quality Index and to reduce the overall pollution.

6.2 Future Scope

In future, these models can be tried to be implemented in a country wide scale taking data sets from a number of stations all throughout the country. Additionally, the data could also be taken during an interval of 8 or 12 h and the changes in the obtained models can be analysed.

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Discrimination Between Fake and Real Emotion Using Modified CNN Model

M. P. Sunil, S. A. Hariprasad, S. Shrishti, and S. Sriharshini

Abstract Since standard emotion identification seeks to categorize the emotion of a given set of facial reactions, distinguishing between real and simulated emotion presents a fresh problem. In this study, we analyse different nets, such as LeNet, AlexNet, ResNet, and VGGNet, using which features are then extracted in the spatial-temporal domain from facial landmarks and then discriminated as real and fake using the nets. We then propose a fake emotion detection model by combining mirror neuron modelling and convolutional neural networks. The net with the best training and testing accuracy was found after using and analysing all four nets. The maximum score achieved by our system employing ResNet was 98% training accuracy and 96% testing accuracy.

Keywords Computer vision · CNN · ResNET · AlexNet · LeNet · VGGNet · Emotions · Fake · Real · Feature extraction

1 Introduction

Human faces convey vital information for socializing, including emotional responses. Human facial expressions allow for quick and subtle communication. Because there are so many potential uses for this technology, such as in intelligent surveillance, human–robot interaction, and video search, it has become a major study area. Although there are other facial expressions that people can use, there are six universal facial emotions that are well known: anger, contempt, fear, happiness, sadness, and surprise. The ability to anticipate human emotions from facial expressions has been the subject of numerous studies in recent years. However, rather than focusing on comprehending human emotions at a deeper level, the bulk of them mainly focused

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on detecting common emotions that are easily identified at first glance. One of the most challenging challenges for the human brain is differentiating between genuine and fraudulent expressions. Empathy is the primary means of perceiving the true feelings of others, but it can still lead to numerous misunderstandings. Computers must be taught rules in order for them to manage such a challenging task based on computer vision because, unlike humans, machines do not yet have the same level of empathy. There have been numerous psychological and neuroscience investigations to make things more concrete and less abstract. Computer vision researchers [1] can then use those particular guidelines to train machines based on the actual facial muscle movements.

2 Literature Review

The existing research papers for fake emotion detection have used various algorithms like LSTM with 63% accuracy, SVM with 70% accuracy, bidirectional SVM with 76.6% [2] accuracy, CNN, CLBP-TOP [3] with 57% accuracy, and hybrid algorithm LSTM-PB [4] with 67% accuracy. And the datasets used were MAHNOB for LSTM, FER-2013 for CLBP-TOP, and ChaLearn for other models. Some papers have worked on a single expression and others on seven emotions. All the papers have worked on two-dimensional images. The processing speed and face recognition are slow (Table 1).

3 Functional Block Diagram of Proposed Method

Our design and development is done in six steps, namely.

(i) Dataset Gathering
(ii) Pre-processing
(iii) Feature Extraction
(iv) Classification

Figure 1 is the work flow diagram of the model.

3.1 Dataset Gathering

Dataset used is combination of existing datasets like ChaLearn, Fake smile master, and our own dataset to improve the robustness of the dataset.

Dataset—It consists of total 210 labelled images divided into two categories (fake and real). With Train set: 210 and Test set: 40 (Fig. 2).

Table 1 Dataset, accuracy, and techniques used in previous work

Tıtle of the work	Database	Technique	Result
Towards recognizing facial expressions at a deeper level: Discriminating genuine and fake smiles from a sequence of images [5]	MAHNOB	Bidirectional LSTM	87% accuracy
A novel framework for real and fake smile detection from video [6]	ChaLearn dataset	SVM	Accuracy in detecting true and fake. smiles is close to 66.66%
Discrimination between genuine versus fake emotion using long- and short-term memory with parametric bias and facial landmarks [7]	ChaLearn dataset	Long-and short-term memory (LSTM) with parametric bias (PB)	66.7% accuracy
Fake smile detection using linear support vector machine [8]	ChaLearn dataset	SVM	86% accuracy
Differentiating spontaneous from posed facial expressions within a generic facial expression recognition framework [9]	Google images	SVM	57% accuracy

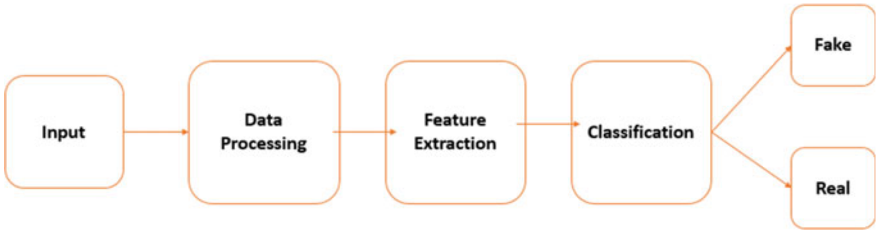

Fig. 1 Workflow diagram

3.2 *Pre-processing*

Only our own created dataset is pre-processed [to improve the dataset's robustness]. Other datasets images have already been pre-processed. This is an important stage in which we remove noise from the image and enhance the features, but before we begin, we convert our images from RGB to grayscale. The following are the reasons for converting an RGB image to grayscale:

(a) Fake Smile (b) True Smile

Fig. 2 Example of labelled smile

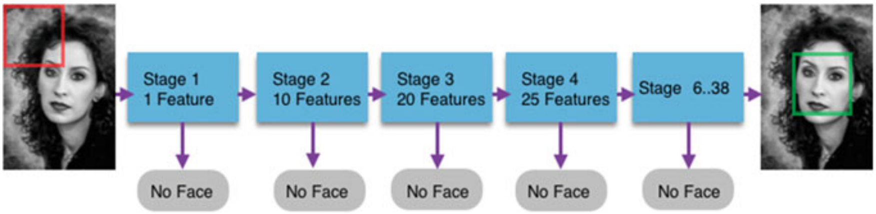

Fig. 3 Face detection

Grayscale images are much easier to work with in a variety of tasks; a single-layered image (Grayscale image) is much easier to work with than a three-layered image (RGB colour image).

Face detection is necessary so that the model only learns the required features and the irrelevant features are removed from the images. The Viola-Jones HAAR Cascade Classifier is the most commonly used algorithm for detecting faces in input images. Classifiers are used to recognise objects in images. Face detection is determined by the number of HAAR features and sliding windows (increases a number of stages increase). The Viola-Jonas Method is divided into 38 stages. Face detection can occur at various stages depending on the size of the sliding windows and the location of the face, as well as the number of features (Fig. 3).

3.3 *Feature Extraction*

Load annotated original labelled images to extract faces, select images found online (real smiles and smirks), then store the faces in two arrays (one for real smiles and another for the fake) separately (true and false) two other folders. While extracting eyes and mouth, only load previously saved face images (same order as loaded above). Source image, detected faces, eyes, mouth can correspond to each other), select eyes, and generate two arrays from the extracted eyes, and do the same to extract the mouth. For all arrays generated, we also add labels to them such that features extracted from fake smile images have label of 1 and the rest 0. In short, from feature extraction, we should have six sets of data (fake smile faces, true smile faces, fake smile eyes, and so on) for training the fake smile detection models plus testing them.

3.4 Convolutional Neural Network

Our model uses various nets of CNN to analyse and select the best net to develop the standard model. Convolutional neural networks (CNN/ConvNet) are a class of deep neural networks that are frequently employed in deep learning to interpret visual data. Matrix multiplications come to mind when we think of neural networks; however, ConvNet does not operate in this way. It uses a process called convolution. A mathematical technique called convolution takes two functions and produces a third function that expresses how the shape of one is changed by the other.

Any model contains the following seven layers training steps in any net of the CNN architecture:

(1) **Input layer**

An image input layer is responsible for sending images to a network. The row vector of integers [*h w c*] is used to specify the size of the input data, where *h*, *w*, and *c* stand for the height, width, and number of channels, respectively. Use a vector with $c = 1$ for images that are in grayscale. For RGB images, specify a vector with *c* equal to 3.

(2) **Convolutional layer**

Convolutional filters are applied to the input through with a convolutional layer. By moving the filters horizontally and vertically along the input, computing the dot product of the weights and the input, and then adding a bias term, the layer convolves the input.

(3) **RE-LU layer**

A ReLU layer performs a threshold operation on each input element, where any value less than zero is set as zero.

This operation is equivalent to

$$f(x) = \begin{cases} 0, x < 0 \\ x, x \geq 0 \end{cases}$$

(4) **Pooling layer**

When a pooling layer is added to a model, it reduces the dimensionality of images by reducing the number of pixels in the output of the previous convolutional layer. This, in turn, reduces the computational complexity. In order to extract the most extreme features, max pooling is preferred. Because average pooling counts everything and returns an average value, which may or may not be significant for object detection tasks, it cannot always extract useful features.

(5) **Batch normalization layer**

A training method for very deep neural networks called batch normalization standardizes the inputs to each mini-batch. As a result, the learning process becomes more stable, and deep neural networks can be trained with a significant decrease in the number of training epochs.

(6) **Dropout layer**

Dropout is a training method in which a random subset of neurons is turned off. At random, they are "dropped out". This means that any weight updates are not applied to the neuron on the backward trip, and their contribution to the activation of downstream neurons is erased in time on the forward pass.

(7) **Fully connected layer**

A fully connected layer is simply a feedforward network. The network's final layers are fully connected layers. The input to the fully connected layer is the output of the final pooling or convolutional layer, which is flattened and then fed into the fully connected layer. The output of the final (and any) pooling and convolutional layer is a three-dimensional matrix, which can be flattened by unrolling all of its values.

4 Evaluation

Folders containing different images of fake faces, eyes mouth and similarly for true faces, eyes and mouth for any particular emotion to be trained and tested. And among these folders, some considerable amount of data is taken for testing (Figs. 4 and 5).

4.1 Validation of the Best NET

Depending on the number of times the seven layers of CNN are repeated, the model will be classified as the following NETS.

Fig. 4 Real images folder for testing the proposed model

Fig. 5 Fake images folder for testing the proposed model

(i) LeNet
(ii) AlexNet
(iii) ResNet
(iv) VGGNet

4.2 Standard Model for Fake Emotion Detection

On analysing all the four nets keeping the classifier constant (Softmax classifier), the net which gives the highest accuracy is used to develop the standard model.

Train and testing using four NETs–

(i) LeNet

- The model comprises five layers with learnable parameters, three convolution layers, two average pooling layers, two fully connected layers, and a softmax classifier.
- The input to the model is a grayscale image.

(ii) AlexNet

- The Alexnet has eight layers of parameters that can be learned.
- The model is composed of five layers, the first of which is a max-pooling layer, followed by three fully connected layers, and each of these layers, except the output layer, uses Relu activation.
- It made use of two dropout layers. Softmax is the activation function used in the output layer.

(iii) ResNet

- The fundamental breakthrough with ResNet was that it enabled us to successfully train extremely deep neural networks with 150 + layers.
- Training very deep neural networks was difficult prior to ResNet due to the problem of vanishing gradients. The concept of skip connection was first introduced by ResNet.

(iv) VGGNet

- VGGNet-16 has 16 convolutional layers and is appealing due to its very uniform architecture.
- It, like AlexNet, has only 3×3 convolutions but a large number of filters.

5 Result and Discussion

CNN recognises the facial emotion of a person; the model classifies emotion as real and fake.

İn this, four CNN nets, namely, LeNet, AlexNet, ResNet, and VGG were used to analyse.

- LeNet—the result of LeNet with two convolutional layers and 50 epochs with a training accuracy of 58% and test accuracy of 50%.
- AlexNet—the result of AlexNet with five convolutional layers and 50 epochs with a training accuracy of 69% and test accuracy of 70%.
- ResNet—the result of ResNet with 13 or more convolutional layers and 100 epochs with a training accuracy of 98% and test accuracy of 96%.
- VGGNet—the result of VGGNet with 13 convolutional layers and 10 epochs with a training accuracy of 81% and test accuracy of 80%.

From the above observation, we can conclude that ResNet yields the highest accuracy and it can be adopted for our model (Table 2).

Table 2 Various networks with train and test accuracy

CNN networks	Train accuracy (%)	Test accuracy (%)
LeNet	58	50
AlexNet	70	69
ResNet	**98**	**96**
VGGNet	81	80

Bold significance is the ResNet which is producing high accuracy compared to other 3 Nets

The model gives 98% of training accuracy and 96% of testing accuracy for Fake emotion detection using the dataset that was created by us for testing using ResNet with 100 epochs.

6 Conclusion

By using the compiled dataset of images with added labels, we successfully detected faces, eyes, and mouths which we then use individually to train numerous CNN models, and then determined the final predicted label of an input image by majority voting (among three feature models) (among three feature models). CNN network architectures such as LeNet, ResNet, VGGNet, and AlexNet were also investigated. We found out that using ResNet and the whole face as input data leads to the most accurate result. Hence, we developed our standard model with 96% accuracy for fake emotion detection using ResNet with 100 training epochs for the dataset considered.

When the faces, eyes, and mouths features are extracted from the original input pictures, CNN's with appropriate network structure be capable of distinguishing fake smiles from true ones, which is significant because it represents a further advance in the capability of machines in the already rapidly evolving machine learning-oriented world. Our findings show that there is no limit to what computers may accomplish if they are given enough high-quality data to train on and that civilization will thrive as additional machine functions are uncovered. Further, the work can be extended on other emotions and discriminate between fake or real.

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Clean Room System for Malware Analysis

Duong Tuan Anh, Bui Trong Vinh, Phan Truong Lam, and Phan Duy Hung

Abstract This research is used to consolidate and standardize a centralized anti-malware approach, helping the malware analysis team have a total solution that makes malware investigation and analysis simpler through thereby tracing the source of the malicious code. By aggregating the world's leading solutions as well as some self-developed solutions, it provides the most efficient centralized malware detection, analysis, and treatment. The solution will divide the malware analysis team into two different teams. Each team will have a different specific mission. The first team will be provided with toolkits to research and analyze malicious code and clarify the harmful effects of malicious code affecting the system. The second team will be tasked with receiving analytical information from team one and using that information to find the source of malicious code on a number of network intelligence sources through which to find solutions to deal with malicious code, identify the source of malicious code, and identify hacker group is attacking the organization. The teaming and provision of these solution-specific tools will provide a complete process for the organization's malware research team to have a malware handling process as well as useful tools for analysis, handle, and find the source of malicious code.

Keywords Clean room system · Malware analysis · Malicious Code Analysis

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1 Introduction

Infiltrating, stealing information, and cyber warfare is an existing trend in recent years. Infiltrating cyber espionage is the most effective method in the history of war. This method gathers secret information deep within the enemy organization with almost zero risk of human life. Because of this, the trend of using malicious code as a destructive attack tool, a tool to collect information is becoming more and more popular, from competition between large corporations, governments, and cybercriminals.

Currently, most malware is designed to target predefined targets, which can be an individual or an organization. For that purpose, malicious code is designed to be concealed for as long as possible, and then it carries out its purposes of sabotage, information theft or espionage, with the assurance that if the current attack fails, the attacker can use that malicious code for another attack at a later time with a different form or approach. Furthermore, with that in mind, when designed, the malware has been tested to bypass most anti-virus programs available.

Among the analyzed malicious code, one also noticed a sophisticated improvement trend in data theft—one of the important purposes of malicious code. The method used by the malware must ensure that the stolen data is not intercepted or detected, but still maintain confidentiality, which requires the attacker to use common protocol channels (e.g., transmissions) through free file sharing services, commonly used chat services, etc.) as well as encrypting data sent and received. The targets of recent malicious code may include military, political or economic intelligence gathering, disrupting operations, or destroying industrial equipment. In Vietnam, companies or offices use two main network models, as shown in the Fig. 1:

- A network connected to the Internet to exploit information, exchange data, and deploy Internet-based services.
- Intranet without Internet connection.

These systems have been initially invested and equipped with basic anti-malware, network attack, and information loss prevention solutions. However, with the continuous development of malicious code, especially targeted attack malware (APT), Therefore, basic anti-malware solutions are not enough.

Before attacking, hackers will penetrate software into the enemy target to investigate the security and network infrastructure of that organization. Moreover, the attack tools that hackers use are tested to bypass these security infrastructures before being used.

Most agencies and organizations do not have a specialized network security unit, nor have they invested properly in technical infrastructure to support the investigation and analysis of APT attacks. There is no system to connect knowledge from organizations and malware analysts around the world to evaluate analysis results and trace the origin of attacks.

In the fight against APT attacks, the human factor is very important. Through training to help users avoid being scammed or taken advantage of to install and

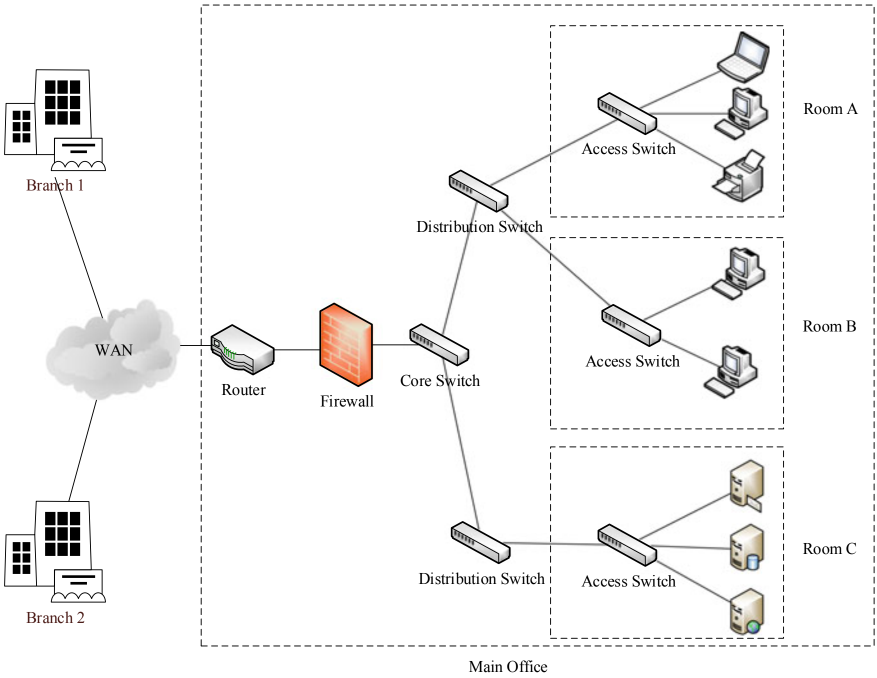

Fig. 1 Popular network model in organizations in Vietnam

distribute malicious code; or need experts to investigate, analyze, remove malware, assess and mitigate damage. However, most units still lack officers, malware analysts, and cyber attack investigation specialists.

Assessing the situation

- Most organization and units have not yet been equipped with a specialized malware analysis support system to respond effectively to information system security risks.
- The level of information technology of officers and employees in charge of information technology is not uniform. Many organization and units do not have a main officer in charge of information security.
- There has not been a close and consistent coordination between agencies and units at all levels to build protection systems and processes using highly automated information technology system.
- The demand for information exchange via USB and email is increasing, but there are no specific and comprehensive measures to ensure information safety and security.
- There is not yet a separate area to analyze and research malicious code to have a timely response to localize processing, minimize damage, and remove malicious code from the system.

- For the attacks that have happened, there is no place to store and compare the types of malicious code encountered to create a data warehouse, a common mining knowledge store.
- There are no intelligence documents on the types of malicious code and the origin of the malware encountered.

Because of the above issues, organization agencies, and units need to properly invest in infrastructure and a team of experts to defend against cyberattacks and react immediately if they detect an agency being attacked. Whether this response is implemented well and effectively depends on many factors, in which the element of quick and timely malware analysis plays a prerequisite role.

The purpose of the analysis is to provide the information to verify and respond to intrusions. Once the malicious code is analyzed, the unit will be able to locate the infected area, the type of affected device, and then have a plan for isolation and handling. In addition, the analysis also helps determine the cause of malicious code infection, helping to overcome and prevent similar attacks in time. At the same time, it helps to investigate and trace the origin of the attack, verify the attack organization, prevent insider as well as assess the damage, assess the extent to which internal documents have been lost.

In addition, the data obtained through surveys, analysis, and traceability is an extremely valuable store of knowledge that needs to be stored to exploit, learn from, and train the next class of officers. At the same time, helping the unit quickly have an optimal plan when facing similar attacks. This is an important factor to minimize the damage caused by malicious code without disrupting the information system. To solve the above problems, we propose clean room system for malware analysis to support the organization's information security experts in both process and analytical tools with a standard of security and absolutely secure information.

With the analyzed information, the unit's experts will come up with a plan to be able to prevent and completely destroy malicious code from the computer and network system; restore the status quo of the network to its original state; and trace the source of the attack of the object.

2 Related Works

The analysis of malicious code as mentioned above is a burning problem for the whole world. There has been a lot of controversy about whether malicious code analysis is inside the executable system (Internal analysis) [1] or outside the executable system (External analysis) [2]. But until today, the analysis outside the executable system is being used more by researchers with the advent and development of virtualized system [3]. With virtualization, external analysis tools possess higher privileges than malware. Therefore, the tools will not be compromised by malware, given two assumptions. One is that the hypervisor is immune to malware. Another thing is that the operating system during initialization is trusted.

There are many types of software as well as tools offered to serve the analysis of malicious code, and in which there are two main types of analysis: dynamic analysis and static analysis [4, 5]. Among which static analysis is the most popular method for malware analysis. It is done by analyzing the malware without actually running the malicious code. While in dynamic analysis the actual malware sample is observed to behave when running the sample in a generally controlled environment (in a virtual machine).

For static analysis with complex viruses, it is very difficult to read and understand its executable code and requires a certain level of skill for analysts; however, this method gives the analyst a very precise view of what it does.

Dynamic analysis method has the advantage that the analysis process takes place faster and easier [6, 7]. However, not all behaviors can be analyzed; for example, when viruses detect the analysis tool, it will no longer work, or the virus will wait until a certain time to work. Therefore, when analyzing malicious code, it is necessary to combine the two methods above to achieve the best effect.

Analysts will normally use these two methods to analyze malicious code samples to learn about its execution method and find ways to remove and prevent it, but there is one thing that is equally important: the classification of malicious code [8] and finding the source of the hackers who attacked. It is not an easy task, but it takes a fully equipped organization in terms of technology as well as a lot of cyber intelligence [9] from around the world to be able to do this. In addition, the collection and storage of malicious code samples, creating a malicious code execution environment, and generating reports are also things that analysts face.

However, in organizations, malware analysis is not appreciated as well as malware analysts do not have enough tools and processes for them to do their job well. We found that agencies and organizations in a number of important sectors have not invested enough in malware analysis systems, which are the conditions for analysts to build processes to deal with different types of malware.

That's why we suggest the solution "clean room system for malware analysis". This is not only a systematic solution, but also comes with a closed process, from sample collection, analysis, storage, traceability, and report generation.

3 Methodology

Solution clean room system for malware analysis in which there are many different software components of the system and is divided into two main areas, as shown in the Fig. 2.

Each area is made up of many different software and hardware devices, each of which we have selected, evaluated, and compared with a number of similar software and devices.

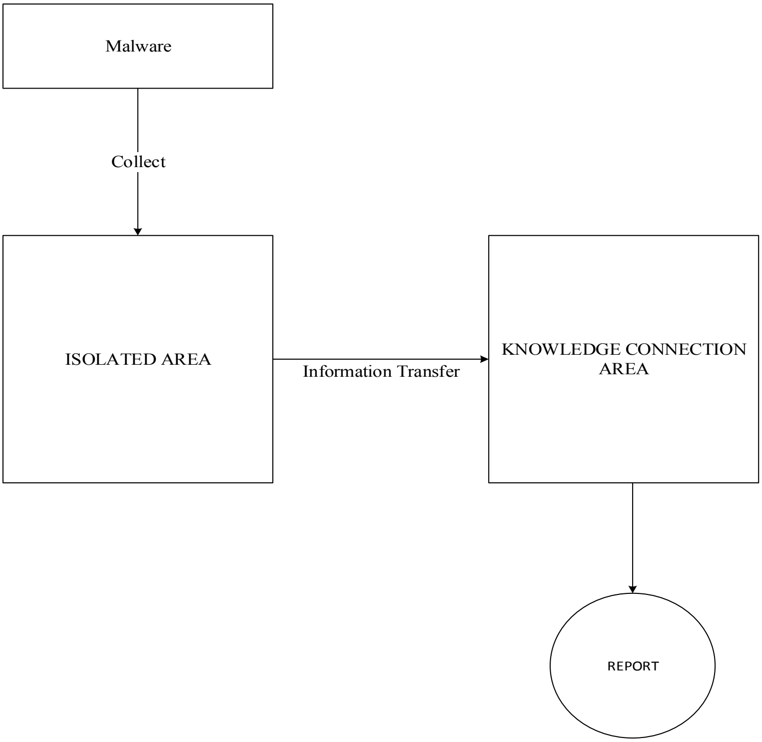

Fig. 2 Working process of clean room

3.1 Isolated Area

What's special about this area is that it is an area inspired by sterile clean rooms that minimize the entry and exit of airborne particles, while controlling other relevant room parameters such as temperature. Temperature, humidity, and pressure as needed. However, according to this solution, a clean room is simply a room that does not have any connection (internet, LAN, WAN, Wi-FI, …) but only a single LAN connection between devices in the room. The entire area, not only that, but this area must be covered with a material that separates mobile waves as well as Wi-Fi waves to ensure 100% that there is no connection to the outside network. This is to ensure the virus is not spread to the outside and prevent hackers from attacking in any way. The mission of this area is to receive malicious code samples, copy, archive, analyze, find ways to process, and transfer information to the knowledge connection area using only a single computer to transmit information out through a one-way firewall. Software and hardware devices for the isolated area is listed in the Table 1.

Table 1 Software and hardware devices for the isolated area

Software/hardware	Function	Similar software
Vmware Vsphere	The central virtualization system is used to store and create virtual machines for malware analysis	Hyper-V, virtual box, OpenStack, etc.
Ninja Demi (Hardware)	Make copies of hard drives, USB containing malicious code	DiskClon
Cyber Triage	Digital forensics tools to analyze and investigate security risks and malicious code on computers and hard drives	Volatility
VFC	Tool to reconstruct the scene from hard drive, hard drive image to virtual machine	
FakeDNS	Software to create a virtual network connection without connecting to the outside network	ApateDNS
Wireshark	Network packet analysis software	TCPDump, NetworkMiner, etc.
IDA	Static malware analysis software	Radare
Kaspersky research sandbox	Dynamic malware analysis software	VmRays, cuckoo sandbox, etc.

3.2 Knowledge Connection Area

This is the area after receiving information about malicious code samples analyzed in the isolated area, they will proceed to use the network detection tool to find the source, classify the malicious code, and finally generate a report. Software for the knowledge connection area is listed in the Table 2.

Table 2 Software and hardware devices for the knowledge connection area

Software/hardware	Function	Similar software
Kaspersky threat attribution engine	Software to find the source of malicious code	
Kaspersky threat intelligence (service)	Cybersecurity intelligence service	InTsights, threat fusion, etc.
Malware information storage software (Self development)	Software to manage information on analyzed, unanalyzed malicious code samples and generate reports	

4 Experiments and Results

Malware analysis is an important step in preventing and completely removing malicious code from computers and networks; restore the state of the network to its original state; trace the source of the attack. During malware analysis, we need to determine exactly what malicious code can do, how to detect malicious code in the network, how to measure the damage it can cause. And most importantly, to find specific rules (Identifier—signature) to identify malicious code, remove malicious code and restore the system.

With a clean room system that analyzes malware, when taking samples of malicious code, experts will analyze it according to a closed process. They will be supported to find the specific rules of that malicious code (Signatures) to be able to identify get them.

Malware has two main identifiers:

- Server-based signatures: These are identifiers used to detect malicious code on a computer.
- Network signatures: These are identifiers used to detect malicious code when monitoring the network.

In the isolation area, malicious code will be distributed into a secure environment (cannot spread within the organization's network), and analysts will use static and dynamic analysis tools to analyze and accumulate them. In addition, with this secure environment, analysts can completely find out the IP address of the hacker that the malicious code connects to. Through a variety of tools, analysts can learn the genetic code of this malicious code and how it affects the system. With dynamic analysis tools (Cyber Triage, Kaspersky research Sandbox, etc.) and static analysis tools (IDA Pro), analysts can analyze most of the popular malware types today.

With the malware characteristics and IP address to which the malware connects analyzed from the Isolation Zone, the analysts will take it to the Knowledge Connection Zone to find information by using threat intelligence sources (Kaspersky Threat Intelligence and Kaspersky Threat Attribution Engine). So that analysts can determine which organization this malicious code was distributed by, when it was distributed, how it was handled, etc. The analysts can then generate reports and store the analyzed malware on a centralized system.

We believe that this system can be of great help to analysts in the prevention and traceability of malware. Because this system is based on the best tools available today. Here we give some results of malware analysis of some tools introduced in this system:

Cyber Triage: computers that are suspected or confirmed to be infected with malicious code when run with the Cyber Triage tool, will be scrutinized each file to find out which files are suspicious or infected files. With the use of this tool, it is guaranteed not to let any infected files slip through as shown in the Fig. 3.

Kaspersky Research Sandbox: for files that are unknown or cannot be identified as malicious or not, we can put them in a Sandbox environment for evaluation (Fig. 4).

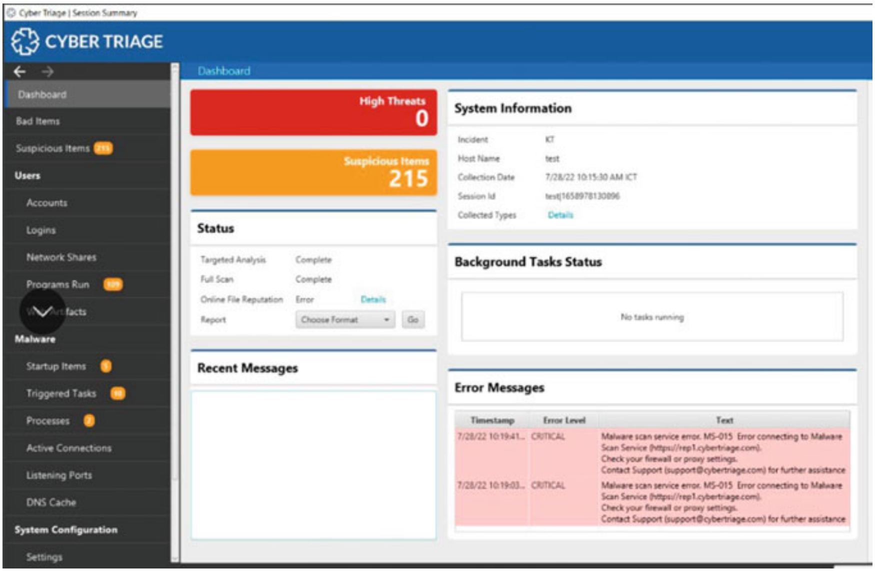

Fig. 3 Scan result by cyber triage

Kaspersky Threat Attribution Engine: if there is information about malicious code, the next thing to do is to find out which team of hackers wrote that malicious code with the Threat Attribution Engine tool. This tool will compare the gene of the malicious code and then evaluate the percentage of which malicious code belongs to which hacker group as shown in the Fig. 5.

The results we give here to prove the capacity of each software in this system. However, we believe that by combining all of the above reliable tools, analysts will have a perfect set of tools for malware analysis, evaluation, and investigation.

5 Conclusion and Future Works

This study provides a recommendation for cleanroom systems to analyze malware, including components from the isolation to the knowledge connection. For all the solutions, the tools we put into this system are tools that we have used and tested many times. If only one area or tool in the solution suite works independently, it will not be able to produce the results desired by the malware analysts, it must follow the process we recommend. Because of that, the research we propose is not only a system but it is also a standard malware handling process that we offer, for malware researchers in Vietnam or around the world. Could consider including it in their system. We hope that it will be more and more improved in terms of solutions in

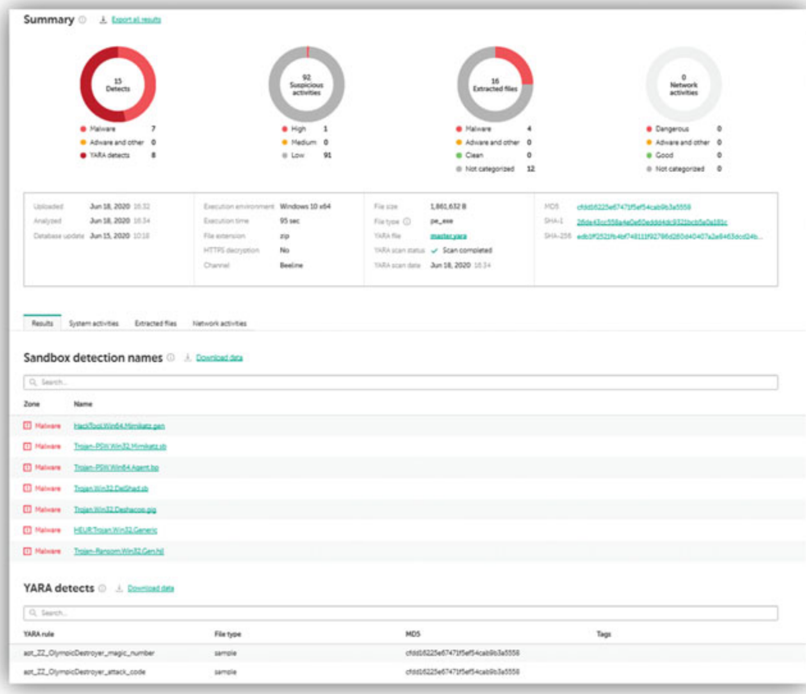

Fig. 4 Analysis results using Kaspersky research sandbox

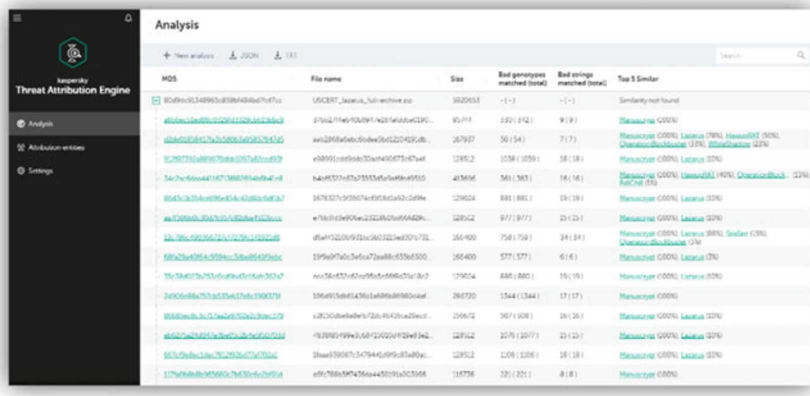

Fig. 5 Search results using Kaspersky threat attribution engine

the future. However, at the moment, we think this is a solution that includes the best tools.

In future developments, we would like to expand the application of this technology to malware analysis systems at large government organizations. In addition, we expect that officers who are performing malware analysis need to add the necessary knowledge to be able to meet all the jobs related to malware analysis that require an extremely deep understanding of malicious code, behavior as well as about these types of cybercriminals. The proposed solution can be applied in building information systems [10, 11] or can be combined with other information security solutions [12, 13].

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Quantitative Assessment and Prediction of Ocean Plastic Motivating Actions to Mitigation

Sharmila Sengupta, Manasvi Patwa, Varnit Batheja, Bhavika Chattani, and Sahil Deshmukh

Abstract Plastic debris has been piling up on dumpsites and is finding its way into the oceans as a result of widespread usage of plastics and inadequate waste management procedures, therefore adding to the global problem of ocean plastic pollution. There has not been a comprehensive assessment of the amount of plastic that enters the ocean through the Indian riverine system. Evaluation of natural elements such as river flow, rainfall, and a variety of other factors like population, harbor activities, climate change, wind speed, amount of fishing, etc., have made quantitative measurements of river plastic difficult and cumbersome. In this paper, we aim to attain a sustainable development goal (SDG13) on climate action through the "Microsoft AI for Earth" grant under project id AI4E-2245-K6x8-21,100,305. Plastic waste generated by the major rivers of India is calculated for the past 10 years to develop a machine learning model for the prediction of the amount of plastic waste contributed by the Indian rivers to the ocean over the next five years.

Keywords SDG · MSW · Ocean plastic · Microplastic · Fishing

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1 Introduction

Plastics are designed to be thermal and electrically insulant, durable, strong, and economically affordable because of which they have widespread applications. Global plastic production has reached 367 million tons in 2020, and is estimated to double in the next two decades. Plastic has been recognized as one of the major pollutants in India. It is the most prevalent type of marine debris found in our rivers and ocean. Plastic debris can come in all shapes and sizes, but those that are less than five millimeters in length are called microplastics. The main contributors of these microplastics are mismanaged plastic waste, wastewater discharge, inland navigation, industrial activities, river transport, beach littering, and they are also available directly at sea via aquaculture, shipping, and fishing activities.

The river acts as a carrier of plastics and microplastics and transports significantly large quantities into the water systems. The river's water is widely used for drinking and irrigation, and its quantity raises the potential harm to species and humans. Toxicity is caused by a variety of pathways and mechanisms. The polymeric components and additives used in the manufacture of plastics, such as.

Copper ions are poisonous, and microplastics absorb these toxins in the water and desorb inside a host organism. Entanglement due to fishing poses danger to species in the Ganges which is mainly due to the gears such as plastic rope and netting. It also induces surrounding or squeezing of marine animals. Plastic ingestion by mistake can have a variety of health consequences, including reduced stomach capacity, which can lead to a loss of appetite and a false impression of satiation, obstruction or perforation of the gut, inflammatory lesions, or gastric rupture often resulting in death.

Microplastic has emerged as a key pollutant recently. The larger plastic debris on land disintegrates forming microplastics which flow into the ocean. India ranks among the top 20 countries contributing this plastic waste into oceans. According to the Central Pollution Control Board (CPCB), 3.5 million metric tons of total plastic waste was generated in India during the year 2019–2020. In this paper, a study and assessment of the abundance of microplastic in Indian rivers and oceans are carried out. It also aims to provide a visual representation of this assessed data and build a ML model to predict the abundance of microplastics for the next five years.

2 Related Work

A mention of providing a rigorous attention to microplastic pollution in India's water sources [1], is made. This study aimed at reviewing the scientific literature related to microplastic (MP) pollution in various environmental matrices in India and highlighted the research gaps for future research priorities. Currently used methods for sampling, extraction, identification, characterization, and quantification of microplastics were assessed.

In Das et al. [2], a study provides a descriptive picture of marine plastic pollution in India and the consequent future if no or limited action is taken. Stakeholder discussions and projections from secondary data had been used to arrive at the findings.

A model was calibrated against reported microplastic concentrations from river surface waters in [3]. This model used geospatial data of population density, rates of mismanaged plastic waste (MPW) production per inhabitant, and monthly catchment runoff, as well as the presence of artificial barriers (for example, dams and weirs).

The approach in [4] has included geographically distributed data on plastic waste and calculates the probability of waste reaching rivers and, subsequently, to oceans. This probabilistic approach highlights regions that are likely to emit plastic into the ocean.

In Robin et al. [5], a study is attempted to ascertain the abundance, distribution, and characteristics of microplastics in coastal waters (14 locations), beach sediments (22 locations), and marine fishes (11 locations) from the state of Kerala, southwest coast of India. The results showed that the mean microplastic abundance was 1.25 $\pm$ 0.88 particles/m^3.

3 Research Methodology

The past data on Indian riverine plastics are not readily available on the Government websites, research journals, or news blogs. They are usually presented in a consolidated manner due to some experiments conducted on certain rivers on a sample basis; other features contributing to ocean plastics are not considered for the evaluations. Data available in quantitative, qualitative, and verbal forms were mostly erroneous in nature.

Therefore, a variety of research papers and news articles were studied, and a substantial amount of data was gathered either through calculations or through estimations suggested by the referred papers.

After pre-processing, the dataset was then divided into two sections, one for the north and one for the south of India. It was then segregated further into land and ocean plastics. Because the data on plastic was discovered in a variety of units, it was converted into a single common unit of concentration (MPs/m^3). The amount of plastic waste discharged into the sea/ocean is determined with the help of the municipal solid waste generated as shown in eq. 1. It indicates that the plastic waste is calculated by multiplying the Municipal solid waste by the percentage of plastic waste present in it which is 3% to obtain the volume of plastic waste being generated.

$$\begin{aligned} \text{Lower Limit} &= \text{MSW} * 0.03 * 0.87 * 0.15 \\ \text{Upper Limit} &= \text{MSW} * 0.03 * 0.87 * 0.40 \end{aligned} \tag{1}$$

Table 1 Plastic accumulation due to wind-speed

States	Year	Wind_speed	Plastic_entering_sea
		kmph	TPA
Andhra Pradesh	2020	27.1	25,292.96
Assam	2020	13.05	18,326.33

Table 2 Plastic pollution due to natural calamities

States	Year	Natural_Calamities	Plastic_entering_sea
			TPA
Karnataka	2019	1	23,465.67
Kerala	2019	1	9145.44

The result is then multiplied by the proportion of mismanaged plastic waste, which is 87% to obtain the volume of mismanaged plastic waste. About 40% of mismanaged plastic waste gives the upper limit of plastic waste going to the sea, whereas 15% gives the lower limit. There are various factors leading to ocean plastic pollution, which are discussed below.

A. **Wind Speed**

About half of all plastics produced are lightweight, single-use products and packaging materials, many of which are inappropriately discarded after usage. These plastics are gradually washed away by rain and mild winds, ending up in sewers, rivers, and oceans.

According to research, such minute minuscule shards can float for days, posing a risk to human life. Since microplastics are both lightweight and durable, they will eventually replace the plastics that are presently contaminating our oceans in the air (Tables 1 and 2).

B. **Natural Calamities**

Following a natural catastrophe, such as flooding or cyclones, a community must cope with a number of challenges, including property destruction, financial loss, and personal injury or sickness. One of the most daunting of them is the waste and debris left behind after major disasters. According to a 2019 study, when a hydrogeological event (such as a flood or landslide) strikes an urbanized area, it can generate between 5 and 15 times the yearly waste creation rates.

C. **Covid 19**

Plastic pollution has risen as a result of the spike in demand for plastic products such as PPE kits, exacerbating an already out-of-control problem. More than eight million tons of pandemic-related plastic garbage were generated globally, with over 25,000 tons ending up in the ocean, majority of which comes from hospital medical waste. A study found that as a result of the COVID-19 outbreak, roughly 3.4 billion single-use facemasks/face shields are discarded every day around the world, most of

Table 3 Plastic generation during pandemic

States	Year	Covid _19	Plastic_entering_sea
			TPA
Goa	2020	22,108,098.45	25,292.96
Gujarat	2020	19,828,696.35	18,326.33

Table 4 Plastic generation due to harbor activities

States	Year	Harbour_Plastic	Plastic_entering_sea
			TPA
Karnataka	2017	43.31	36,387.30
Kerala	2017	47.80	14,600.52

which have been dumped into the terrestrial environment, causing a surge in plastics washing up on ocean shores and fouling the environment (Tables 3 and 4).

D. **Presence of Harbors**

A study from a 2014 research paper found small pieces of plastic measuring less than 5 mm in each of the surveyed sites along the harbor's length. The researchers discovered 60 to 100 plastic particles per 100 ml of wet harbor sediment, which was highly concerning. These plastics are small enough to be consumed by 96% of the world's animals, invertebrates, and then passed on to fish and larger animals. Plastic fibers not only have the potential to clog fish guts, but they also release toxins absorbed by the plastic after it is released into the environment.

E. **Fishing**

Fishing has recently been identified as a major contributor to the rise of plastic pollution. Fishing entanglement risks to species in India's rivers are caused by plastic rope and netting, which further causes choking of marine animals. Reduced stomach capacity, which can provide a false sense of satiety, obstruction, or gut perforation are just a few of the health effects of ingesting plastic. This can ultimately lead to death. Data on the amount of fishing done in each state comes from the fisheries department's recent studies and reports.

The area of the country, the length of the peninsular coastline, the Exclusive Economic Zones, and the amount of fishing can all be used to compute the amount of plastic generated. Exclusive economic zones are areas with a higher concentration of economic activities; hence, areas with a thriving fishing industry have a significant economic impact (Tables 5 and 6).

F. **MSW**

Municipal solid waste (MSW) management is inefficient, and plastic waste recycling is not a common practice in India. Annual reports from 35 State Pollution Control Board (SPCB)/Pollution Control Board (PCB) were used to compile the

Table 5 Plastic pollution due to fishing

States	Year	Fishing_Inland	Fishing_Marine	Plastic_entering_sea
		Lakh Tonnes	Lakh Tonnes	TPA
Kerala	2016	1.61	4.31	12,748.55
Lakshadweep	2016	0.00	0.30	133.37

Table 6 Effect of MSW in ocean plastic

States	Year	MSW	Plastic_entering_sea
		TPA	TPA
Uttarakhand	2015	334,705	3494.32
West Bengal	2015	4,366,282	45,583.99

MSW data. However, the data supplied is insufficient because many Indian states fail to register the amount of MSW discharged on a regular basis. In addition, there is a lack of cooperation between UDDs, ULBs, and SPCBs, as well as other organizations involved in reporting the amount of MSW created. It is also important to note that the scientific processing of MSW increased from 18 to 70% when the Swachh Bharat Mission-Urban was launched.

G. **Beach Plastic**

Thousands of tourists visiting Indian beaches each year. Hotels and small-time vendors operating near the beaches contribute to plastic waste such as single-use carry bags, polyethylene terephthalate (PET) bottles, packing materials, styrofoam food wrappers or containers, straws, and plastic tea cups, resulting in beach litter. Plastic and other non-biodegradable synthetic materials that are wasted fall into the sea. It eventually makes its way to the ocean, where it does not degrade and remains suspended in the water. Despite this, no comprehensive research of beach trash in the country has been conducted (Tables 7 and 8).

H. **Population**

Countries continue to emulate the habits of industrialized countries, consuming more and more plastic materials, and their indiscriminate disposal polluting the terrestrial ecosystem, as well as causing pollution, entanglement, and death of aquatic organisms at an alarming rate.

Table 7 Concentration of plastic in beaches

States	Year	Beaches	Plastic_entering_sea
		kg	TPA
Andhra Pradesh	2014	19,034.2	128,480
Goa	2014	1563.22	104

Table 8 Effect of population on plastic pollution

States	Year	Population_urban	Population_rural	Plastic_entering_sea
		Persons	Persons	TPA
Andhra Pradesh	2012	18,343,000	34,256,000	243,820
Assam	2012	29,492,000	5,301,000	1116

According to a 2010 research, each person produces roughly 0.01 kg of plastic garbage per day, resulting in a total waste of around 503.7 crore every year. This demand from developing countries is a major driving force in the plastics industry.

I. **Rainfall**

Large plastic waste (macroplastics) leaking into the ocean is a serious environmental issue. Coastal cities account for a considerable portion of this leakage, particularly during high rainfall events. Because the amount of plastic waste produced is mostly determined by the temporal variability of rainfall, its distribution across the year, and the presence of pre- and post-monsoon changes. The data presented in study publications isn't always reliable. Increased heavy rainfall events are likely to put strain on our current water management systems, increasing the risk of plastic spilling into the ocean (Tables 9 and 10).

The multivariate linear regression is then applied on the prepared dataset with an accuracy of 97%.

J. **Climate change**

Biodegradation or exposure to the light, heat, or water can cause plastics to break down into smaller bits known as microplastics. They are found all around the world, even in the deepest parts of the ocean. Researchers discovered plastic in the Mariana Trench, the deepest region of the ocean, 11 km below the surface, in a remote part of the Pacific Ocean. The plastic emits significant greenhouse gases as a result of

Table 9 Rainfall affecting plastic waste

States	Year	Rainfall_actual	Rainfall_normal	Plastic_entering_sea
		mm	mm	TPA
Bihar	2013	722.2	1027.6	10,794.30
Chandigarh	2013	363.3	466.3	1678.34

Table 10 Climate change versus plastic pollution

States	Year	Climate change	Plastic_entering_sea
			TPA
Himachal Pradesh	2020	1	1482.32
Assam	2020	0	4929.63

sunshine and heat, resulting in a worrisome feedback cycle. As the earth warms due to climate change, the plastic breaks down into additional methane and ethylene, speeding up climate change and so repeating the cycle.

4 Constraints

Some of the major constraints faced during the research were data set generation, unit conversion, feature evaluation, use of formula etc. Due to some of the major rivers being non perennial the plastic data on government sites is not updated constantly therefore including a number of gaps. Since the amount of plastic waste majorly depends on temporal variability of rainfall, and considering there are pre monsoon and post monsoon variations, the data found in the research papers isn't always consistent. Since riverine plastics are taken at only selected sample sites and using different sampling procedures along the course of the river, the total contribution of microplastic(MP) of that river becomes difficult to calculate. Marine plastics concentration in rivers and lakes in a fixed area are much more than oceans, so variation of MP in rivers and oceans are quite skewed and their units keep changing between MP/m^3 and tonnes. The data available is having microplastic abundance in %, tonnes, kg, MP/m^3, kg/m^3 etc. Therefore, the conversion of these units to one single unit for data comparison and processing becomes a tedious task.

5 Results

The plastic from the land disintegrates forming microplastic which gets dumped into the river or its tributaries. The river then flows these microplastics into the ocean. The refined broadranged data of the amount of plastic obtained from the research of land plastic, river microplastic abundance and ocean plastic is proportionately plotted on a heatmap as shown in fig. 1.

The larger dots show a sign of concern, where action needs to be taken to reduce plastic pollution. The purple dot represents the amount of plastic released in oceans through major rivers in tons; red dots represent microplastic abundance in rivers and their tributaries in MPs/m^3, whereas orange dot represents the amount of land plastic in tons. The eastern coast contributes to the Bay of Bengal, and there are no purple dots on western coast because no rivers are opening their mouths in the Arabian Sea. The red dots depict an abundance of microplastics in MPs/m^3 along the course of Ganga river from various sampling sites (Fig. 2).

Here, Figs. 3 and 4 explain the direct correlation between MSW and the amount of plastic entering the sea Eq. (1) (Fig. 5).

Figure 6 visualizes the amount of plastic entering sea from each state in the year 2020, and Fig. 8 visualizes the predicted amount of plastic entering sea from each state in the year 2025. Consider the example of Maharashtra, where the amount of plastic

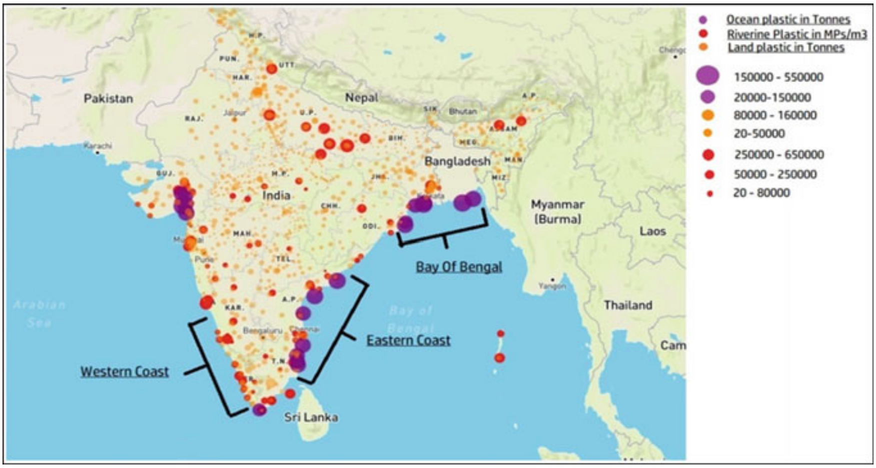
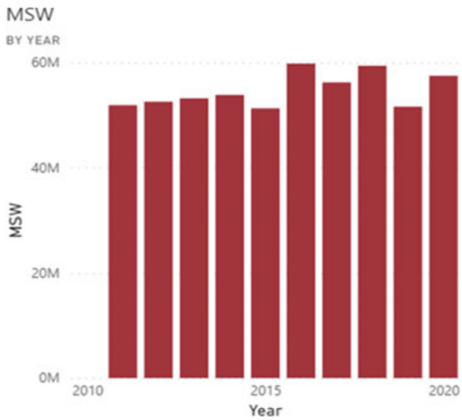


Fig. 1 Visualization of amount of riverine, land, and oceanic plastic in India for the year 2019–2020

Fig. 2 Visualization of the amount of plastic along the course of the river Ganges

Fig. 3 Visualization of MSW production over the past 10 years



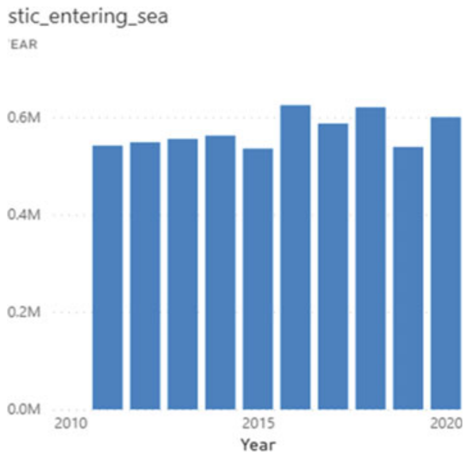


Fig. 4 Visualization of plastic entering sea over the past 10 years

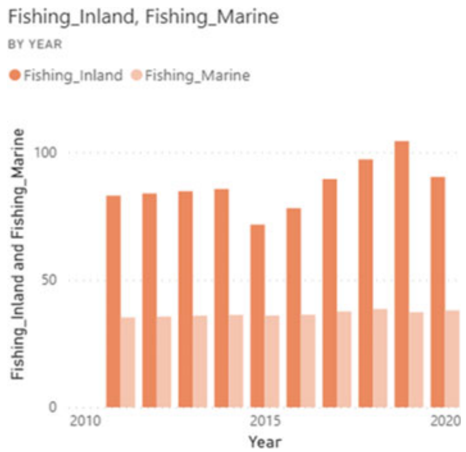


Fig. 5 Visualization of major factor—fishing—to the amount of plastic entering sea over the past 10 years

entering the sea has increased from 90.26 K tons to 93.31 K tons. This change in amount can be expected to increase depending on the factors like population growth, amount of fishing activities, occurrence of natural calamities, and many more.

Using Azure Machine Learning services, we built a multivariate linear regression model. The findings of the evaluation are shown in Fig. 7, with a 97.98 percent accuracy rate (Fig. 8).

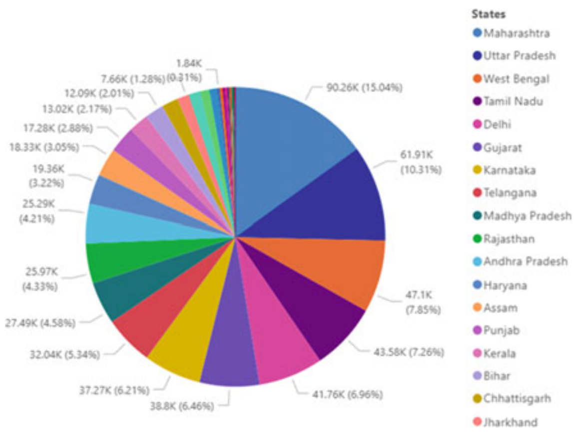


Fig. 6 Visualization of states contributing to plastic entering the sea in year 2020 (as an example)

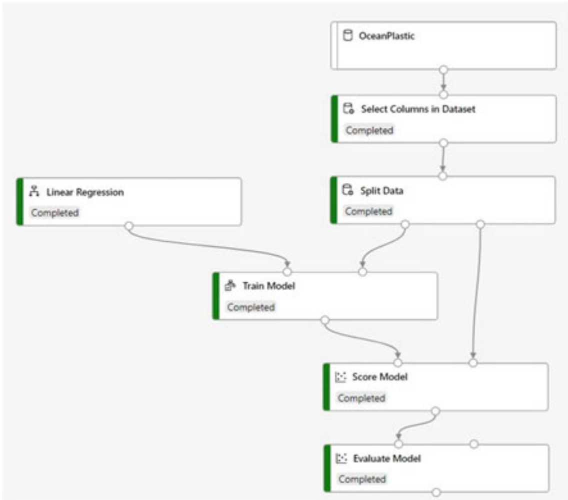


Fig.7 Regression result

6 Conclusion and Future Scope

As seen in Fig. 9, there exists a high correlation between urban population and the plastic entering sea, harbor plastics and the plastic entering sea, and marine fishing and beach plastics. Thus, in future, direct or indirect dependency of similar other features can be considered to predict the amount of ocean plastic.

This project will help to create awareness regarding poorly managed plastic waste entering the ocean through numerous channels. This will also encourage greater investigation into the issue of ocean plastic. This will eventually bring the attention of concerned authorities to the dangers of ocean plastic and encourage them to work on mitigation measures to lessen the severity of the problem.

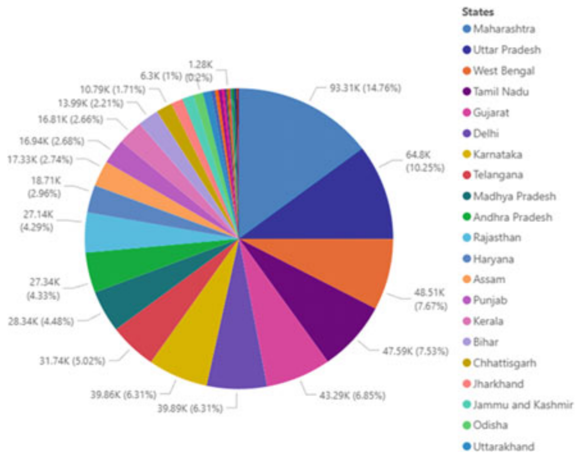
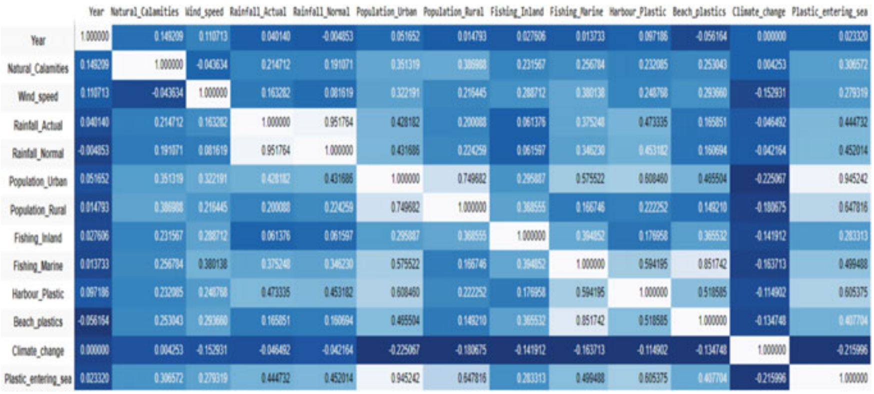


Fig. 8 Visualization of states contributing to plastic entering the sea in year 2025 (as an example of prediction)



	Year	Natural_Calamities	Wind_speed	Rainfall_Actual	Rainfall_Normal	Population_Urban	Population_Rural	Fishing_Inland	Fishing_Marine	Harbour_Plastic	Beach_plastics	Climate_change	Plastic_entering_sea
Year	1.000000	0.149209	0.110713	0.040140	-0.004853	0.051652	0.014793	0.027606	0.013733	0.097186	-0.056164	0.000000	0.023320
Natural_Calamities	0.149209	1.000000	-0.043634	0.214712	0.191071	0.351319	0.386988	0.231567	0.256784	0.232085	0.253043	0.004253	0.306572
Wind_speed	0.110713	-0.043634	1.000000	0.163282	0.081619	0.322191	0.216445	0.288712	0.380138	0.248768	0.293660	-0.152931	0.279319
Rainfall_Actual	0.040140	0.214712	0.163282	1.000000	0.951764	0.428182	0.200088	0.061376	0.375248	0.473335	0.165851	-0.046492	0.444732
Rainfall_Normal	-0.004853	0.191071	0.081619	0.951764	1.000000	0.431686	0.224259	0.061597	0.346230	0.453182	0.160694	-0.042164	0.452014
Population_Urban	0.051652	0.351319	0.322191	0.428182	0.431686	1.000000	0.749682	0.295887	0.575522	0.608460	0.465504	-0.225067	0.945242
Population_Rural	0.014793	0.386988	0.216445	0.200088	0.224259	0.749682	1.000000	0.368555	0.166746	0.222252	0.149210	-0.180675	0.647816
Fishing_Inland	0.027606	0.231567	0.288712	0.061376	0.061597	0.295887	0.368555	1.000000	0.394852	0.176958	0.365532	-0.141912	0.283313
Fishing_Marine	0.013733	0.256784	0.380138	0.375248	0.346230	0.575522	0.166746	0.394852	1.000000	0.594195	0.851742	-0.163713	0.499488
Harbour_Plastic	0.097186	0.232085	0.248768	0.473335	0.453182	0.608460	0.222252	0.176958	0.594195	1.000000	0.518585	-0.114902	0.605375
Beach_plastics	-0.056164	0.253043	0.293660	0.165851	0.160694	0.465504	0.149210	0.365532	0.851742	0.518585	1.000000	-0.134748	0.407704
Climate_change	0.000000	0.004253	-0.152931	-0.046492	-0.042164	-0.225067	-0.180675	-0.141912	-0.163713	-0.114902	-0.134748	1.000000	-0.215996
Plastic_entering_sea	0.023320	0.306572	0.279319	0.444732	0.452014	0.945242	0.647816	0.283313	0.499488	0.605375	0.407704	-0.215996	1.000000

Fig. 9 Correlation matrix for factors affecting ocean plastic

Plastic pollution is a widespread issue that is wreaking havoc on the marine environment. Every year, at least 14 million tons of plastic end up in the ocean. Plastic debris is now the most abundant type of litter in the ocean, accounting for 80% of all marine debris discovered from surface waters to deep-sea sediments. However, once the debris has degraded into microplastics, recovery becomes nearly impossible.

Controlling plastic waste from entering our oceans is the most effective solution. This is easier said than done, and it has a lot more to do with national and corporate practices than it does with the individual. Improved waste management systems, recycling processes, and a reduction in single-use plastics would all help to reduce pollution.

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Comprehensive Survey of Deep Learning Applications in the Diagnosis of Epilepsy

Amrita Ticku and Sachin Gupta

Abstract The human brain is a complex structure where we have innumerable neurons connected to each other, passing signals from one part of the body to another. Normally, signals are transferred without any loss, but sometimes, for people suffering from epilepsy disease, this signal process is disrupted. For a person suffering from epilepsy disease, the signals cannot transfer properly. For analyzing epilepsy disease, the epileptic seizures electroencephalogram (EEG) is being commonly used in medical institutions. The aim of our research paper is to survey the state of the art and to suggest an efficient deep learning approach available through the literature which suggests potential diagnosis of epilepsy disease. After studying the available literature through research papers, the authors concluded that the Local Neighbor Descriptive Pattern (LNDP) model is the most efficient model available. The LNDP model achieves 99.82% accuracy, 98.30% sensitivity, and 98.8% specificity with deep learning as evident through available literature.

Keywords Deep learning · Convolutional neural network · Electroencephalogram · Epilepsy · Seizure

1 Introduction

Epilepsy is a neurological condition that causes a person trouble with seizures. A seizure is a sudden rush of abnormal electrical activity in our brain. The two main forms of epilepsy are generalized seizures and focal seizures. Generalized seizures affect your whole brain. Focal or partial seizures affect only one part of your brain. There is a lot of similarity in brain structure of the human brain and mice brain so

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comparative studies for seizures have commonly been conducted on mice. The signal of seizure is not only found in the brains of epileptic patients but also in the brains of the common herd [1]. Millions of people are currently suffering from epilepsy, and for continuously monitoring the signals of the brain by the medical fraternity is quite impossible and risky and therefore the EEG comes into play to monitor the people suffering from epilepsy. EEG signals are usually disorderly and unsteady time series, which can be detected by the sensors. To record the EEG signals, probes are placed on the scalp of the subject, and the signals are the external demonstration of a very large number of neuronal membrane potentials [2]. Doctors are able to understand the brain's status by observing EEG signals. Therefore, the EEG readings manifest any anomalous electrical activity in the brain and also helps in finding out the type of seizures. EEG signals are studied for a small time to a couple of hours for better results. During recording of signals, a large amount of signals are generated, but it is a very tedious task to study it manually and to diagnose it properly besides being time consuming, and even then we are not sure that the prediction of the signal is correctly diagnosed or not. Hence, it is a need of time to develop intelligent automatic seizure detection systems [3].

Over several past years, automatic computer-aided diagnostic techniques have been used to realize the automatic diagnosis of epilepsy disease. Most automatic computer-aided diagnostic techniques are mostly classified into various categories: time domain, branch of nonlinear dynamic, frequency domain, and time and frequency domain [4]. With the help of short-time Fourier transform, the researchers have implemented seizure detection model for EEG signals [5–7], wavelet transform [8–11], Stockwell transform [12], Lyapunov exponent [13, 14], fractal dimension [15, 16], and multiple entropies [17, 18], which are widely used for extraction in the feature extraction stages. For accurately characterizing the feature extraction of EEG signals the nonlinear dynamic and time–frequency domain methods are analyzed.

1.1 Research Motivation

- Several approaches are used in medical society to predict the reasons for seizures
- Manual diagnosis is a very tedious task, and it is a very time-consuming process. There is a need for intelligent automatic seizure detection systems
- Nonlinearity of the techniques.

1.2 Research Contribution

- We have analyzed the research papers to find out efficient datasets that will be very useful with approaches to deep learning.

- Secondly, we analyzed the approaches with the help of datasets to suggest the most effective model which will efficiently diagnose the disease and overcome the limitations.

1.3 Organization

The structure of our paper is as follows: Sect. 2 is a discussion of the literature survey. Section 3 analyzes the deep learning techniques used for diagnosing the disease. Section 4 is a record of the studied data sets used with research approaches as found in the literature. Section 5 contains the discussion about findings of the research, and a conclusion of our survey paper is discussed in Sect. 6.

2 Literature Survey/Approaches Used for Brain Diagnosis

There is a rich and extensive literature available on the approaches used towards the identification the epilepsy disease. At the time of the survey, we noticed that most of the approaches are potentially promising to give the best performance. We used the search query "approaches used for diagnosis epilepsy" on the search engine. Then we went through over 50 research papers in the deep learning domain. Out of the total, we found 45 papers had some relevance towards automatic diagnosis of epilepsy. After detailed screening, we selected 31 papers that are exactly related to our domain.

Figure 1 represents the step-by-step process of our research paper to suggest efficient approaches. While conducting our survey, we found that in the paper [19], authors implemented a supervised deep convolutional auto-encoder (SDCAE) model for seizure detection in pediatric patients. The model used 23 pediatric patients' datasets, and the datasets are taken from CHB-MIT. With the help of datasets, the model achieved 98.79% accuracy. In paper [20], researchers introduced a stacking ensemble algorithm (SEA)-based DNN model to predict whether or not there is epileptic seizure. Model used a benchmark clinical dataset, and the datasets are derived from Bonn University. The model achieved an efficient parameter whose accuracy is 97.17% but failed to calculate all parameters. The advantage of the SEA-based DNN model is important for the clinical diagnosis and treatment of epilepsy disease. In the paper [21], authors implemented the LNDP model for classifying epileptic EEG signals. The advantage of the LNDP model is that it is effective in feature extraction approaches. Model used five sets of EEG, and each set contains 100 clinical intracranial readings. The LNDP model achieved 99.82% accuracy, 98.30% sensitivity, and 98.8% specificity. In paper [22], researchers deployed the ApEn model to determine complexity of the epileptic seizure. The model is workable, and the ApEn model used five data sets and each set contains 100 clinical intracranials which are available at Born University. The model performance is best achieved

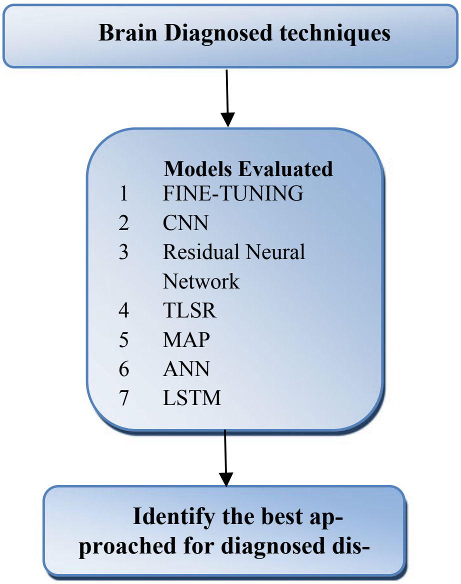

Fig. 1 Flowchart of research paper

with 99.26% accuracy, 98.34% sensitivity, and 99.35% specificity. In paper [23], the author introduced a P-1D-CNN model for detecting epilepsy that has far less learnable parameters. The model is very robust, and it achieved a great 99.01% accuracy. The model proposed data loss prevention and privacy protection as future work. In the paper [24], researchers implement a HTM + LSTM model for improved healthcare service. The model is a combination of HTM and LSTM; it is also it achieved 89.05% accuracy, 76.02% precision, 91.02% recall, and 73.03% F-measure, respectively. The detailed study of literature is represented in Table1.

After studying Table 1, which discussed the approaches for diagnosis of epilepsy disease with deep learning, we noticed some challenges and issues. First, researchers have shown interest in the huge scope of automatic diagnosis of epilepsy disease. Secondly, there is a need to implement more effective approaches for diagnosing epilepsy disease. Also in Table 1, various existing techniques are also discussed toward diagnosing the disease. After studying the literature survey, we formulated our research question as below.

Research question (RQ1): Suggest an efficient multi-view deep learning approach that will capture multiple signals of the brain and capture the epileptic seizures.

Table 1 Approaches used for diagnosis of epilepsy

S. No	Finding	Citation nos	Approach used	Advantages	Future scope
1	A deep-learning technique for seizures detection in pediatric patients	[19]	SDCAE	Effective seizure detection	NA
2	To predict that there is epileptic disease is present or not	[20]	SEA-based DNN	Important for treatment epilepsy	SEA-based DNN integrate with expert model
3	To classified epileptic EEG signals	[21]	LNDP	Effected in feature extraction technique	The approach can be implement as process as 1D signals
4	To determine complexity of the epileptic seizure	[22]	ApEn	Feasible model	With the solving of 3 problem achieve effective application
5	For detecting epilepsy that has far less learnable parameters	[23]	P-1D-CNN	Robust systems	Data losing and privacy protection achieved parameters
6	Improved healthcare service	[24]	HTM + LSTM	Works in real time	NA
7	More accurate technique for seizure detection	[25]	FT-VGG16	Outperformed among all models	Implemented automated EEG seizure prediction
8	Implement model to capture brain abnormal from multi-channel	[26]	Multi-view deep learning mode	Effective in detecting the disease	NA
9	Automatic elliptic seizure detection model	[27]	DNN	If data increase DN give better result	NA
10	Implement to automatically identifies the seizure states of the EEG	[28]	VGGNet	Lightweight model	Avoid potential error in future

Table 2 Studied datasets used for document classification

S. No	Data set	Domain
1	23 Pediatric patients [19]	Children's Hospital Boston–Massachusetts Institute of Technology
2	Benchmark clinical dataset [20]	Bonn University
3	Publicly available [21]	University of Bonn
4	Five sets of clinical intracranial [22]	Bonn Epilepsy Laboratory
5	Five sets A to E, each set contain 100 One-channel instances [23]	University of Bonn dataset
6	Continuous recording of different Vital signs of 76 people [24]	Oslo University Hospital
7	Five EEG datasets (A, B, C, D, and E) [25]	Bonn University
8	Real world EEG dataset [26]	Bonn University
9	20 Patient data [27]	Bonn University
10	22 Patients EEG datasets [28]	Bonn University
11	EEG Epilepsy dataset [29]	Boston children's Hospital

3 Datasets Used for Brain Diagnosis

After studying the literature, the authors also noticed existing approaches are associated with multiple types of datasets for achieving effective performance and datasets are available in numerous languages. While studying datasets, we faced some difficulties, considering that some datasets are available only in private sites and not in public access. Table 2 represents the literature review of datasets regarding their domain.

After studying the datasets in Table 2, our research work suggested that the Bonn university datasets are most widely used amongst all approaches.

4 Performance Comparison

In this section, our research work extended to study the performance of existing research techniques used for diagnosing epilepsy disease. In the preceding research work, most techniques tried to achieve all parameters with deep learning approaches. Table 3 shows the detailed comparison of the existing baseline model. In this, the comparison is done by the parameters they are accuracy, precision, recall, F-measure, sensitivity, specificity, respectively.

Table 3 tabulates the comparison of the existing baseline model with deep learning. The LNDP model achieved 99.82% accuracy, 98.30% sensitivity, and 98.8% specificity. The ApEn model performance is best with an achieved 99.26% accuracy, 98.34% sensitivity, and 99.35% specificity. The P-1D-CNN model is very robust, and

Table 3 Performance comparison of researched approaches for document classification

Researched approaches	Accuracy (%)	Precision (%)	Recall (%)	FMeasure (%)	Sensitivity (%)	Specificity (%)	Remark
SDCAE [19]	98.79	98.86	NA	98.79	98.72	98.86	Efficient model
SEA-based DNN [20]	97.17	NA	NA	NA	93.11	76.99	Expert system
LNDP [21]	99.82	NA	NA	NA	98.30	99.82	Results were better
ApEn [22]	99.26	NA	NA	NA	98.34	99.35	Efficient model
P-1D-CNN [23]	99.01	NA	NA	NA	NA	NA	Results were better
HTM + LSTM [24]	89.05	76.02	91.02	73.03	NA	NA	Outperforms on LR
FT-VGG16 [25]	99.21	NA	NA	NA	99.04	99.38	Efficient model
STFT + SSDAE [26]	93.82	NA	NA	NA	NA	NA	Efficient model
DNN [27]	97.21	NA	NA	98.48	98.17	94.93	Better result
VGGNet [28]	98.13	NA	NA	NA	98.85	98.47	Best performed
DCNN [29]	99.65	NA	NA	NA	90	91.65	Best performance

it achieved great 99.01% accuracy. The model is a combination of HTM and LSTM; also it achieved 89.05% accuracy, 76.02% precision, 91.02% recall and 73.03% F-measure, respectively. The FT-VG16 calculates 99.21% accuracy, 99.04% sensitivity, and 99.35% specificity. The STFT + SSDAE model achieved 93.82% of accuracy and the STFT + SSDAE model is very efficient.

5 Discussion

In this discussion section, our research work draws the graph of deep learning approaches to meet our objective. The graph is drawn based on accuracy parameters because every model achieved accuracy parameters. After study, we know the EEG signal plays a very vital role and it is also predicted by stacking ensembles. Therefore, with the help of an efficient deep learning approach, it is possible to diagnose the EEG signals. Many approaches have been deployed to verify EEG signals are epileptic, binary and normal.

Research question (RQ): Suggest an efficient deep learning approach that will diagnose of Epilepsy disease.

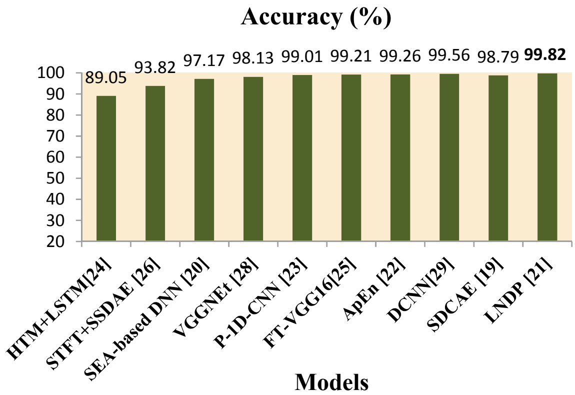

Fig. 2 Comparison Graph of epilepsy diagnosed approaches

Figure 2 represents a performance comparison graph of eclipse diagnosed approaches with deep learning. In Fig. 2, we combine all researched document classification techniques with deep learning. After analysis Fig. 2, our research work suggests the LNDP model achieves the highest parameters among all baseline models with deep learning. The Local Neighbor Descriptive Pattern [LNDP] model achieved 99.82% accuracy, 98.30% sensitivity, and 98.8% specificity with deep learning. The advantage of the LNDP model is that it is effective for feature extraction techniques.

6 Conclusion

In the machine learning/deep learning area, multiple approaches have been introduced to diagnose epilepsy. Epilepsy is a neurological condition that causes a person trouble with seizures. A seizure is a sudden rush of abnormal electrical activity in our brain. In this disease, the EEG signals are not properly transferred from one part to another. The EEG signal uses EEG benchmark datasets, and the datasets are collected from Born University. After analyzing our research work, we conclude the local neighbor descriptive pattern model is best for diagnosing epilepsy disease because the LNDP model achieved 99.28% accuracy and the model is implemented to classify epileptic EEG signals. In the future work, we will implement a combination of convolutional neural network (CNN) and LNDP model to diagnose the epilepsy disease.

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Privacy Preserving Algorithm for Blockchain-Based IOT System

Sarvesh Sawant and D. P. Rathod

Abstract In the field of medicine, both machine learning and blockchain technology have been investigated for their prospective uses, but thus far, the results have been somewhat disappointing. The investigation of how these technologies may be combined with other encryption strategies that protect users' privacy in order to improve their usefulness has been the primary focus. It appears that this combination, when applied to federated learning, is the key to successful applications of these technologies to rapidly advance evidence-based medicine. This combination makes it possible to execute functions and conduct analyses remotely, without the need to move highly regulated personal health information. In this paper, RSA technique is used to improve delay time for encryption in privacy preserving blockchain system for number identification.

Keywords Machine learning · Encryption · Security · IOT

1 Introduction

Regardless of whether the action was performed by a person or a machine, data is gathered without a clear objective in mind. Analysis of the data will be place in the future, as and when considered necessary [1]. A trust issue emerges because the data must pass through many stages before being analysed by a variety of people. It's possible that the data includes private or secret information that might be utilised unethically by the organisations involved in the analysis [2]. As a consequence, we need to pay significant thought to the privacy of personal data problems at this time. Privacy of data refers to the means by which a certain piece of data may be controlled as to its relevance to be utilised. Most people don't think twice about introducing

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themselves to a complete stranger, but they aren't going to give away their phone number or email address until they get to know the other person better. It's common knowledge that the most private and sensitive information about a person is at risk in today's digital world [3]. With regard to an organisation, the concept of data privacy covers considerably more actions and concerns than just protecting the private information of workers and consumers. In general, it has been concluded that privacy issues hinder AI and ML technology. For training and testing purposes, machine learning depends on large datasets [4]. More data sets are needed to train and test the ML algorithms, as well. The unencrypted version of the message is referred to as "cypher text", whereas the plain text version is called "plain text". A common practise is encrypting communications or information such that only those who have been authorised to do so may decode it, and this is known as encryption. The sender is responsible for implementing this method, which entails a plain text message that has to be encoded, a secret key, and an encryption algorithm. An encrypted message can only be decrypted back to its original form via decryption software, while encryption protects the original communication from being read by others. In order to decipher the encoded message, it is essential to have a form of the message, a secret key, and an algorithm for decryption. Encryption and decryption rely on the symmetric key (also known as the secret key) and the asymmetric key (also known as the public key). Asymmetric-key cryptography and secret key cryptography refer to the same thing. The key categorisation method distinguishes between symmetric and asymmetric keys. Symmetric key cryptography is detailed in reference [1] using a randomised technique for generating the encryption and decryption keys, which may be used for any file, including binary, text, or any other file. The keys are generated using a randomisation process. Using this method, you may encrypt or decrypt any file. The security of the data acquired is critical in sensor networks, thus an approach like this would be an excellent option. A new approach to gathering, analysing, and acting on data has emerged in the manufacturing industry: the Industrial Internet of Things (IIoT). Industrial Internet (sometimes referred to as Industry 4.0) applications are being developed to boost productivity and efficiency in key industries such as the energy and agricultural sectors. In the year 2020, Cisco Systems predicts that more than 50 billion connected "things" will be incorporated into the Internet. This includes everything from vehicles and kitchen appliances to TVs and security cameras to smartphones and utility metres. As a result, IoT companies supplying hardware, software, and comprehensive IoT solutions are expected to generate annual sales exceeding $470 billion dollars [2]. Everything from smart cities and smart homes to education, health care, manufacturing, mining, public utility management, commerce, transportation, surveillance, and infrastructure management will be impacted by IoT goods and services. Traditional data gathering, storage, and processing methods may not be able to keep up with the massive amounts of data generated by IoT devices. In addition, the sheer volume of data may be utilised to identify patterns, behaviours, forecasts, and evaluations. Moreover, IoT's data heterogeneity also presents a new challenge for conventional data processing methods. As a result, new procedures are required to maximise the value of data created by the Internet of Things. ML is one of the most appropriate computational paradigms for providing embedded intelligence in IoT devices in this context. Since Internet of Things (IoT) devices create enormous amounts of data, conventional data collecting, storage, and processing methods may be inadequate. It is also possible to establish patterns, behaviours, forecasts, and assessments out of the massive quantity of data. Another challenge for existing data processing methods is the variability of data supplied by IoT. As a result, new processes are required to fully use the value of IoT-generated data. ML is one of the most appropriate computational paradigms for providing embedded intelligence in IoT devices in this context.

2 Methodology

In this part, you'll learn about machine learning algorithms, data encryption techniques, the IOT framework, privacy and security in IOT, threat models, and all of the other ways to keep IOT systems private.

Separate levels of privacy

There are several ways to keep your personal information private, but one of the most effective is to use a privacy model known as differential privacy (DP). With respect to each data item, DP establishes the maximum amount of information that may be disclosed to third parties for analysis. Epsilon and delta have long been used to describe these boundaries. Two of the most prominent perturbation methods in DP, Laplace and Gaussian, are both utilised often.

It's a network of peers

Two peers, or nodes, interact with each other without the need for a central server in a decentralised peer-to-peer (P2P) network topology. For example, instead of a "seeder" and "leecher" (or "client" and "server") paradigm, P2P networks enable each side to be both "seeders" and "leechers" at the same time.

Blockchain

A computer network's nodes share a distributed database or ledger known as a blockchain. A blockchain is a digital database that keeps data in an electronic manner. Cryptocurrencies, such as Bitcoin, rely heavily on blockchain technology to keep transactions safe and decentralised. Using blockchain technology, data records are guaranteed to be accurate and secure. This eliminates the need for a third party to verify them.

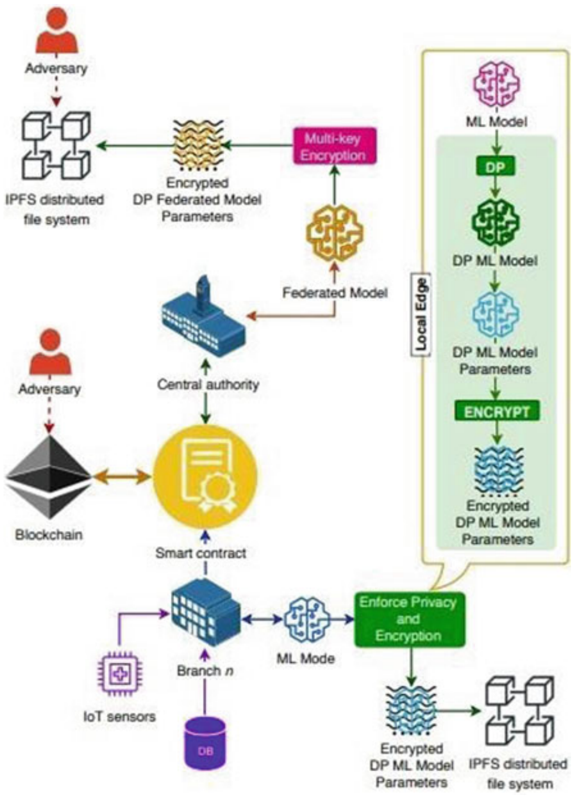
Ethereum

A smart contract platform built on Ethereum's decentralised, open-source blockchain. The platform's native cryptocurrency, Ether, is referred to as ERC-20. Ether is the second-largest cryptocurrency after Bitcoin in terms of market capitalisation. Vitalik Buterin, a computer programmer, came up with the idea for Ethereum in 2013. Zero-knowledge proofs and mixers are also being developed by the Ethereum team to make the Ethereum blockchain more secure.

IoT-based agreements
To put it another way, smart contracts are just computer programmes that execute when certain criteria are satisfied and recorded on the blockchain. They are often used to automate the implementation of an agreement so that all parties may be confident of the conclusion instantly, without the participation of an intermediary or time lost. Additionally, they may be used to activate the following step in an automated process, if certain circumstances are satisfied. Simple if/else statements written in a programming language like solidity or vyper are the building blocks of a smart contract. Devices linked to the blockchain may verify smart contracts on the peer-to peer-network.

Figure 1 shows a modular arrangement and Fig. 2 shows a layered architecture of a blockchain-based framework for privacy in IoT system. The hardware layer Homogeneous devices with varying capabilities (such as processor power, memory capacity) and supported access mechanisms make up this tier (Wi-Fi, Bluetooth, radio wave, etc.). In this way, many methods of authentication (such as passwords, RFID, and PINs) may be used to verify a user's identity. The Layer of the Network SDN-capable network components, such as OpenFlow switches, routers, middle

Fig. 1 Modular arrangement of a blockchain-based framework [1]



boxes, and the like, make up this layer. These access points may also offer basic data services since they are fog-enabled (i.e. OpenStack nodes). The software layer Over the virtualised core network, a set of apps may be installed. These apps, which are created by third parties, may pose significant security threats. As a result, the virtualised and controlled deployment of these programmes across the core and access networks necessitates rigorous access control.

Encryption protects digital data by using one or more cryptographic algorithms. The original text, known as plaintext, is converted into an alternate form known as ciphertext using an algorithm. This makes the data unreadable. A binary key or password may be used to decrypt the data if an authorised user requires access to it. This will decipher the ciphertext and provide the user with the original data. Standard for Encryption of Data The National Institute of Standards and Technology (NIST) released the Data Encryption Standard (DES), a symmetric key block cypher (NIST). One of the most widely utilised IoT encryption algorithms, Advanced Encryption Standard (AES), is used by the US government's National Security Agency (NSA). The AES has grown in popularity since its creation in 1997. This is owing to the ease with which it may be implemented on hardware and in contexts with less restrictions. Indeed, this symmetric method was certified capable of preserving sensitive government secrets "far into the next century" once it was declassified. When utilised in 128-bit version, AES is incredibly efficient. Heavy-duty encryption, on the other hand, makes use of keys with a bit size of 192 or 256. Rijndael's Cryptography For encryption and decryption, the Rivest-Shamir-Adleman (RSA) algorithm employs two separate keys, one for the public key and the other for the secret key. To decode an encrypted communication, you need a private key that matches the public key used to encrypt the message. VPN clients and servers, SSH clients and servers, and so on all employ asymmetric encryption. In the Internet of Things (IoT), When we say we're using "machine learning", we're talking about performance criteria may be improved by comparing them to previous data sets gaining knowledge and/or experience To be more specific, machine learning algorithms develop mathematically-based models of human behaviour vast amounts of data A further benefit of ML is that it enables the computer to learn without human intervention. being consciously programmed. Models such as these are used as future forecasting based on fresh data inputs data. Inheriting its origins, ML is a multidisciplinary endeavour. many fields of science and engineering, including, but not limited to, optimisation theory, information theory, and artificial intelligence and the study of the mind. Because of the widespread usage of Internet of Things (IoT) devices, consumers' security and privacy have become major issues. Cyber risks are increasing at an accelerating rate, rendering current security and privacy solutions ineffective. As a result, hackers are interested in anybody and anything connected to the Internet. Because of this, the outputs provided by Machine Learning (ML) algorithms may be utilised to forecast and discover vulnerabilities in IoT-based systems by analysing massive complex datasets. The use of Blockchain (BC) technology in current IoT applications is growing in popularity as a way to address privacy and security concerns. The use of machine learning algorithms or Bayesian network approaches has been the subject of several research.

There is a need for an integrated overview of current attempts to solve security and privacy concerns utilising ML algorithms and BC approaches, since these research focus on either ML algorithms or BC techniques.

3 Implementation

To begin, the AES algorithm, which is sometimes referred to as the Rijndael method, is a symmetrical block cypher technique. It takes plain text in blocks of 128 bits and transforms it to ciphertext using keys that are 128, 192, or 256 bits in length. Because of its reputation for reliability, the Advanced Encryption Standard (AES) has been adopted as a global standard. Figure 1 shows the complete steps involved which loads the model. Generate key, encrypt and saves in server, then saves hash code in blockchain as shown in Figs. 2, 3 and 4.

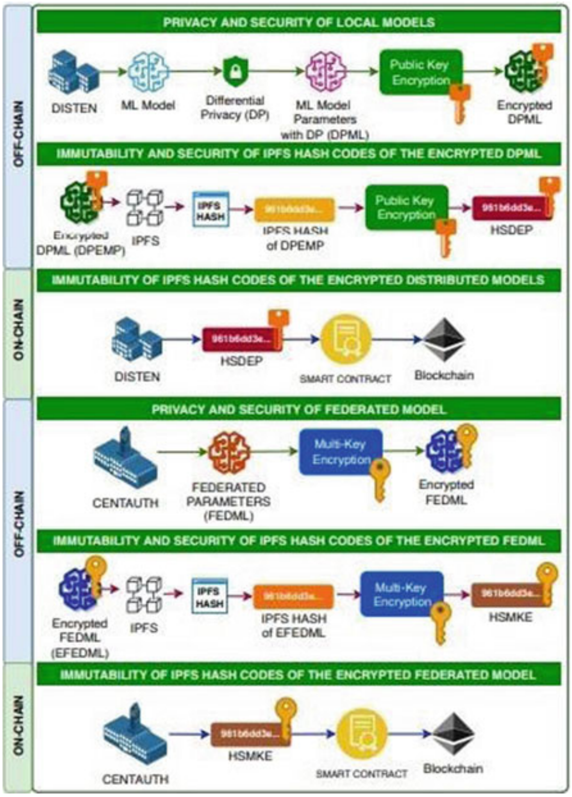


Fig. 2 Layered architecture of a blockchain-based framework [2]

Fig. 3 GUI functions

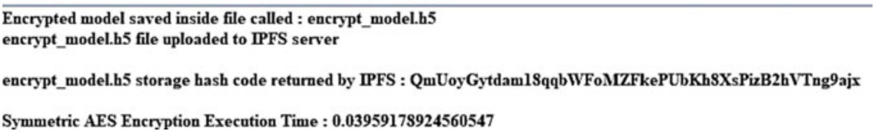


Fig. 4 Encryption

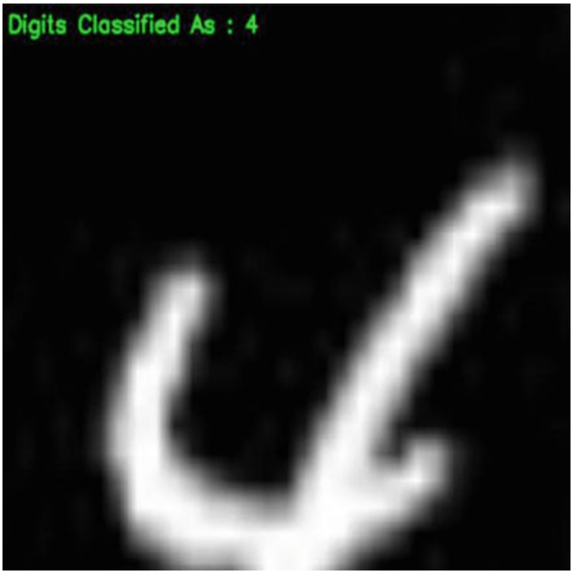
The technique that uses public keys to encrypt data is also known as the asymmetric algorithm. Asymmetric algorithms are algorithms in which the sender and receiver each utilise a unique key for the encryption and decryption processes. Each sender is given a unique pair of keys, which are as follows: The public key and the private key both. The Public Key is put to use in the encrypting process, whereas the Private Key is put to use in the decrypting process. Using a public key to decrypt information is not possible. There is a connection between the two keys; however, the private key cannot be obtained using the public key. While everyone is familiar with the public key, the private key is kept a closely guarded secret and is only known to the person who has the key. It indicates that anybody may communicate with the user by sending a message using the user's public key. However, only the user, via his or her private key, may decode the communication. The advancement of machine learning and artificial intelligence relies heavily on the accuracy and safety of the data used in these processes (AI). Traditional ways of logging into a data centre and practising there will be hampered since rich data is often sensitive to privacy

Model hashcode saved inside Blockchain Ethereum

Block Chain IPFS Stored Hashcode : ['QmUoyGytdam18qqbWFoMZFkePUbKh8XsPizB2hVTng9ajx']
Previous Block Hash : a4d4ed8cc232642d0587672d27f9052168090c1e94a2faa4c5d60b74f35e5327
Current Block Hash : 009ea7da8fa3b849dff29adfc58c1178b667684c5e6dd624a4d131e5f5bac8ca

Fig. 5 Blockchain hash code

Fig. 6 Classification of digit



concerns and is stored on a huge scale. In addition, the majority of the data and resources required for efficient training of machine learning models are controlled by a relatively small number of big technological corporations, which is harmful to the security of personal information and further contributes to issues of centralisation (Fig. 5).

Because the RSA algorithm is an asymmetric cryptography method, it requires both a public key and a private key in order to function properly (i.e. two different, mathematically linked keys). A public key is disclosed to the general public, while a private key is kept confidential and must never be divulged to any third party under any circumstances. Figure 6 shows the classified digit output.

4 Results

When you want to encrypt anything, you use one key, known as your "public key", and when you want to decode something, you use a second key, known as your "secret key". RSA is an example of an asymmetric cypher. The Advanced Encryption

Fig. 7 Encryption time result

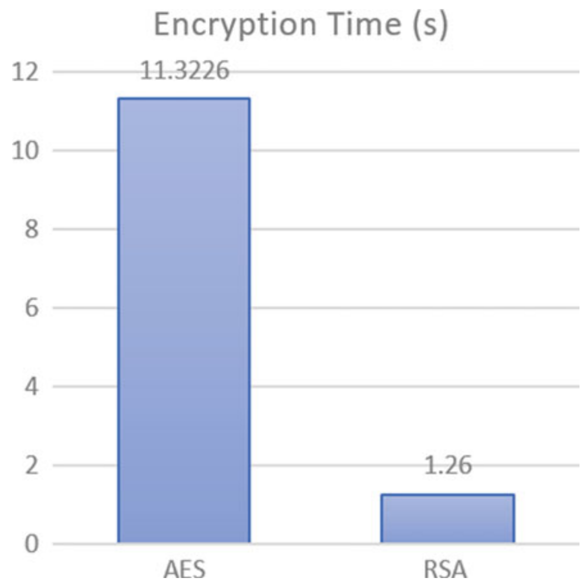


Table 1 Result for encryption time

	AES	RSA
Encryption time (s)	11.3226	1.26

Standard (AES) is a symmetric cypher, which means that the same key is used for both encryption and decryption. RSA improves the encryption time in this as shown below.

The result for Encryption time is shown in Fig. 7 and Table 1.

5 Conclusion

The Industrial Internet of Things (IIoT) is bringing about revolutionary change across a wide range of industries, including energy, agriculture, mining, shipping, healthcare, and everything in between. This shift is being ushered in by the IIoT. The Internet of Things (IoT) is a crucial driving factor behind the Fourth Industrial Revolution. This is because it makes heavy use of machine learning (ML) to make use of the vast interconnectedness and large amounts of data produced by IIoT. Because it is a basic driving factor behind the Fourth Industrial Revolution, the Internet of Things (IoT) is a vital driving force behind the Fourth Industrial Revolution. On the other hand, the network that is built on blockchain technology for the Internet of Things is open to the public. This means that in the event of a breach in network security, transactional information and encryption keys are accessible to everyone who is connected to the network. As a direct result of this, an adversary may get sensitive information on users by using this publicly accessible infrastructure, and the users themselves are not even aware of what is taking place. In order to find a solution to this issue, this research offers a high-speed encryption method that maintains a high level of safety for use in industrial IoT settings.

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Performance Analysis of ML Techniques for Spectrum Sensing in Cognitive Radio

H. B. Sandya, K. Nagamani, and Y. Rahiti

Abstract Spectrum sensing has been the main focus of cognitive radio. Cognitive radio (CR) is an ingenious detection system that provides an essential technology for efficient utilization of spectrum and overcomes spectrum insufficiency issues. The frequency spectrum is an important resource. Recent studies show that the spectrum is being underutilized. In this paper, the analysis of ML techniques for spectrum sensing in cognitive radio is introduced, and it is implemented by collecting the real-time data from the spectrum analyzer. Machine learning (ML) techniques were trained in conjunction with the dataset generated. A single ML technique out of KNN, SVM, logistic, and decision tree regressor is selected for optimal detection in spectrum sensing. The resultant ML technique achieved accuracy, i.e., 0.998, in the detection of spectrum holes. Hence, the unallocated channels were occupied by the secondary user using the Simulink model.

Keywords Cognitive radio · Machine learning · Spectrum sensing

1 Introduction

The scarcity of the frequency spectrum is to blame for the increased demand for radio channels. Recent spectrum measurements, however, show that the spectrum is underutilized, meaning that some spectrum will remain unutilized. It has been demonstrated that CR is a key strategy for maximizing spectrum utilization and resolving spectrum shortages. The secondary user (SU) is given access to the unused spectrum, also referred to as white spaces or spectrum holes, without interfering with

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the primary user (PU) or licensed user, thanks to CR technology. If there are no more open spectrum bands when the PU joins the network, one of the SU must release the band, which is then given to the primary user.

The capacity to reuse spectrum resources is one way that cognitive radio (CR) technology helps 5G increase the demand for wireless communications services. The main goal of cognitive radio is to share the spectrum by allowing unlicensed users (SU) to use the spectrum space that is free and not in use by licensed users (PU) by adjusting to the environment, but only when SU cannot interfere with PU communication without degrading PU Quality of Service (QoS) [1–9].

In 1999, Joseph Mitola presented the idea of cognitive radio. There was no established channel for data communication in CR. There are sensors that must communicate with their neighbors and choose a frequency channel. Because there is no coordination between PUs and SUs, it is clear that various methods must be used to forecast the PU's entrance onto the canal.

Figure 1 represents the spectrum utilization diagram. It demonstrates that a few frequency bands are extensively filled, while others have a medium level of usage. The remaining frequency bands are free. A cognitive radio approach is required to tackle the problem of unutilized spectrum.

According to a study released by the Federal Communications Commission (FCC), it indicates many permitted bands are underutilized and vacant. The FCC also indicates that spectrum usage seldom exceeds 35% in highly populated metropolitan areas.

Health care, military, household appliances, real-time monitoring, and vehicle networks might be benefited from CR. The industrial, scientific, and medical (ISM) band, which is saturated, is where the conventional wireless sensor network (WSN)

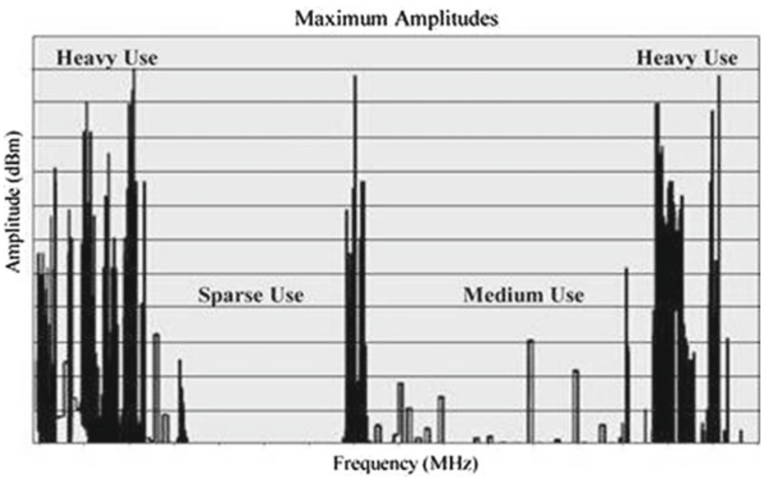

Fig. 1 Spectrum utilization diagram

operates. Researchers and industry will be offered by new dimensions and opportunities if the WSN is added with cognitive capabilities, which will aid in the construction of new algorithms, hardware, and software. By properly using the channel, WSN with cognitive technologies can decrease interference, collision, and delay. As a result, network lifespan is enhanced while power consumption is lowered. Different spectrum bands are regulated differently in each nation.

2 Proposed Methodology

Figure 2 illustrates the suggested model for cognitive radio spectrum sensing utilizing ML techniques.

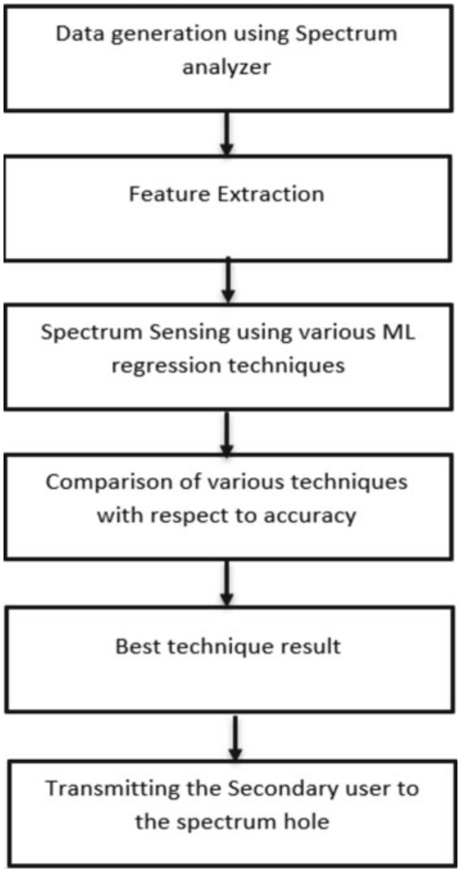

Fig. 2 Workflow for implementation and analysis of proposed system

2.1 Feature Extraction

The word features describes the extraction of parameters from the spectrum analyzer like frequency (Hz) and power (dB). The receiving antenna is connected to the spectrum analyzer, and the start frequency 10 MHz and stop frequency 7 GHz are set in the analyzer. Then the data is collected into the csv file.

2.2 Spectrum Sensing Using ML Regression Techniques

The data generated from the spectrum analyzer is used in order to diagnose different machine learning techniques using Pycaret library of Python. The machine learning techniques are:

K-nearest neighbor:

The K stands for the k closest neighbors, where k is an integer number that the user specifies. The value of k is determined by the information available in the dataset. Pattern recognition, data mining, and intrusion detection are some of the applications of which is found in the supervised machine learning area.

Logistic Regressor:

The statistical analysis method of predicting the binary outcome such as yes or no is called as logistic regression. It is based on the prior observation of a data set. In this model, the dependent data variable is predicted by analyzing the relationship between one or more existing independent variables.

Support Vector Machine:

Each data sample is shown as a point in the dimensional space on the data-scatter diagram, or the number of attributes of a given data sample in the support vector machine (SVM) algorithm. Each data attribute's value indicates one of the point on the graph's component coordinates, and by adding a straight line, it classifies various and separate data pieces. In other words, one of the finest techniques for separating data sets is a vector support machine. The nonlinear separation issues are resolved using the kernel functions. These routines provide a method for dividing the data depending on user-defined tags.

Decision Tree Regressor:

Guided learning techniques called decision trees can be used to solve both classification and regression issues. It is a tree-structured classifier, with leaf nodes reflecting the conclusion, branching denoting decision rules, and core nodes representing dataset attributes. The decision tree's two nodes are the decision node and the leaf node. Decision nodes are used in this instance to make any choice; they represent the outcome of such decisions and do not contain any further branches.

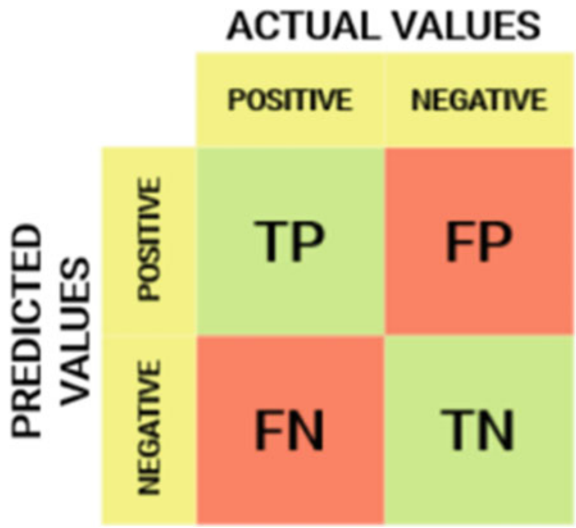

Fig. 3 Confusion matrix

2.3 Performance Matrix

The accuracy here is calculated by the confusion matrix. Confusion matrix is a N × N matrix used to assess the effectiveness of a classification model as represented in Fig. 3.

Where number of target classes is denoted by N. In the given matrix, the genuine goal values are contrasted with those of the ML model anticipated.

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{FP} + \text{TN} + \text{FN}} \tag{1}$$

Where

True Positive (TP)

- The predicted value matches the actual value
- The actual value was positive, and the model predicted a positive value.

True Negative (TN)

- The predicted value matches the actual value
- The actual value was negative, and the model predicted a negative value.

False Positive (FP)

- The predicted value was falsely predicted
- The actual value was negative, but the model predicted a positive value.

False Negative (FN)

- The predicted value was falsely predicted
- The actual value was positive, but the model predicted a negative value.

3 Implementation Results

The data is generated from the spectrum analyzer that is connected to the receiving antenna as shown in Fig. 4, then the features like frequency in Hz and power in dB are collected and converted into csv format for the further process. The start and stop frequency and the threshold set in the proposed methodology are shown in the Table 1. Fig. 5 shows the data output collected from the spectrum analyzer.

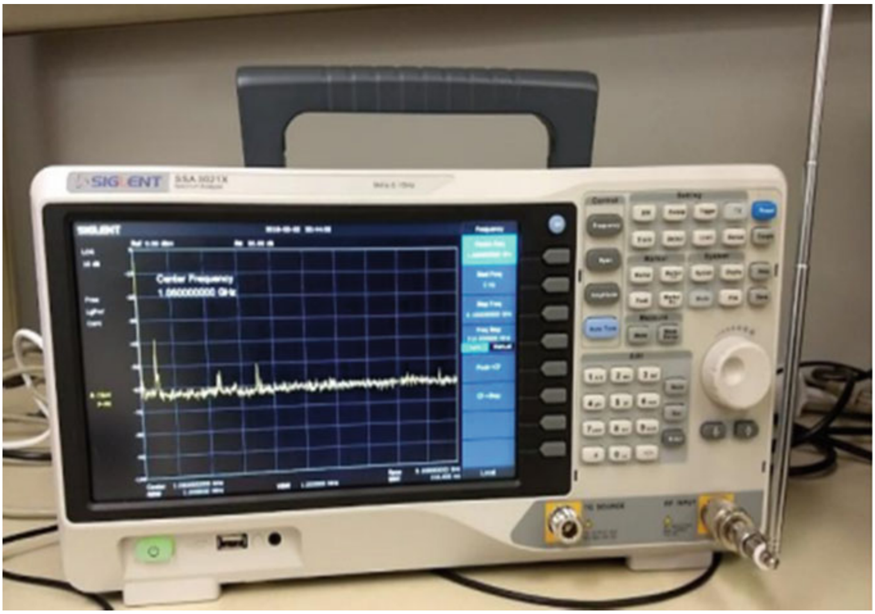

Fig. 4 Spectrum analyzer

Table 1 Specifications

Parameters	Value
Start frequency	10 MHz
Stop frequency	7 GHz
Threshold	$-$ 90 dB
Channel occupied	$> -$ 90 dB
Channel	$< -$ 90 dB

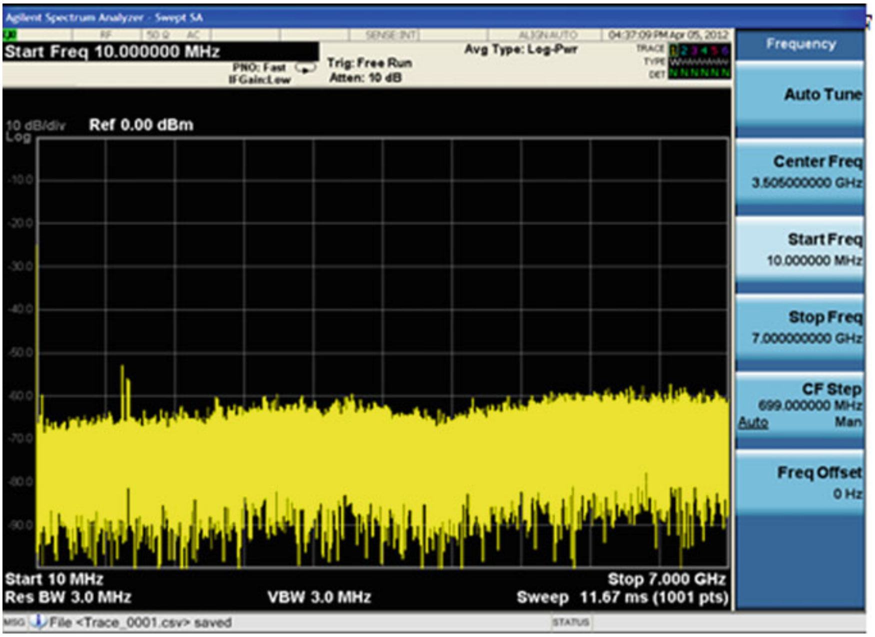

Fig. 5 Data collected from the spectrum analyzer

Here, the frequency is shown on the x-axis in Hz, while the power is shown on the y-axis in dB. And the attenuation set in the analyzer is 10 dB. The frequency range is from 10 MHz to 7 GHz in the spectrum band. The data output generated from the spectrum analyzer is then converted into csv file for getting the best fit in spectrum sensing using various machine learning techniques.

The frequency range is from 10 MHz to 7 GHz in the spectrum band. The data output generated from the spectrum analyzer is then converted into csv file for getting the best fit in spectrum sensing using various machine learning techniques. Therefore, a single ML technique out of KNN, SVM, logistic, and decision tree regressor is selected for optimal detection in spectrum sensing. Next, this file is imported into the Python environment in order to work with different ML techniques. The 30% of the data is thought of as testing data, while the remaining 70% is thought of as training data. The accuracy is obtained for the four machine learning techniques is shown in Fig. 6.

The accuracy table of ML techniques is shown in Table 2, and K-Nearest neighbor ML technique is selected out of 4 techniques, where it proves to be a better technique in sensing the spectrum in terms of accuracy of 0.9966.

As the accuracy is found out, now the spectrum holes are detected in given band, then the transmission of the data happens in the unutilized spectrum. The transmission of the real-time data to the spectrum holes is implemented in Simulink as shown in Fig. 7. The unallocated band are declared as a constant variable and this constant

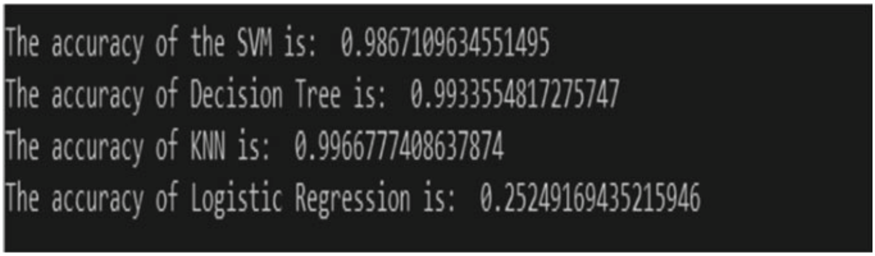

Fig. 6 Accuracy of ML techniques

Table 2 Accuracy table of ML techniques

Algorithms	Accuracy
SVM	0.9867
Decision tree	0.9933
KNN	**0.9966**
Logistic regression	0.2524

Bold indicates best fitting result compare with other techniques

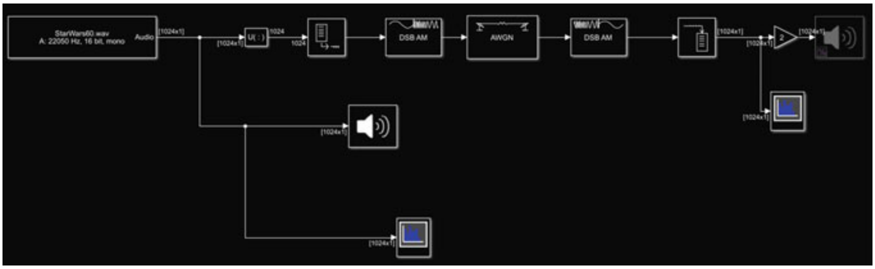

Fig. 7 Implementation of SIMULINK model

variable is declared in the modulator block, and when the spectrum is not in use the secondary user allocates the band.

In the Fig. 8, it is observed that there is no transmission from 0.1 to 1 GHz, which is highlighted by orange color, so at this time we can allocate the secondary user to the spectrum band.

Figure 9 shows that the secondary user has occupied the band from 0.1 to 1 GHz.

4 Conclusion and Future Scope

The dataset is generated using the spectrum analyzer, which consists of 1000 data points and comparison of machine learning techniques are obtained. The 30% of the

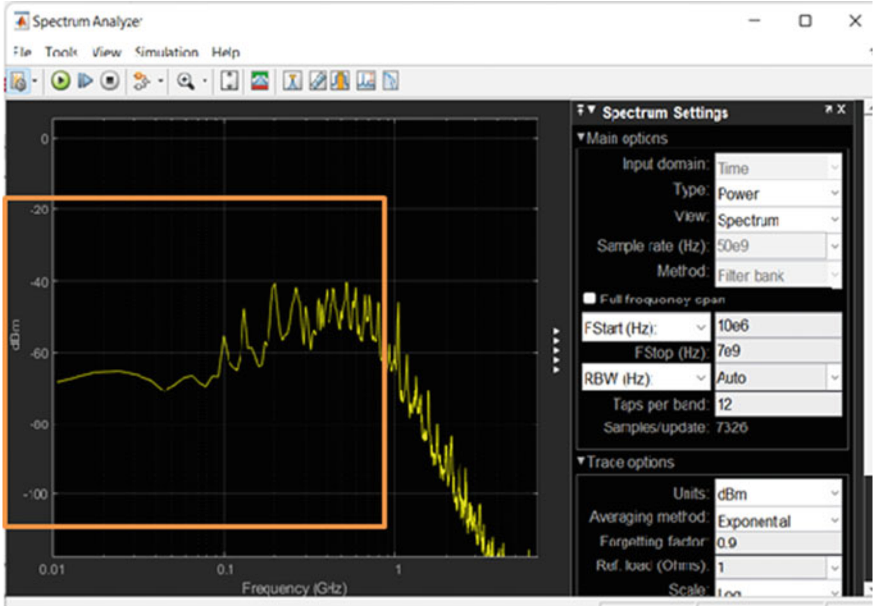

Fig. 8 Channel unoccupied by primary user

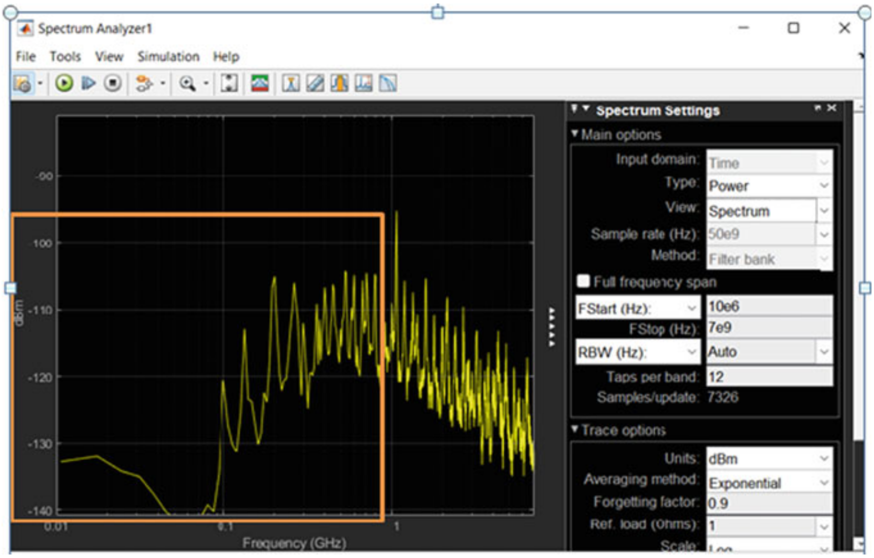

Fig. 9 Channel occupied by the secondary user

data is thought of as testing data, while the remaining 70% is thought of as training data. K-Nearest neighbor ML technique is selected out of four techniques, as it proves to be a better technique in sensing the spectrum with accuracy of 0.9966. Then the spectrum holes are detected by setting the threshold to 90 dB, and the secondary signal is transmitted to the spectrum hole.

In the future, the work can be extended for other frequency bands such as TV: VHF and UHF frequency band, etc. Moreover, the outcomes of this project can be implemented into Internet technologies and mobile communication using ML-based spectrum sensing features to reduce the correlation time and eliminate traffic, and it can be rendered as a commercially available product.

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A Fake News Classification and Identification Model Based on Machine Learning Approach

Ashish Kumar, M. Izharul Hasan Ansari, and Kshatrapal Singh

Abstract In the recent past the popularity of the social media platform has increased exponentially and at the same time various challenges have also been increased. One of the major challenges is related to fake news on social media platforms. It is really nontrivial task to filter and distinguish between fake and the real news. In this paper, various machine learning models have been applied to identify and examine the fake news on social media platforms. The Naive Bayes, Support Vector Machines, Passive Aggressive Classifier, Random Forest, BERT, LSTM, and Logistic Regression, were used to classify and identify the fake news on various social media platforms. The work is based on an ISOT dataset of 44,898 news samples gathered from a variety of sources and pre-processed with TF-IDF and count vectorizer. On evaluating the performance of algorithms on the given dataset, it shows that the precision of the Passive Aggressive Classifiers is 99.73%, Naive Bayes is 96.75%, Logistic Regression is 98.82%, BERT is 97.62%, LSTM is 97.44%, SVM is 99.88%, and Random Forest is 99.82%. Therefore, it is concluded that the SVM is one of the best performing algorithms in terms of precision to identify the fake news on social media. However, there are very marginal differences in the performance of the SVM, Random Forest, and Progressive Aggressive Classifiers in terms of precision. Further, an algorithm can be designed and developed to collect the news available on the various social media platforms to maintain the dataset in real time and analyze the same to identify the fake news.

Keywords Fake news · Machine learning · Neural network · Deep learning · Identification

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1 Introduction

During the previous decade, social networking and media platforms have grown at an unforeseen rate. The number of users has also risen dramatically, and as a result of the vast number of users, the volume of data produced and accessible has increased dramatically. To boost their online consumer base, social media-based news organizations have compromised content and quality. The ease with which malicious clients could create content and share it on social media sites such as WhatsApp, Twitter, and Facebook contributed to the rise in harmful clients. Such hostile clients, in particular, degrade the entire social media platform by creating, publishing, and disseminating bogus news, articles, and messages. It is now one of the most difficult chores to distinguish between fake and true news on numerous social media sites. Various instances have already occurred as a result of such bogus, erroneous communications, and news in the recent past. The issue of fake news and messaging came up during recent elections in both developed and developing countries. Dealing with bogus news and messaging is one of the most difficult challenges for government entities as well. There is, however, no clear procedure, norms, or framework in place to deal with fake news and propaganda distributed via social media sites. Several web sites are regularly destabilizing the entire social fabric by disseminating fraudulent and hateful comments and news. The primary goal of disseminating and making fake news viral on social media platforms is to influence the general public and modify public perceptions of a specific group, faith, political party, or social group.

Scientists are regularly working on Artificial Intelligence (AI) and machine learning (ML) methods to recognize and categorize bogus news, communications, and publications, as is widely known. Scientists have developed various effective methods to address classification difficulties using modern AI and machine learning research. In essence, a fake news or communications identification system aims to classify and identify false information. The analysis of the existing dataset of real and false news is used to identify whether a given news is fake or not. As a result, we'll need a large amount of actual and fake news data to train our model [1–3]. Previously, scientists presented various models based on natural language processing, but the majority of the proposed models were context-specific. To identify and investigate bogus news and messages, numerous factors were taken into account.

1.1 Problem Definition and Motivation

It is a well-known fact that social networking and media platforms are increasing drastically in the recent past. Fake news is one of the challenging problems that have the potential to spoil and weaken the entire social fabric of our society. Nowadays, it is being observed that it is very frequently used to build a perception, to influence the customer, voters, students, and kids. Therefore, it is the need of the time that there must be such platforms where a common person verifies a particular news and makes his or her perceptions after knowing the reality, facts, and figures about a particular viral content.

1.2 Key Objectives

a. To identify and classify the fake news by using Long Short-Term Memory (LSTM), Passive Aggressive Classifier (PAC), Naive Bayes, Logistic Regression, Bidirectional Encoder Representations from Transformers (BERT), Support Vector Machine (SVM), Bidirectional Encoder Representations from Transformers (BERT), and Random Forest.
b. To evaluate the performance of the models in terms of accuracy to classify and identify the fake news.
c. To compare the performance of the various models and identified the best performing model to classify and identify the fake news.

1.3 Our Contributions

In this paper, the data size is equal to 44,898 samples, and our testing sample size is equal to 13,470 samples have been taken into consideration to train our model for classifications and identifications of the fake news. The preprocessing steps starts with cleaning data by removing unnecessary special characters, numbers, and white spaces, etc. At last, the most popular feature extraction method TF-IDF method is used. In this paper, we discussed various issues related to identifications of various existing models. Here, in this paper we highlighted the key.

a. We classify and identify the fake news by using various existing models based on machine learning.
b. We evaluated the performance of the existing models to classify and identify the fake news based.
c. We compared the performance of all the models to identify the best performing models for classifications and identification of the models.

1.4 Paper Outline

Further, the paper is structured in three different sections. In Sect. 2, a review of literature is presented. In the review of literature various machine learning algorithms like Naive Bayes, Support Vector Machines, Passive Aggressive Classifier, Random Forest, BERT, Logistic Regression, and LSTM are discussed. In this section various techniques have been reviewed and various challenges and pitfalls are identified. In

Sect. 3, the performance of the various models is presented and in sub-sections data processing and analysis, methodology and results has been discussed. Finally, the conclusion and future direction are presented.

2 Related Work

The primary goal of this proposed project is to classify and identify fake news based on the substance of news that is transmitted to a substantial portion of the population. The performance of the classifiers BERT and PAC are examined in the suggested study [1]. Machine and Deep Learning research has shown significant gains in classification and identification based on Natural Language Processing over older methodologies. Previously, approaches based on linguistic features were employed to identify and detect bogus news. To categorize and identify the bogus news content, the author employed Naive Bayes Classifiers [2]. The author analyzed and evaluated the proposed algorithm's performance using the Facebook news dataset. Long short-term Recurrent Neural Networks (RNNs) and Convolutional Neural Networks (CNNs) were employed in the suggested approach to provide a framework for recognizing and distinguishing Twitter messages [3]. Using the several convolutional layers in the TI-CNN model (Text and Image data-based CNN), the hidden patterns and images utilized in fake news can be recognized by deleting a large number of latent features [4].

Machine learning classifiers included Random Forest, KNN, and SVM [5]. Various writers have demonstrated the Deep Neural Network in image processing and language representations. It may, however, be used to detect fake news, respond to inquiries based on graphics, and summarize pictures. Using the n-gram technique and machine learning algorithms, the author devised an algorithm for detecting fake news [6]. For feature extraction and classification, the LSVM and TF-IDF are used. To detect deceptive information, a model called Multimodal Variational Autoencoder (MVAE) [7] is used. This method uses three main components: an encoder, a decoder, and a fake news detector. The stochastic idle vector models are learned using the variable autoencoder. An algorithm is a set of instructions. The Event Adversarial Neural Network (EANN) [8] is presented to evaluate the symmetric highlights from event to event, hence benefiting from the identification of current event disinformation. The three key components are the Multi-Module Extractor, Fake News Detector, and Event Discriminator. The linguistic and graphic highlights are separated by the multi-module extractor. The selective photographs from the phone news or article are identified using the fake news detector. The event discriminator is used to remove the event's explicit highlights. The same problem can be overcome by utilizing news feedback, as discussed in microblogs [9]. Fake news can also be detected using a naïve technique. In order to identify whether the label of the category is being searched, a Passive Aggressive algorithm [10] uses an effective randomization mechanism. The

Passive Aggressive Classifier has never been used to classify bogus news previously. When they're needed, and removing any updates that don't upset the balance. As a result, it's used to spot bogus news.

2.1 Algorithms

PAC is a class of online learning algorithms that are employed on a big scale. If the proper result is acquired after classification, this method remains passive, but becomes aggressive if there is any deviation from proper result. The purpose is to fix the inaccuracy, which will result in a little increase in the weight vector norm. The algorithm uses the margin to alter the current categorization. The classifier takes a TF-IDF feature matrix as input. As a result, a model is created that is trained training set data and then executed on test set data to evaluate the performance [1, 14]. Naïve Bayes is a probabilistic classifier and based on Bayes theorem [12]. Logistic regression is a technique that employs mathematical modeling to characterize the relationship between a dichotomous (binary) dependent variable and a number of independent variables [11]. BERT is a pre-trained word embedding model and used the concept of transformer encoded architecture [13]. LSTM is a RNN type of deep learning model and mostly used in NLP [11, 15]. SVM is based on statistical theory learning. SVM has been used by a number of researchers in a variety of data categorization and pattern recognition applications [11, 17]. One of the most effective categorizing systems is Random Forest. The basic idea of RF is that a collection of weak learners can band together to form a powerful learner. RF is capable of identifying large datasets precisely and accurately. In RF, each tree serves as a classifier, and each tree is built on a random vector value. RF builds a huge number of decision trees during training. The majority vote or the average of all decision trees are used to make predictions [11, 16].

3 Proposed Work

The standard methodology has been followed to evaluate the performance of the proposed algorithm for news classifications. Algorithms mentioned in Sect. 2.1 have been used for classification tasks.

3.1 Data Preprocessing and Analysis

Data preprocessing is one of the important aspects before the same could be taken into considerations for further processing and analyzing. Data preprocessing is a technique for data exploration and converts the dataset in a proper and suitable format. It is being observed that generally raw data is inaccurate and therefore cannot be utilized for further processing and analyzing. So, before utilizing the data for processing and analyzing, we have to pre-process the dataset to make it in proper and suitable format and usable.

The steps were taken to evaluate the performances are:

- Importing libraries
- Importing the dataset
- Check and correct the missing value
- Dividing the dataset into test data and training datasets

The experiment used the ISOT dataset (ISOT Research Lab, University of Victoria, url: https://www.uvic.ca/ecs/ece/isot/datasets/fake-news/index.php) and performed in Python. The dataset has two files True.csv and False.csv. It has a total of 44,898 samples out of which 21,417 are true and 23,481 are false. The dataset has five attributes: news title, news text, subject, date, and label (True/False). Dataset was pre-processed to remove any stop words, punctuations and special characters using NLTK and re standard python libraries. Thereafter, experiments were performed to analyze the data and it was found that average no. of characters in a real news sentence is approx. 64 while in fake news sentence is around 94 (Figs. 1 and 2 Histogram). Also, it was found that average numbers of unique words are less in real news (≈ 9) compared to fake news ($\approx$14). More special characters were found in the fake news (Figs. 3, 4, 5 and 6). It might be due to the fact that fake news is being made attractive by using more superfluous words. Word cloud before and after processing is shown in Figs. 7 and 8.

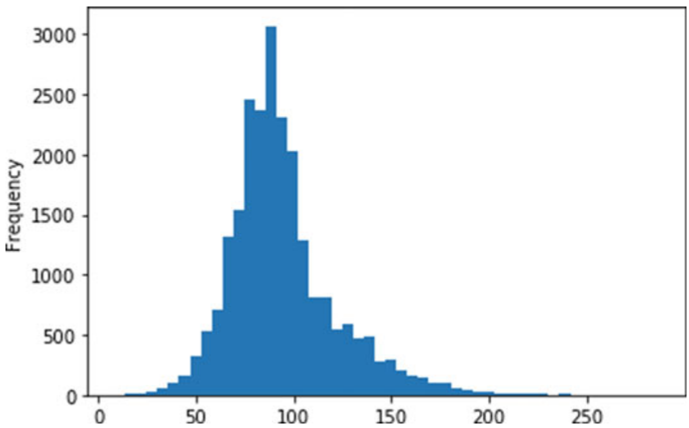

Fig. 1 Fake news

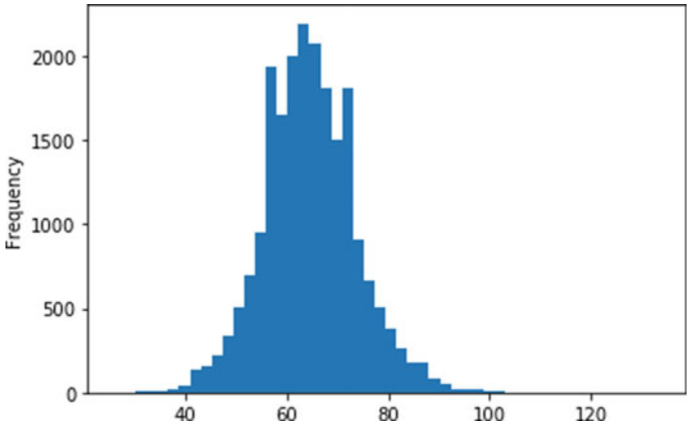

Fig. 2 True news

Count: 23481
Mean:94.1980
Standard deviation: 27.1844
Min: 8.0000
Max: 286.0000

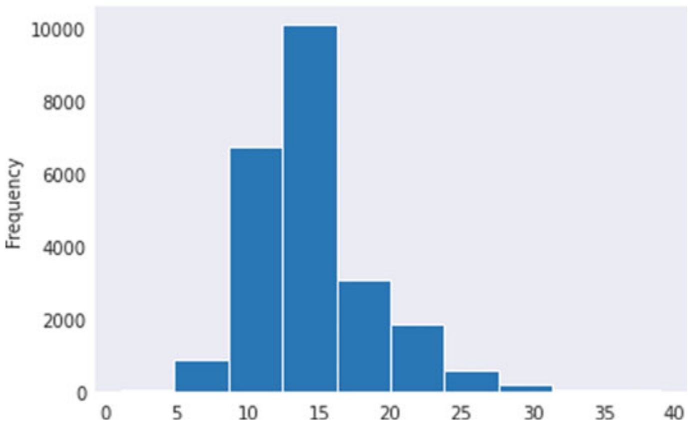

Fig. 3 Frequency of unique words in fake news

3.2 Methodology

The extracted features are input to classifiers for analyzing and identifying best performing models. Using sklearn, a TfidfVectorizer is built on the dataset. TfidfVectorizer turns a set of raw documents into a TF-IDF feature matrix. Term frequency (TF) refers to a word frequency in a document. When the term is part of the search terms, a greater number indicates that the term appears more frequently than others,

Count: 21417
Mean: 64.6678
Standard deviation: 9.1689
Min: 26.0000
Max: 133.0000

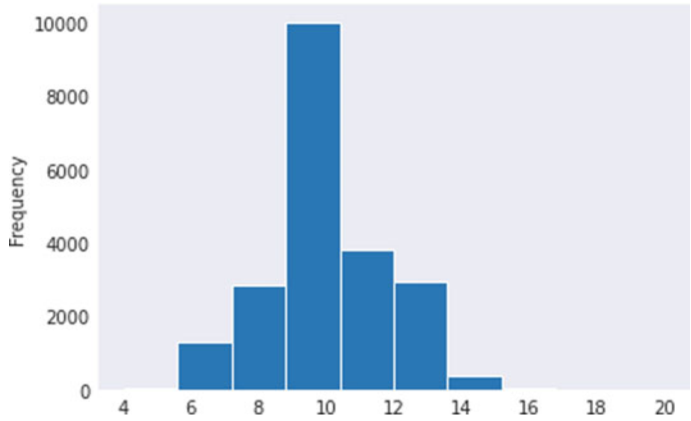

Fig. 4 Frequency of unique words in true news

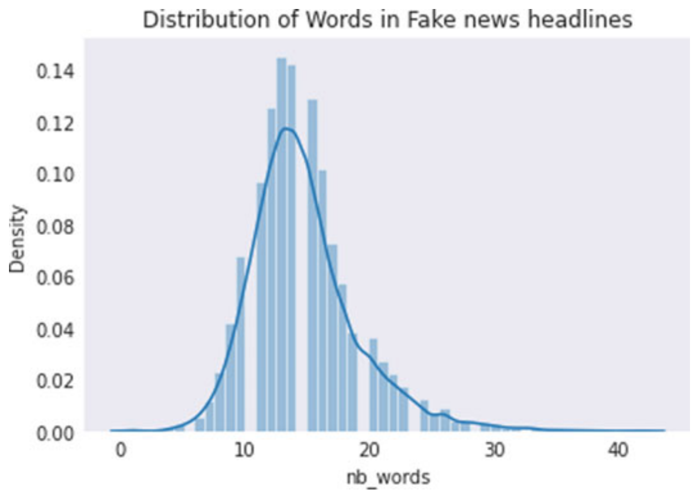

Fig. 5 Distribution of words in fake news

indicating that the document is a good match. Inverse Document Frequency (IDF) is defined as the intra and inter frequency of a word in document(s). The IDF determines the importance of a term across the entire corpus. The classifier is initialized and fitted to the data after the TfidfVectorizer is built. The dataset is split into training and test data. The model is evaluated using test data. The models are trained on 70%

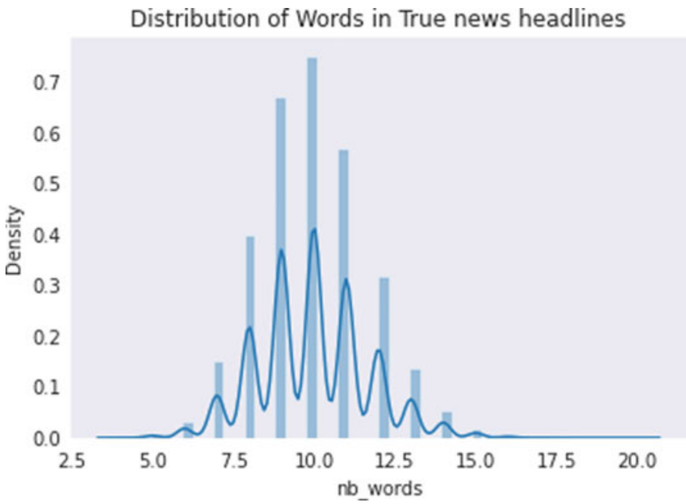

Fig. 6 Distribution of words in true news

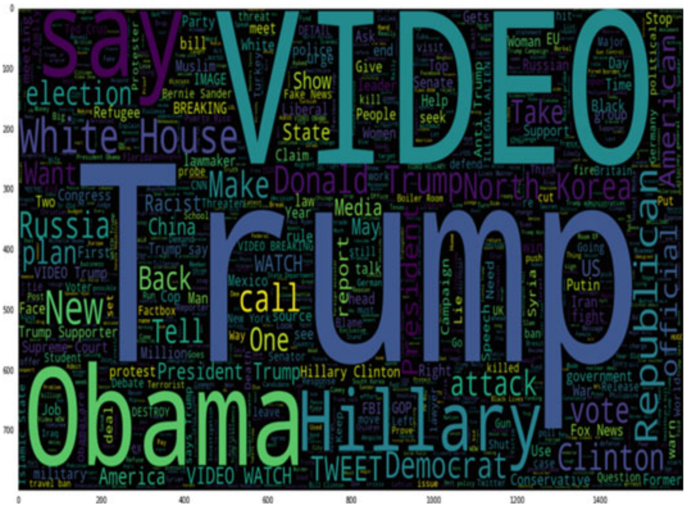

Fig. 7 Word cloud before processing

training data and the remaining 30% test data is used for calculating the accuracy. Precision, F1 score, and Recall have been used as a selection criterion.

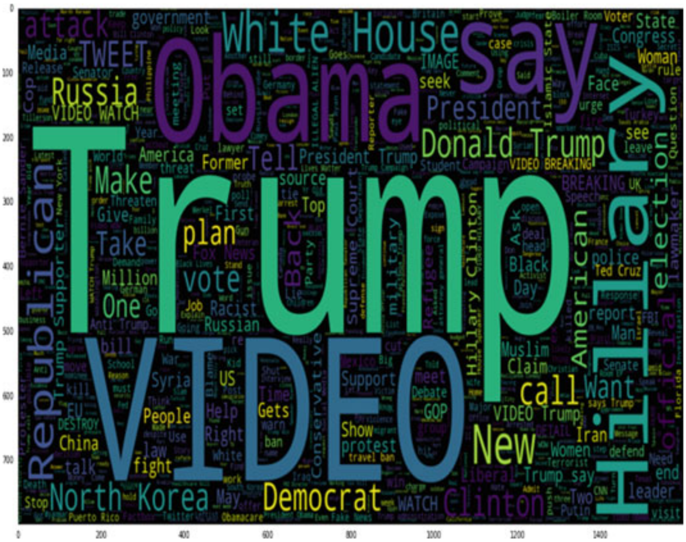

Fig. 8 Word cloud after processing

3.3 *Results and Discussion*

The performance of classifiers is shown in Fig. 9. The results show that PAC and SVM have the highest accuracy (Fig. 10) on the dataset compared to other classifiers and the claim is corroborated by F1 score which is also highest in case of both the classifiers. The dataset is mainly having news related to politics and world news. Therefore, in order to check the efficacy of classifiers considering generalizability we tested for other categories as well as regions of data having sports news, technology news, and Indian political news.

However, during test runs on other categories (sports, technology, and Indian political news) it does not predict correctly. Therefore, in order to have a generalized robust classifier requirement of a diverse dataset having data from variety of domains was realized during the test run.

4 Conclusion and Future Work

Fake news is a serious problem and spreads like wildfire since the general public can avail information from number of media. According to reports, fake news can have a substantial impact on politics and, as a result of a domino effect, on the general public [20]. Despite the vast amount of research on false news detection, there is still opportunity for innovation, and fresh insights into the nature of fake news could lead to more efficient and accurate algorithms. We investigated the effectiveness of

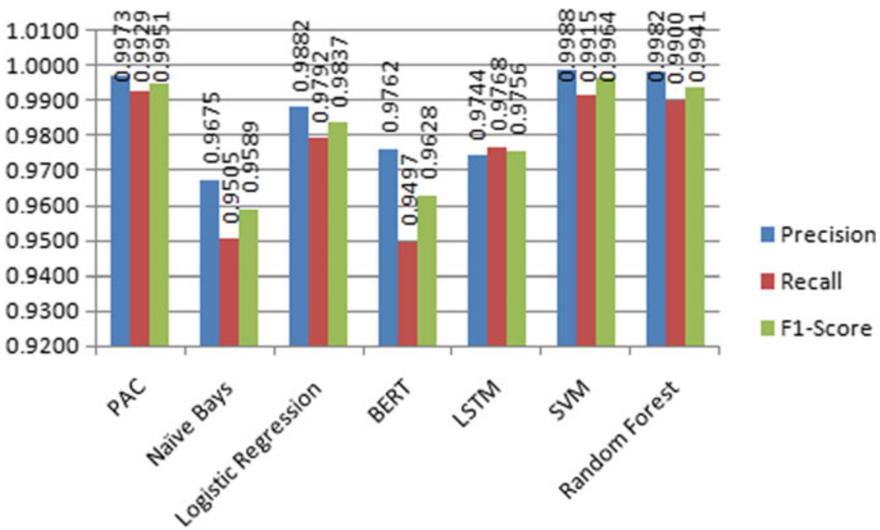

Fig. 9 The performance of classifiers

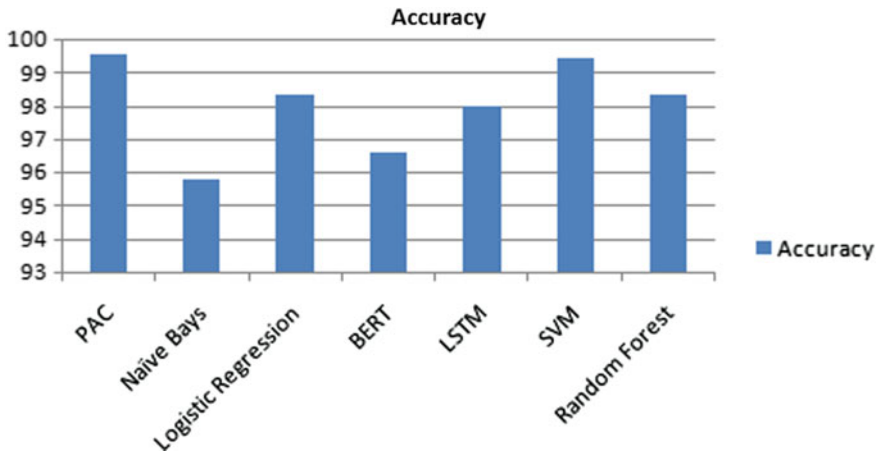

Fig. 10 PAC and SVM have the highest accuracy

seven (07) classifiers on the ISOT dataset, although PAC and SVM outperformed the others in terms of efficacy. Several different versions of classifiers have been given in the literature, with varying outcomes when applied to specific datasets, but finding and proposing a generalized classifier remains an open subject that requires further research.

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Blockchain Technology in Healthcare

Akshay Kumar and Vishwajeet Shankar Goswami

Abstract Blockchain is really a radical concept which is being used to provide novel ideas in a variety of industries, such as healthcare. A blockchain technology is utilized in the healthcare industry to store and distribute patient data across health facilities, outpatient services, pharmaceutical businesses, and physicians. As a result, it also has the ability to improve the efficacy, privacy, and openness of the healthcare system's medical data interchange. This technology helps medical institutions get insight and improve medical record analysis. We investigated blockchain technology and its huge potential in healthcare in this paper. Blockchain is crucial in combating clinical trial fraud; this invention has the potential to increase computational efficiency in healthcare. It can help to reduce concerns about data meddling in healthcare by offering a unique centralized data pattern with the highest level of security.

Keywords Blockchain · Healthcare · Storage · Bitcoin · Capabilities · Technology · Clinical trials

1 Introduction

Blockchain technology is a distributed, organization dedicated database that saves data on several computers in such a manner that no facts can be updated retrospectively without impacting succeeding blocks. After all, the name of the record is blockchain. Blockchain guarantees a high level of accountability because every transaction is recorded and confirmed publicly. It is impossible to modify information after it has been entered into the blockchain. Its objective is to show that the information is current and unaltered [1].

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Researchers have been striving to broaden the utility of blockchain beyond financial use cases since its debut through Bitcoin. Following the October 2008 publishing of the cryptocurrency white paper, blockchain gained attention as a decentralized ledger system [2, 3]. A minor party component may be maliciously hacked, glitch, or fail, leaving the financial system insecure or unavailable; hence, a reasonable and informed third party ultimately reduces a program as a single point of failure. It also boosts process efficiency by eliminating the central authority's delay, and it reduces transaction costs by eliminating the central authority's transaction fees.

Blockchain allows merchants to keep a record of medical products. Using blockchain technology, you can determine where counterfeits originate from. Blockchain allows for the encryption of patient data; the moment a medical history is created, and blockchain may preserve it and prevent it from ever being altered [4]. This decentralized network is utilized at the hospital using entirely commodity hardware. Experts can estimate drugs, therapy, and treatments for various disorders and various conditions.

Blockchain is a distributed ledger system that never updates or deletes entries without unanimous agreement [5]. A computational hash that joins dynamically accurate and real-time block entries with each block of data determines the worth of a blockchain hash. By integrating health data to a blockchain system, the patient will be responsible for keeping track as to where their information travels.

Researchers use this blockchain technology to analyze a vast amount of the previously unknown information on a certain group of people. It aids in the progress of precision medicine by providing adequate finance for this longitudinal research. Blockchain's decentralized nature allows it to be safely hacked while without compromising any one copy of the records.

2 Blockchain

Blockchain is a great solution for safeguarding sensitive data within the system. This technology facilitates the flow of essential data while keeping it private and secret. It is an ideal solution for securely storing all linked papers in one area. It enables dependable cooperation by storing and exchanging information across network users and keeping a continual record of the previous and present events [1]. This technology can connect dissimilar networks and give insights on the significance of individual therapy.

The blockchain runs on demand over the Web connection, on such a peer-to-peer (P2P) computer network that all operate the protocols and also have an exact duplicate of the ledger of transactions, enabling machine consensus to enable Peer-to-peer payments made without the necessity of an intermediary [5]. There exist four different types of technologies of blockchain: private, public, consortium, and hybrid. Every Bitcoin chain has distinct pros and cons which define their ideal uses.

- The decentralized system was the one that first incarnated blockchain systems, and from there digital currencies were created, but also where distributed database technology was first advocated (DLT) [6]. As a reason for its decentralized behavior, it needs some type of record validation
- A personal blockchain network is the one which runs inside a limited environment, (that is just like a closed network) or is owned by a company. From the outset, the designer of a personal Ethereum blockchain understands who the participants are. On a public Web, it is impossible to establish a permission-based system, because users are completely anonymous
- This enables enterprises for building personal, authorization parts that contribute to a non-private, censorable system, enabling it to handle who can access particular records recorded onto the blockchain technology and also what kind of data is publicly disclosed [7].

The blockchain technology enables digital data to be distributed rather than copied. Transparency, trust, and data security are all provided by this distributed ledger. A block is a compilation of valid trade requests received during a specific time range, such as 10 to 15 min [5]. This type of consensus algorithm shows the working order through which the accepted blocks are committed to the log. The public or pseudonymous blockchain is a form of blockchain implementation in which any node may access the system and mine without any authorization or access permission. Permitted blockchain, but from the other side, needs participants to be permitted and also has necessary permitted privileges just before it can add and contribute to this network.

2.1 Advantages of the Blockchain Technology in Healthcare

Here are eight advantages of blockchain technology. The advantages were classified as either patient-related or organizational-related [3, 8]. This section discusses four patient-related advantages and four organizational-related benefits.

- **Patient-related advantages**: Security and authorization are two such aspects of this system. 11 researchers discovered that putting these patients at the heart of the system and utilizing blockchain to safeguard medical data over decentralized peer-to-peer networks can increase health information security [4, 5]. Five further studies found that using timestamps, which are kept for each transaction, blockchain can help surgeons monitor patients' data more easily (Fig. 1).

- **Benefits to the organization**: Bitcoin is well-known for its organizational benefits, in addition to patient-related ones. Blockchain, according to six academics, can enable secure patient data sharing with healthcare companies. Three other studies looked at the decentralization characteristic, which was found to be the

Fig. 1 Patient and organization-related benefits

most essential factor in ensuring a smooth interoperability between healthcare organizations.

Ten studies discovered that, in addition to medicinal effects, blockchain offers non-clinical advantages such as health coverage management [9]. The previous research identified immutability as the most essential feature of blockchain that contributed to the advancement of the medical insurance business. Furthermore, three studies found that because clones of the shared ledger are saved on customers' devices, blockchain technology allows firms to maintain or backup insurance policies.

2.2 Blockchain Technology's Risks in Healthcare

The included studies identified eight threats to this technology, which were distributed as technical/technological, organizational, or social threats. Thirteen studies cited three forms of technical/technological dangers, fourteen research noted two types of social threats, and fourteen studies mentioned three types of organizational threats [3, 8, 9]. Here are the following subsections go into further detail on the identified dangers.

Threats that are technical or technological: Five academic articles addressed the sustainability of blockchain technology. Furthermore, two studies found that scalability was constrained by the trade-off between computing power and transaction volume necessary to estimate the transactions [10].

By the accordance of seven research, authorization and security are intertwined challenges in blockchain technology. As per three studies, distributed ledger technology is vulnerable to cyberattacks such as top-level domain (DNS) assaults and massive pooled intrusions (in which exchanges are flooded), in which the adversary gains control of blockchain systems.

Social dangers: According to three academics, the most significant barrier to acceptance of this technology was public adoption. Nine studies found that surgical data decentralization and absence of the trustworthy other party made it tough for legal jurisdictions to provide entrance, stressing security as a genuine issue [11, 12]. Four researchers also highlighted absence of directorship norms and standards as a barrier to blockchain use in healthcare.

Threats to the organization: From an organizational standpoint, eight studies identified interoperability as main in the primary challenges of cryptocurrency deployment in the medical sector [13]. Lack of interconnectivity and limited open standards contribute to the loss of integrity between parties, which makes it difficult for healthcare companies to exchange comprehensive health data.

Furthermore, while blockchain has the potential to save money in the long term, the initial setup fees are too expensive. According to one approximation, the Bitcoin protocol charges a transaction cost of up to USD 0.30.

3 Blockchain's Requirement in Healthcare

The need for progress in the field of healthcare is growing very quickly. There is an increasing need for somewhat elevated health services that are supported by creative and cutting-edge technology. Furthermore, the healthcare environment is shifting toward a customer-centric approach that emphasizes two critical components: always-available therapies and suitable healthcare resources [1, 14]. Citizens may participate in health research thanks to blockchain technology. Furthermore, improved research and data interchange on public health will assist many individuals in receiving better care. Data security is another big problem, particularly in the domains of personalized medicine and wearable technology. Clients and medical professionals seek an easy and safe way to gather, transfer, and retrieve data through networks; as a consequence, cryptographic algorithms are being used to tackle these issues.

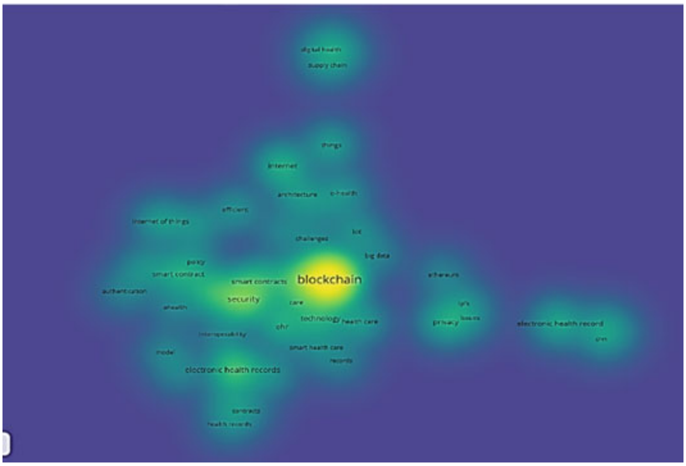

Fig. 2 Web of science core collection

3.1 Bibliometric Analysis

A. **Bibliometric Analysis Web of Science Data**

(1) *Web of Science Data Core Collection:* The keywords "blockchain (all fields)" and "healthcare (all fields)" are used to search the documents from the Web of science database, and total of 194 keywords 38 meet the threshold (Fig. 2).

B. **Bibliometric Analysis SCOPUS Data**

(1) *SCOPUS Core Collection:* The figures give the country wise detail of the publications and citations. Out of the 118 countries, 62 meet the threshold (minimum number of publications and citations taken is 2) (Fig. 3).

(2) *Co-occurrence Keywords:* Out of 4223 keywords, 77 meet the threshold (minimum number of occurrences of a keyword is 20). Occurrences of "blockchain" are 642. Occurrences of "healthcare" are 107 (Fig. 4).

4 Blockchain's Potential to Aid Healthcare

By permitting the reliability and security of individual medical information, controlling the drug supplier base, and facilitating the regular and accurate of patient health data, blockchain technology supports healthcare researchers in discovering genetic code. The blockchain tracks the whole pharmacological process in real time, from manufacture to drugstore shelves [1]. IoT and blockchain can track occupancy, shipment direction, and speed [15]. It assists you in properly planning purchases to

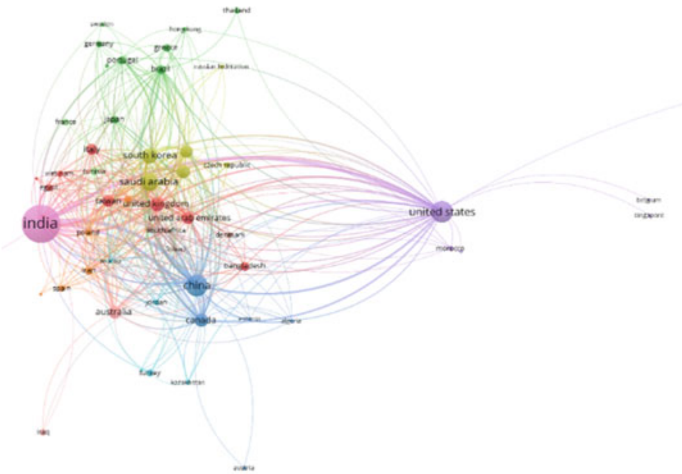

Fig. 3 SCOPUS core collection

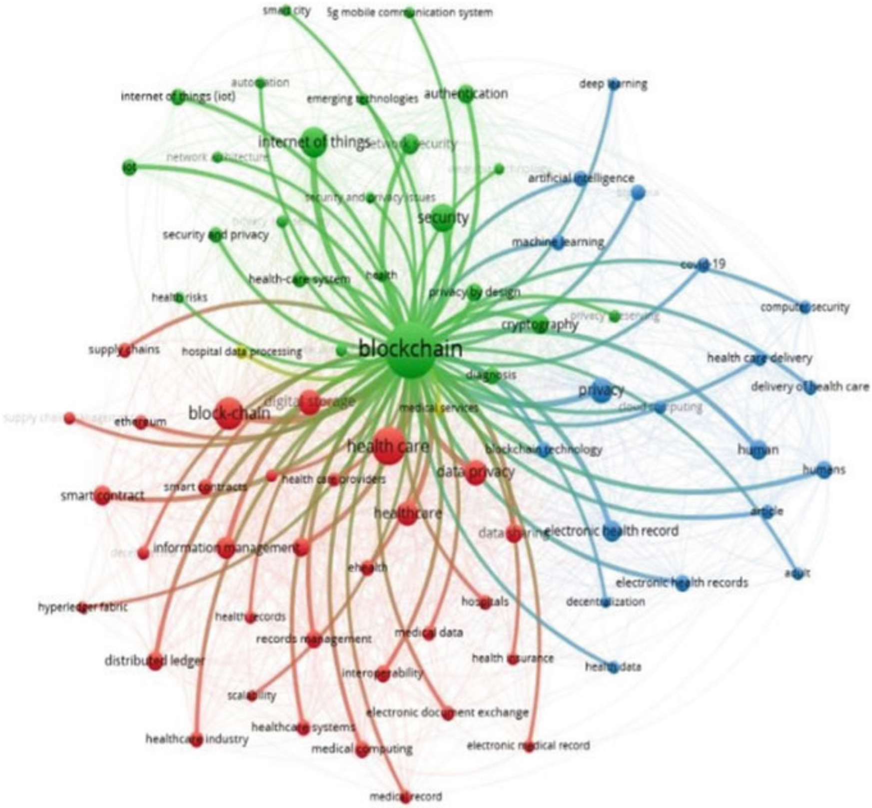

Fig. 4 SCOPUS co-occurrence keywords

minimize disruptions and shortfalls at hospitals, pharmacies, and other medical institutions that use a certain prescription. Blockchain is suited for security applications because it can maintain an irrevocable, transparent, and complete log of all medical data.

Because this automation lets people handle their surgical data and handle all the available laws, it facilitates each move to internetworking driven by users. This allows patients to take more control across personal information while also improving secrecy and privacy. Quality management and enforcement are difficult to monitor and implement.

Blockchain applications in the business might address any of these technological challenges. This assures that all authorized parties, including patients, are exchanging digital transactions. Patients who change providers can transmit all of their health information with a single signed permission. Others in the heavily affected are similarly excited about the technology's early phases. It provides doctors, patients, and pharmacists with immediate access to all accessible information.

Medical businesses are investigating, testing, and applying digital money in the medical profession for health records at all hours of the day and night. It has shown to be a key tool in healthcare by replicating medications, enhancing payment choices, and democratizing patient health history information. To fine-tune the medical supply chain, the app employs blockchain monitoring technology.

The blockchain's potential enables a complex data storage system that tracks a person's whole medical record, comprising diagnoses, test results, past therapies, and even smart sensor assessments. The organization's current networks can be bypassed using blockchain. If a healthcare company efficiently adopted a blockchain network, problems such as rescue operations and database malfunctions or hardware failures might be prevented.

5 Blockchain Technology Realization of a Single Workflow Process

Benefits of the blockchain practices among the medical healthcare sector include master patient indexes, demand adjustments, specialized medical logistics, accessibility, unique and longitudinal record collection, and so on. Distributed networks, digitized transactions, and digital ledgers allowed for the interactive work-process flow, which enabled blockchain drivers to produce better, healthier medical care than ever.

The blockchain concept is basic, but it is always evolving, as it expands the Web of blocks to meet the different demands and also unique features of different industries. It enables the permanent deal of time-stamped therapeutic research findings and conclusions, which reduces the danger of fraud and errors in clinical studies. The suggested system's implementation is heavily reliant on the health industry.

Blockchain is a distributed ledger that affects every industry. T thrilled by the prospect of being a crucial element of pharmaceutical consent management, enabling for information interchange. Individuals also may join various institutes and have their medical records instantly transferred to them utilizing blockchain technology.

A cryptocurrency that is been approved is just a closed network that allows all system members to connect to other networks [15]. As a consequence, it is developed and used within organizations and enterprises to securely interact and transfer information. Everyone is encouraged to create a Website using the Internet. Someone in an Ethereum blockchain may connect to anyone else in the network by generating their network address.

The safety, validity, and timeliness of pharmaceutical product delivery are all ensured by a proof-of-stake supply chain system. It allows the maker to keep the correct formulation blend in compliance with medical laws. Trust, security, confidentiality, and data interoperability are all required for excellent healthcare.

Cryptocurrency stands out as a feasible solution for health privacy protection because of its everlasting, autonomous, and entirely open nature. It can also let people submit medical records and allow parties to read them. By enabling EMRs more efficient, trustworthy, and secure, blockchain technology may usher in a new era of health information exchange. Record of transactions keeps track of important transaction information.

6 Healthcare Blockchain Applications

This technology is a comparatively young and growing technology with brand new and exciting use cases in healthcare. Smooth and quick sharing of data and transmission among all major broadcast users and healthcare professionals aid in the creation of cost-effective drugs and sophisticated therapies for a variety of conditions [1]. The benefits of blockchains in this transportation industry and also some merits of this technology are involved in the medical sector and have recently been demonstrated [2]. Given the media frenzy that many difficulties are imagined to be solved by blockchain, a mapping of application domains in this industry wherein these are important will aid practitioners and academicians in concentrating their attention on those practices and programs of blockchain applicability in the sector.

Keep track of a single patient's information: A significant amount of client healthcare and social information is generated both before and during the various clinical research phases. Healthcare specialists will examine the data available and suspect its veracity, which they will confirm by comparing it to the genuine data stored on the Bitcoin protocol. In EHR format, the healthcare provider records the patient's reg number, personal details, prognosis, treatments, and ambulatory histories. This data is stored either in the cloud or in traditional databases.

Investigate the outcomes of a certain technique: Researchers can study each specific procedure on a large section of the clinical setting quickly because of verified access to patient data. As a result, significant improvements in the way patients which are treated are achieved. Blockchain makes pharmacists' tasks simpler since it contains a plethora of info on the pinnacle of it [6]. These data will assist patients in understanding how to utilize the drug correctly. This will give physicians real-time updates on a patient's condition based on peripheral data and will alert them to potential emergencies.

Reassurance: Algorithms verify transactions in a Bitcoin before they are added to the chain. Healthcare corporations, technological innovators, and the healthcare sector are all thinking of ways to learn much about what they are accomplishing either now or in future to make it more comfortable and affordable. Blockchain has the potential to revolutionize the health ecosystem if healthcare management can successfully validate the outcomes.

Security and translucency: A healthcare system's diagnostic accuracy, cost-effective ecosystems, and efficient therapies can all benefit from smooth exchange of data across medical solution suppliers. Blockchain allows many health ecosystems companies to communicate and share details about the specific distributed ledger, which improves security and translucency. When using such a software, users might trade and analyze their data as well as other system activities without the need for extra alternatives for privacy and availability.

Maintaining a clinical information: This technology might be an exact part of medical records data. Individuals could use an app that gives their health data to an Ethereum blockchain. This will consolidate whole data and offer patients who have had the previous access. The collecting of all information in one place will provide us additional insight into a proposed treatment.

In addition to the existing health informatics frameworks, the function of Ethereum is to gather all trades in a public record. It is accurate and uncomplicated, decreasing administrative effort by freeing up, effort, and money. Another important feature is ensuring that database clients and parties have up to date, a go, and accurate healthcare data and evaluations.

The application of blockchain in medical services appears to be very promising and exciting, since it aids in the resolution of some of the industry's most important concerns. Patient information, medical knowledge, new treatments, the small medical links, and the pharmaceutical products are all delivered through it.

7 Summary

Because of its intrinsic encryption and decentralization, blockchain has revolutionary potential in healthcare. It promotes interoperability among healthcare facilities and aids in the fight against counterfeit defense department medications by improving the security of patients' electronic patient records, incentivizing the adoption and implementation of health data, and ramping up the private information of patients' computerized medical data. The ecosystem's adoption of connected new materials is important to blockchain's promise in healthcare. It includes system management, insurance coverage, medication tracing, and clinical research. Healthcare facilities may track their services using a blockchain architecture that includes device tracking throughout the life cycle. Blockchain technologies, for example, are being used to boost healthcare history management, particularly charting and insurer arbitration procedures, allowing clinical activities to be completed more swiftly while ensuring data integrity. Ultimately, such technology would assist patients and professionals in maintaining and accessing patient information while also improving healthcare services.

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Review on Blockchain in Bitcoin Security

Rahul Negi and Vishwajeet Shankar Goswami

Abstract Blockchain technology is required in the progress of mostly all industries. Privacy, network services, inspection, and database access inside digital platforms might all benefit from blockchain decentralized technology and privacy regulations. The nodes in the network produce, add, and authenticate blocks of data; blockchain is based on decentralized and secure decentralized protocols with no central authority or control. The use of blockchain technology across a range of manufacturing sectors has risen in recent years, according to this report. Also, this paper evaluates the study using a complete literature review, as well as exploring and providing insights into the security problems and risks associated with blockchain installations.

Keywords Blockchain · Decentralized · Blockchain technology · Network

1 Introduction

Blockchain cloud computing is a relatively new development in accessible networked secure computing that does not rely on a central authority. From the perspective of data management, a blockchain network that tracks a growing list of public ledger by arranging these into a recursive chain of blocks. A peer-to-peer composite is used to build and maintain the blockchain, and it is protected by sophisticated and decentralized encryption paired with crowd computing [1]. From \$2.5 billion in 2016, worldwide revenue from blockchain-based corporate applications is estimated to reach \$20 billion (approx.) by 2025. This is an annual growth rate of 26.2%. Meanwhile, major financial institutions, consulting companies, IT suppliers, and Internet behemoths such as Morgan Stanley, Goldman Sachs, HSBC, Citibank, Microsoft, Accenture, Cisco, IBM, Ali, Tencent, and others are speeding up laboratory research and capital allocation on blockchain technology. Artificial intelligence (A.I), big data, and blockchain are the three most important computing technologies for the future generation of financial services. There are other similar initiatives, including the

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IBM-sponsored ethereum, hyperledger project, and file coin, in addition to bitcoin. Since the introduction of the initial bitcoin blockchain in 2008, several permissioned blockchains, such as cryptocurrency and hyperledger fabric, have grown with governmental and non-governmental accessibility outside of traditional monetary systems and electronic voucher systems. Blockchain technology has lately been the subject of a rising number of scientific investigations and has piqued the curiosity of academicians, developers, and business professionals because to its superior trust and security qualities. The payment of ransoms to unlock ransomware is a classic example of bitcoin usage. Criminals utilize bitcoins to pay for services, information, extortion, and other forms of monetary exchange. In 2008, bitcoin was first introduced. Since then, it has grown to popularity as one of the most prominent cryptographic currency among several competitors/contestants, boosting economic growth by millions and millions of dollars within several years after its introduction. Instead, because Bitcoin users may freely determine when and how to utilize digital currency, they have ultimate control about what they were doing with their own money. Bitcoin is growing in popularity, and more individuals are opting to use this as a payment option in a variety of companies. Furthermore, cryptocurrencies have fueled the growth and development of blockchain, as crypto depends on its network to function. Blockchain uses, on the other hand, transcend beyond bitcoin. Technology isn't only for the financial industry; it provides a wide range of alternatives that already have impacted and will proceed to disrupt other industries in the coming years.

2 Blockchain Technology Features

2.1 Decentralization

Centralization and decentralization are not the same things. It provides you with greater security and freedom than a centralized app. Decentralization has been chosen by various organizations because speedy decision-making is required. Everything is done in one spot in a centralized environment. A distributed environment is one in which a decentralized environment is employed in numerous locations. It has the ability to provide both profitability and efficiency. Efficiency focuses on costsavings, and it should result in improved results. Innovation generates new concepts. That must be a brand-new bennet.

2.2 Network Distribution

Because no one controls the network because it is distributed, different users can always have several copies of the same information. Because the failure of one node does not signify network wide failures, this attribute makes it resilient and robust to any kind of failures. In contrast, because the information must be vetted by a vast number of people in the network, a distributed network suggests that there are nearly no errors. Erroneous or damaging data is nearly tough to locate on the blockchain. Low costs benefit the users. The decentralized structure of blockchain makes it possible to validate person-to-person transactions quickly and securely. By removing the need for such a broker, users save money.

3 Synopsis of Blockchain Technology

Theorem of CAP: Consistency, availability, and partition Tolerance are referred to as CAP. The CAP theorem is a key theorem in distributed systems for determining transactional qualities. A distributed system is made up of a group of computing nodes which are linked together by an underlying network model and communicate with one another to execute tasks (Figs. 1 and 2).

CAP characteristics are defined as follows in the distributed ledger's perspective:

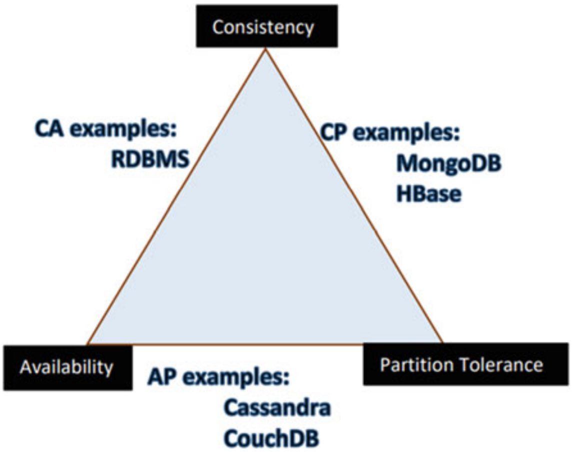
Consistency: In the perspective of a distributed ledger, consistency means that all nodes keep exact records of the most recent alterations.

Availability: Any network transaction will be accepted in the ledger at any moment.

Partition-tolerance: The network can carry on to function correctly even though some nodes fail.

The major problem is that no widely accepted money can exist unless all three requirements are accomplished. Nobody will use a cryptocurrency if the technology is down at the moment of the transactions or if certain transactions are not recognized by the system (CP system) (Tables 1 and 2).

Fig. 1 Pictorial presentation of CAP



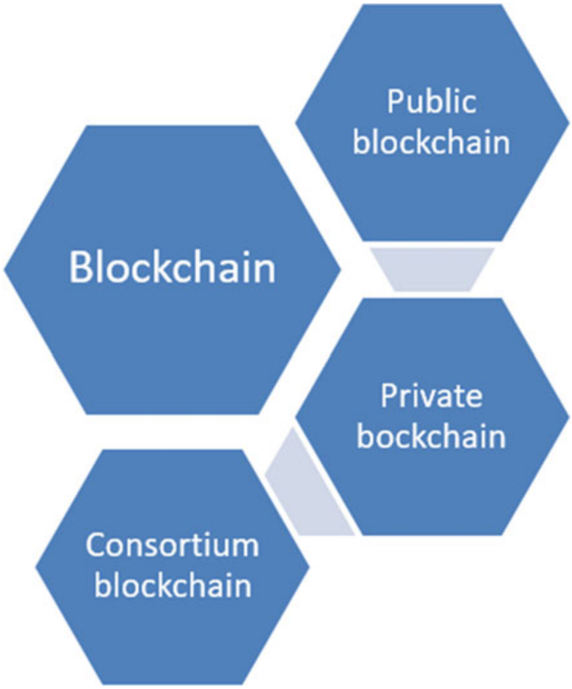


Fig. 2 Classification of blockchain

Table 1 Types of different blockchain with scenarios

Type of blockchains	Description	#TA	System and organized controls	Scenarios
Public	It is available to everyone	$= 0$	Steady	Scenarios involving worldwide decentralization
Consortium	Handled by consortium nodes that is already selected	≥ 1	Scarcely fast	Selected organization's businesses
Private	An organization is in charge of writing rights	1	Fast	In an organization, information is shared and managed

If one node fails, no one will utilize a currency; the system cannot function properly (CA system). Nobody will use a distributed database system if the ledger recorded by different nodes is inconsistent (PA system).

The Blockchain Solution: The CAP theorem appears to have been breached in the ledger of the cryptocurrency market, and among the most efficient blockchain implementations, since it accomplishes the CAP components. However, this may

Table 2 Summary of the requirements, properties, and techniques for privacy and security

S&P	Requirements	Properties	Corresponding techniques
Bitcoin supports	Availability Integrity Anonymity Prevention of double spending Consistency	Consistency Defending against DDoS assaults Tamper-resistance Pseudonymity Double-spending attack resistance	Algorithms of consensus Byzantine fault consensus methods Hash chained storage Pseudonyms for public keys Signature and verification
Require improvement	Confidentiality Unlikability	Confidentiality Unlikability The majority's (51%) consensus attack is met with resistance	Game-based solutions, TEE-based solutions, ABE, HE, SMPC, NIZK Anonymous signature, mixing Consensus algorithms which does not rely at computational hierarchy

not be the case. In reality, blockchain consistency emerges over time rather than simultaneously with accessibility and partition tolerance.

4 Blockchain's Classification

Blockchain is being used by a variety of application fields, and its development, access, and verification are all rising. Users can choose between three varieties of blockchain, depending on their requirements and scenarios. Although the topology of these blockchains differs, they all have distributed and decentralized structures, consensus mechanisms, P2P (peer-to-peer) communication, digital signatures, and time stamping in common.

4.1 Public Blockchain

There are no limits on receiving information from a blockchain network because it is decentralized and accessible to the public. A common blockchain, at the other hand, can be allowed to access or permissionless in the framework of writing. Anybody can write into the network if it is permissionless, but only particular nodes are authorized to pursue new operations (publishing through into ledger), validate another nodes' transactions, and view current transactions if the network is permissioned (reading the blockchain). Furthermore, as all nodes have access to the ledger of records, the blockchain is transparent. However, because of the gigantic number of nodes in the network, such a blockchain has several drawbacks, such as poor processing speed.

4.2 Private Blockchain

A constrained blockchain network operates in a confined space. When an enterprise needs a ledger with restricting exposure and involvement, such networks are ideal. Furthermore, no one has access to the cryptographic data or may take part in transactions. These blockchain networks may or may not be accessible to a private group of people. The disadvantage of such a blockchain is its upkeep, since the business must inspire confidence among network participants because classified data is at risk; secondly, a system with very few nodes is simpler to hack.

4.3 Consortium Blockchain

Management of such a blockchain is entrusted to a few nodes within the network. Representatives from the participating organizations are in charge of making network decisions at those nodes. Only a small number of these authoritative nodes are permitted to engage in transactions, and they are in control of the consensus procedures. This blockchain, also known as a distributed block chain technology, is a p2p public blockchain that lets anybody to read network information and only reflective nodes may upload data.

5 Privacy and Security Properties of Blockchain

We'll start by going through the security requirements for online transactions, which are all centered on a certain type of known vulnerability. We then present the basic (and essence) data security of bitcoin, as well as a number of critical privacy and security characteristics of blockchain that are either visible under certain blockchain-based innovation or desired by several blockchain applications, relying during its first application in bitcoin.

The following are seven types of privacy and security requirements for web transactions which are widely classified as:

Ledger's Consistency among firms: Due to the architectural style and operational processes of various lenders, as well as the active engagement of manual processes in the procedures of peaceful coexistence, clearing, and liquidation among financial institutions, this not only results in high-processing fees generated from service users and the background side of the business of banking institutions, but that also lead to inconsistencies and inconsistencies among ledgers provided by different financial institutions.

Transaction Integrity: Separate intermediaries manage shares, treasuries, coupons, income vouchers, warehousing receipts, and numerous other assets when using electronic payments for trading and asset management. It not only adds management fees, but also build-up the risk of certificates being intentionally fabricated. As an aftereffect, the system must maintain the transaction integrity while also preventing manipulation.

Data and System Availability: Users were able to view financial data at whatever location and at any time while using online services. Both server and transaction availability are referred to as "availability." The ability to accomplish dependably at the component level even in the case of a network attack. Members can access transaction details without them being unavailable, corrupted, or inconsistent at the transaction level.

Double-Spending Prevention: Avoiding twofold, or expending a coin multiple times, is one of the most challenging parts of transferring virtual currency in a decentralized network. A reputable central 3rd party affirms whether or not a coin has been double-spent in a centralized setup. In a decentralized network setup, thorough security mechanisms and remedies are necessary to avoid double-spending.

Transaction's Confidentiality: Users desire to do as little knowledge about their activities and accounts published as possible during numerous financial online transactions. The following is the bare minimum of information:

Unauthorized users are unable to view the user's transaction details;

No user's information should be disclosed to anyone without the user's permission;

Users' Anonymity: The challenge of securely sharing user data across many financial institutions might result in a high cost of recurrent user authentication. It also puts users' identity in danger of being revealed by mediators. In some rare cases, one or both of the transaction's sides maybe not willing to disclose their genuine identities to the other.

Transaction's Unlikability: Users should require that transactions committing them not be connected, which is different from the anonymity of identity. Curiosity or adversarial parties can anticipate (infer) a user's genuine identity with high degree of confidence using transaction and account statistics along with certain background information about the user.

6 Working on Bitcoin Blockchain

Bitcoin is more than a digital currency that may be used to make payments or held by investors in the hopes of seeing its value rise. A cryptocurrency is supported by a complete ecosystem. Many of these ecosystems are active today on the Internet.

6.1 The Bitcoin Blockchain

The bitcoin blockchain is a decentralized database of transactions that is encrypted and peer-verified. This is how it goes. Instead of being stored in one location, the blockchain is spread among multiple computers and devices inside the network. Nodes are what these systems are called. Each node seems to have a copy of the blockchain, which is refreshed whenever it is validly changed.

6.2 Blocks

A 256-bit number that keeps track of all preceding blocks' information. The block was opened at a specific time and date, as indicated by the timestamp. The network target is the target in bits. The nonce is a 32-bit number that is produced at random. Queued transactions are added to the block, which is then closed, and the hash is generated by the blockchain. Because each block is "chained" to the one before it, the blockchain cannot be changed because each block contains information from the previous blocks. Mining is the process of validating and opening blocks.

6.3 Bitcoin Mining

The procedure of validating transactions and adding more (new) blocks to the blockchain is known as mining. Application-specific integrated circuits (ASICs) are computers or machines created specifically for mining that execute software programmers. The hash is the primary focus of mining software and devices. They're trying to give an estimate that matches the hash of the block. Depending on the number of miners, bitcoin's protocol will require a longer string of zeroes, with the difficulty adjusted to hit a rate of one new block every 10 min. It's also competitive.

6.4 Halving

In bitcoin mining, halving is a crucial idea. For solving the hash, the mining payout was initially 50 BTC. The award is halved in half every four years, or 210,000 blocks. As a result, in 2012, the prizes were reduced to 25, 12.5 in 2016, and 6.25 in 2020. The award will be halved again in 2024, when it will be reduced to 3.125, followed by a reduction to 1.5625 in 2028. Around 2140, the last bitcoin is likely to be mined. At that point, all 21 million bitcoins will have been mined, and miners will rely only on fees to keep the network running.

6.5 Keys and Wallets

"I bought a bitcoin, now where is it?" is a popular question from newcomers to Bitcoin. To grasp this, consider the bitcoin blockchain as a communal bank that holds everyone's money. A wallet, which is similar to your bank's mobile app, is used to check your balance. If you're like most people these days, you rarely use cash and rarely see the funds in your checking account. Instead, you utilize credit and debit cards as means of accessing and using your funds. A wallet and keys are used to access your bitcoin.

6.6 Keys

At its foundation, a bitcoin is data that has been allocated ownership. When you make a transaction, such as sending money to an online store using your debit card, data ownership is transferred. To transfer or receive bitcoin, you use your wallet, which is a smartphone application. When bitcoin is distributed to an owner via a blockchain transaction, that owner is given a number, which serves as their private key. When someone sends you bitcoin, they use your public address (also known as your public key), which is similar to how they input your email address in an email.

6.7 Wallets

A wallet is a piece of software that allows you to check your balance and transfer and receive bitcoin. The wallet connects to the blockchain network and searches for your bitcoin. The blockchain is a ledger that contains chunks of bitcoin. Custodial and noncustodial wallets are the two kinds of wallets. A custodial wallet is one in which your keys are held for you by a trustworthy party, such as an exchange. Hot storage refers to storing keys in an application that is linked to the Internet. Hot storage, on the other hand, is the most commonly exploited vulnerability. A detachable USB drive or a piece of paper with your keys inscribed on it could be used (this is called a paper wallet). A personal safe or a storage deposit box are two examples of items that need extra effort to get your keys.

6.8 Bitcoin Transactions

When you give or receive bitcoins, this is considered a bitcoin transaction. To transmit a coin, you must first program your wallet with the recipient's address, then type your private key and accept the transaction cost. After that, press the 'send' button on your keyboard. Because transactions are queued in a mining queue called the MemPool, the recipient must sit tight for the mining network to validate the transaction, which can take up atleast 30 min. Once the fee has been paid, the transaction is moved to a block and processed. When the block's transaction information is validated by miners, the block is closed, and all recipients receive their bitcoin. The balances of both wallets are displayed, and the next transactions are performed.

6.9 Bitcoin Security

The bitcoin blockchain and network are made up of numerous components, but it is not necessary to grasp them all to use this innovative currency system. You simply need to be aware that you use a wallet to transfer, receive, and store your bitcoin keys; you should also utilize a cold storage technique for security reasons, as non-custodial wallets are vulnerable to hacking. Many consumers are worried about bitcoin's security for a solid reason, especially since it entails swapping money for the ownership of encrypted data.

7 Conclusion

Blockchain has become a major topic, and it will be used for an extensive variety of applications. The blockchain will provide enhanced security for all types of transactions. This technology is mainly intended for the processing of bitcoin transactions (or other cryptocurrencies). Blockchain applications include smart contracts, ethereum, and distributed ledgers. This will increase security. Bitcoin is the fitting and most generally used blockchain application. Blockchain allows transactions to be completed faster and at a lower cost than any other application. It will enhance safety, particularly for delicate/sensitive data. Blockchain applications are widely praised for their transparency and immutability.

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A Statistical Analysis of the Contribution of Enrollment Process Toward Quality of Higher Education in the State of Uttarakhand

Rohit Rastogi, J. V. Desai, Sachin Gupta, N. P. Singh, and Anchal Gupta

Abstract In the case of higher education quality, assessment techniques have been one of the most important themes that need to be addressed by the University for enhancing competitive advantage. Higher education institutions need to incorporate activities with a high range of integrity for attracting students in their direction. Uttarakhand is one of the upcoming states in India which consists of good number of universities in and around Dehradun. Quality concerns in Higher education or directly divided into some sections that include a range of technical integrity. This study includes statistical analysis of the quality of education in the few selected private universities. The concept of quality does not depend on any one factor, and it is a collective performance of so many parameters that any university has like its enrollment, faculty, research, academic infrastructure, etc. In this article, our focus is on the role played by enrollment factor in grading the participating universities of Uttarakhand. The data collected through various sources and statistical tools applied for the analysis, and the results obtained are also mentioned in this paper.

Keywords Factor analysis · Reliability · Likert scale · TOPSIS: multi-attribute decision making · Education management

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1 Introduction

The quality determination of a higher education institution does not depend only on dissemination of knowledge but also on their ability to become a place for creation of knowledge which can be created with the integration of so many deciding factors like vision and mission, admissions and enrollment, administration and governance, human resource management and development, resources and infrastructure for learning, student support services, curricular attributes, teaching–learning and evaluation [2], research, consultancy and extension services and quality assurance and assessment. Figure 1 shows a holistic view of the assessment parameters.

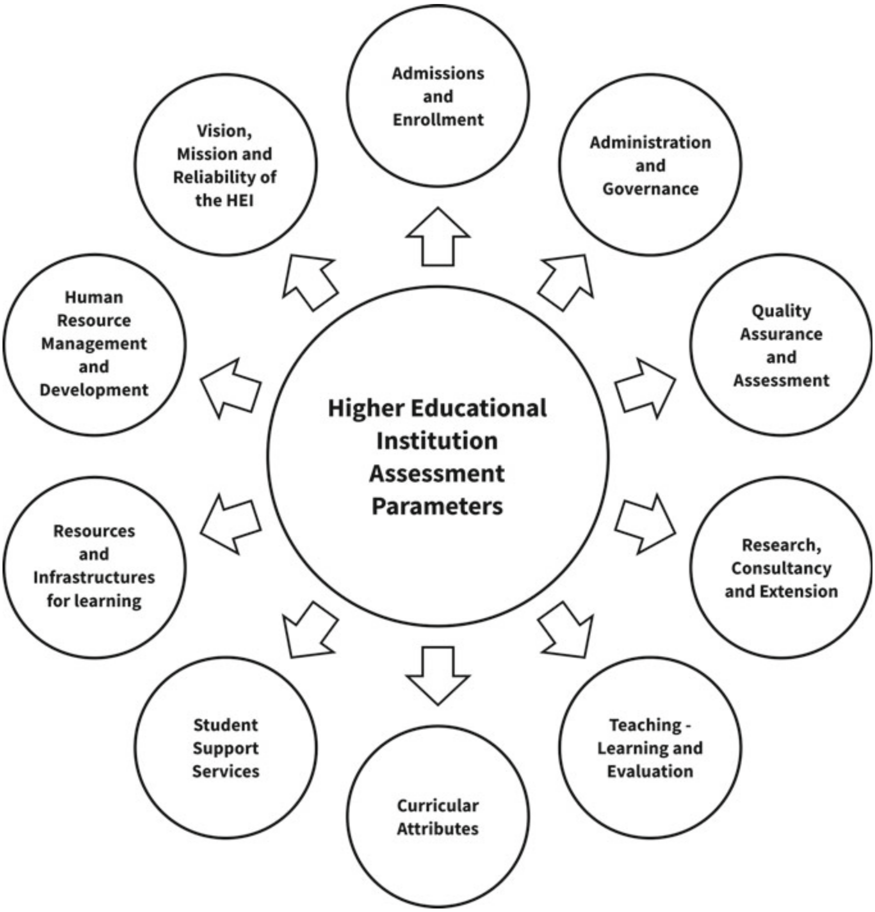

Fig. 1 Higher education institution's quality assessment model

With the increase in competition in the field of education, many state private universities were opened in the State of Uttarakhand. These universities are catering to the needs of the students and shaping themselves in different ways to attract the students. The enrollment in any universities basically depends on major factors like enrollment policies, process, financials like fees, scholarship along with student welfare schemes and the facilities like infrastructure, faculty, industry-academia interaction, and placements.

In this world of digital innovation, the youth nowadays have been trying to break the traditional ways of selecting the higher education institutions for their education through search on digital platforms provided by the institutes and other digital resources. In fact, there are few parameters in the above-mentioned model (Figure 1.0), and the information of these parameters is usually available on the institute website supported by other digital knowledge portals. Among these parameters, the students look for admissions and enrollment process with all its attributes like fee, tuition fee, scholarship, admission policies, current strength of students, and gender diversity. In this paper, an attempt is made to support the students' search by grading a few selected universities based on enrollment criteria.

1.1 Contributions of This Paper

The remainder of the paper is organized as follows to find the perfect model to assess the service quality in higher (HEIs) and to do the grading in each area.

2 Related Work

Education is an integral and essential part of life for every human being, and holds significant importance in equal measures for both students and parents. The quality assessment of higher educational institutions, however, is tricky, and has been assessed using different methods by several researchers. One prominent research says that to achieve a high standard of education, we need to apply specific rules and advanced technology with good learning outcomes [1]. The Higher Education Quality Assessment Model (HEQAM), proposed by another researcher, is developed to apply for upliftment of university services and contributes to the quality again. This is required as there is no unified quality standard model to evaluate the quality criteria in higher education institutes [2].

To standardize the quality, there are few parameters that are defined such as quality control (Process in the HEI for benchmarking and uplifting the quality of their provisions), quality audit (Audit of external scrutiny provides guarantees that institutions have quality control systems in place) quality assessment (It helps to get review and suggestion about the quality of teaching and learning in institutions) [3].

The global education industry has been transforming at a high speed, and Indian institutions are in the process of catching up, with several initiatives by the Government for maintaining quality. The literature suggests that the future prospects of Indian higher education institutions will certainly depend upon the quality of education [4]. The efficiency of higher education is also reflecting incomplete accomplishments due to the high rate of unemployment among the highly educated people, which can be attributed to the policy failure to imbibe appropriate skills and knowledge. Unfortunately, Indian higher education is still not inclusive, globally competitive, and innovative.

To uplift the quality of education and to compete with global competition, Indian higher education institutions need to regularly update the curriculum and upgrade as per the market future requirement [5]. To deliver quality teaching, professionals need to treat their profession as their passion and change their attitude toward students as the facilitator and supportive to clear their donuts and enrich the young brains to settle in their life. Students need to be aware about the learning of the program so they can focus and learn.

Indian higher education is quality assurance as ideology, technology, and power [6–8]. The three are collectively impacting higher education practice. To improve the quality of higher education, we need to extend beyond the traditional paradigm of higher education quality assurance and move toward quality culture (Tables 1 and 2).

Table 1 A brief survey of higher education service quality models

Authors	Year	Purpose of the model
Siddiek [1]	2012	Strategic quality management in the Arab higher education institutes: a descriptive and analytical study
Noaman et al. [2]	2017	Higher education quality assessment model: toward achieving educational quality standard
Wariyo [3]	2020	Higher education quality assessment in Ethiopia: a comparative study
Joshi et al. [4]	2019	Higher education in India: issues related to access, equity, efficiency, quality, and internationalization
Potluri et al. [5]	2019	Students' perception on quality of Indian higher education system
Yingqiang and Yongjian [6]	2016	Quality assurance in higher education: reflection, criticism, and change

Table 2 Questionnaire used for quality assessment model for grading based on enrollment attribute

S. No	Questions
Q1	Openness and fairness in admission policies
Q2	Quality of counseling and guidance provided during the admission process
Q3	Equity/equality of admission processes
Q4	Centralized admission process and reporting procedure
Q5	Conduction of entrance examinations (national level)
Q6	Transparency in evaluation of entrance examinations
Q7	Exposure to international students
Q8	Procedures and guidelines related to admission of international students
Q9	Merit-based admissions
Q10	Availability of programs, fee, facilities available and faculty details
Q11	Use of user-friendly information and communication technology (ICT) during admission process
Q12	Financial support for the backward classes
Q13	Scholarship policies and guidelines
Q14	Merit-based scholarships percentage versus fee paid students
Q15	Innovative scholarships for the meritorious students
Q16	Unique welfare schemes for the under-privileged students
Q17	Regional priority for students in admission
Q18	Admission policy for corporate employees (part time)
Q19	Facilitating of campus visit and tour during the admission
Q20	Ease of documentation work (hard copies of academic documents) during the admissions
Q21	Special support during admission process for differently abled students
Q22	Teaching faculty involvement in admission process
Q23	Pre-admission support in terms of coaching and guidance
Q24	Post-admission support in terms of coaching and guidance

3 Methodology

The adopted method for statistical analysis for grading the private universities of Uttarakhand by selecting eight private universities, three universities among the selected are accredited by the National Association of Accreditation Council (NAAC), two universities are young and opened two years back, and three universities are present since around ten years and yet to be accredited.

3.1 Questionnaire

The grading analysis begins with developing a questionnaire to collect the data from various primary and secondary resources. Enough care is taken to include gender diversity, age diversity, and demography while collecting the data. Each response for every item is recorded on a Likert Scale 1–5.

3.2 Cronbach's Alpha Reliability Test

The response metrics of all the responses recorded on the Likert scale are tested for reliability using Cronbach's Alpha Reliability method, and the results are mentioned in the Eq. (1).

$$\alpha = \frac{K}{K-1}\left[1 - \frac{\sum S^2 y}{S^2 x}\right] \tag{1}$$

where

K is the number of test item
S^2y is sum of item variance
S^2x is the variance of total score

The values obtained from the reliability test are discussed in the results section.

3.3 Factor Analysis

Factor analysis is a data reduction technique that boils down many variables into a handful of comprehensible underlying factors. In a simpler sense, it is a way to take mass of data and shrink it to a smaller dataset, i.e., more manageable and more understandable. In our methodology, the variables content in the questionnaire are reduced to four factors. Factor analysis [9, 10] has been used by researchers in several domains, including assessment of groundwater quality in a Blackfoot disease area in Taiwan, and we find that the tool serves the purpose of our study and thus has been used in the present work (Figs. 2 and 3).

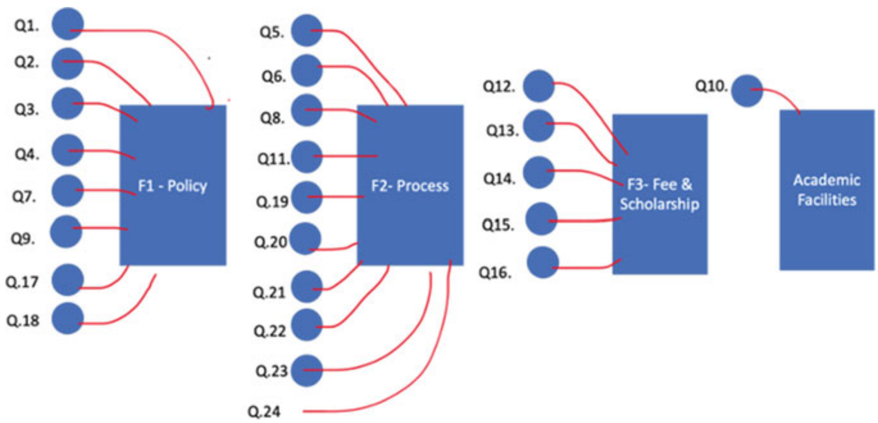

Fig. 2 Table of the dimensionality reductions in the study

24/4
F1- Policy (8)
F2- Process (10)
F3- Fee & Scholarship (5)
F4- Academic Facilities (1)

Fig. 3 Representation of the response metrics to four predominant factors

3.4 TOPSIS Method-Technique for Order of Preference by Similarity to Ideal Solution

The reduced four factors will be the basis of grading of the selected universities based on the enrollment. Among the various techniques available for grading, we chose the TOPSIS method due to its simplicity, rationality, comprehensibility, good competitional efficiency, and availability to measure the relative performance of each alternative in a simple mathematical form. TOPSIS has been used by researchers in several domains including conflict resolution, learner satisfaction, and assessment. This multi-criteria decision-making (MCDM) provides a foundation for selecting, sorting, and prioritizing materials and helps in the overall assessment. The core concept of this technique is that the chosen alternative should have the smallest geometrical distance from the positive idea solution and the largest geometrical distance from the negative ideal solution. The steps for calculation are as per below:

Step 1: Calculate Normalized Matrix

Step2: Calculate Weighted Normalized Matrix

Step 3: Calculate Ideal best and ideal worst value
Step 4: Calculate the Euclidean distance from the ideal best (Si)
Step 5: Calculate Performance Score
Step 6: Grading (Gi) = Descending Order of Performance Score (pi), Range 1 to 8 results.

4 Results and Conclusion

We have used the Chronbach's Tool for checking the reliability of our model. The standard reference table for the same is produced in Table 3.

Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. It is a measure of scale reliability. The calculated value for the reliability of the responses received as per the Cronbach's Alpha Reliability Test is found to be 0.92 as shown in Table 4, and we could conclude that the questionnaire response reliability can be considered excellent for the sample data.

The results obtained by response metric testing, to calculate the respective rankings of the university based on the questionnaire responses by the stakeholders using TOPSIS method is tabulated in Table 5 as shown below.

The analysis shows that the grading of the selected private universities in the state of Uttarakhand is well justified, since the top graded university is recently ranked by NAAC as A+ grade followed by other universities having met their targets of admissions in the recent years.

Table 3 Reliability test—Cronbach's tool

Cronbach's	Internal consistency
0.90 and above	Excellent
0.80–0.89	Good
0.70–0.79	Acceptable
0.60–0.69	Questionable
0.50–0.59	Poor
Below–0.50	Unacceptable

Table 4 Result of the reliability test for the response metrics

S. No	Tool used	Result orientation
1	Reliability test for likert scale (Cronbach's alpha reliability test)	0.92

Table 5 Representation of response metric using TOPSIS method

University	F1 (Policy)	F2 (Process)	F3 (Fees/scholarship/welfare scheme)	F4 (Academic facilities)	Si+	Si−	Pi (Performance score)	Rank
U1	0.04935	0.08528	0.21433	0.10141	0.09740	0.15999	0.62158	4
U2	0.09128	0.04264	0.07144	0.10141	0.17254	0.05654	0.2468	8
U3	0.09128	0.08528	0.21433	0.0676	0.07102	0.16115	0.69409	2
U4	0.13693	0.1279	0.14288	0.10141	0.07144	0.15021	0.6776	3
U5	0.09128	0.08528	0.07144	0.0676	0.15956	0.06092	0.27630	7
U6	0.08574	0.04170	0.13228	0.06405	0.13483	0.17519	0.56509	5
U7	0.08111	0.07698	0.06499	0.0866	0.1680	0.1556	0.48089	6
U8	0.10939	0.07184	0.17033	0.07947	0.07949	0.2290	0.74233	1

The study is presently limited to only a single criterion for the NAAC and is based on enrollments. The assessment of quality for the higher education institutions is a complex framework, and the present work just lays the foundations for our future research in connecting all the criteria of NAAC accreditation to the perceived quality of the technical higher education institutions in the state of Uttarakhand.

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Optimal Route Locator Mobile App for Timber Depots Using Shortest Path Algorithms

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Abstract Government timber depots provides the citizens with the various kinds of timber available at their required quantities. Usually, the customer travels to their nearest timber depot available to buy the timber. A mobile application for timber depot management will make the process of buying timber so simple that they can order any kind of timber. Usually, tendering process will take place in Government depots in order to buy timber, so in our mobile application the user will send a mail to the Principal Chief Conservator of Forests (PCCF) for requesting to participate in tendering. This app is developed as per the requirements given by APSAC. This app provides details on various timber depots available in the districts of Andhra Pradesh. It has the features such as information on types of timber depots, locations using maps, quantity of timber available in each depot, and price of the timber. Such information not only saves the time for the user but also price comparison can be made from this application. Users can place the order for the amount of timber. Government officials can track each timber depot and control the prices as per Government rates. Each person could be furnished their logins for acting diverse transactions together with putting orders, updating information, monitoring the orders. Apart from Android Studio in Java, Firebase, graph algorithms such as Dijkstra's algorithm and A* algorithm are used to calculate the shortest distance from a Point X to Point Y in Google Maps.

Keywords Mobile application timber depots · Geo locations · Optimal path · Mobile interface · Google maps API · Dijkstra's algorithm · A* algorithm · Firebase

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1 Introduction

1.1 Basic Concepts of the Work

The set of strategies and techniques concerned in constructing software program program utility application for small, Wi-Fi computing devices, inclusive of clever telephones and specific transportable devices, is called cell software program program utility improvement. When a program had to be cross-platform and run on many working systems (OSes) with inside the past, there has been possibly little, if any, code reused from the preliminary improvement assignment. The aim of this paper is to provide a mobile application that acts as an interface among the Government wooden depots and residents who need to shop for wood. This lets in developers to use a single codebase for Apple iOS, Google Android and contemporary internet apps (PWAs). The goal of this paper is to layout and area into effect a mobileular software program application that acts as an interface among the Government wooden depots and residents who need to shop for wooden. Figure1 provides Andhra Pradesh Districts Map objectives to create an interface for verbal exchange among Government, depots and the user. Figure2 depicts the cell app improvement process, which incorporates approaches together with strategy, planning, design, app improvement, testing, and deployment.

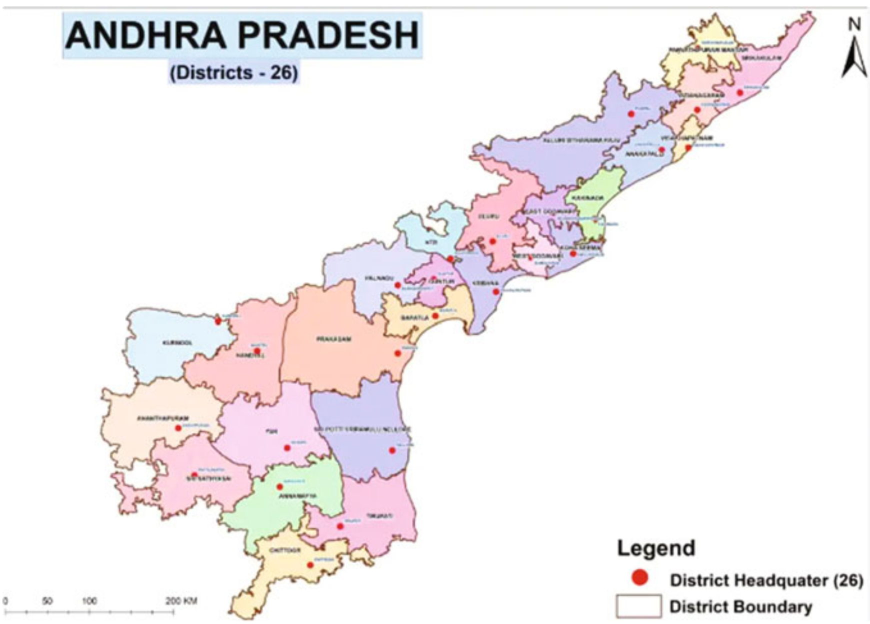


Fig. 1 Andhra Pradesh districts map [1]

Fig. 2 Mobile app development process [2]

1.2 Motivation

Providing timber depot information is the primary duty of any Government to the public. Such information in the form of mobile app even more will help both Government and citizens in a user-friendly manner. As our title name is mobile application for timber depot management for Andhra Pradesh Space Application Center (APSAC), it says that it is a mobile application for APSAC for identifying various timber depots and the price and quantity of timber available in various depots and also finding the optimal path between various depots and user's location using maps.

1.3 Problem Statement

In the real world, the customers are suffering with ordering the timber from timber depot and they don't know how much quantity of timber is present in Government depots. Also, they don't know the cost of the timber and the customers are facing the problem of shortest path of timber depot. This work is developed for Godavari district timber depots based on the requirements given by Andhra Pradesh Space Application Center (APSAC). This application is user friendly where the buyer can simply sit and explore all the depots available in their district. They can check the prices of the timber and can find the shortest path to timber depot.

1.4 Objectives

The main objectives are:

- Identify the timber depot districts
- Display the routes from forest to depots in the districts
- Various transaction by the user and Government officials to update corresponding to timber depot such as quantity of timber, price in each depot, accept the requests
- Find the optimal route between the user location and the depots.

1.5 Organization

The paper is organized as follows: Literature review on various types of timber depot management is described in Sect. 2. The suggested framework is described in Sect. 3. Results and discussion are provided in Sect. 4.

2 Literature Survey

The technique in [3] is to locate the shortest route and practice Dijkstra's set of concepts to lessen the full fee of a route, where in the full fee may be the excursion distance or time. They additionally mentioned how shortest paths may be hired in the actual international to keep time and enhance tour efficiency. With Dijkstra's algorithm we are able to locate the shortest direction from a start line node to every top notch node in a network. Many blessings may be received even from statistics. For example, the shortest or fastest manner in an excursion direction can lessen excursion time, power, and gasoline consumption, and the density of automobiles on pleasant quantities can decompose. The finest drawback of the set of regulations is that it plays a blind hunt down there, ingesting a sizeable quantity of time and losing precious resources.

The technique in [4] is the general purpose of GPSTRACK, that is to apply GPS era to help in enhancing transport logistics and decreasing prices in the Irish wooden hauling business. The portray represents a massive leap forward with inside the more and more famous integration of statistics era with the Irish wooded area industry. In particular, this work, which becomes achieved in collaboration with the organization and the Forest Industry Transport Group (FITG), evaluated the cap potential for the usage of GPS asset tracking gadgets from a monetary standpoint. The advantages are that the effects had been applied to decide the usefulness and value of such GPS tracking gadgets. Installation of GPS Hardware and Truck Specifications are the disadvantages.

The approach in [5] is that they created reference implementations for format the use of Solidity and deployed them over the ethereum blockchain. It uses practical parameters and indicates that the prototype is a likely possibility to fashionable a couple of database systems in contexts wherein in data integrity is a strict requirement. The blessings are as follows: Digitization of data, increased traceability of goods, Transactional non-repudiation, extended transparency, and get proper of get right of entry to facts for customers and Government alike. The risks are confined ability to show transaction data and metadata with inside the supply chain, confined ability to soundly percentage facts among a couple of trust horrible parties (humans-auditors, humans–humans, and humans-customers).

The technique in [6] is an advanced ant colony optimization algorithm. A set of guidelines is used to give the shortest distance and at the same time ignoring the vacationer experience. People's preference of tourism vacation spot is closely stimulated with the aid of using contextual information of scenic spots, so the pheromone replace technique is blended with contextual information. The effects of the experiments advocate that the optimized tourism course considerably improves the vacationer experience. The course duration is decreased with the aid of using 25%, at the same time as the convergence velocity is elevated with the aid of using 21.2 percent. The following are the disadvantages: Additionally, the ACO set of regulations consists of flaws, along with a loss of pheromone in the preliminary diploma of route construction. The price of evolution may be extraordinarily slow.

The paintings mentioned via way of means of [7] will clear up the shortest direction trouble, the authors examined the Dijkstra's Algorithm, Floyd-Warshall Algorithm, Bellman-Ford Algorithm, and Genetic Algorithm (GA). The GA framework for locating the maximum brilliant answers to the shortest direction trouble is described. The effects of reading Dijkstra's, Floyd-Warshall, and Bellman-Ford algorithms on their time complexity are discussed. The advantages are as follows: It is able to resolving any optimization trouble that may be described in phrases of chromosomal encoding. It solves a trouble via way of means of providing diverse options. The negative aspects are as follows: When positive optimization troubles cannot be resolved, they are known as model troubles.

The method in [8] is that trees which have grown for lots of years; a few are included for source internal limited areas, and others are either fallen down or smuggled. Watching for those unlawful spots may be very hard and additionally very dangerous. It is pretty not possible for rangers to patrol each access and go out factor of forests that covers hundreds of squared kilometers. Applying Internet of Things (IoT) generation to ecological forestry, illegal logging normally makes a specialty of high-cost species and outcomes in a selective clearing of positive species. Deforestation is the lack of biodiversity and the emission of greenhouse gas.

Authors of [9] studied to research the guidelines so as to assist in growing the sales, constraints confronted via way of means of the wood land officers and intermediaries with inside the take a look at area. For this cause, three primary depots having maximum sales realized after income from Canara circle had been selected. Secondary facts had been accumulated from the statistics of the land wood depots for the duration of 12 years (2005–06 to 2016–17) and number one facts had been accumulated to understand the limitations confronted via way of means of the woodland officers and intermediaries. Compound increase price evaluation and Garrett's rating approaches were hired to examine the facts. The advantages are easy to collect. The outcomes found out that nice and large increase in price for sales in Dandeli forest timber depot at the same time as increase price for sales in Kirwatti and Chipgi wood land wood depots had been negative. The disadvantages are lack of understanding approximately auctioning became the most important constraints confronted via way of means of the intermediaries in shopping for the wood.

The methodology in [10] is the paintings give a newly shortest direction set of rules aiming on the factor-to-factor issues in visitor's network. The set of rules uses the axiom that distance is much less than direction primarily based totally at the traits of transportation network. Dijkstra indicates the validity and performance of the proposed set of rules. It also save tour time, power, and much less gas consumption, and the density of motors on positive segments can decompose. It does a blind seek there via way of means of eating plenty of time waste of essential sources. Ant colony optimization which is reported in [11] is used by [12] to place virtual machines in cloud. Timber tracking systems for the countries such as Africa, Asia Pacific, and Latin America/Caribbean are reported in [13].

The proposed system is implemented using Android Studio, Firebase (Real-time Database), Android Virtual Device (Emulator), and Google Maps API.

3 Proposed System

The architecture of the suggested system, the methodology utilized, and the dataset used are all described in this section.

3.1 Architecture

The proposed system clearly describes the whole process of what will be happening in the application from the start to the end exactly in the way mentioned in the methodologies. Figure 3 presents the proposed system model for the mapping of the entire client and depot member.

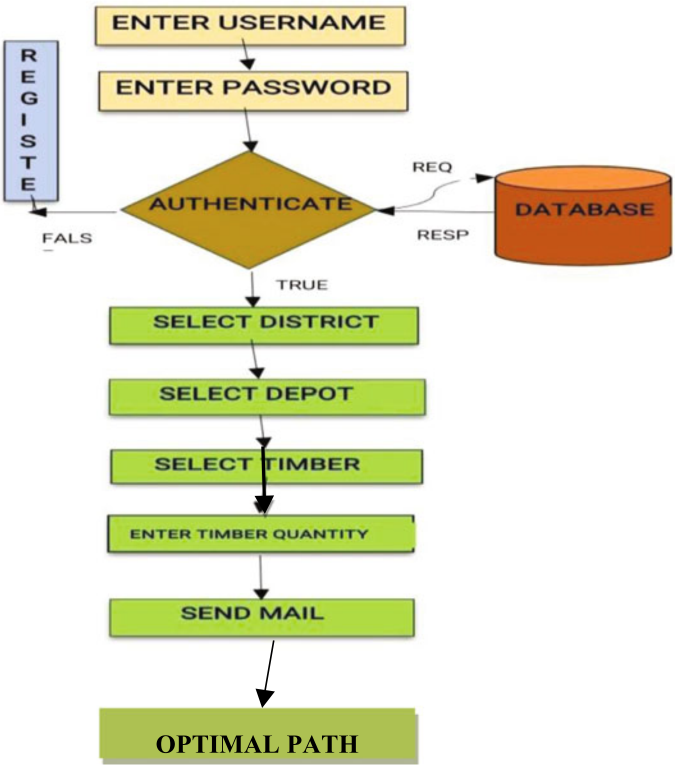


Fig. 3 Proposed system of the timber application

3.2 Methodology

The proposed system has the following modules:

1. Creating the Registration page: The registration page is the primary element you will see while you operate our tool. In this screen, the consumer has to input credentials along with username, email address, phone number, and password, and then click on the register button. The individual will thereafter be efficiently registered.
2. Creating Login Page: The customers who are already registered will immediately come to the login page through clicking the login button that's at the bottom of the registration page. Here, the person enters the Email Id and the password with which he/she registered. Then they will be logged into our application.
3. Sending Mail to the User to change the Password: If a user forgets his or her password, he or she can simply click the lost password button at the bottom of the page and input either an email address or a phone number, to which we will send a link to change his or her password so that he or she can easily login again.

4. Connecting our Application with the Database: Firebase is a platform introduced by Google in which any type of application from web, iOS, or Android, no matter which programming language is used for development can be connected to it for database connectivity. Firebase provides two types of databases: Firebase Real-time Database and Firebase Cloud Firestore Database. In the current methodology, Firebase Real-time Database is used.
5. Storing User's Data in Firebase: The firebase authentication is one of the best and easy way for developers to create authentication-based applications. It provides wide range of authentication methods from email, phone number, and also other social media site authentications such as Facebook and Twitter.

The Firebase Real-time Database is a cloud solution that is proposed by Google. It is an NoSQL document typed database in which all the statistical data exchanging between the end user and the cloud is updated in real time. No matter your device is turned off or on, the data is perfectly updated to the go, hence the name Real time.

6. Querying: The user queries all the districts in the Andhra Pradesh which have timber depots to select his desired district. After selecting the desired district the user queries the available timber depots available in the selected district. After selecting the desired timber depot the user selects the type of the timber he wants from the list of timber types available in the selected depot.
7. Google Maps API: Graph Algorithms such as Dijkstra's algorithm, A* algorithm are used to calculate the shortest distance from a Point X to Point Y in Google Maps. A graph can be described as a collection of nodes in which all are connected by means of edges and vertices.
8. Dijkstra's Algorithm

    a. Consider a Queue Q and an empty set S and a weighted graph G which has weights for each edge present in that and a dis array that is used to store distances of all nodes from a start node.
    b. Consider a start node and make its distance as 0 in dis array, add this to the set and add it to queue.
    c. Choose one of the adjacent nodes to the start node whose weight from initial one is the minimum. Visit that node, update the dis array and add it to the set S.
    d. When the queue Q has elements in it, pop a node which is not in S and update the values as mentioned above and keep on repeating the process until there are no more nodes present in the queue Q.
    e. At any instance of updation or relaxation, it should follow the condition that $dis[v] + weight of node(u,v) < dis[u]$ then this value should be updated.
    f. Finally the dis array will contain the shortest distance from one point to all other nodes in the graph.

9. A* Algorithm

    a. Initialize the open list

b. Initialize the closed list positioned the start node on the open list (you can leave its f at zero)
c. On the identical time because the open list isn't empty
   a. Find the node with the least f on the open list, call it"q" b) pop q off the open list
   b. Generate q's 8 successors and set their parents to q d) for each successor
   c. If successor is the cause, stop seek
   d. Else, compute every g and h for successor successor.g = q.g + distance amongst successor and q successor.h = distance from cause to successor (This can be completed using many ways, we recap in a position to talk three heuristics- Manhattan, Diagonal and Euclidean Heuristics) successor.f = successor.g + successor.h
   e. If a node with the same feature as successor is with inside the OPEN list which has a lower f than successor, by skip this successor
d. If a node with the same feature as successor is with inside the CLOSED list which has a lower f than successor, by skip this successor otherwise, add the node to the open list end (for loop) e) push q on the closed list end (on the equal time as loop)

10. Dataset Collection: Timber depot's dataset collection as shown in Fig. 4.

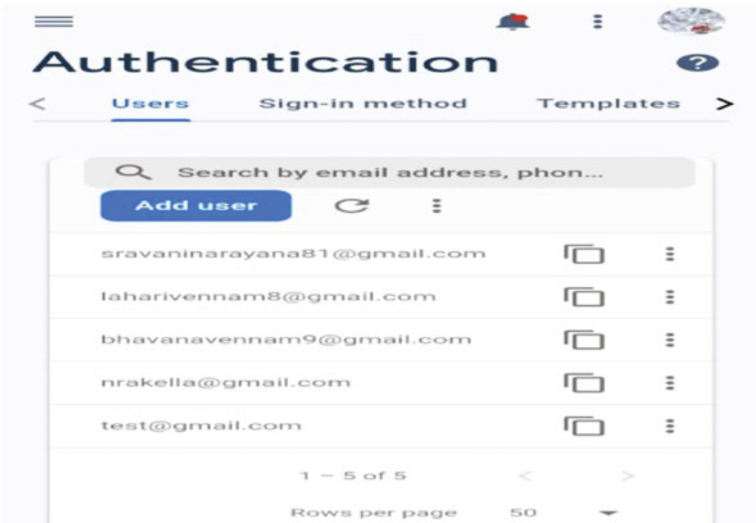


Fig. 4 User's data in firebase

4 Results and Analysis

The outputs and findings of the suggested system are presented in this section. The division displays the output screenshots are shown in Figs. 5, 6, 7, 8 and 9.

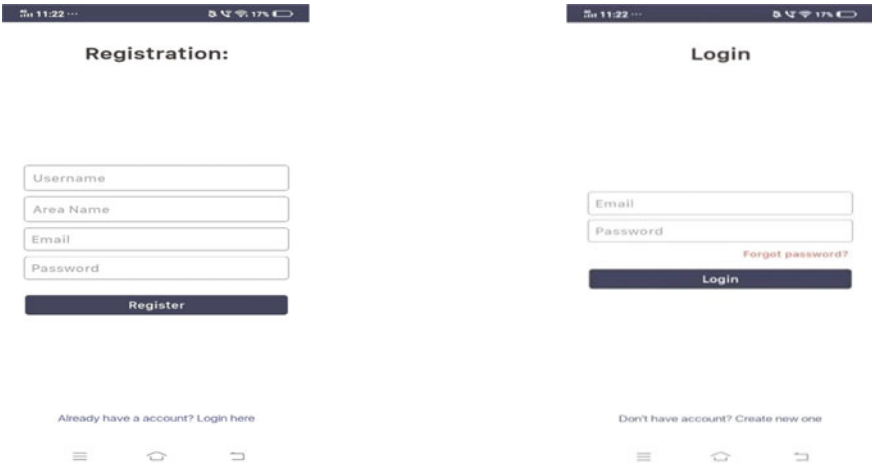
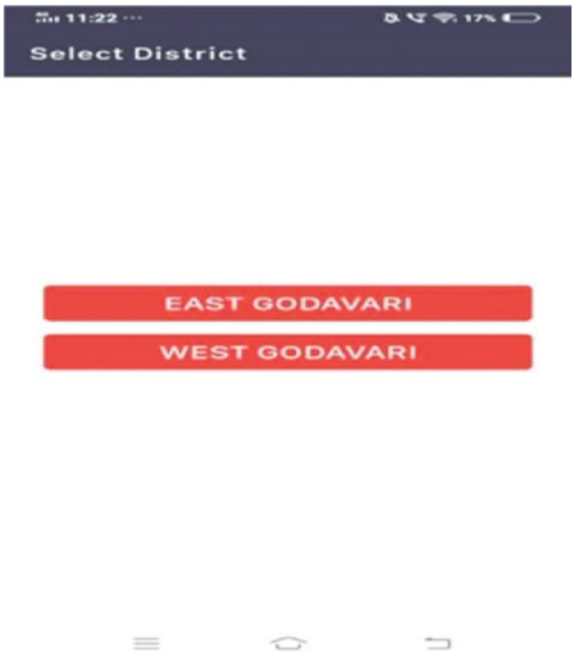


Fig. 5 Home page of the timber depot

Fig. 6 User selection of districts and depots



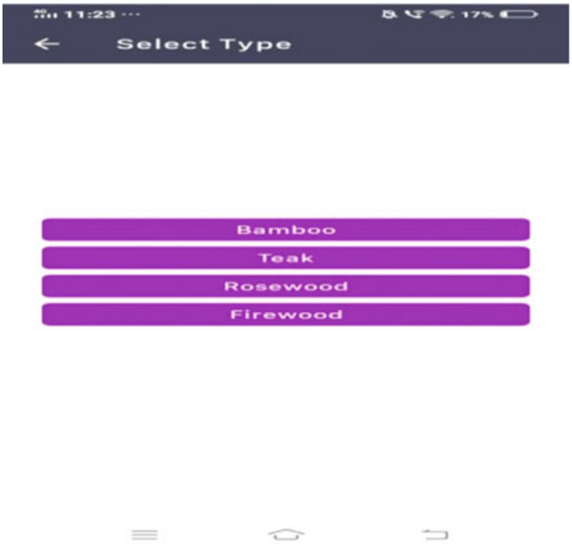


Fig. 7 Timber selection

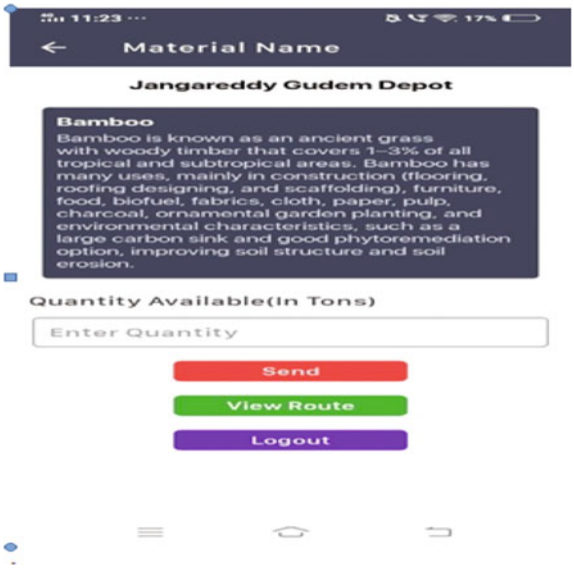


Fig. 8 Send email to PCCF

5 Conclusions and Future Work

Nowadays, everyone is busy in their own lives. Everything is Online now they can simply sit at their homes and order their needs. But buying wood or any kind of timber needs traveling and searching for the good quality of timber. Buying timber in Government depots ensures the quality. Traveling results in wastage of time and

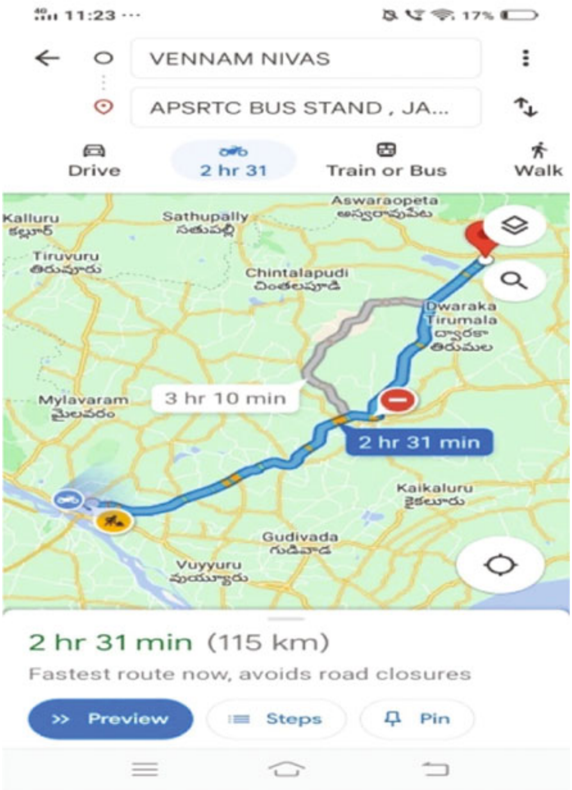


Fig. 9 Optimal Route between users location and depot

money of the user, so our app definitely saves time and money for the user they can simply open our app select their districts, select the depot, and select the timber. This would definitely help the users. User can easily select his district and send a mail to PCCF requesting for the timber needed, and PCCF will send a response back about when the tendering process will take place.

In the future, some of the additional features can be included like, edit and delete the districts, depots, and types of timber. The aim of this paper is to provide a mobile application that acts as an interface among the Government wooden depots [14] and residents who need to shop for wood.

The Firebase Real time database [15] is a cloud solution that is proposed by Google. It is an NoSQL document typed database in which all the statistical data exchanging between the end user and the cloud is updated in real time. No matter your device is turned off or on, the data is perfectly updated to the go, hence the name Real time.

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Risk Prediction Near Dams of Krishna River Using GIS and Real Time Flooding Data

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Abstract India is ranked 90th out of 181 nations in the ranking, which was determined by factors such as exposure, sensitivity, susceptibility, lack of capacity for adaptation, and lack of capacity for climate change response. Location information is crucial since disasters often occur in a particular place and have an impact there. The government may access important facts in layers and make decisions by using GIS Interactive maps, which pop up places through layers and also convey danger in a visual fashion. This application was created for the state of Andhra Pradesh at the recommendation of the Andhra Pradesh Disaster Management Authority (APSDMA), which determines the number of dam gates that should be opened based on the dam's current water level. Here, we utilize GoogleMyMaps to develop informational maps that are interactive that related to the dam. The information that will be shown on the interactive maps is also stored in the MongoDB.

Keywords Geolocations · Risk prediction · Web application · Interactive maps · MongoDB · GoogleMyMaps

1 Introduction

1.1 Basic Concepts of the Work

When water from a stream, river, or other body of water overflows its natural or constructed banks and lands that are usually dry, it creates a flood. Heavy rains or thawing snow are common causes of floods. The most typical hazard is flooding. Flooding can have a very small-scale influence on a single neighborhood or community or a very large-scale impact on entire river basins and numerous states. In order

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to establish how many gates should be opened during a dam overflow, this paper will monitor the water level at dams. It will also determine the height at which each gate should be opened.

From the recent floods we observed the severe conditions people had to face due to improper management of the dam. People and animals lost their life's, all the living standard was disturbed. As they have the potential to suddenly unleash a significant amount of water downstream, dams are easily transformed into a weapon of terror rather than the temple of growth that is intended for them. Keeping this scenario and recent incident in mind, there is a need to develop some proper dam management system. Adam management system is being developed in this project to avoid floods occurring due to improper management of opening and closing of gates of dam. An attempt is made to monitor the water level, depending on which the opening door percentage will be decided.

1.2 GoogleMyMaps

GoogleMyMaps is used to create interactive maps. First step is to gotogoogle.com slash MyMaps hit enter and when you do it'll take you to the right place. Figure 1 represents the interface of GoogleMyMaps.

Click create a new map and it goes to take you to a map relative to where your current location is. Figure 2 represents the current location of the user.

GoogleMyMaps makes it easy to create and share maps online. You can import and edit your maps in bulk through the use of spread sheets and here we are importing

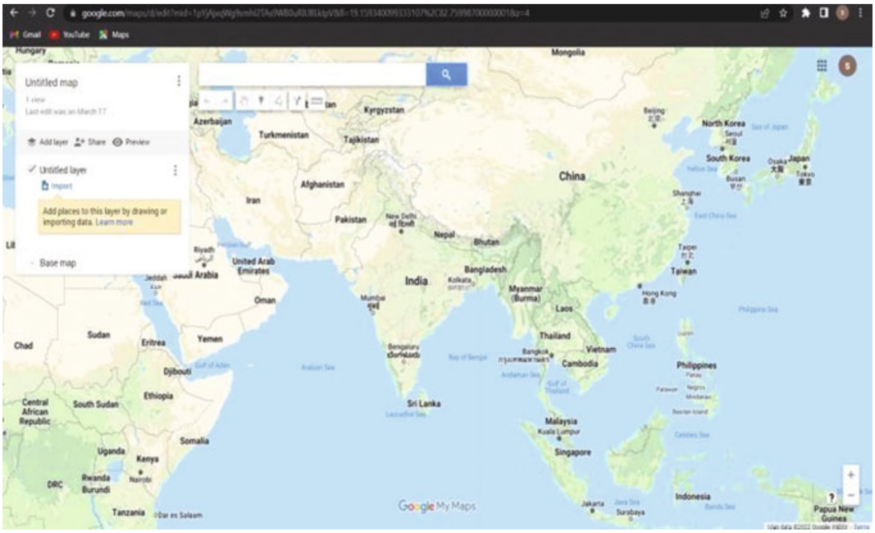

Fig. 1 Interface of GoogleMyMaps

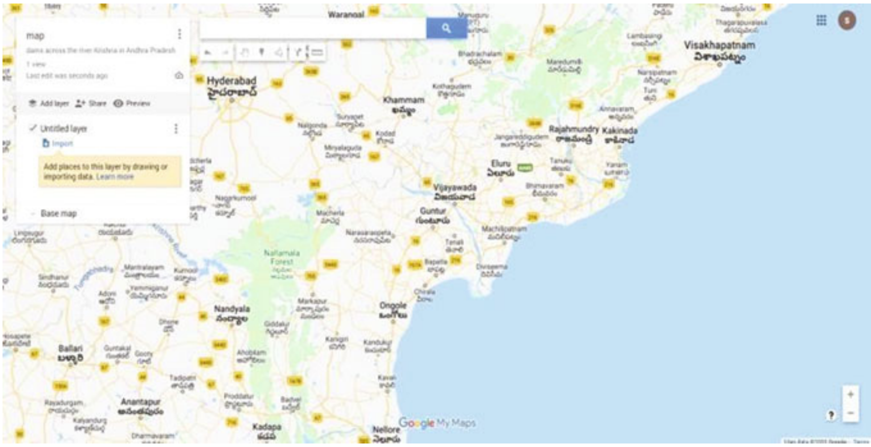

Fig. 2 Current location of user

data through .CSVfile (comma separated values). This file contains data in form of plain text so it is not possible to import images or charts. Figure 3 shows the interface for importing a file.

By using GoogleMyMaps, a map has been created to represent the dams which were constructed across river Krishna in Andhra Pradesh. Figure 4 presents the map of Krishna River and its dams.

This data includes information about dam such as Total storage, Numberofgates, current capacity of water present in the dam, etc. Figure 5 represents dam database.

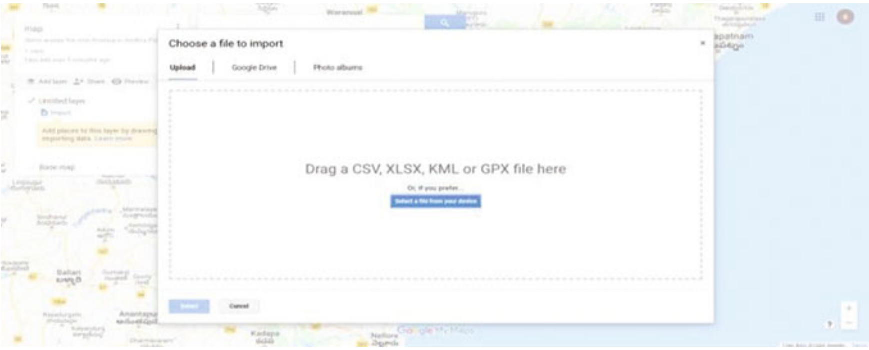

Fig. 3 Importing interface

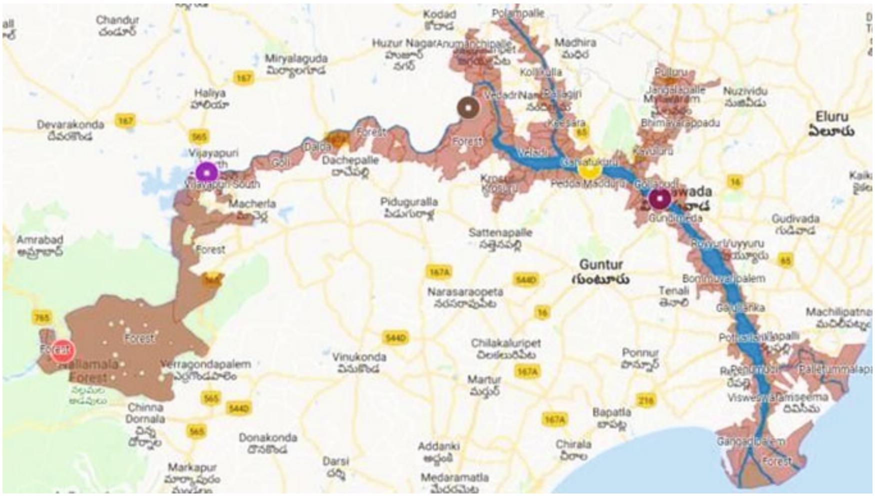

Fig. 4 The map of Krishna River and its dams

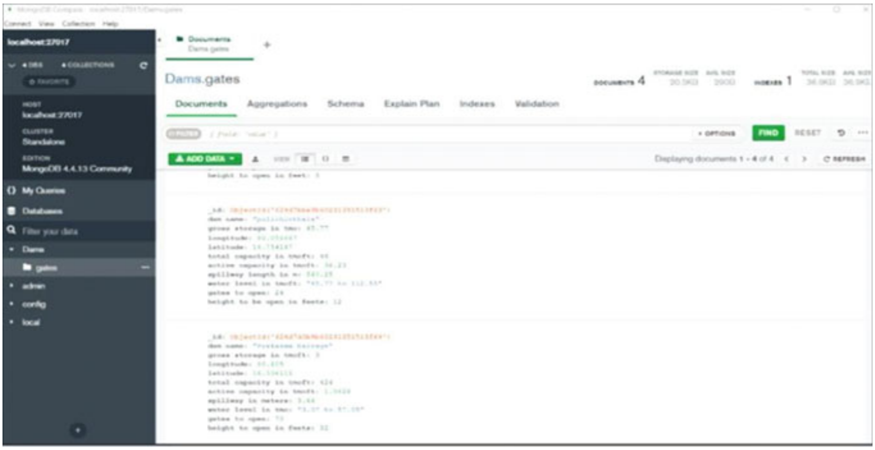

Fig. 5 Dam database

1.3 Motivation

The main motive of our project is to save lives, limit damage. Disaster management contributes to reducing the loss of life from natural disasters as well as the impact of the crisis on the affected areas. In this paper we have created a web application in which all the dams that have been built on the Krishna River are marked. On day, when a particular dam is selected, the data for that dam will be displayed which will help us to estimate how high the gates should be opened based on the water flow, so that we can prevent flooding.

1.4 Problem Statement

There are various effects of flooding. The lives of humans and other species are put in peril, and it causes harm to property. When the lake has reached its capacity, the continued water level in the lake can lead to sudden overflow of the lake. Given its magnitude and the unpreparedness of people living in the surrounding areas, risk analysis must be anticipated to save lives. This proposed system is a solution to manage the situation during a disaster. This system would carefully assess the flooding problems in the state of Andhra Pradesh. This system is developed based on the requirements of Andhra Pradesh State Disaster Management authority (APSDMA).

1.5 Objectives

The main Objectives are:

a. To develop a web application that monitors the water capacity at a dam.
b. To identify when the gates should be opened and how many gates should be opened according to the capacity.
c. To assess how many areas are going to be affected.

1.6 Organization

The paper is organized as follows: Literature review on flood prediction is described in Sect. 2. The suggested framework is described in Sect. 3. Results and discussion are provided in Sect. 4.

2 Literature Survey

Method followed in [1] is using cutting-edge machine learning (ML) algorithms to predict floods and provided an overview of the best fit models. ML models have been compared through qualitative analysis for robustness, accuracy, efficiency, and speed specially studied to provide a comprehensive overview of the different ML algorithms developed used in this field.

Advantages: This can be used as a guide for hydrologists as well as climatologists in choosing the appropriate ML method depending on the forecasting task. Machine learning algorithms are great at handling multi-dimensional and multivariate data, and they are capable of doing so in dynamic or uncertain settings.
Disadvantages: In machine learning, choosing an algorithm is still a manual process. All algorithms must run and be tested on data. This process goes on for a long time. The capacity to correctly comprehend the information produced by the algorithms presents another significant challenge.

In this study [2], they used two data-driven artificial intelligence approaches: Perceptron multi-layer neural network and adaptive neural reliable models for prediction using fuzzy inference systems.

Advantages: The efficient algorithms MLP and ANFIS both generate the required output from the input. The flexibility and quick learning of ANFIS allow it to capture the non-linear structure of a process.
Disadvantages: ANFIS suffers from limitations that cause the application to stop working in case of problems with large inputs. In the MLP algorithm, the computations are long and difficult.

In this study [3], a series ARX model, machine learning based on close support vector regression, and non-linear auto regression models are developed and compared. Groundwater flooding in Ireland's low karst regions can be predicted in linear time.

Advantages: Hydraulic dynamics of high flow piping networks in a more realistic way using network specific morpho metric measurements This is model type seems to work best for simulate groundwater and surface water interactions in karst basins.
Disadvantages: Requires large amounts of structured manual training data. Training must be monitored frequently: training data must be tagged performance cannot be tested or guaranteed for long tail.

The fundamental goal of [4] is to recreate intricate mathematical representations of actual flood processes. Machine learning techniques have aided forecasting system advancements by delivering more effective and affordable solutions. More advantageous and more cost-effective. Therefore, the best short- and long-term flood forecasting techniques are presented in this work. Additionally, the key developments in flood prediction model quality are examined.

Advantages: Because it can categorize and regress data from different sources into classes for floods and non-floods, flood forecasting using machine learning algorithms is effective. ML techniques offer the ability to increase precision while cutting down on the time and expense associated with model construction.
Disadvantages: The challenge of selecting the optimum ML algorithm can be challenging because to the complexity of the data and frequently necessitates trial and error to fine-tune parameters.

The most important contribution of [5] is to construct aversion to expect the upwardthrust of water stage on the river for seven days ahead. They used statistics from climate stations, gauges, and satellites fusing those statistics reasserts in a composite version.

Advantages: AutoML can automate the entirety from accumulating statistics to deploying gadget learning models, so that you can without difficulty make strategic decisions, and it is scalable.
Disadvantage is greater hard to carryout AutoML in dynamic surroundings than in static surroundings, because the environments maintain dynamically changing.

In order to provide a trustworthy and workable solution for damage during floods, this study [6] uses Artificial Intelligence technology. They used the Arduino Uno microcontroller to detect floods solely based on the rise in water level, humidity, air pressure, and temperature as detected by the BMP180 sensor. YOLO's item identification method is used to determine how many people are trapped in flooded locations. Raspberry Pi has been utilized to carry out drone-based total rescue operations.

Advantages: A task can be completed faster thanks to AI. The demand on the available resources is lessened and multitasking is permitted.
Disadvantages: Because AI is always evolving, hardware and software must keep up in order to fulfill the most recent standards. Its introduction will be expensive.

Support Vector Machines, a machine learning technique for making predictions, are used in this work [7] and were coded in Python. Using tracking unique climate characteristics and dam-related data, this notion was used to develop an early flood prediction and warning system.

Advantages: SVM is rather memory-efficient. The multi-dimensional and multi-variety statistics that machine learning algorithms are capable of handling can be handled in uncertain or dynamic contexts.
Disadvantages: SVM set of rules is not always appropriate for massive information sets. And also high algorithmic complexities calls for big memory.

The main methodology defined in [8] is based on time collection forecasting and device getting to know regression algorithms, authors defined a revolutionary multi-approach version water logging prediction framework to expect water logging intensity. The framework combines historic precipitation and water intensity to well-timed expect near time period water accumulation below destiny weather conditions.

Advantages: This framework is beneficial for well-timed and correct prediction of the intensity of goal points. Using multi-standards checks for various factors also can assist pick out hazard areas.
Disadvantages: The sample rate is not constant because of how the flood intensity sensor operates. Because there is a limited selection of water logging sensors, they cannot cover a large region.

The proposed system is implemented using Web-based technology, MongoDB, and GoogleMyMaps.

3 Proposed System

The architecture of the suggested system, the methodology utilized, and the dataset used are all described in this section.

3.1 Architecture

Figure 6 exemplifies the suggested system model. The proposed system first takes the water level of the dam as input and conducts analysis. After getting the output of the processed data, we compare it with the water level of the dam data stored in the database. If the output data is higher than the water level, the valves must be opened. The number of ports that must be opened depends on the output data processed from the input. We have created a map that will display its data on the map.

3.2 Methodology

The proposed system has four modules:

1. Creation of map for dams using GoogleMyMaps. In this module we will create a map to represent the dams of Krishna River in AP and the information related to dams like total capacity, active capacity, spill way, etc. Using GoogleMyMaps.
2. Creating dam database: In this module we will store data related to the dams using MongoDB [9].
3. Dynamic display of data using popup of maps: In this module we will select a dam from the map we created by clicking on it, hence the data related to that dam is displayed on the left side of the map.
4. How many number of gates should be opened and at what height: In this module we will determine how many number of gates should be opened at what height based on the inflow, and also create a map which displays the information related to opening of gates of various dams.

3.3 Algorithms

3.3.1 Algorithm for Creating Map Using GoogleMyMaps

- Prepare the database of dams which contains name of the dam, capacity, spillways.
- Now click “create new map” in the GoogleMyMaps.
- Import the.csv file to represent the dams of Krishna River in the map.
- Now select the fields which should be displayed in the dam information.

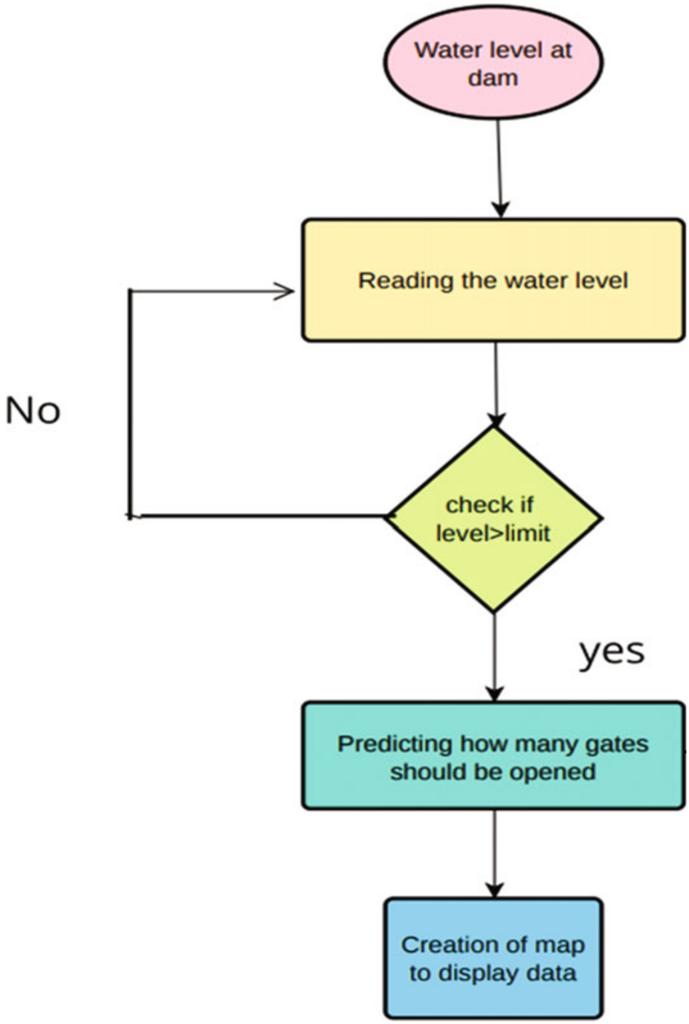

Fig. 6 Process flow diagram

- Now select the field which should be popped up on the map.
- Click on individual styles to change the color, symbol, and model of the pop ups.
- Follow these steps to create maps.

3.3.2 Algorithm for Opening the Gates

1. Take the water level of the dam as input.
2. Analyze the input.
3. Check whether the limit reached the water capacity.

   a. if yes then open the specified number of gates.
   b. if no then close the gates.

4. Create a map using GoogleMyMaps to display the information related to dams.
5. Repeat step 2

4 Results and Analysis

The outputs and findings of the suggested system are presented in this section. The proposed model is able to determine the water layers at the dams tested. It is possible only when we get the map where all the dams built on the Krishna River in Andhra Pradesh are marked. Also when we select a specific dam and the data for that dam is displayed on the left side of the map. Figure 7 symbolizes the data layers used to build the map. Figure 8 presents the map displaying dams.

Figure 8 represents map displaying the dams.

Figure 9 shows how a dam database was created. To do this, we must first establish a connection to local host before naming the database we intend to build. Then, in the following step, we should click the add data option after selecting the document choice from the menu. The next step is to choose the insert document option to enter information about dams, such as the name of the dam, its latitude and longitude, its capacity, the total number of its gates, its active capacity, etc. Figure 9 presents the

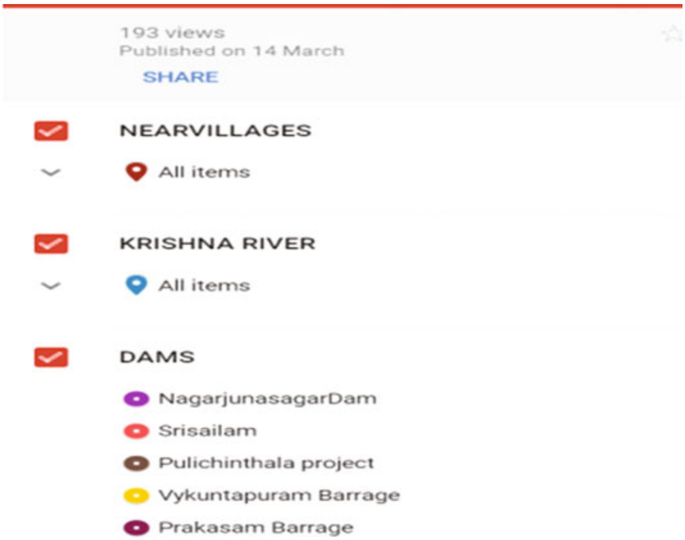

Fig. 7 Data layers used to create map

Fig. 8 Map displaying dams

creation of database. Figure 10 illustrates that how many gates that the particular dam has, what height gates are opened, etc.

5 Conclusions and Future Work

Floods include severe property damage and loss of life. The current warning system is ineffective and not as fast as expected, leading to poor management of flooding during emergencies. A map-based dam management system is being developed under this project to prevent flooding caused by poor opening and closing management of the dam gates. Thus, our application performs analysis of the number of gates that must be opened at a given height by flow, and the generation of maps to display the contents of the dams helps government officials in better management of these flood situations.

Future work is to extend the system for other rivers in the country so that people living near the rivers can be saved with right information in advance.

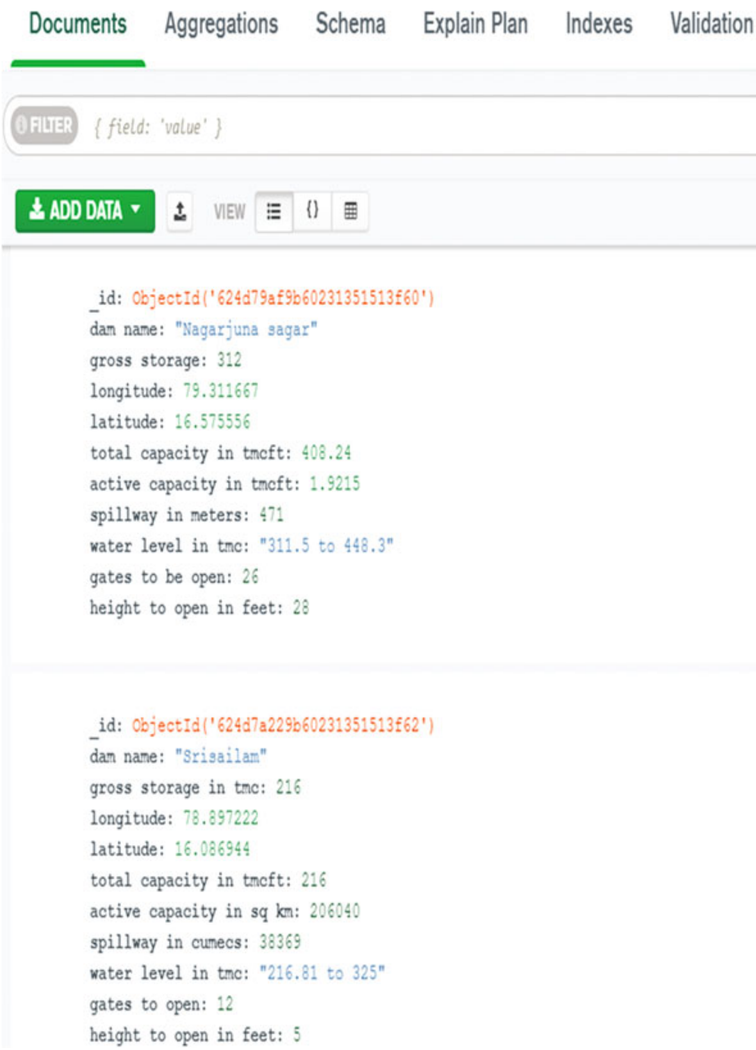

Fig. 9 Creation of database

Fig. 10 Number of gates should be opened

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Challenges in IoT in Higher Education

Deepti Chopra and Praveen Arora

Abstract IoT has contributed tremendously to the development of the society by contributing in the field of communication and information technology. In recent times, there has been tremendous growth in the field of Information and Technology. IT has impacted everyone's life in some way or the other. One such thing it has taught us is that 'everything is possible, it only takes our willpower to do it'. In the recent times, there has been unimaginable success especially in the IT and education sector. The following paper discusses how to maximize the impact and benefits of IoT in higher education and minimize the risks involved.

Keywords Internet of Things · IoT in higher education · IoT as a global network

1 Introduction

In this era, people have learned to grow with advancement in information and technology. With the Internet and IoT connected, it made impossible things possible and the results were achieved with great success. Internet of people can be defined as the process of connecting people and things on the Internet. IoT has brought about a technological revolution that involves interaction between people, things and the environment. Using the Internet and online meetings, it has become possible to conduct online classes, workshops, seminars, conferences, examinations, etc. very easily, effectively, and without any hassles.

The communication models given by the Internet Architecture Board that describe IoT characteristics include the following: Device-to-device communication model is a collection of two or more devices that are directly connected to each other and communicate through IP networks and application servers such as the Internet. For example, it may be possible for students to conduct practical online for two labs and

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have them share the results online. The use of IoT has not hindered the achievement of higher education, rather the process of delivering higher education has been enhanced by the use of IoT. The device-to-cloud communication model is based on the idea that devices are connected to an Internet cloud service. For example, with its help, a faculty is able to upload all the study material to the cloud and even the college can arrange online study material or books for the students on the cloud, which they can easily access.

The device-to-gateway model is an intermediate between cloud computing services and Internet devices and performs functions such as security, protocol, and data translation, etc. Security features are very important in many aspects. Like the student will be able to see only his marks.

- The back-end data-sharing model allows the user to export data from cloud services and other sources. For example, after the college library or faculty uploads the study material to the cloud for the students, this study material can be exported and can be useful for all the students to understand the lesson and pass the exam. IoT has proved beneficial not only in the field of education but also in transportation, energy, business, home, and other sectors.

IoT is a global network that connects things, devices and objects to the Internet and communicates within an external or internal environment. It involves the exchange of information through information sensing devices using specific protocols [1]. This is shown in Fig. 1. It is an extension of the Internet-based network that provides an extension of human to things, human to human and things to things communication. It is shown in Fig. 2. It is called the Internet of Everything. The Internet of Everything provides an insight into the fact that today the Internet rules every component. Human beings, processes, things and also relationships exist among themselves and they are all connected using Internet.

Applications of IoT

IoT today has emerged as an efficient field in all walks of life. It is not just higher education that has been affected by the advent of IoT. Other topics in which IoT is popularly used these days include the following: Safety, health, and well-being of human beings—These days IoT is extensively used in the medical field.

It helps in early and accurate diagnosis of patients. It has helped in achieving better understanding between patient and physician by providing timely and quality treatment to the patients.

Agriculture—IoT has empowered millions of illiterate farmers with information about best and worst yields and the easiest and fastest ways to expand their business and make their products available in the markets.

Irrigation—IoT has played an important role in educating farmers about freely available government schemes and policies, so that they can increase their yield.

Transport—IoT has been beneficial in the field of transportation. This has resulted in timely and safe travel of goods and persons. Groundwater Management—Has been instrumental in dissemination of important information among the general public.

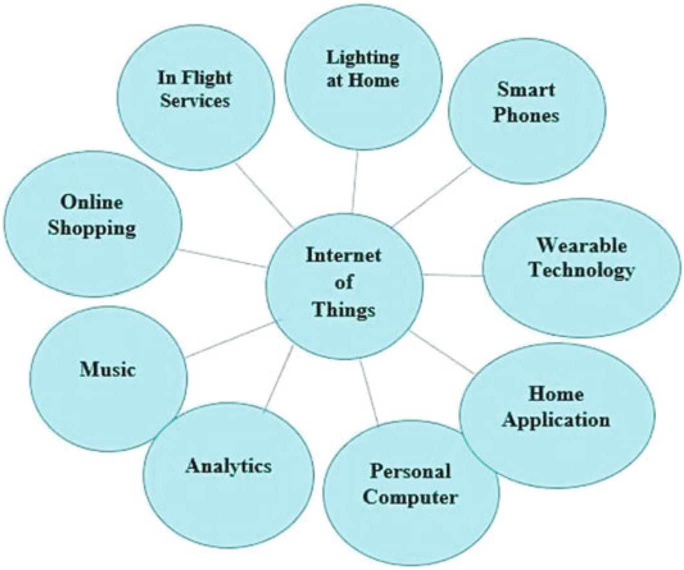


Fig. 1 IoT as a global network

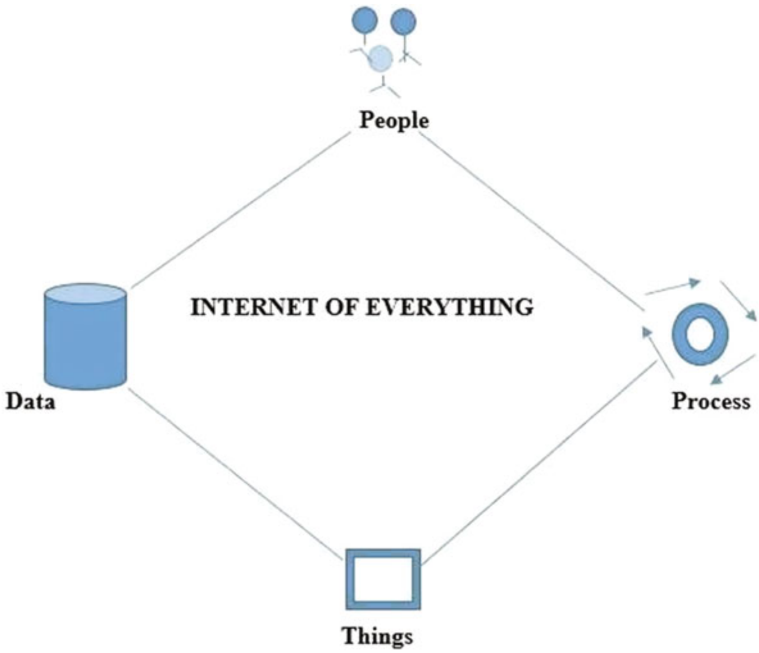


Fig. 2 Internet of everything

Waste Management—IoT has been a boon to all of us. Waste collection, waste treatment, and waste management are all managed by IoT Traffic Management—IoT has helped in avoiding major accidents, traffic jams, and helped all commuters to take advantage of smooth and convenient travel.

Smart Cities—IoT has played an important role in realizing the dream of Smart City. The objective of Smart Cities is to improve the quality of life of the common people by providing improvement in the local area which also improves the economic development.

Manufacturing—IoT is also used extensively in the manufacturing sector. It ensures that quality products are made within time and cost and thereby improves the quality of life of the people and improves their economic condition.

Environment Monitoring—IoT is used to control various environmental issues like air quality, pollution, global warming, etc.

Energy Management—IoT has also been very beneficial in the energy sector. It uplifts the people and the region socially, mentally, physically, and economically.

Smart Homes—It is the dream of every person to live comfortably and comfortably in today's time. IoT has helped in achieving both the objectives.

Animal Husbandry—Animal husbandry has always proved to be a business of earning money. IoT has helped and trained farmers on how to grow in the animal husbandry sector.

Education—This is one of the areas which benefit greatly by using IoT. With the introduction IoT nothing has stopped its functioning from online learning to examinations, declaration of results and dissemination of important information is stopped. Rather, by incorporating IoT in higher education, it has made it more convenient for faculties to provide quality education to students, conduct fair examinations and declare results in a timely and fair manner.

In higher education, IoT has an important role in colleges and universities [2–4]. Some of these include:

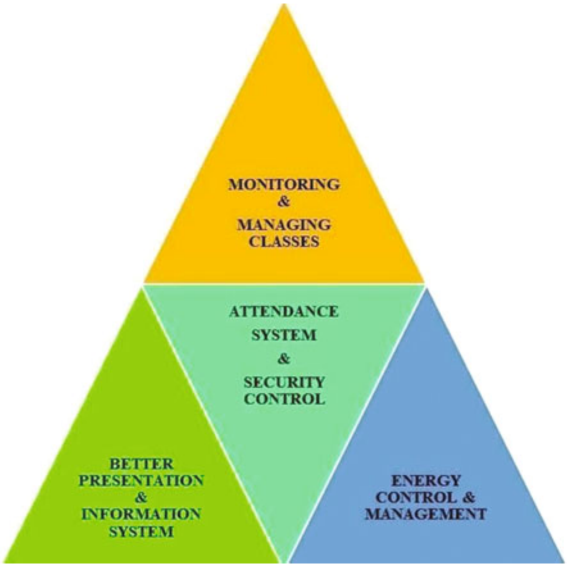
Using IoT, students can be issued smartcards and have access to college campus, laboratories, library, and classrooms [5]. It can help in accessing useful information such as books available and issued in the library, attendance of students, maintaining student records, etc. It may also help to introduce security feature with these smart cards.

When a student enters the college campus, he gets information from the library about the time-table, class and availability of books required for him. This will ensure safe and easy access to essential information.

Students can choose the subject of their choice. Students can have easy access to the syllabus and study material related to a particular subject. He can choose the subject of his choice based on his interest.

The IoT system can be used to monitor student attendance and can be able to send notification regarding low attendance to parent's mobile. Parents will be able to watch their child's class performance without visiting the faculty [6]. The benefits of IoT in higher education is depicted in Fig. 3.

Fig. 3 Benefits of IoT in Higher Education



The student's health can be monitored using fitness equipment. The report of the students whose health is not good will be sent to the concerned doctor for their consultation.

IoT devices will be able to monitor and control laboratory equipment and temperature in laboratories. It will check the room temperature and ensure that the laboratories do not overheat.

IoT-based smart projectors and touch boards can be created which can save lectures automatically and students can be able to download the material on board using Internet and mail [7, 8].

Access to educational resources for staff and students globally. Faculty and students should be able to share their knowledge, ideas, and research with others within and outside their organization [6]. The work submitted by the students is maintained by experts from all over the world.

2 Challenges in IoT in Higher Education

Nothing is perfect. To achieve something significant, we also have to make some sacrifices and face great challenges. There are many challenges in incorporating IoT in higher education. This includes:

Big data explosion can be a major issue in future which may result in Internet connected devices, vehicles, buildings, etc. This is a matter of major concern these days. It is important to discuss about the impact of Big Data explosion and the ways in which we can handle this problem in a commendable manner.

Connectivity standards are still required for many wired and wireless devices, in order to connect different devices. We should adopt the common high standard methods of wireless or wired connectivity.

The security and confidentiality of important and confidential data can be a major challenge [9]. It is favorable to include authorized access to the most sensitive and confidential information.

Availability of high-speed Internet facility at a given location. High-speed Internet is required otherwise it takes time to access the pages online. Also, lack of high Internet speed can lead to system error.

Maintaining quality in teaching and evaluation of students is a major challenge. It is important to maintain error free and authorized access to such data.

Increase in cost due to advances in information technology. The cost will include the cost of manufacturing the highly sophisticated IoT-based equipment and the cost of setting up the network. The following technologies may be required to promote IoT in higher education:

IoT Analytics—It involves processing large amounts of information that are collected using IoT objects and stored as Big Data. All the information related to the IoT-based application is first collected, then preprocessed and finally the results are obtained after computing on the preprocessed data.

IoT Security—This includes encryption of data and communications and to prevent physical tampering and information attack. In IoT-based applications, we must ensure that aspects such as privacy, abstraction, encapsulation, and message passing are also present. The processor in an IoT-based application should be capable of processing tasks with high speed, should be free from error and should be able to produce quality output in less time.

IoT Device Management—IoT device management performs certain functions such as security management, software updates, and device monitoring. It controls and coordinates the proper functioning of various devices in an IoT-based application.

IoT Platform—This includes integration of services and IoT infrastructure components. The platform acts as a middleware between the IoT components and the IoT.

It includes 3 types of services namely: (1) communication, equipment control, and monitoring. (2) Transformation, data acquisition, and data management. (3) IoT applications are developed including adapters, analytics, and event-based logic.

IoT Operating System—Requires IoT specific operating system which requires less power.

Have features like consumption, real time response capability, security, etc. IoT-based operating system will be able to deliver quality-based output in less time.

3 Components of IoT

IoT-based systems are modern and sophisticated devices. IoT components are interconnected using wired or wireless network technologies. The components of an

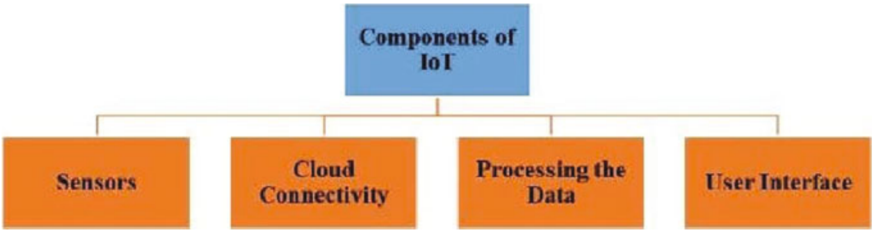
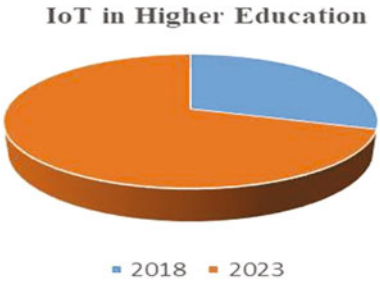


Fig. 4 Components of the IoT

Fig. 5 IoT in the Higher Education Market



IoT-based product are shown in Fig. 4. These include: Physical objects or things, Sensors, Actuators, Virtual objects, People, and Services.

Physical objects or things represent all the entities that are directly or indirectly involved in building an IoT-based application. Sensors are used to sense the environment. The sensor can be used to collect input data in a particular format for our IoT-based device. Actuators are used to affect the physical environment. Virtual objects include wallets, electronic tickets, agendas, etc. These are helpful in performing the required functions in IoT-based applications. People refers to the humans who benefit from the IoT-based device and who control the environment. Services may include cloud services.

According to Markets, a research-based firm, IoT in the higher education market is expected to grow from.

$4.8 billion in 2018 to $11.3 billion in 2023 based on region, application, end user and component, as shown in Fig. 5 Is. innumerable [10]. The applications have shown great use in recent times. Today, IoT has been extensively used in the education sector and has proved to be beneficial for both students and faculty.

4 Future of IoT in Higher Education

The advent of IoT will have a positive impact on our education system. There is a need to change the mindset of teachers, students, and parents about new progress and adoption of this new change in our education system also.

With the advancement in the education system and the introduction of IoT, the need for physical presence has become nil. Due to IoT, the learning process has also been greatly impacted as students and faculties have access to international tools, certifications, and many more opportunities. Using IoT, there has been a lot of change in the traditional student–teacher learning and teaching concept. Now, more contemporary methods such as practical-based teaching–learning which include live examples and subjects that are in power with industry standards are taught. IoT will help students, faculty, and researchers from around the world collaborate better and take advantage of the rich research opportunities.

IoT-based applications are becoming an integral part of our lives day by day [11–13].

IoT is based on connecting various gadgets with on/off buttons and Internet. With the addition of IoT; teachers, students, and researchers get a vivid and productive educational experience. By using cloud linked gadgets, teachers are able to monitor and analyze individual student performance records in a better way. IoT will help in imparting knowledge to the teacher in the best possible manner and will also save the time of manual attendance marking as the attendance of the students can be detected by the sensor and the attendance sheet can be maintained automatically. Advancements in technology will help teachers to formulate their lesson plans in the most innovative way and enable students to give their best [14–19].

Thus, apart from providing quality education to the students by the teachers, IoT also helps in saving both money and time of the organization.

5 Research Interval

Not much work has been done in the field of IoT in the field of education. Work has been done in the field of knowledge management but not on knowledge sharing. From the previous work we understand that education system has been studied a lot and they have taken into account only technical factors. This research paper attempts to fill this gap. Some of the research gap issues discovered are as follows:

Research Gap 1:

Although IoT is a novice and an emerging field especially in an education system; there are many devices like cameras, sensors, preprocessors, actuators, etc. and all these components need to be made available for an individual classroom or laboratory. In this regard, there is a need for larger research on which technology and subset of components need to be used together to create an intelligent education system.

Research Gap 2:

Teachers, students, and researchers have depended on IoT for the purpose of acquiring knowledge. But, the knowledge once shared can also be accessed by people outside the campus of the institute. It is also a security, economic, and privacy threat. Moreover, there is huge power consumption and bandwidth usage in running these

IoT-based devices. Therefore, a lot of research can be done in this regard and a solution can be found to include the security and effective IoT usage aspect as well.

Research Gap 3:

The Education system when combined with IoT involves huge complexities in terms of hardware, software, and communication. There is a need to research and build an intelligent system and similar systems can be used in similar applications with few or no modifications [20–28].

6 Results and Discussion

Although the introduction of IoT has had a huge positive impact in the education sector. But, there is also a loss in learning levels, communication as well as collaborative activities.

Students are increasingly moving from paper based documents to tablets, smartphones, laptops, etc. We have conducted questionnaire of 480 students of BA Eco/BBA/BCA/MCA. 200 questions were asked related to the impact of IoT on the education system. All the students said that they have a smartphone. Out of 1200 students, 1187 students had their own laptop; which is equal to 98.9%. This is shown in Fig. 6.

Out of 1200 students, 1048 students confirmed that collaborative activities using IoT can take place. The remaining 152 students believed that the introduction of IoT influenced collaborative activities.

The introduction of IoT in the education system has also benefited the teachers. We also distributed the same questionnaire among 50 teachers and found that 40 out of 50 teachers believe that the introduction of IoT has made the method of teaching

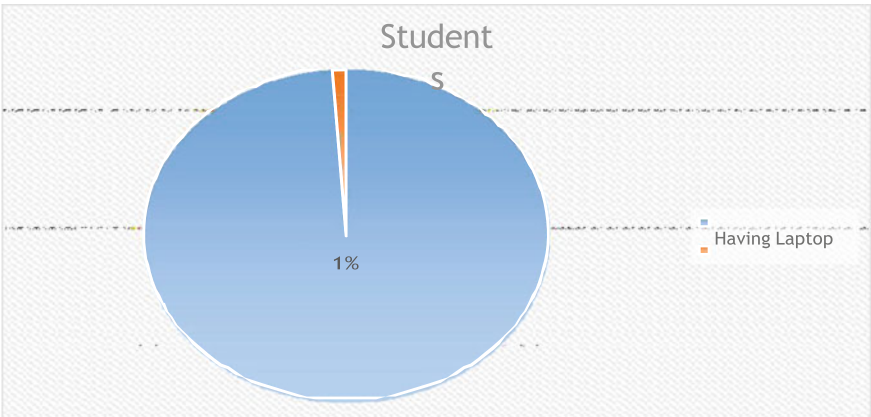


Fig. 6 Number of students holding laptops

more efficient and more student-centered. Teachers are able to efficiently focus on individual students. In addition, mobile devices help students access course materials, projects, quizzes, eBooks, quizzes, projects, as well as view videos of labs and course materials. From the questionnaire, it is found that 82% of the students want to use mobile devices in their classrooms and also wish to perform automated tasks such as taking notes, checking time-table, research. Even outside the classrooms, students have given their consent. Use IoT to make them better informed about the activities in the college and implement the security aspect on the campus. Companies such as Greentech Media, SMART, and IBM have shown their interest in introducing IoT to academia and developing “smart university” projects. Recently, Google has launched Google Apps which allows students and faculty to share their documents online and make changes in real time on screen. There are many aspects of IoT that are positive for academics and will continue to drive learning processes, but there is also a negative impact of IoT on the education system which includes the availability of incomplete and incorrect information as well as reports of plagiarism.

7 Conclusion

IoT has a great impact on our daily lives. It has a great impact on the development of our country and thus improves the fiscal growth. IoT is a new field. Although there are a lot of challenges in accepting new technology as a part and parcel of our life, but with a little effort and dedication it is absolutely possible. In this paper, we have seen that IoT is of great importance in higher education. There are lot of challenges faced in introducing IoT in higher education. But, if we overcome these challenges, then quality of education would improve. We need to incorporate IoT in higher education as IoT helps us introducing security aspects into our applications, reducing human involvement, reducing processing time, and delivering great results.

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Performance Analysis and Optimization of Cross Platform Application Development Using React Native

Piyush Garg, Babita Yadav, Sachin Gupta, and Bhoomi Gupta

Abstract Mobile App Development is scaling rapidly. Creating cross-platform (both android and iOS) mobile apps as well as optimizing the performance is a tedious task. There are multiple cross-application frameworks available in the market but React Native is the most popular framework for cross-application development. Both Android and iOS apps build using the same code base. Developers majorly focus on the User Interface, rather than the performance of the app. The research work presented in this paper focuses on a metric-based evaluation of the debugging features and performance of the React Hybrid App framework.

Keywords Mobile applications · React native · Platform assessment · Debugging · Performance evaluation

1 Introduction

Mobile Apps are majorly categorized into hybrid, native, and web applications (PWA—Progressive web applications). Native apps are developed specifically for one platform. They are quick and perform well as a result. They cannot be accessed through browsers and must be downloaded from one of the many app shops. Therefore, in the case of native apps, code reuse is at a minimum [1]. Hybrid apps are cross-platform applications such as Android and iOS using one codebase. Hybrid

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is cross-platform mobile application which enables both Android and iOS development using same codebase. It reduces the development time and efforts of creating a mobile app. Hybrid apps also support same user Interface same as native apps. Most popular Hybrid Apps Framework is React Native (maintained by Facebook) and Flutter (maintained by Google). React Native is most popular among these two frameworks, since community support of React Native is huge than the Flutter in terms of packages and libraries.

React Native is cross-platform application which supports both Android and iOS application development using same codebase. Due to its huge community support, development is easy in React Native. React Native has good access to libraries and packages which enables the support and features in smartphones [2, 3]. Debugging the app is the major part in application development. It's help in optimizing the app and the rendering time of the screen.

The paper presents a metric-based evaluation of the React Native framework to quantify the performance. The metrics may then be used for a comparative evaluation of other hybrid frameworks of mobile application development.

The contributions of this paper include (1) The performance assessment technique of a cross platform application. (2) The discussion of Memory leakage and its assessment for cross platform applications. The remainder of the paper is organized as follows: Sect. 2 contains a brief review of the research in the domain of cross platform application development and its performance and describes the technical details of the underlying technologies in the React application development framework. The methodology of this study is discussed in Sect. 3, with the results explained in Sect. 4. Section 5 contains the conclusions and future work.

2 Literature Review and Description of Technologies

Several authors have proposed the performance assessment of frontend frameworks including [4–6]. The key focus area of most researchers has remained debugging and profiling [7] but recent developments in the flutter [8, 9] and react[10–12] have spurred the interest of researcher community to cross platform application performance evaluation as done by [13, 14].

2.1 JavaScript

JavaScript is among the topmost languages which is used for developing web applications, desktop application, API development, and mobile app development. Some of the most popular JavaScript Framework [15] and libraries are Angular JS, Node JS, React JS, and React Native, etc. JavaScript is a just-in time compiled programming language, which is lightweight or interpreted. JavaScript is a single threaded, dynamic language, prototype based. It also supports object-oriented, declarative, and imperative styles [16].

2.2 React Native

React Native is a JavaScript framework which brings declarative user interface framework to Android and iOS. React Native is cross-platform application which support both Android and iOS application development using same codebase. When a React Native application is executed, the JavaScript code is collected into a package called JS Bundle.

The JS Bundle is run by the JavaScript thread, whereas the native/UI thread manages UI rendering and native module execution. A bridge, which transmits data to the native threads after serializing as JSON, enables combination between the JS and native threads. There is no synchronous communication supported by this bridge. React Native supports hot loading and live loading, there is no need to rebuild the native apps whenever there is a change in JavaScript code [2, 3].

3 Methodology

We have created a hybrid application using React Native, and for showing the data on the application, we are using rapid-app. The app has been populated with some reusable components displayed on the home screen for the purpose of performance analysis.

Most application developers concentrate their efforts on the task of development itself, with little attention to the application performance. When it comes to actual metric-based evaluation, we all need some statistics, some numbers or benchmarks that can give us a standard unskewed or an unbiased report. The community fortunately has contributed and provided us with a bunch of tools that can help us to monitor our application whether it is to assess its performance, monitor its workflow, debug a malfunction, or essentially sniff out the software conflicts. The assessment techniques using community-based tools have not been standardized however, and thus cannot be used to compare different hybrid application development platforms.

The present work attempts to standardize the metric-based evaluation, so out of the many debugging tools present, the authors shortlisted the most popular tools, and eventually decided to go with two of the tools for the study. One chosen tool out of the above, which is perhaps the most popular, is the Chrome debugging tool with Hermes enabled. The second tool being a slightly more advanced and sophisticated tool or platform which is Flipper, is less preferred by the development community. Before focusing on the work done, a little briefer about the formerly mentioned tool would seem adequate.

3.1 Chrome Debugger Tools

These are a collection of a set of tools that are meant to be useful for the developer to monitor its applications performance workflow, etc. It is provided by the framework as default. To use it first make sure that your device is connected to the same network and then simply pop open the developer menu in your device and choose "Debug" or "Debug JS Remotely" which should then take your local host at whatever port your metro bundler is running on, which by default is 8081. Here you can access the Developer Tools via Inspect where-in you can do the following:

- Show our API's requests responses
- Display messages via console.log
- Can run profiling via Hermes and thus monitor crucial memory leaks and performance bottlenecks.

Chrome Debugger Tools is most used developer tool for debugging [17].

3.2 Hermes

As mentioned earlier, React Native is a JavaScript-based framework that is used to build applications for both Android and iOS. So, a question arises how Android and iOS systems communicate with a React Native application and how do these platforms differentiate between a hybrid app and native app? The answer to this is rather simple but also genius. The operating system, be it Android or iOS doesn't really distinguish between a native and hybrid application. Any React Native app essentially communicates with the operating system in its native language, i.e., Objective-C or swift for iOS and Java for Android. But this leads to another question—Where did the JavaScript go and how is our JavaScript application communicating via Java and Objective-C and Android and iOS respectively?

To answer this, we need to understand that React Native applications aren't pure JavaScript applications. They contain three main components-

- Android Wrapper Code for creating our native android application.
- iOS Wrapper for creating iOS applications.
- The JavaScript Code that contains our entire applications business logic which is eventually wrapped in one of these wrappers and shipped to the platform eventually.

It would be worthwhile to mention here that even though JavaScript is wrapped in native container, it doesn't mean that the entire JavaScript is converted to the platform's native language. Instead, this wrapper is shipped with a JS engine which is in simple terms a place to execute JavaScript code optimally.

Before Hermes, our JavaScript application (containing application's business logic) was shipped to the native platforms as a JavaScript bundle of code and whenever a user launched the app, this entire bundle of code was first compiled that translated into byte code and after this process our app finally starts executing. This process of compiling and translating on runtime caused performance loss which was solved via Hermes that was designed for optimizing the performance by precompiling the JavaScript code into efficient byte code and also reduces the launch time of the app [9].

3.3 Flipper

It is one of the most popular debugging platforms. The mobile native SDK and the desktop application establish a connection which is used to communicate the data to and from the device. It also shows the network responses and bugs. Flipper solely offers the architectural platform itself. It is made useful by the plugins that have been added on top of it. Flipper provides the architecture that allows these plugins to interact with our application. It has many useful plugins that could be helpful in our debugging phase, e.g., Leak Canary for detecting memory leaks, Crash Reporter, Network Monitoring, etc. [18]. To analyze the app performance, we run the application and open the flipper, perf monitor, and google chrome debugger tools one by one, while recording the output each time. A detailed explanation of the output given by the performance analysis tools is available in the results section.

4 Results

The application user interface has been shown in Fig. 1, with a perf monitor display as a layer layout on the top of the screen. The perf monitor shows the following details on the application

- JavaScript thread: It shows the JS frame rate. JS frame drops are measured by API Calls and events (incl touch events). If JS frame drops are high, then user faces the app freeze and glitch on the screen.
- Main thread: It shows the UI frame rate. UI frame drops due to heavy UI an animations.
- It also shows the RAM usage of the application.

We have analyzed the app using flipper tool, which helps to explore the app logs, memory consumption and possible retention by various Nodes, elements, functions, and API Calls, etc. Flipper is developed and managed by Meta company, and is available to developers free of cost. It has various features including Layout Inspector, Logs, and Network Inspector.

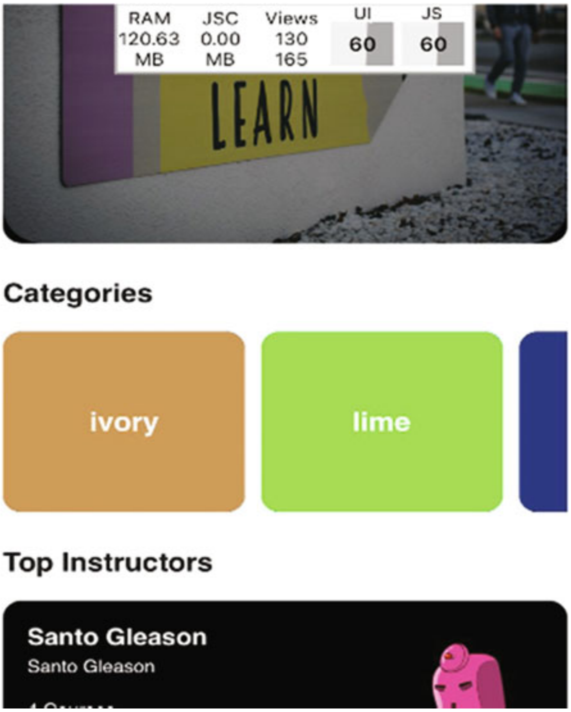

Fig. 1 Perf monitor analysis of the React Native application

A breakdown of the application into smaller components and their rendering time is shown in Fig. 2. Note: Each parent component takes its own rendering time plus the time that it takes to render all its children's components. A flame graph of phase/process/workflow of an application that shows as to what exactly occurs has been shown in Fig. 3

It represents the workflow that your application goes through in a device that involves acquiring memory, executing functions and callbacks, deallocating memory, etc. all exactly in the sequence that happens in the device to the absolute detail. You can also monitor the hierarchy of your components and the performance of any algorithm via monitoring the time and memory your algorithm takes in device [17].

- JS Heaps & GPU Memory—Overall Memory Consumption.
- Listeners—Event Listeners and Garbage Collection, Render Calls.
- Nodes—Your View & Components
- MetaLoads—Collecting Metadata required running a process
- Components—package loads, validating props, etc.—Your RN component active durations (Fig. 4).

This represents the function call-stack of your application. This is a look into the task scheduler of your application that provides data on what functions were invoked in what order, what sub-function were invoked, time that they took and memory that was consumed by the functions.

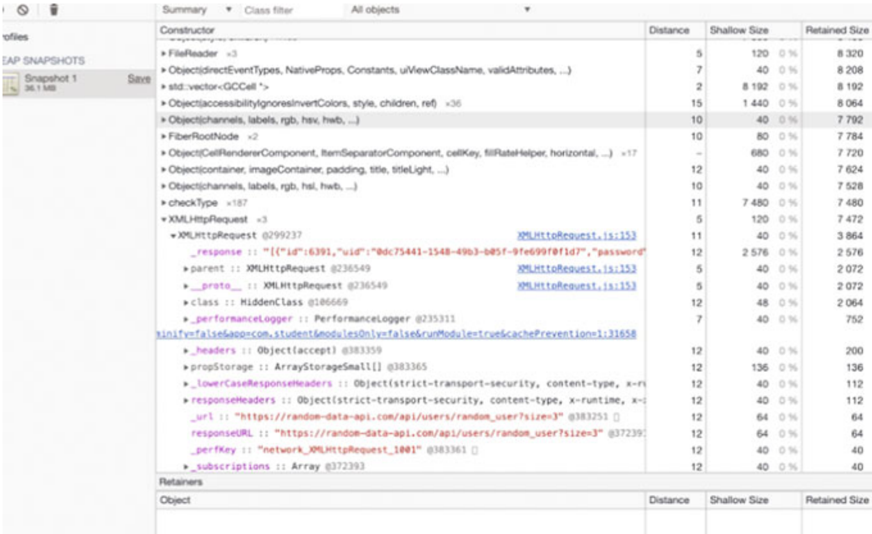

Fig. 2 Flipper memory heap shot

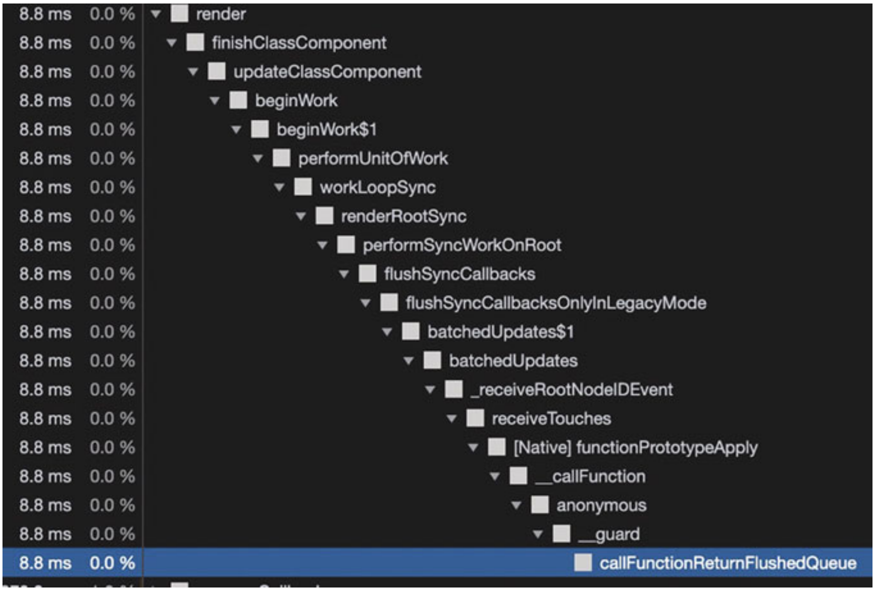

Fig. 3 Flame graph breakdown of the application into smaller components

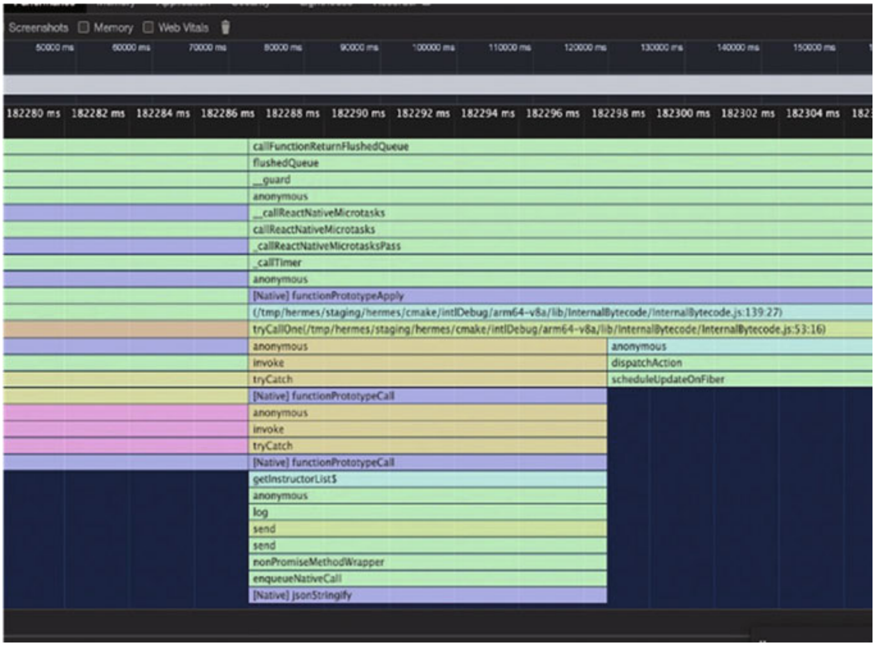

Fig. 4 Function call-stack of application

5 Conclusion and Future Work

This study can help the developers in better understanding of a hybrid platform, its inner working with an unmasking the abstract wrappers to have insights of its architecture and functioning, its pros and cons. It also helps to understand in what circumstances does the JavaScript falls behind its native peers and in scenarios where it outmaneuvers it with its more robust, flexible, and simpler approach.

All of the experimentation/ practices are meant to push the JS-based hybrid app to its utmost potential removing each flaw with extensive profiling, debugging, resource optimization cycle, a cycle that repeat itself over and over until an ambitious performance and effectiveness is achieved.

In the future work, we will compare the performance of Native Modules used in Hybrid Apps which is connected through bridges, if find any difference in performance, then how can we debug those native modules and optimize their performance. The future work will also focus on the ways to optimize the application using the codebase.

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Exploring Cyber Security Issues in the Internet of Healthcare Things (IoHT) with Potential Improvements

Maitri Surti, Vyom Shah, Yogi Makadiya, Kaushal Shah, and Mukti Padhya

Abstract The introduction of IoT in the healthcare sector has benefited the healthcare sector in several ways, such as minimal doctor visits, on-time medication, regular checkups at home, and health alerts. The paper dwells on the development of a technical field—The Internet of Healthcare Things (IoHT) which is growing exponentially. Traditional network security systems have a well-defined set of features. Traditional security techniques, however, cannot be directly employed to protect IoT devices and networks from cyber-attacks due to the resource restrictions of IoT devices and the distinctive behavior of IoT protocols. It primarily focuses on various IoT devices currently employed in the healthcare field. The following paper reviews current implementations of IoHT security protocols and suggests alternative methodologies to enhance the security of various IoHT devices. A detailed exploration of the cyber security issues and potential improvements in security measures of several IoHT devices like iTBra, infusion pumps, Pacemakers, Smart Inhalers, and blood pressure monitors are discussed.

Keywords Internet of Things (IoT) · Healthcare sector · Internet of Healthcare Things (IoHT) · Cyber security · Healthcare devices

1 Introduction

1.1 Motivation

The Internet of Things (IoT) is an interconnected network of appliances containing sensors, processing power, and other technologies that enable the exchange of data between devices over the Internet [1]. The installed base of the Internet of Things

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(IoT) linked devices is predicted to reach 75.44 billion units by 2025, up from 10 billion in 2021 [2, 3]. Furthermore, IoT has numerous applications in domains such as business, agriculture, smart homes, education, and transportation. Health care is a key topic for IoT technology as an enabler, and substantial research is currently being done [4]. Since the data and the impact are inherently linked to human well-being, security is a major concern in an IoT-based healthcare system. Due to the combination of inadequate security and confidential data of the patients, the healthcare sector is a low-risk, high-reward target [5]. Cyber-attacks on IoT healthcare systems have the potential to interrupt medical procedures significantly. For example, if a hacker gains access to an infusion pump and subsequently alters the settings, it begins delivering a high amount of insulin to a patient. This would eventually result in severe hypoglycemia. Similarly, assume a cyber-criminal acquires access to a pacemaker and modifies it to either slow down or elevate the heart rate. Due to this, the patient may show symptoms of severe bradycardia or tachycardia, which can lead to death. The security of healthcare systems has surfaced as the most significant issue of our day [6]. This paper discusses the various applications and services IoHT devices provide. It mainly focuses on identifying and analyzing potential cyber-threats and security risks to currently available healthcare devices and ways to tackle these vulnerabilities. It aims to improve current IoHT security and make it safer for all users.

1.2 Background

Internet of Healthcare things (IoHT) is a subclass of IoT that primarily deals with various healthcare care devices that operate by using digital sensors and incorporating them with mobile technology to ensure that the work is done more efficiently and effectively [7]. The major goal of the IoHT platform is to provide low-cost preventative or active healthcare treatments to those living in geographically isolated places. Numerous low-power biological sensors with minimal processing ability enable IoHT devices to communicate, integrate, compute, and interoperate [8]. Most IoHT devices operate like basic four-layer architecture, as shown in Fig. 1.

Layer 1, known as the *IoHT Devices Layer,* is responsible for connecting various medical devices. The function of this layer is to observe patterns, take readings, monitor the well-being of the patients, and report any deviations in standard patterns. It can assess at-risk patients, make educated judgments, and potentially saving trips to the Emergency Room (ER). Layer 2 manages a multi-service gateway for IoHT devices with remote management and wireless connectivity and is known as the *Machine to Machine* (M2M) *Connectivity Layer*. This layer makes data collection, onboarding, and transmission less difficult for M2M services. The routers in the layer are responsible for gathering and uploading the data to a central repository that is devoted to data collecting. Hence, this layer is also useful for monitoring patient data. However, the network technology currently being used for this process must be updated to ensure that the payment process is carried out successfully. Layer 3 is the

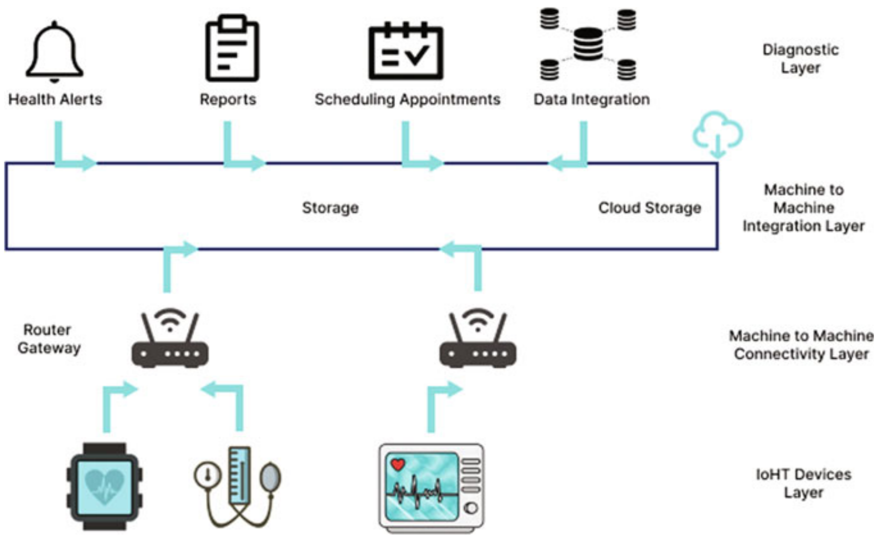

Fig. 1 Basic working of IoHT devices

M2M Integration Layer. M2M can use any sensor to communicate; hence, the system gains the ability to monitor itself and respond automatically to the changes in the environment. Through the platform of M2M Integration, a completely new generation of services can be made available to users using IoHT devices. The patient does not even need to be at the hospital to obtain this type of care, thanks to M2M technology. It is possible to perform it while the patient is at home. Layer 4 is responsible for generating reports, sending health alerts, analyzing health reports, and scheduling appointments for the respective patients. This layer is known as the *Diagnostic Layer*. This layer ensures that the patient has been notified regarding their medication on a timely basis. Furthermore, M2M Integration solutions provide several benefits, including but not limited to social network connectivity, fitness tracking, and health and wellness monitoring. Above all, there are always certain risks associated with IoHT devices, such as hacking a patient's pacemaker to cause death or manipulating the readings of a blood pressure monitor, which leads the patient to take unnecessary medication. Hence, the security protocols of such IoHT devices should be taken care of while implementing these layers [9].

1.3 Research Contributions

IoHT has a broad range of applications and has revolutionized the healthcare industry. Many IoHT devices are currently used and have a wide scope in the foreseeable future. Some of the most useful devices in which scope of development can be seen are

iTBra. It was invented by Cyrcadia Health and is a form of sensor patch worn as a bra. The data of daily heat changes about elevated cellular activity due to tumors is collected. This data can further be shared with healthcare service providers [10]. The accuracy of this data has the potential to be improved. The concept of iTBra works on the technology of temperature sensors that regulate temperature changes within the breast and inform users about any changes that may have occurred. The temperature sensor uses symmetric cryptography to achieve the desired results. Symmetric cryptography makes use of a single secret key for the encryption and decryption of data. In this algorithm, the data is jumbled and hence cannot be understood by anyone without the secret key. The algorithm reverses its action and restores the data to its former readable form once it has been sent to the authorized recipient who has the key [11]. Because it uses a single key, it is considered to be less secure, and the potential hacker can easily intercept the device. To solve the above mentioned challenge, it would be better to use the RSA algorithm, which relies upon asymmetric cryptography and utilizes two public and private keys.

Infusion Pump. They are generic devices that administer medications and nutrition to patients in controlled doses [6]. Poor design, usability concerns like programming mistakes, various degrees of end user acceptability, and their dependent nature are all reasons that infusion pumps are not frequently used. Infusion pumps use TELNET and File Transfer Protocol (FTP) mainly. Although TELNET and FTP are supposedly used for technical support interfaces, malevolent attackers may attempt to use these protocols to hamper the functionality of the infusion pump. TELNET and FTP have vulnerabilities that permit the protocol to be exploited; because network sessions are not encrypted, hostile attackers could construct systems for recording network sessions, consisting of any authentication activities, or detecting sensitive data, such as passwords [12]. SSH and FTPS are suggested as alternatives to TELNET and FTP for infusion pumps to secure file communication.

Pacemaker. It is a tiny device implanted in the chest that helps control the heartbeat. Its purpose is to keep the heart from beating too slowly [13]. The most recent development in pacemakers is the leadless pacemaker. Here, the entire device is kept inside tiny cardiac chambers, and it has been observed that this type of pacemaker improves the life expectancy of the person compared to the earlier version. Currently, most pacemaker manufacturers use the Secure Software-Defined Network (SDN) security protocol [14]. There are some security concerns pertaining to SDN protocol: Forwarding Device Attack, which launches a Denial of Service (DoS) attack, threats in the control plane, which can lead to failure of the central controller by any failure in the network, the vulnerability of the communication channel, which can lead to issues of administration, fake traffic flow, authenticity, confidentiality, and availability. A blended strategy combining the data link layer, control link layer, and encryption is incorporated to increase SDN security and address flaws in the protocol dramatically [15].

Smart Inhaler. The task of *Smart Inhalers* is to assist patients in keeping a record of the proportion of healers or preventers acquired at different times of the day. This smart gadget may send users reminders and alarms depending on prior dose administration patterns or user inputs [16]. Most smart inhalers use Bluetooth to connect the inhaler to a mobile device [17]. Bluetooth does not rely upon an Internet Protocol (IP) and does not consist of highly progressive and IP-based standard security features, for example, Secure Socket Layer/Transport Layer Security (SSL/TLS), IPSec, or digital certificates [18]. So, a potential solution to solving this cyber-threat in smart inhalers is to use Near Field Communication (NFC) as they use Radio Frequency Identification (RFID) technology to interact with other devices. This method is more stable due to its short range than Bluetooth [19].

Blood Pressure Monitor. It aims at measuring the pressure of blood in the arteries when the heart beats [6]. The most recent development in blood pressure monitors is the self-use wireless upper arm blood, pressure monitors. This device uploads accurate data to mobile phones or computers. It increases the desire for regular blood pressure readings and facilitates physician oversight. Blood pressure monitor uses the Advanced Encryption Standard-Cipher Based Message Authentication Code (AES-CMAC) algorithm to function efficiently. This algorithm is based on the cipher-based authentication algorithm. The algorithm is secure mainly due to its public security key. As a result, if the security key is compromised, neither authentication nor device integration can be ensured [20]. To improve the security of the key, the AES-HMAC algorithm is proposed for blood pressure monitors.

1.4 Outline

The paper's second section consists of the applications and uses of various IoHT devices. The third section provides insight into the security measures and possible breaches on current devices. The fourth section follows up with potential solutions to prevent the breaches identified in the third section. The fifth section summarizes the entire paper and the direction this work is headed toward in the future.

2 IoHT Applications and Services

IoHT has a wide range of applications and services that benefit the patient and physicians. IoHT is used in hospitals to increase patient comfort, make it easier for physicians to treat their patients, and provide a better environment for both doctors and patients. Furthermore, wearable technology makes monitoring patients' data more feasible for physicians and helps examine the disease more precisely. After deploying the initial infrastructure related to IoHT, adding a new device is simple and cost-effective [21] (Fig. 2).

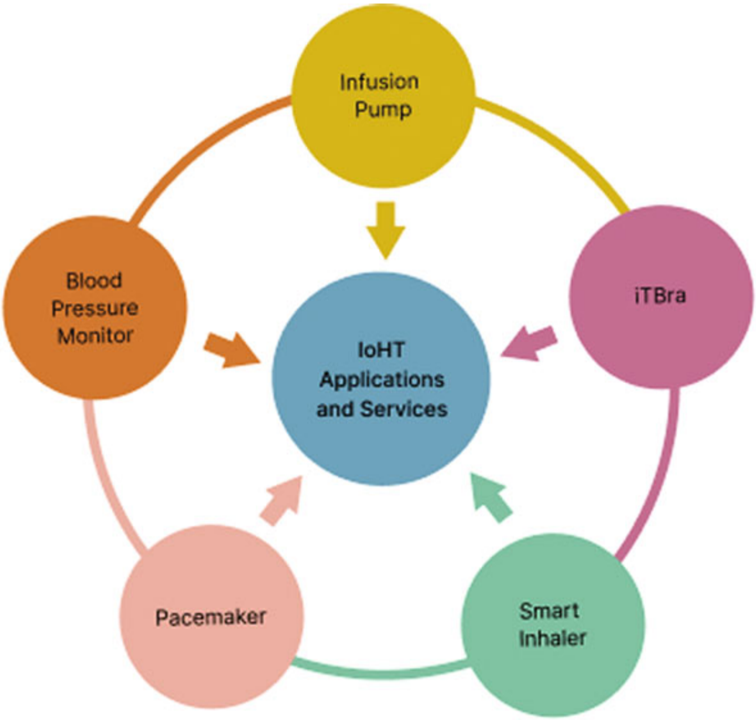

Fig. 2 Applications and services of IoHT

2.1 *iTBra*

It enables women to monitor their breast health while detecting breast cancer in its early stages. After wearing the iTBra, the user is supposed to navigate to the respective application on their mobile phone to connect the bra with the device. The user is required to wear the bra until the procedure is completed. The procedure consists of measuring and monitoring changes in metabolic profiles and the implementation of algorithms that can differentiate between healthy metabolic profiles and those that may be malignant. After this process, results would be transmitted to the physician after this process and can be worn again the next month [22]. Current tests on the device's accuracy in terms of cancer detection have shown 87% accuracy, so this could be improved in the future by using other machine learning algorithms [23].

2.2 Infusion Pump

These medical devices are responsible for delivering the required fluid to the patient in a controlled manner. They can provide high or low volumes of fluids. They can also be used to give nutrition or pharmaceuticals such as insulin or other hormones, antibiotics, chemotherapeutic treatments, and pain killers [24]. The IoT infusion pumps use Arduino to facilitate the entire process and an LCD to display various measured parameters on the screen. The device options include adjusting the flow direction, flow rate, syringe brand and size, total dose to be administered, and more. As soon as the user enters the required settings onto the device, the machine calculates the push rate of the plunger. The device injects only a required fluid into the patient's body and stops the delivery as soon as the fluid requirement is met [25]. Further, improvements can be made to this device to ensure greater security for the patient. Iterative user-centered design, along with a network and real-time alarm monitoring, may be employed to increase the effect of infusion pumps [26].

2.3 Pacemaker

One of the most vital organs in the human body is the heart. Due to diseases related to the heart, there were approximately 17.9 million deaths reported back in 2019 [27]. However, implantable IoHT devices like smart pacemakers can be important in treating heart problems. It is a device with electrodes to generate electrical impulses to make blood pumping in the heart chamber easy [28]. It combines a battery, computerized generator, and sensors with wires on the electrodes where the battery generates the power. The computerized system on the device decides to make the sensors work. Smart pacemakers have one added feature: monitoring remote devices like mobiles or computers. They contain one extra sensor for transferring the data to the remote device, and then the remote device analyzes it. Remote monitoring can predict future patterns based on the working of pacemakers using previous data. This data can be transmitted directly to the physicians, who can take preventive actions based on that. Soon, battery-less pacemakers may be designed. This innovation will seek to extract cardiac mechanical motion to create current, or to tweak or add cells to induce biological pacing activity [29].

2.4 Smart Inhaler

The function of this device is to monitor the frequency and environmental circumstances of breathing problems such as asthma to better inform users about how their asthma is being controlled, reduce nonadherence to medication, and assist users in determining the cause of their asthma attacks [30]. A sensor on the device sends data to the mobile app through Bluetooth, allowing one to track inhaler usage statistics via the app. This tool records the date, time, and often the location of each dosage taken and helps the user to schedule the next dose reminder [31]. For this device to have a bright future, one must make sure that, in the inevitable rivalry between manufacturers, gadgets and data exchange systems are built for free interoperability so that the patient does not suffer. The same necessitates the development of technological standards for these devices so that they are integrated with existing electronic medical record systems, as well as unambiguous identification of data ownership [32].

2.5 Blood Pressure Monitor

Monitoring Blood Pressure at home is one of the well-established diagnosis systems in IoHT. The current smart blood pressure monitoring system includes wireless technology that links wireless sensors through radio signals to remote devices like mobiles and remote analysis devices. After getting readings through wireless signals and sensors, data can be run through different algorithms to analyze better previous readings and patterns generated through them. Physicians can directly access the patients' data from remote places to make the monitoring easy and fast and can give required medicines with immediate effect. This technology is innovative and also promising [33]. The future technology of blood pressure monitoring may introduce cuffless blood pressure devices. These devices will aim at measuring pressure by making use of suitable IoT sensors. This technology will be less bothersome for the patients, especially when measurements need to be taken when the patient is sleeping [34].

3 Existing Security Solutions and Research Gaps

Currently, various protocols have been implemented in IoHT devices. Though these protocols work efficiently, a few security challenges must be addressed to mitigate the chances of a security breach on devices.

3.1 Existing Solutions

Different IoHT devices use different protocols to ensure safe data transmission between the IoHT device and the data receiver. The current security mechanisms applied to current IoHT devices consist of symmetric cryptography (iTBra), File Transfer Protocol and Telnet (infusion pumps), SDN Security Protocol (pacemakers), Bluetooth Connectivity Protocol (Smart Inhalers), and AES-CMAC (blood pressure monitors) [14].

Symmetric Cryptography. It is also known as symmetric encryptions or symmetric key cryptography. Typically, this is used to encode bulk messages transferred among two systems. In these cryptographic systems, the keys used for encryption and decryption are the same for both sender and receiver. It may be considered a safe box into which communications can be placed before being locked and transmitted to the other party [35]. Currently, most temperature sensors use this cryptographic technique to encrypt the sensor data [14]. In the concept of iTBra, basic sensors used in this device are temperature sensors that monitor the regular temperature and analyze data for the detection of breast cancer. This cryptography algorithm encrypts all the data that comes through the sensors.

File Transfer Protocol (FTP). This protocol transfers files between different systems over various networks and connections. It is a client–server protocol comprising two communication channels between the client and server: a command channel for controlling the dialog and a data channel for transmitting data files [36]. Systems use the command channel to transfer commands and responses from the server to the client and vice versa. On the other hand, the data channel is responsible for transferring the data or files from the client to the server. The user is asked to enter the credentials when a secure connection is built between the server and the client. After verifying and authenticating the credentials, the client allows the user to transfer the required files through the connection [37]. This protocol is implemented in infusion pumps for transferring the medical records and necessary details of the patients to the respective doctors so that the doctors can examine the health records precisely and then prescribe the required amount of fluid intake to the patient.

Telecommunication Network (TELNET). This protocol allows the user to connect to a remote network over a TCP/IP network. When the device gets connected to the remote host, it transforms into a virtual terminal, permitting users to communicate with the remote host from the computer [38]. It is a two-way dynamic text-oriented networking system that comprises 8-byte virtual terminal connection. User data is mashed with TELNET control information via the transmission control protocol (TCP). It is extensively used on a terminal to do functions remotely. The user communicates with the server by entering this protocol into a command line. The user then performs server commands by entering specified TELNET instructions into the TELNET interface [39]. In devices like infusion pumps, physicians are sometimes required to access the device to examine the patient's fluid doses and ensure that the patient is taking in the fluid in the right amount through the device.

Software-Defined Networking (SDN) Security Protocol. SDN is a networking technology that connects to underlying hardware resources and guides network traffic using software-based controllers or application programming interfaces (APIs). This architecture differs from traditional networks, which govern network traffic using specialized hardware devices (such as routers and switches). SDN may utilize software and traditional hardware to construct and maintain a virtual network [40]. Generally, in smart pacemakers, SDN is used in which SDN is responsible for securing the data when it is moving through the network. In some instances, virtual switches, which may be implemented in either software or hardware, can take over the functions of physical switches and combine their activities into a single, intelligent switch. Before packet forwarding, the switch validates the data packets' integrity and their distant recipients, such as smartphones or other peripheral gadgets [41].

Bluetooth Connectivity Protocol. This protocol is an open standard for radio frequency (RF) communication over short distances. The technology is largely utilized to establish wireless personal area networks (WPAN), often called ad hoc or peer-to-peer (P2P) networks [42]. When electronic devices connect, Bluetooth establishes a connection that employs optional pre-shared key authentication and methods that are deemed strong when utilized appropriately. The unpredictability and duration of the passkey used during the initial connection majorly contribute to determining the level of security. The discoverability and connectivity options are also significant in defining the security strength. These options govern whether or not other Bluetooth devices may discover the device and how it can be linked [43]. Smart inhalers use this protocol to communicate with the connected electronic device. This allows data to be sent to the electronic device so patients can be informed about when the inhaler has been used, their current health, and the number of doses left [44].

AES-CMAC. The AES authentication protocol uses a 128-bit symmetric block cipher method. It translates these discrete blocks using 128-, 192-, and 256-bit keys. It encrypts these blocks and then connects them to generate the ciphertext. It is constructed on a substitution–permutation network or SP network. It is made up of a sequence of connected processes, such as substituting inputs for a particular output (substitution) and others requiring bit shuffling (permutations) [45]. AES-CMAC is derived from the Advanced Encryption Standard [NIST-AES]. AES-CMAC accepts a private key, a varying-length message, and the length of the message in octets as inputs and produces a constant-bit string termed MAC [20]. So, it is mainly the authentication code to provide integrity between server and device. Blood pressure monitors use this encryption algorithm to ensure the data is transferred without being hacked into the electronic device. It allows the data to remain accurate and be understood accordingly.

3.2 Research Challenges

The protocols mentioned above are widely used in various IoHT devices, but some challenges must be taken care of before implementing these protocols. Some challenges in the protocol tend to deteriorate security and increase the vulnerability of these devices, thus making them more susceptible to malicious attacks. Mentioned below are some of the challenges that can be worked upon in the future to increase the security of the device.

Symmetric Cryptography. This encryption technique uses a single secret key between the sender and the receiver. Using a single secret key allows an attacker to intercept the secret key during transmission and decode the communication. Another challenge this cryptography technique may have to deal with is the trust issue between the sender and the receiver. Because the sender and recipient utilize the same symmetric key, there is an implied need for them to trust each other [46]. The secret key may get lost by the receiver to an attacker. Then, the data received from the temperature sensors in the iTBra will also be available to the attacker. The same, in turn, mislead the patient and proves to be disastrous for them.

File Transfer Protocol (FTP). This protocol is generally insecure because it uses clear-text usernames and passwords. It cannot incorporate encrypted texts into the system. Due to the lack of authentication and encryption, the data transmitted over FTP gets vulnerable to cyber-attacks like spoofing, sniffing, and other brute-force attacks. Through this security gap, attackers can easily access the credentials and patients' medical history while they are being sent to the physician over an insecure network [47].

Telecommunication Network (TELNET). In this protocol, similar to FTP, the username and password of the user are transferred without being encrypted. The same makes it easier for intruders to eavesdrop on the data over a network connection [48]. Using this protocol in infusion pumps is not considered secure because insecure network sessions may allow attackers to access the pump. Because the user's credentials are written in plain text and are not encoded, the hacker can attack the device without any difficulty decrypting the entered credentials. The same can prove harmful for the patient because the intruder can change fluid doses and trick the patient into changing the number of doses.

Software-Defined Networking (SDN) Security Protocol. SDN differentiates between the data and control planes, allowing for more efficient network administration and eventually replacing conventional networks. The current research examines the effort and issues in enforcing security in software-defined networks. Here are some challenges regarding wireless SDN in pacemakers: Switches or access points can disrupt network traffic, and unauthorized users can execute denial of service (DoS) attacks. Servers require authentication and security, and failure to do so might risk the entire network operation. Because SDN API is vulnerable to man-in-the-middle attacks, it is unsuitable for channel security implementation. Because a central controller is employed, any failure in the SDN controller might cause difficulties throughout the network [15].

Bluetooth Connectivity Protocol. Denial of service attacks, eavesdropping, man-in-the-middle assaults, message manipulation, and resource theft are all common attacks that are possible on this protocol. They are also vulnerable to more targeted Bluetooth-related attacks that exploit known flaws in Bluetooth executions and protocols. Threats on unsecured Bluetooth systems can provide attackers with unauthorized access to sensitive information and illegal usage of Bluetooth gadgets and other systems or networks to which they are tied [42]. As in a smart inhaler, one can use message manipulation to alter the data about the number of doses taken. Such a scenario could lead to grave consequences for the patient.

AES-CMAC. AES-CMAC is considered quite secure, but if the secret key were hacked or improperly disclosed, neither authentication nor message integrity is guaranteed [20]. The algorithm involves all the blocks having the same encryption pattern, and the algebraic structure is simple [49]. Hence, in the case of blood pressure monitors, the data is encrypted using this protocol, so if one was to hack this protocol, they could manipulate data for nefarious means.

4 Proposed Solution

The protocols that are currently being used in IoHT devices have some cyber security challenges. These challenges must be addressed to facilitate security and ensure the efficiency of devices. Several solutions based on the protocol used are further discussed in this section (Table 1).

4.1 iTBra

The temperature sensor in iTBra uses symmetric key encryption to ensure data security and avoid infringement of data. The challenge that symmetric cryptography faces is that it makes use of a single key to transfer data. This mechanism requires two parties to trust each other. It also becomes easier for the attacker to seize control over the secret key and access the data. These challenges can be addressed by introducing asymmetric encryption instead of symmetric encryption in the device. Asymmetric cryptography requires two distinct keys for encrypting and decrypting data [50]. The mechanism of using two different keys makes it more secure as compared to the symmetric cryptographic algorithm. One of the best asymmetric algorithms that can be implemented in iTBra is RSA. RSA holds itself responsible for converting the plain text into gibberish that takes on the nerve of the intruder who may be trying to access the data [51].

Table 1 Different IoHT devices with their existing and proposed security protocols

IoHT devices	Existing security protocols	Proposed security protocols
iTBra	Symmetric cryptography	Asymmetric cryptography
Infusion pump	File Transfer Protocol and TELNET protocol	Secure shell and File Transfer Protocol secure
Pacemaker	Software-defined networking protocol, NIST standard	Identity management modification techniques and threat isolation
Smart inhaler	Bluetooth Connectivity Protocol	Near field communication connectivity protocol
Blood pressure monitor	AES-CMAC	AES-HMAC

4.2 *Infusion Pump*

These pumps currently use TELNET and FTP, each of which works for different workflows. TELNET means TErminaL NETwork. It is a standard TCP/IP protocol for virtual services and is used to access the command line interface of a remote server. At the same time, FTP means File Transfer Protocol, which sends and receives files more reliably and efficiently via TCP/IP protocols to remote users. As it transmits data like usernames and passwords without encryption, eavesdropping and snooping are easier to implement by intruders, which is one of the main drawbacks of TELNET in terms of security. Another protocol, Secure Shell (SSH), can be introduced to avoid the abovementioned threats. It can perform all primary functions like TELNET, but more securely as it uses public-key encryption to encrypt data and is transmitted via a secure channel. Also, in the case of FTP, the main lack of security comes when files are transmitted through any channel. When a file is transmitted through a channel, it is transmitted in plain text only. There is no secure channel or encryption present, which can be vulnerable to attacks. Currently, approximately five alternatives are present which can securely transfer files. The five alternatives are SSH File Transfer Protocol (SFTP), FTP Secure (FTPS), Application Exchange 2 (AS2), Hypertext Transfer Protocol Secure (HTTPS), and Managed File Transfer (MFT). In terms of securing the medical data received from an infusion pump, the best-suited protocol that can be used is FTPS. FTPS integrates TLS/SSL encryption to secure the connection between device and server. So, the proposed solutions for securing the transmission of files in infusion pumps are SSH and FTPS in place of TELNET and FTP accordingly [52, 53].

4.3 *Pacemaker*

Software-Defined Networking Protocol (SDN) is currently being used in the functioning of pacemakers. There are several challenges regarding the security of this protocol. One of the major challenges in the domain of cyber security is that unauthorized users can carry out denial of service (DoS) attacks. To combat vulnerabilities in SDN protocol, a combined strategy, including the data link layer, control link layer, and encryption could be employed to improve SDN security significantly. The use of Transport Layer Protocol to provide SDN security seeks to safeguard the privacy of data sent from the pacemaker. For authentication management, the user must verify their identity before receiving the data using private keys. Message authentication codes (MACs) are appended to receiving messages, which would then be authenticated at the receiving end. The security of the SDN agent is vital since it makes up the environment. The primary necessity is the implementation of threat isolation and identity management modification techniques. Firewalls, IDSs, and IPSs should all acquire dynamic updates [15].

4.4 Smart Inhaler

This device uses Bluetooth to transmit data from the inhaler to the mobile phone. Security is provided in the Bluetooth protocol using SAFER Block Cipher [14]. In this protocol, frequent attacks include denial of service, eavesdropping, man-in-the-middle attacks, message manipulation, and resource theft. A hacker may connect to the inhaler without the user's knowledge and take the data or manipulate it. To counter such vulnerabilities, Near Field Communication (NFC) could be used as they operate at short ranges and connect the device to the phone using point-to-point contact. They use ISO/IEC 14443, an existing radio frequency standard, to ensure authenticity, confidentiality, and integrity. Confidentiality is achieved by the use of encryption methods such as hashing, whereas authenticity and integrity are achieved through the use of signature mechanisms [19].

4.5 Blood Pressure Monitor

Currently, most BP monitors use AES-CMAC as an authentication protocol, basically a cipher-based message authentication code. Some of the drawbacks are that it works slower in authenticating messages and can only be faster if embedded hardware has hardware for accelerating block ciphers. Also, if the public security key is compromised, then, in that case, the message can be compromised, or a man-in-the-middle attack can happen [54]. To overcome these drawbacks, another alternative can be introduced as Advanced Encryption Standard-Hash-based Message Authentication Code (AES-HMAC), in which a key is used to hash the data, and the key will be kept secret between the device and server. Also, it can use a range of hashing algorithms ranging from SHA-1 to SHA-256 and MD5. As there is no public key for encryption and the key is kept secret between sender and receiver, it is much more secure than the AES-MAC. Also, hashing methods generally are faster than block cipher methods.

5 Summary and Future Directions

The world's technological and application methodology for new and innovative advancements is continually evolving; the Internet of Things (IoT) is one of the most significant breakthroughs these days. This paper presents an overview of IoT in health care, as well as a discourse and understanding of some pertinent difficulties. Also, potential solutions to current flaws are presented using IoHT devices which are used in today's world. Since these devices may prove to be the future of the healthcare sector all around the globe, it is necessary to implement the best security measure to reduce the existing vulnerabilities of the devices. To achieve this, we have proposed an alternative to the current security protocols used, which plans to solve all the existing cyber security challenges and reduces the risk of devices being attacked by intruders. As IoT research advances, the future of IoT-based healthcare devices seems bright.

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Predictive Analysis of Energy Consumption for Energy Management in Smart Homes

Tarana Singh, Arun Solanki, and Sanjay Kumar Sharma

Abstract The pace of energy use has significantly grown during the previous several years. In order to reduce energy consumption and demand, energy management systems (EMS) are required in households, workplaces, structures, industries, etc. Newly developing technologies like artificial intelligence (AI), the Internet of Things (IoT), big data, machine learning (ML), deep learning (DL), etc., may assist with this. This helps the users to achieve a very new, sustainable, and advanced life experiences in their homes. This paper aims to discuss smart home energy consumption and weather conditions which affects the demand and consumption of energy in any particular environment. In this research work, a smart home dataset which has different parameters of energy consumption and weather conditions is taken from the online repositories. This dataset is preprocessed using different machine learning techniques. After the preprocessing, the best suited model for the predictive modeling of the energy consumption in smart homes is obtained. A comparative analysis is carried out to find the best techniques among the existing techniques with the batter results and less error rate. This paper aims to perform the predictive modeling of the energy consumption dataset and find out the best suited technique with less error rate.

Keywords Machine learning · Internet of Things · Big data · Artificial intelligence · Smart home · Energy management · Sustainability

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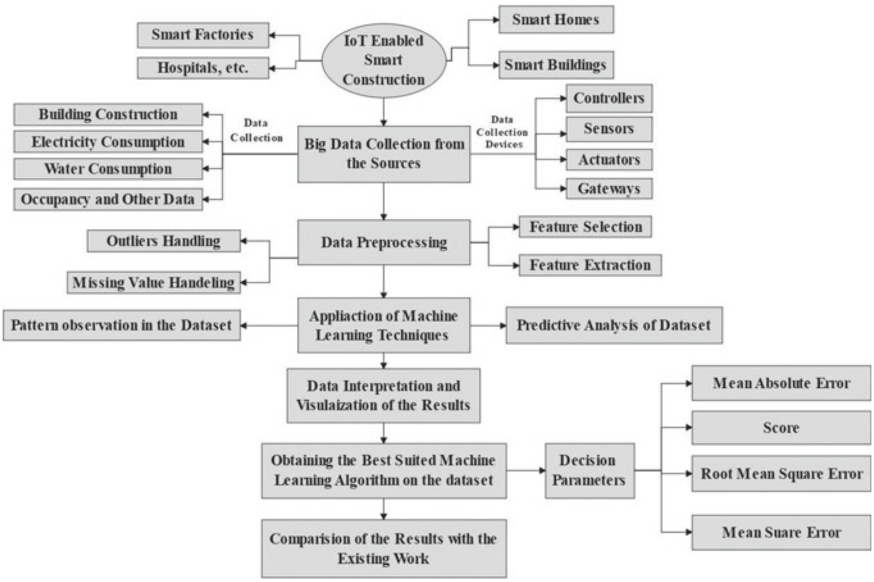
1 Introduction

Saving energy has become the most important duty since it is the source of all life. Energy conservation has recently emerged as a crucial concern, and new, creative technology solutions are being developed to do so [1]. In the past, researchers have found that the majority of the study on energy usage is in the area of smart houses. Smart buildings (SBs) [2] are constructed in a different manner than conventional structures in order to save energy, reduce power usage, and provide more durable constructions. Regardless of a variety of obstacles, smart buildings enhance quality of life. An effective energy management system (EMS) [3] aids in lowering excessive energy usage, reducing peak demand, and lowering related expenses. Artificial intelligence is necessary for future EMS development. Additionally, the Smart Micro Grid (SMG) [4] and ML enable the prediction of index factors including temperature, humidity, etc. Machine learning algorithms come in a variety of forms, such as linear and logistic regression [5–7], random forest (RF) [8], decision tree (DT), Neural Networks (NN), and Gradient Boosting, among others [9]. The best method for evaluating data and improving SB energy management is deep learning (DL) [10]. Home automation is another possible technique to reduce energy use [11, 12]. Such automation improves the uninterrupted flow of electricity, addresses issues with power consumption, and schedules equipment using cutting-edge technology [13]. Prediction accuracy of ML algorithms has an impact on effective home energy management. Making accurate and trustworthy forecasts is currently a difficult challenge [1, 14]. In this paper, machine learning prediction algorithms are examined along with their implementation for several home energy metrics, including load forecasting, household consumption, energy output from rooftop solar panels, and price prediction. Additionally, this work seeks to examine how ML prediction algorithms [15, 16] might improve the overall precision and dependability of home energy management [17]. The final three years of 2019, 2020, and 2021 are covered under the review.

The term "Internet of Things" (IoT) [18] is used by researchers to refer to the process of connecting commonplace items to the Internet, such as smart phones, Internet TVs, sensors, and actuators. These devices are then intelligently connected to one another to enable new types of communication between things and one another as well as between things and people. IoT development was seen as a next-generation technology a few years ago [19]. These days, practically every industry uses this technology. The use of these technologies in smart homes is quite widespread. IoT technology is being used to link residential appliances [20]. The estimated energy use of the smart home's smart equipment is shown in Graph 1. To compile the information shown in the graph that shows the approximative energy consumption by the various gadgets present in the home environment, a number of recent research publications are evaluated [21, 22].

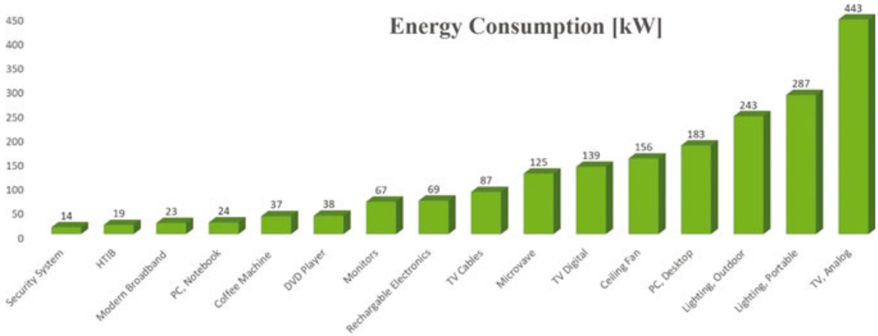
Currently, governments must create policies for energy conservation due to the problem in the energy supply brought on by fluctuating oil prices and the need to reduce greenhouse gas emissions. Since buildings in industrialized countries use over



Graph 1 Approximate energy consumption by the smart home appliances

40% of the total energy used in the country, the need for an active, comprehensive, and ICT-based architectural system for energy management like ML, DL, IoT, etc., is becoming more and more essential [23]. The design and implementation of effective energy management systems, notably for homes and offices, in the construction sector have been recommended in a number of recent initiatives [24]. Home energy management is crucial to the advancement of distribution system efficiency, cost, reliability, and energy conservation in upcoming smart grid technologies. The sale of smart home appliances dramatically increased in 2016 by 64%. The estimated energy usage of the smart house is shown in Graph 1. With the development of cutting-edge technology, HEMS is being redesigned to manage Cyber-Physical Energy Systems that are powered by renewable resources (CPES). By combining the conventional grid supply with renewable energy sources like solar and wind power, smart houses increase their energy efficiency [25, 26]. Graph 2 shows an approximation of the amount of energy produced from several energy sources, including coal, electricity, and hydraulics. The right energy source may be employed depending on the demand, reducing the quantity of power received from the grid and saving a significant amount of money. Energy management is essential for automating the link between the energy sources in smart homes. Based on the quantity of battery charge remaining after being charged by a renewable source, the energy management selects the source.

As a consequence of population growth and economic growth, it is projected that there will be a large increase in the global demand for energy during the next years. The majority of the world's energy demand is accounted for by energy usage in buildings. Demanding energy efficiency in buildings is thus recognized as one of



Graph 2 Energy generation from different sources of energy

the most significant aims in order to achieve global energy sustainability [27, 28]. This problem has spurred recent attempts to create residential energy management systems based on a sensor network that monitors energy use in structures.

This essay is divided into eight sections, the first of which addresses the rationale for writing this article and a short introduction. The relevant literature review in the field is presented in Sect. 2. The approach and progression of the research study are covered in Sect. 3 of the article. The dataset and its many factors that directly or indirectly impact the demand for energy are discussed in Sect. 4 of this article. Predictive modeling of the smart home dataset is presented in Sect. 5. The analysis's findings are shown visually in Sect. 6. The comparative analysis of the findings is presented in Sect. 6, and the conclusion and future work is presented in Sect. 7.

2 Related Work

According to a 2018 discussion by Kumari et al. [29], the linear regression is a statistical approach for finding the value of a dependent variable from an independent variable. According to the authors, it quantifies the relationship between two variables via modeling in which a dependent variable is predicted based on one or more independent factors. According to the authors, linear regression analysis is the method that is most often utilized. The authors also covered how to apply this idea using SPSS and Excel. Moletsane et al. [7] provided a description of the energy usage data analysis using regression analysis for smart infrastructure in 2018. The authors discussed about how they predict the demand for energy to rise in the next years and how buildings are the primary driver of this need. The authors said that it is crucial to implement energy efficiency in buildings since they are the primary area where there is a substantial demand for energy. In order to examine the energy usage data from two actual smart houses, the authors employed the linear regression model. Two residences' operational data is included in the databases. Using deep reinforcement learning, Wan et al. [21] discussed a solution to the domestic energy management challenge in 2018. The authors claim that the recommended approach, which is based on reinforcement learning, can instantly learn the ideal energy management strategy and does not need any previous knowledge of uncertainty. The authors also represented that how well the outcomes of the proposed strategy worked.

By monitoring and managing the smart house equipment, Chouaib et al. [30] proposed a model in 2019 with the purpose of decreasing the power usage in smart homes. The authors proposed a general architecture for microcontroller-based smart infrastructure power organization framework. The authors claim that the microcontroller lowers energy usage by lowering or switching off household utilizations when not being utilized. According to the authors, a lighting system that uses less energy was designed and put into place in houses using their suggested methodology. The development of an ontology to reflect the body of knowledge around the field of machine learning was discussed by Braga et al. in 2021 [16]. To provide findings acceptable for software- and human-developed agents, the authors employed Protégé 5 tool. According to the authors, Protégé generates explicit knowledge and includes an internal inference engine that may generate implicit knowledge.

Yu et al. explored DRL for smart infrastructure energy organization in 2021 [31]. The authors conclude that it is difficult to design an explicit building thermodynamic model that is reliable and efficient enough for infrastructure control, and according to the authors, several problems in searching pointing out. Additionally, there are some ambiguous system settings. Lastly, a number of operational constraints with regard to time and space. Fourth, when problems involving building energy optimization have enormously broad solution spaces, they cannot be conventionally addressed in real time. Fifth, conventional building energy management techniques have certain conditions that must be followed, which limits their adaptability to different building contexts. The authors continued by saying that with the IoT's quick expansion and increased computing power, AI technology has discovered its important competency in control and optimization. DLR has greater promise as a broad AI method to handle the above-mentioned issues. According to the authors, the use of DLR for smart infrastructure energy organization has increased significantly in recent years. The authors once again stated that there isn't a complete evaluation of the various DRL approaches for SBEM. To bridge that gap, the authors focused on this specific study, which offers a thorough analysis of DRL for SBEM. The authors specifically pointed out the current unsolved problems and suggested potential future study options.

A complete analysis of current research on the use of AI knowledge in smart infrastructures in 2021 using the ideas of an infrastructure organization framework and a requirement and fulfillment program was published by Farzaneh et al. [32]. The authors also commented on a few more uses for AI-based modeling techniques that are often employed in predicting building energy usage. The author presented an assessment methodology that may be used to access current research in this area and in other important AI areas, such as energy, comfort, design, and maintenance. Finally, the authors analyzed the current issues and potential future prospects for the study of AI applications in smart buildings.

Canese et al. analyzed and examined the most underutilized multi-agent reinforcement learning methods that was published in 2021 [33]. The authors focused on the most crucial factor that must be taken into account when expanding single agent reinforcement learning algorithms to multi-agent environments. The authors studied the algorithms and then organized them into groups according to common characteristics. The authors focused on the mathematical models that go along with the primary multi-agent techniques that are suggested in the literature and gave a complete taxonomy of such approaches. The authors listed potential application fields for each algorithm and highlighted the benefits and drawbacks of each. Observability, scalability, and non-stationarity were a few of the many features the authors used to estimate the algorithms. The achievement of the approaches under consideration was also evaluated by the authors using descriptions of the most typical benchmark settings.

3 Methodology and Flow of the Proposed Work

The process flow diagram for the proposed work in this research is shown in Fig. 1. The flow diagram starts with the IoT-enabled smart construction like smart homes, smart buildings, smart factories, etc. These constructions have different IoT devices attached within them. These IoT devices enable the data collection on the different parameters with the help of sensors, actuators, gateways and controllers, etc. After the data is collection, different algorithms are applied to process the data and prepare it for the further use. The preprocessing of the data is performed to remove the outlier, handling the missing values, selection of the relevant features, and extracting the most relevant features from the dataset. After the dataset has been preprocessed, many different machine learning methods are used to it in order to do predictive analysis and spot trends. After the predictive analysis, all the results are visualized and discussed in detail to obtain the best suited algorithm on the dataset with the high score and less error rate in the prediction. To obtain the best suited algorithm, there are different parameters like accuracy of the model, RMSE, MSE and MAE. At the end, a comparative study of the results is done on the implemented algorithms.

The work flow of the proposed work has the following steps:

Step 1: Gathering the information from the smart construction.
Step 2: Preprocess the collected information.
Step 2: Apply machine learning algorithm for the predictive analysis.
Step 4: Using different decision parameters, obtain the best suited algorithm on the dataset.
Step 5: Comparative study of all the machine learning algorithm in different scenarios for analysis.

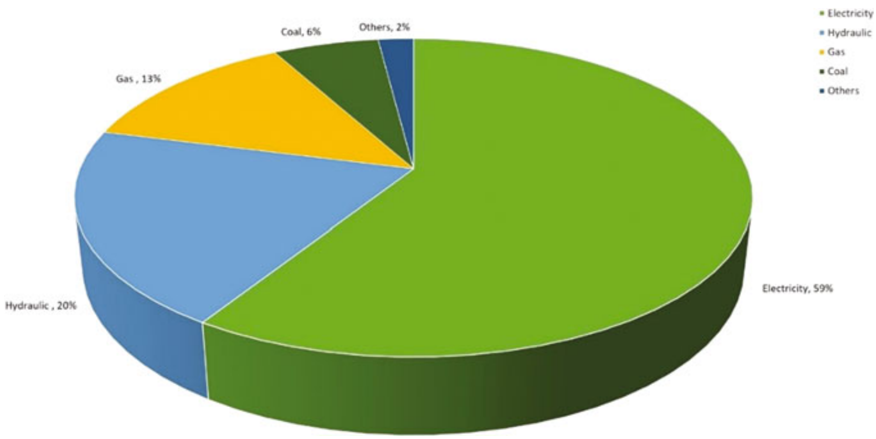
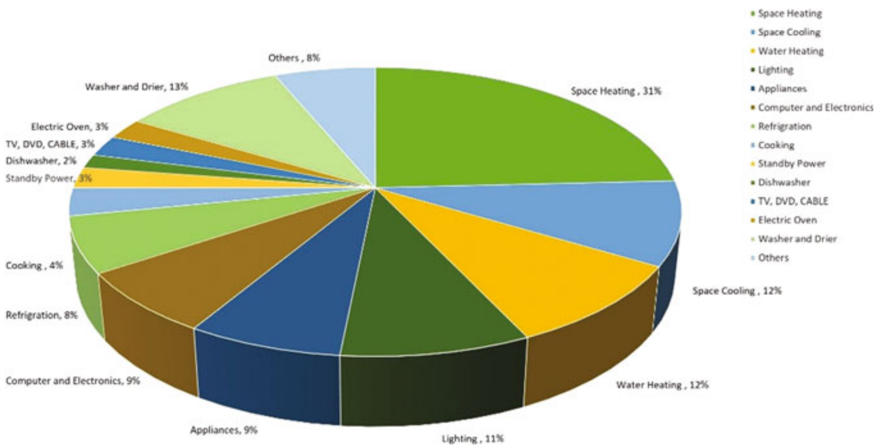


Fig. 1 Methodology and work flow of the paper

4 Discussion and Preprocessing of the Dataset

In the smart home environment, there are number of smart appliances which consumes the electricity. These appliances in association with the smart IoT devices are able to generate the data all the time, when they are switched on. Using machine learning methods, the aim and primary goal of this work is to decrease energy use as well as electricity costs. The dataset which is used to achieve the task is taken from the online repository. This dataset has different parameters of the energy consumption like living room, kitchen, garage, etc., and the weather condition like temperature, humidity, wind speed, etc., some of this parameter. Graph 3 represents the overall energy consumption from different appliances in a smart home. Preparing the data for the construction of the ML models for data analysis and pattern detection is done in order to do the machine learning analysis on the dataset. To prepare the dataset for the ML model, all the missing values and outliers are handled. The outliers and the missing values in the dataset can deviate the results from the actual results. So, the dataset is currently being subjected to feature extraction and feature selection. This dataset may be divided into two categories: the weather dataset and the energy usage dataset. This paper aims to perform the predictive analysis on the energy consumption dataset. So, all the energy consumption parameters are being extracted out from the dataset.

A significant portion of the energy used in the smart home is used by the many parameters in the dataset, such as lights, heaters, air conditioners, and TVs. The data is ready to apply ML on after preprocessing. This article uses machine learning (ML) techniques to reduce the overall energy consumption in the smart home. In the further section of this paper, the predictive modeling is being performed using ML techniques.



Graph 3 Energy consumption by smart home appliances

5 Predictive Modeling of the Smart Home Dataset

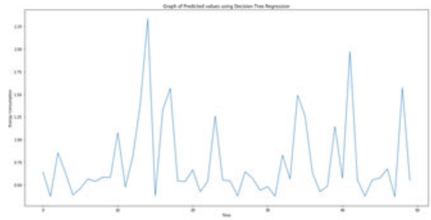
Nowadays, machine learning, deep learning, Internet of Things are the most powerful tool and enable the developers to face the challenges in the innovative development in every domain. In this section, the predictive modeling of the dataset is performed using six different regression models of machine learning, i.e., different regression models like DTR, RFR, SVR, SLR, KNNR, and RR. Graph 4a–f and 5a–f represents the predicted energy consumptions using different ML algorithms in smart homes. Different parameters like kitchen, dishwasher, living room, etc., of energy consumption are taken from the dataset to predict the energy. To perform the predictive analysis on the dataset, first 5000 data points are taken. The training and testing datasets are then created from this dataset, with the ratio of 80–20% represented in Graph 4a–f. Decision tree regression, which creates a regression model in the form of a tree structure, is used to illustrate the prediction graph in Graph 4a. It produces a decision tree to go along with the dataset and breaks it up into more understandable portions. The outcome is a tree containing leaf nodes and decision nodes. A value for the property under examination is represented by each of the decision node's branches. The leaf node represents a decision result. The top-most decision node in a tree that corresponds to the best forecast is called the root node. Graph 4b represents the prediction values using random forest regression. During training the random forest regression many individual decision trees. To produce the final prediction, the model of the classes for the mean prediction for the regression, all the prediction from all the trees is combined. This approach is name ensemble learning because it concludes on the basis of a group of outcomes. Graph 4c represents the prediction values using support vector regression. During the training support vector regression there are basically three crucial factors in this machine learning model, i.e., kernel, hyperplane, and decision boundaries. Kernel basically supports in the exploration for a hyperplane in the high dimensional space. If the size of the dataset is increased, the computation cost also increases. The hyperplane usually splits the line between two data classes in the support vector regression which is used to predict the output in support vector regression. The decision boundaries are considered as the separation line for simplification, with the constructive instances on one side and unwanted instances on the other side. Graph 4d represents the prediction results using simple linear regression. In this regression model, a line is fitted on the observed data, and the model estimates the connection between the variables. This model is used to calculate the values of the dependent variables at a certain value of the independent variables as well as the assets of the relationship between two variables. Graph 4e represents the prediction results of both classification and regression. This model predicts the values of novel data points based on feature similarities. This model works on the bases that a value is given to the new data point depending on its similarities to the points in the training set. The distance between the new point and each training point must first be calculated. There are number of ways to calculate the distance like Euclidian, Manhattan, etc. Graph 4f represents the prediction results of the ridge regression. In situations when the independent variables are strongly correlated, this approach may be used to estimate the coefficients of multiple regression models.

Graph 5 represents the predictions with the 70–30% split ratio. Graph 5a represents the predictions using decision tree, and Graph 5b represents the predictions using random forest. Graph 5c represents the predictions using support vector regression, and Graph 5d represents the predictions using simple linear regression. Graph 5e represents the predictions using k-nearest neighbor regression, and Graph 5f represents the predictions using ridge regression.

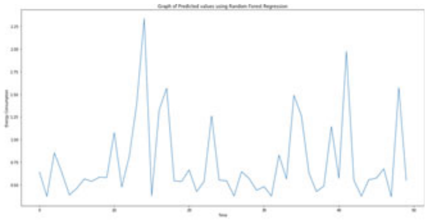
In the prediction graphs, the energy prediction is performed with respect of time. Different regression models, i.e., DT, RF, SVR, SLR, KNNR, and RR are performed to obtain the energy prediction represented in Graphs 4 and 5 with different split ratios of training and testing datasets. All the results are shown in Sect. 6.

6 Discussion and Visualization of the Results

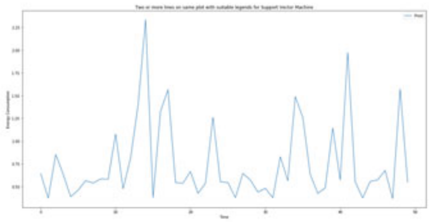
The ML techniques are discussed and implemented in Sect. 5 used to perform the analysis of the statistics. The information is first divided into an 80–20% ratio, with 80% of the information is for the training purpose and 20% for testing. After the implementation of the ML models, i.e., DT, RF, SVR, SLR, KNNR, and RR, different parameters are also calculated like accuracy score, RMSE, MSE, and MAE [34]. The dataset is then divided once again into a 70–30% proportion, with 70% of the information used for training and 30% for testing the model. Both the time the obtained results are being compared to obtain the best performance. On the basis of the results of parameters, the best suited model for the prediction is obtained. Table 1 represents the accuracy score, RMSE, MSE, and MAE for both 80–20% and 70–30% split ratio.



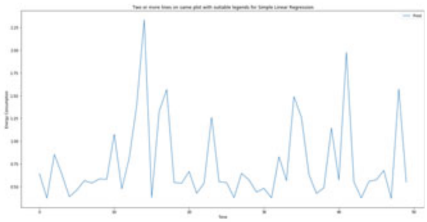
Graph a. Predicted values using Decision Tree



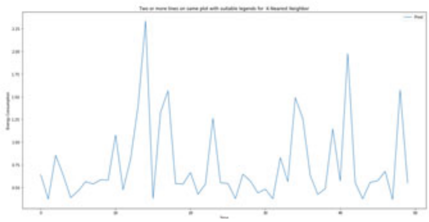
Graph b. Predicted values using Random Forest



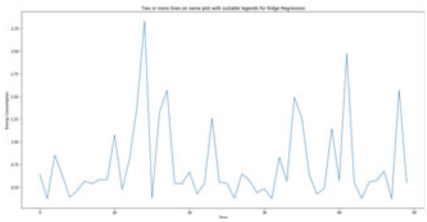
Graph c. Predicted values using Support Vector Machine



Graph d. Predicted values using Simple Linear Reg.



Graph e. Predicted values using K-Nearest Neighbor



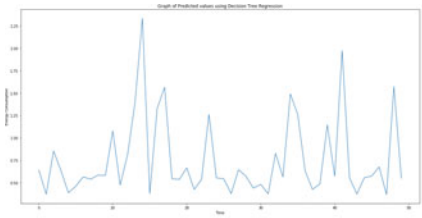
Graph f. Predicted values using Ridge Regression

Graph 4 **a**–**f** Prediction graphs for 80–20% split ratio

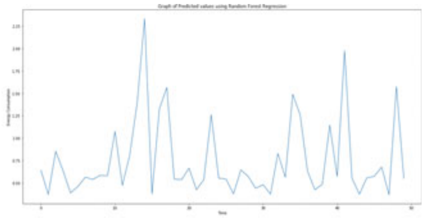
Graph 6 visually represents the results of all the six algorithms implemented in this research paper with the parameters like accuracy score, RMSE, MSE, and MAE for 70–30% split ratio. The DTR and RFR are found to have the best accuracy and low error rate at the conclusion of all the discussion. All the other models are with low accuracy score and high error score.

Graph 7 visually represents the results of all the six algorithms implemented in this research paper with the parameters like accuracy score, RMSE, MSE, and MAE for 80–20% split ratio. The DTR and RFR have the highest accurateness in the score and lowest error rate, according to the results of the whole discussion. All the other models are with low accurateness in the score and high error score.

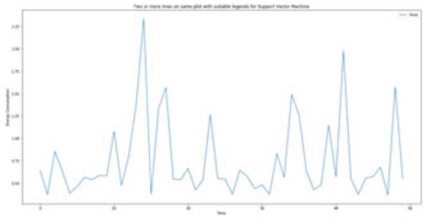
On the basis of the above analysis in this section it is clearly visible that when the ML models are implemented in 80–20% split ratio, the results are better than the 70–30% split ratio. So, when the training data is reduced the accuracy is also decreased and error is increased and when the training data is more than the accuracy is also more and the error is less.



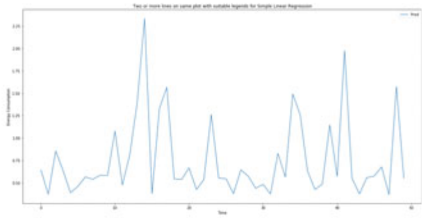
Graph a. Predicted values using Decision Tree



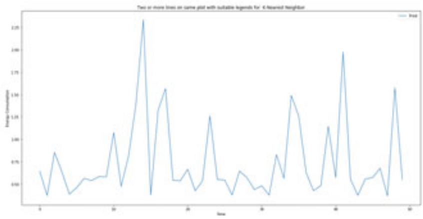
Graph b. Predicted values using Random Forest



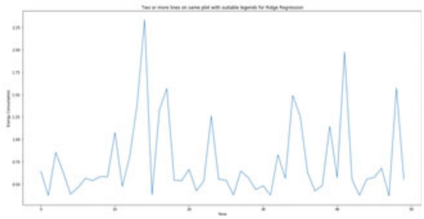
Graph c. Predicted values using Support Vector Machine



Graph d. Predicted values using Simple Linear Reg.



Graph e. Predicted values using K-Nearest Neighbor

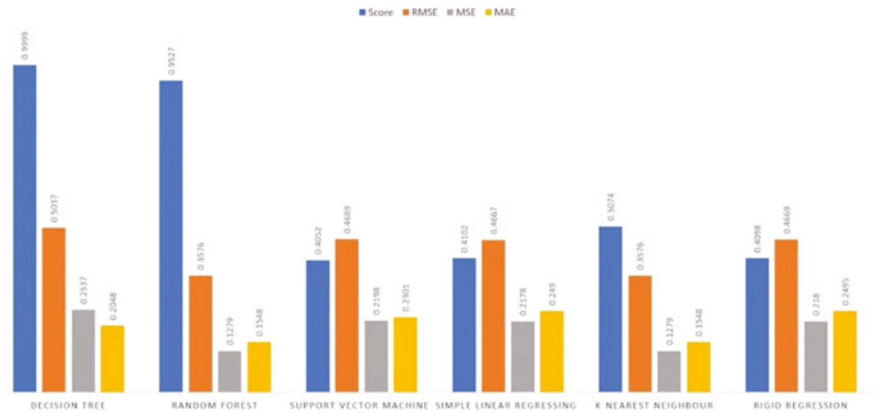


Graph f. Predicted values using Ridge Regression

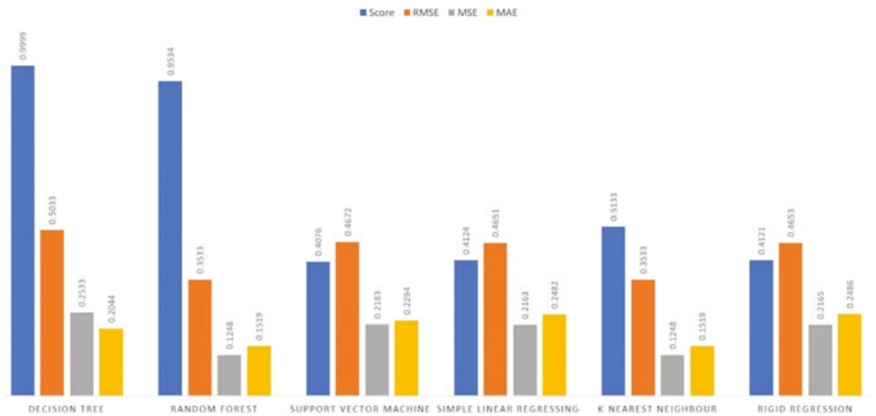
Graph 5 **a–f** Prediction graphs for 70–30% split ratio

Table 1 Results

Split ratio	Algorithm	Score	RMSE	MSE	MAE
80–20%	Decision tree	0.9999	0.5033	0.2533	0.2044
	Random forest	0.9534	0.3533	0.1248	01.519
	Support vector machine	0.4076	0.4672	0.2183	0.2294
	Simple linear regression	0.4124	0.4651	0.2163	0.2482
	K-nearest neighbor	0.5133	0.3533	0.1248	0.1519
	Ridge regression	0.4121	0.4653	0.2165	0.2486
70–30%	Decision tree	0.9999	0.5037	0.2537	0.2048
	Random forest	0.9527	0.3576	0.1279	0.1548
	Support vector machine	0.4052	0.4689	0.2198	0.2301
	Simple linear regression	0.4102	0.4667	0.2178	0.2490
	K-nearest neighbor	0.5074	0.3576	0.1279	1548
	Ridge regression	0.4098	0.4669	0.2180	0.2495



Graph 6 Results representation of 70–30% split ratio



Graph 7 Results representation of 80–20% split ratio

7 Conclusion and Future Work

The amount of energy used is rising daily in accordance with how people are now living. To manage the increasing demand of the energy is making the researchers to realize the importance of considering the benefits of new concepts and technologies like ML and DL in the smart cities or smart homes is undeniable. In order to do a predictive analysis of the dataset for smart home energy consumption, the purpose of this article is to investigate and apply ML models to the dataset. Use of technology in the domain of energy consumption eases to deal with the challenge. In this paper, few parameters of energy consumption like dishwasher, living room, kitchen, etc., are being considered to perform the predictive analysis. In this paper, few regression models like DT, RF, SVR, SLR, KNNR, and RR are applied to the dataset to train the machine learning model. The model is trained first on 80–20% split ratio then on 70–30% split ratio to make the prediction of the energy consumption. Graphs 6 and 7 show that the DT and RF models are the two that are generating the greatest results, with the model score being the highest and the prediction error being the lowest. To conclude the work done in this paper, out of all the ML models the lowest error rate is achieved by the decision tree and random forest than the other ML models, i.e., SVR, SLR, KNNR, and RR. Future areas for the research design include managing the rising demand for energy in smart homes and optimizing energy use using real-time data from smart homes. The overall purpose of this effort is to lower energy use and power costs in smart homes without compromising the residents' ability to support themselves.

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Detection of Fake Reviews on Products Using Machine Learning

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Abstract It is hard to exaggerate how crucial user reviews are in figuring out an organization's e-commerce income. Before purchasing any goods or service, online customers rely on product and service reviews. As a result, firms must consider how reliable Internet reviews are because they might directly affect their reputation and bottom line. Because of this, some businesses pay spammers to post false reviews. These false reviews profit from consumer buying choices. As a result, during the past twelve years, there has been substantial study into techniques for spotting false reviews. However, there is still a need for a survey that can analyze and summarize the diverse techniques. In this paper, we are going to put the SVM and Naive Bayesian machine learning model system into place that can spot false reviews with an accuracy of 0.801 and 0.687.

Keywords Reviews · E-commerce · Machine learning

1 Introduction

When customers want to make a decision regarding a service or a product, reviews have become the primary source of information. For example, when consumers take the initiative to book a hotel, they read reviews about previous customer's experiences with the company's services. They select whether or not to reserve a room based on the feedback from the reviews. If they get great feedback from the reviews, they will most likely reserve the room.

As a result, past evaluations have become quite reputable sources of information for most individuals in a variety of Internet businesses. Because reviews are regarded as real ways of exchanging input about positive or negative services, any attempt to

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alter such evaluations by providing misleading or inauthentic information is deemed dishonest behavior, and such reviews are classified as phony. This situation makes us wonder if not all of the published reviews are honest or genuine. What if any of these reviews are fictitious? As a result, identifying phony reviews has become and continues to be an important and necessary study field.

Machine learning approaches can make a significant contribution to detecting bogus Web content evaluations. Web mining approaches, in general, employ a variety of machine learning algorithms to identify and extract important information. Content mining is one of the Web mining duties. Opinion mining is a conventional example of content mining since it is focused on discovering the sentiment of text using machine learning, in which a classifier is trained to examine the characteristics of the reviews as well as the feelings. Detection of phony reviews is often dependent not only on the category of reviews but also on some factors that are not directly related to the content. Text and natural language processing (NLP) are commonly used in the development of review features.

2 Literature Overview

Unrelated words may appear in a review at times. This gives another consumer the wrong impression, and he or she may decide not to purchase it. This type of behavior is commonly referred to as a bogus review. This paper presents an active learning method for detecting fake and genuine reviews. This include creating a system that only accepts reviews from authenticated users. After accepting evaluations from reliable clients (Guanine users), they will categorize and forecast good, negative, and neutral reviews utilizing NLP-based sentiment analysis and text mining algorithms. Fraudulent, unreliable, and irrelevant word content in fake reviews. They applied only a few fake review detection techniques for Amazon dataset. They will try to investigate the possibilities for spotting bogus reviews that are based on actual data by integrating active learning. This study's findings can advance the science of fake detection on social media platforms [1].

This framework can be utilized for other tasks like the detection of harmful user activity or, as was already noted, the detection of fake news, which may need sophisticated semantic analysis. They suggest expanding the proposed Fake Feature Framework (F3) on a wider domain outside of the e-commerce industry as future work. In this paper, they used four machine learning algorithms to find fake Yelp reviews. The results showed that XGBoost has a very high score in prediction. To train the model, SVM algorithm took a long time, and Naive Bayes has a low score on average as the dataset is imbalanced. They considered some basic and complex features for training the model; a few of them are useful, funny cool ratings, the similarity of reviewer reviews, etc. They had said that we can't predict that the filtered reviews of Yelp are 100 percent fake because there were some factors that lead the machine learning to false predictions. Taking a proper dataset and applying potentially reliable techniques for filtering review.

In this paper [2], the reviews for a certain product are pulled from the WebHarvy crawler, coupled with reviews of other products and information about the reviewers to help spot fraudulent reviews. Reviewers using information gain and decision tree classifier. The decision's features' significance is verified using information gain. Entropy is calculated for the potential features such as response, template, reply, and useful profile to identify whether the review is fake or not. The accuracy can be increased by adding more features. The efficiency of the proposed approach achieved a 96% success rate. One of the primary techniques to tackling the problem has been supervised learning. Obtaining branded false reviews for training [3], on the other hand, is challenging. Because it is extremely difficult, if not impossible, to correctly classify false manual reviews Existing research has employed a variety of instructional purposes, using phony reviews. Possibly the most intriguing kind refers to the phony reviews created by Amazon Mechanical Turk (AMT) is a crowdsourcing platform. Using a custom-made AM claimed an accuracy of 89.6% utilizing solely bogus reviews. Consumers may be misled by fake reviews.

A high number of bogus reviews might potentially result in massive property losses and public opinion disasters. However, because they only employ a single attribute, most existing approaches have lower accuracy in detecting bogus reviews [4]. With scarcity of labeled experimental data to address this issue, we present a unique approach for detecting reviews. Based on the synthesis of numerous features and rolling collaborative training first, the procedure necessitates the creation of an initial index. A system with a variety of characteristics such as text features, emotion features in reviews, and behavior features reviewers. Second, the procedure necessitates the collection of an initial training sample set. As a result, they created similar algorithms to extract all of a review's characteristics.

Potential customers must base their purchasing decisions on Internet reviews [5]. However, its use carries a curse: misleading opinion spam. Potential customers and companies are misled by opinion restructuring their businesses and guarding against opinion-mining approaches for arriving at correct conclusions as a result, the identification of fraudulent reviews is becoming increasingly important. The purpose of this article was to conduct a linguistic analysis of the nature of fraudulent reviews in the commercial setting of Yelp.com. According to our findings, linguistic characteristics generated a decent 81.3% accuracy, which is clearly greater than the 68.1% accuracy. As individuals spend more time shopping and reading reviews online, some reviewers produce fictitious reviews to get credit and boost (demote) the sales of products and companies [6]. Detecting fake reviews and spammers becomes more crucial as spamming behavior grows more harmful. Additional work will involve gathering large amounts of review data from various review Web sites, computer-assisted classification of reviews to minimize the labor of human specialists, and developing a more efficient model for recognizing the association between reviews, reviewers, and retailers.

In this paper, they used three phases of machine learning model for gaining prediction. Steps include data preprocessing, using the right algorithm like SVM classifier [7], and prediction of the result. They mainly used SVM algorithm because it is used for each classification as well as regression. Subjective prediction is used to pick features for coaching desktop mastering classifiers. As a result, some of the characteristics can also be ineffective for a range of classification systems. For the detection of fraudulent reviews, the cutting-edge find suggests an ensemble pretend overview detection model. Data resampling, characteristic pruning, parameter optimization, and classifier meeting are the techniques in the model. It can improve the text classification as sentiment textual content and make it by means find faux review. They simply acquire the important points only, so we can improvise by taking all points into consideration. They ought to no longer put in force the prediction work, so this can be changed by improvising. Future work may consider the faux evaluate detection that is designed for filtering the pretend reviews. In this, SVM classification furnished a higher accuracy of classifying than the Naïve Bayes classifier for trying out dataset. But, we can use another different algorithm than these two for higher accuracy.

This paper [8] consists of various techniques and methods which include: feature extraction, review clustering, and classifying fake reviews. One of the most useful techniques to recognize spamming activity in online reviews is examining the duplicates of reviews. Clustering methods and classification methods are used. Computer-generated fake reviews were used to simulate how real-life fake reviews would work. This is because fake review attackers are always looking for new ways without much human involvement. These reviews are generated using language models such as ULMFit and GPT—the two algorithms used to detect fake reviews are the support vector machine (SVM) and OpenAI fake detection model. The dataset used in the experiment, namely the Amazon Review dataset, might already contain some fake reviews which can create a bias.

There is also a need to develop datasets in various languages as e-commerce is a growing platform in recent times and attracts people from all cultures. The Amazon Review dataset is used for this experiment [9]. The evaluation approach used in this model is a supervised text approach that classifies the reviews based on the scores given and takes the spam class into consideration. A tenfold cross-validation is performed, and the model is proven to be effective. Burst pattern detection is used along with spam detectors to achieve the needed results.

The classification accuracy won't be high as the authenticity can't be determined by the content alone. The Amazon China dataset is used for this experiment [10]. The unsupervised fake review method was used for detection. A temporal feature is built and processed. An isolation forest algorithm is used to give an outlier score and thus, the outlier sample. The isolation tree is formed by considering both the temporal features and their respective value. The window size is an important consideration in this model as the optimal results are obtained only in a specific interval (15–30 days). If the window size is not the same, results may vary.

The proposed model takes the products and the reviews to be evaluated as the input and gives the classification results as the output. The classification is done by bagging, which considers three bags, namely the product word composition classifier (a CNN model), TRIGRAMS, and BIGRAMS. A new dataset is created by taking the Amazon dataset into consideration. The only consideration made here was the data searched through fake review keywords in the Amazon dataset. This may not be accurate as there are way more review or reviewer-related features to consider. Sample reviews are generated using language models and then evaluated using qualitative assessments. The better language model is used to create a dataset of fake reviews and some manually written ones (by humans). Some classifier algorithms are trained to differentiate between the two. Next, the accuracy of the classification algorithms is tested against the accuracy of ones annotated by crowd workers. The accuracy of this method can be increased by adding other features such as comparison of reviews and guaranteed purchases.

3 Proposed System Architecture

Firstly, importing all the libraries and reading the dataset using pandas and removing the unwanted data by removing stop words later tokenizing the sentence by splitting into words and removing it so that a corpus of the list of words will be created in (Fig. 1). Now, count vectorization is used to count the number of repeated words and form a document of vocabulary. Perform POS tagging to tag the list of words with their parts of speech and later label encoding happens to convert the labels into machine readable form which are 0 and 1 s. Once the final data are achieved, split the data into train data and test data which is required to train the model using various algorithms like SVM Naive Bayes, and now for the prediction and the output, we developed a Web interface using Python Flask.

1. In this module, we import the necessary libraries for the paper like pandas, math, and pickle. And we read the data from the csv file using the pd.read_csv command and downloaded the Nltk libraries.

   READ DATASET OF CSV FILE USING PANDASMODULE
   THEN :
   FIND LEN_DATASET USING MATH FUNCTION.

2. Now, as a part of NLP processing, we will be doing tokenization which is the process of partitioning text into a sequence of words, whitespaces, and punctuation tokens. A tokenization dictionary identifies runs of text that should be considered words.

   FOR I IN RANGE 0 *TO LENGTH OF THE DATASET* :
   REMOVE STOPWORDS FROM THE DATASET REVIEWS
   JOINING AND CREATING THE CORPUS OF THE FINAL REVIEW

3. Next, we perform count vectorization which involves counting the number of occurrences of a particular word in a document (i.e., distinct text such as an article, book, and even a paragraph!) Python's Sci-kit learn library has a tool called count vectorizer to accomplish this.

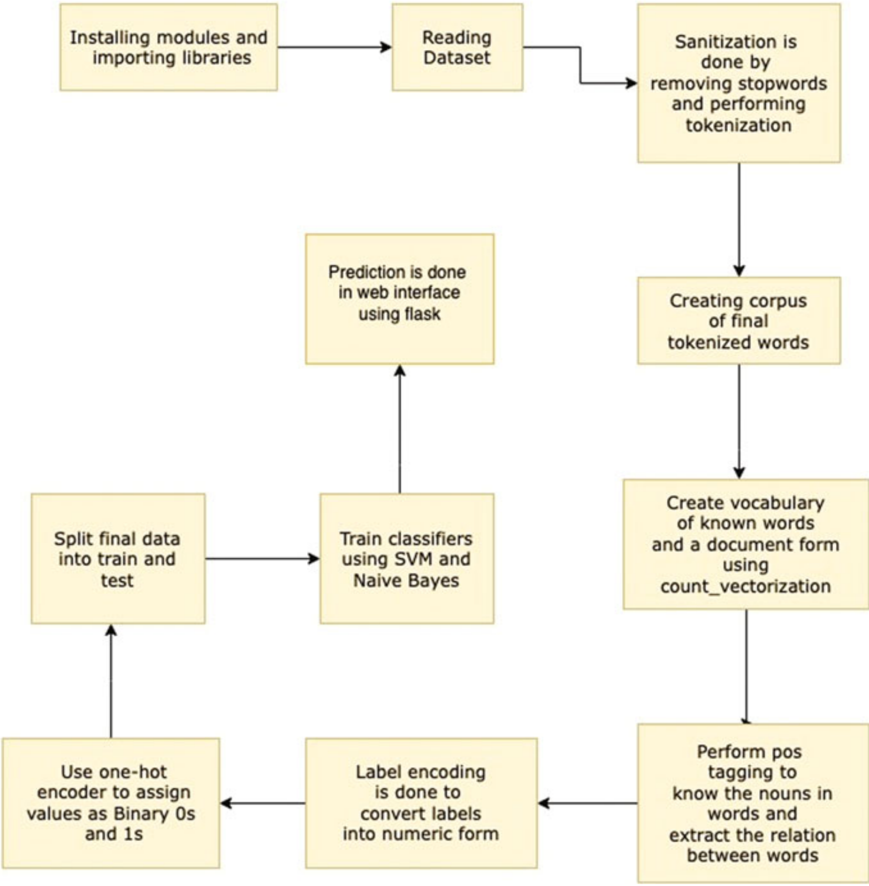

Fig. 1 Flowchart of detection of fake reviews on products using machine learning

$$IMPORT\ COUNT\ VECTORIZER$$
$$CV = COUNT\ VECTORIZER(MAX\_FEATURES = 3000)$$
$$X = CV.FIT\_TRANSFORM(CORPUS).TOARRAY()$$

4. Now, we do POS tagging. It is a process of converting a sentence to forms—list of words, list of tuples (where each tuple is having a form (word, tag)). The tag in case of is a part-of-speech tag, and signifies whether the word is a noun, adjective, verb, and so on.

$$FOR\ EACH\ ITEM\ IN\ TAGS:$$
$$IF\ EACH\ ITEM\ IN\ VERBS$$
$$COUNT\ VERBS+=1$$
$$ELIF\ EACH\_ITEM\ IN\ NOUN$$
$$COUNT\ NOUNS+=1$$
$$ELSE:$$
$$CONTINUE$$

#splitting the dataset as training and testing with 80% for training and 20% for testing.

5. Naive Bayes and SVM are used as a classifier for this model to predict the outcomes with better accuracy. Label encoding refers to converting the labels into a numeric form so as to convert them into the machine-readable form. Machine learning algorithms can then decide in a better way how those labels must be operated. It is an important preprocessing step for the structured dataset in supervised learning.

4 Implementation

- First, we find the dataset and import the necessary libraries in Python to read the data in the dataset and download the Nltk libraries.
- We will be doing tokenization, i.e., nothing but the process of partitioning text into a sequence of word, whitespace, and punctuation tokens. A tokenization dictionary identifies runs of text that should be considered words.
- We do count vectorization, i.e., counting the number of times each word appears in a document.
- We do the POS tagging. It is a process of converting a sentence to forms—a list of words, a list of tuples (where each tuple is having a form (word, tag)). The tag in case of is a part-of-speech tag, and signifies whether the word is a noun, adjective, verb, and so on.
- Label encoding refers to converting the labels into a numeric form so as to convert them into the machine-readable form. Machine learning algorithms can then decide in a better way how those labels must be operated.
- In one hot encoding, every word (even symbols) which are part of the given text data is written in the form of vectors, constituting only 1 and 0. So, one hot vector is a vector whose elements are only 1 and 0. After one hot encoding divides the training set and test split and train the model.
- Here, we have trained the model and used it for prediction.

5 Results and Discussion

A programming language used—Python. The tools used for implementing fake review detection are the Pycharm, Jupyter Notebook.

- Dataset—From Kaggle (Link: https://www.kaggle.com/lievgarcia/amazon-reviews).

After getting the models, we test the trained models using deploy.py. We need a user interface for inputs, so we are using the HTML and CSS to create a static Web page, and using flask, we host that page, and we will be writing in server.py in which we will be using models to predict and return to the page. This Web interface will run on a local host which was shown in (Fig. 2) after running the server.py code, so we open through the local host and give some random review inputs in (Fig. 3). Attaching the screenshots of the reviews and the output in our Web interface.

Here, we can see in (Fig. 4) that the review is true, and it got predicted as true because we gave the review text extracted from Amazon Web site.

Now let's see a review text which was given by us randomly. We give our review in our own words so that ML model that we trained can detect that it is fake as shown previously in Fig. 2.

As you can see from the different performance metric values in each algorithm, the SVM classifier gives the best performance out of all the others as shown in Table 1. The model which is trained by this algorithm is working effectively. Generating the most accurate results which we desire for.

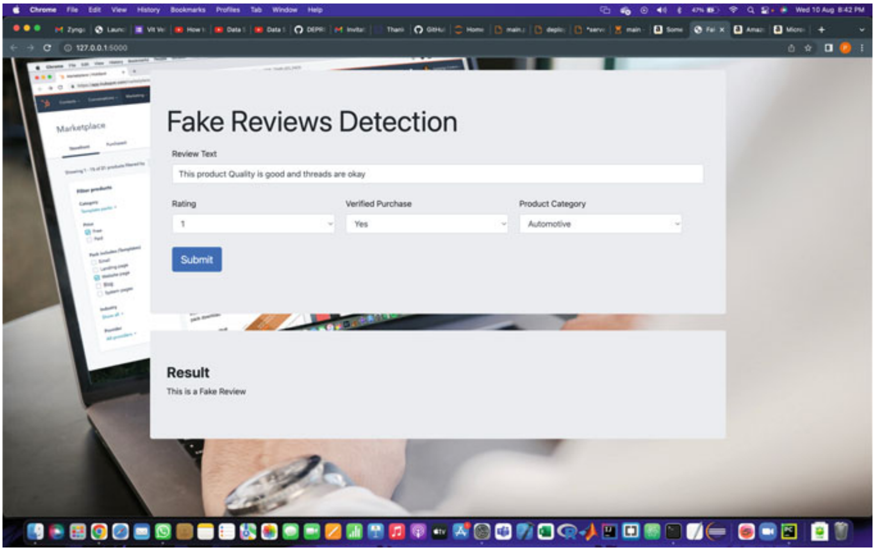

Fig. 2 Web interface

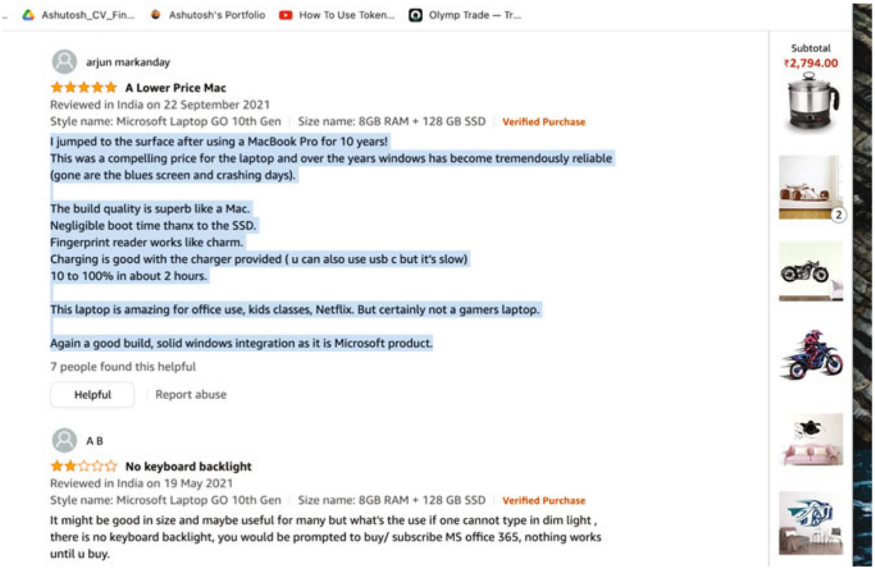

Fig. 3 Random review inputs

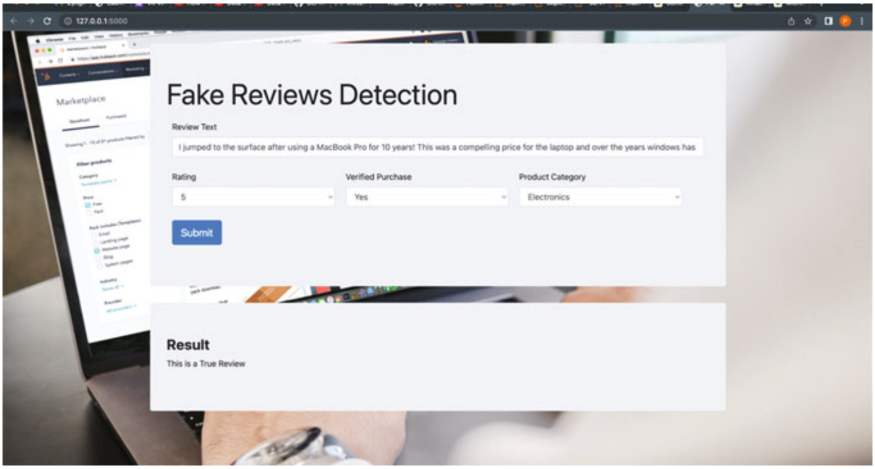

Fig. 4 Predicted review

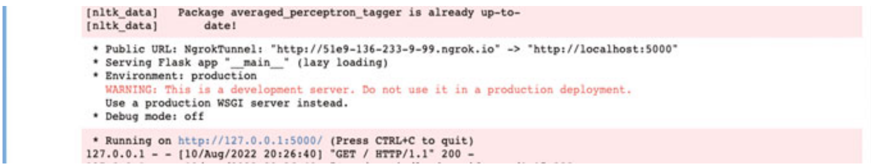

Fig. 5 Generated URL for the website where user can give the input

Table 1 Performance comparison of Naïve Bayes and SVM classifiers

Classifiers	Performance metrics		
	Accuracy	Recall	F-score
Naive Bayes	0.687	0.722	0.694
SVM	0.801	0.889	0.815

6 Conclusion

The objective of this paper is to detect the fake review which is present in Amazon reviews. This can be achieved by creating a model that can detect fake reviews by taking input in a text format. The model is trained with numerous reviews, which consist of more than 21,000 reviews. In the dataset, the data contain half reviews as fake and one more half as true. So that the model can predict the new data by getting trained with the trained dataset which is the Amazon reviews dataset. The input review text is taken as a sequence of words and performs tokenization and stemming and also removes the stopwords. Later, we do count vectorizer to count the number of repeated words that are present in multiple texts.

Perform POS tagging to tag the word with respective parts of speech. Converting into label encoding so that machines can understand the binary format of it after conversion. The training is done with 2 different classifiers like Naïve Bayes and SVM. Fake review detection is intended to screen out fraudulent reviews. For testing the dataset, we employed the SVM classifier in this paper. The SVM classifier, on the other hand, outperformed other algorithms on the training data. Demonstrating that it can generalize better and anticipate fraudulent reviews. This technique can be used on further sampled instances of the dataset. Several variables, including the addition of additional vectors such as ratings and verified purchases, have improved the accuracy of data classification.

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Deep Learning Technique to Analyze and Perceive Traffic Sign in the Intelligent Transport System

Manjula Gururaj Rao, H. Priyanka, K. Hemant Kumar Reddy, and Sumathi Pawar

Abstract Automobiles have evolved into a necessary part of our daily lives as a result of the rapid advancement of technology. One of them is advanced driver assistance systems (ADASs). The development of (ADAS) depends heavily on research into the automatic traffic sign detection and recognition (TSDR) system. Traffic sign detection is very important during the process of driving. Studies on vision-based TSDR have drawn a lot of attention from the research community, which is primarily motivated by three things: categorization, tracking, and detection. The detection of the traffic signs and taking precautionary majors is necessary while driving. This paper proposes the framework to detect the traffic signal and classify them into the different category. So, the driver will understand the severity of the signal. The proposed work consists of the modules as road sign detection, classification, and recognition. To identify the image, the color space conversion and color segmentation are applied. After the segmentation, the image is high lightened, and image is normalized and classified. For classify the different signals, neural networks are used. The proposed system is able to identify the cautionary sign, mandatory and informative signs. This paper evaluated some of the traffic signs such as no entry, stop, give way sign, and speed limit sign.

Keywords ADAS · TSDR · CNN · Traffic signs · Deep learning · Over fitting

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1 Introduction

Drivers are given crucial information about road restrictions and conditions by visual signals, such as traffic signs and traffic lanes, in every country on earth. Traffic signs are a crucial component of road infrastructure since they tell drivers about the condition of the road, as well as about limitations, cautions, and other navigational information [1], i.e., what the advanced driver assistant system (ADAS) wants to do. High-tech in-vehicle systems known as ADAS are intended to improve road safety by warning the driver of potentially dangerous road conditions. Lane departure, collision avoidance, and traffic sign recognition are a few essential ADAS sub-systems (TSR). Due to the significance of traffic sign recognition, it has recently been a popular and active study area. Drivers face a number of challenges that make it difficult for them to properly view traffic signs. The recognition, classification, and detection play an important role in the TSDR. To do all these tasks, the machine learning contributes a major portion in the TSDR.

The machine learning and deep learning is very important concepts, because of the ever-increasing volume and unpredictability of data, as well as the cheaper and more powerful computational processing. The techniques of deep learning and machine learning are used in image processing field. One of them is traffic signal identification and classification. Machine learning is based on the idea of using algorithms to analyze data, learn, and then make predictions about the problem. Rather than attempting to hand-code all procedures to execute a task, the machine is given a large amount of data to perform the operation [2]. Deep learning employs a computing model known as a neural network, which is loosely based on the brain of the human. Neurons, which are the network's fundamental building elements, make up neural networks. The neurons in a neural network are arranged in layers. The input is received by the neurons in the bottom layer, and it is related to important neurons in the top layers. The processing of the data will take place in the hidden layers. To analyze the traffic signs, it is broadly classified into the 3 categories depending on the severity of the signs as shown in Fig. 1. They are classified as follows:

1.1 Mandatory Signs

Orders are given using these signs. Red circles are used to depict them. Some of the mandatory signs are no entry, stop, speed limit, etc., are the order given to the driver's pedestrians. It is a criminal violation to disobey them. These indicators ensure that all vehicles follow the same pattern and that the road is not chaotic.

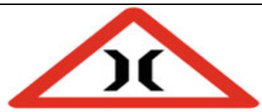
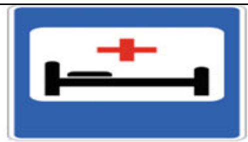
General Classification of the Traffic Signs	
Mandatory Signs	
Cautionary Signs	
Informative Signs	

Fig. 1 Shows different types of traffic signs

1.2 Cautionary Signs

The signs are used as cautionary indicators. Red triangles are used to signify them. Some of the cautionary signs are Right Hand Curve, Slippery Road, Narrow Bridge, etc. These indicators also alert the driver to the need for fast action. They warn the motorist ahead of time about what is about to happen. Depending on the cautionary sign presented, drivers can control their speed, modify their lane positions, and so on.

1.3 Informative Signs

This sign provides information. Blue rectangles are used to depict them. These indicators may not have a direct effect on your driving, but they are unquestionably useful. Some of the instructive signs that can be observed on highways include School Ahead, Hospital Nearby and others. They supply the required information, and the information concerned people can choose to act accordingly.

The next section elaborates on the different research conducted in the identifying and detecting the traffic sign. The proposed methodology is presented in Sect. 3. The implementation, result and discussion are offered in Sect. 4.

2 Literature Survey

The object identification and the recognition in the outdoor environment are very much important in the case of the automatic driving car. De la Escalera et al. [2] proposed the "Driver Support Systems and Intelligent Autonomous Vehicles" [2]. The proposed model, detection step employs a genetic algorithm, which allows for invariance localization in the face of changes in scale, rotation, weather, cluttered background and presence of other objects of the same color are factors that has to be taken into consideration. The classification is accomplished using a neural network. The global system not only identifies the traffic sign, but also includes data on its state or condition. ADAS uses the high data density, and recognizing the curves and edges plays a prominent role which is performed by using the wavelet descriptor by Sanyal et al. [3]. The authors also proposed the LL band pictures to avoid normalization and used the classifiers such as CNN, CNN ensemble, and LSTM.

To deal with the heterogeneous traffic sign datasets, the authors Abdel-Salam et al. offer "the Real-Time Image Enhanced CNN (RIECNN) for Traffic Sign Recognition" [4]. RIECNN is a real time. This architecture performs the better results in the recognition and the execution time of traffic signs. The proposed system is resilient to hindrances such as brightness and contrast variations in the surroundings, when recognizing traffic sign.

The new approach for identifying the traffic signals by using the modified CNN-based is proposed by Tong and Yang [5]. The proposed system comprises of inception modules; the network topology is extended, and a new loss function is utilized to solve the original model's difficulty in detecting small targets. When traffic signs are detected, that might be results into the identification or classifications of different signs in the inner class are proposed by Batool et al. [6]. This is done by using extreme learning machine network based on an extreme learning machine (ELM), convolution neural network (CNN), and scale transformation (ST) to detect traffic indicators in a real-time setting. The proposed model includes a proprietary DenseNet-based new CNN architecture, as well as an upgraded version of area proposal networks known as the accurate anchor prediction model (A2PM), ST, and ELM modules. To improve the edges of traffic signs, CNN architecture employs handcrafted features such as scale-invariant feature transform and Gabor. To make the model more efficient, the A2PM reduces redundancy among extracted features, while ST allows the model to identify traffic signs of various sizes. By rearranging the features, the ELM module improves efficiency.

To get the better results for identification of traffic signs, the author Fernando and Sotheeswaran [7] proposes a broad background, clutter, various degrees of illumination, variable sizes of traffic signs, and changing weather conditions to allow users to observe traffic sign information without having to move their attention away from the road. To get this type of better result, the author focuses on the information extracted from skipped layer connections.

The detection and classification of the traffic signals and the identification of the potholes in a single model were projected by the Sharma et al. [8]. The proposed system was developed for the Indian roads. It has the features such as "Accelerated Segment Test and Random Sample Consensus" (ASTRSC) methods for extracting and matching the traffic signs. To reject the mismatching corners, random sampling techniques are used, and for matching the spots, corner detection and edge detection techniques along with the accelerated segments are used. To detect potholes, the improved Canny edge detector as well as a bio-inspired contour detection method is used. A support vector machine classifier is used to classify the potholes and traffic signals. The bounding box regression model is then used to calculate the sizes of the discovered potholes.

The traffic sign detection is done by using the concept of spatial transformer-convolution neural network (ST-CNN) which is proposed by Wei et al. [9]. In this system, the spatial invariance of traffic signs was maintained via a network, and to maintain the network, spatial transformer network (STN) is used. This proposed system does classification by changing complicated images in the source image spatial into a characteristic spatial, focused on the source images. Some of the informative traffic signs are lane change. The lane-changing choice model for tunnels was proposed by Xu et al. [10].

The mechanism of information sources' influence on the tunnel entrance is investigated. The driver's lane-changing decision model is based on the synthesis of multiple sources of information. Another informative traffic sign is speed limit identification. For automatic identification and recognition of text in speed limit traffic signs, Sanjeewani et al. [11] propose a multi-stage deep learning-based technique paired with optical character recognition (OCR). The proposed traffic sign classification, detection, and identification model uses the multimodal or blended model which comprises of deep learning, CNN, and OCR attribute. This approach is used to check the real-world dataset.

3 Proposed Model

The proposed system is shown in Fig. 2. The proposed system contains the different modules such as image acquisition, preprocessing of the images; features are extractions, CNN model development, classification and identifying the image. The classification and identification of the traffic sign is done using CNN deep learning module.

3.1 Input Data

Datasets: "The German Traffic Sign Recognition Benchmark (GTSRB)" dataset is used by the traffic surveillance system which is available on Kaggle. It has more than 40 classes and more than 50 k images of various traffic signs. Following are the three different datasets that will be used during the project [10]. The available Kaggle data

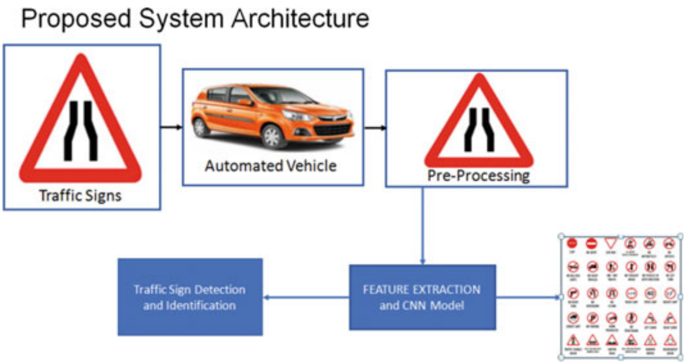


Fig. 2 Architecture of the proposed model

has been separated into two datasets: a train dataset and a test dataset, which will be used to train and test the model. The data has the shape (39,209, 30, 30, 3), indicating that there are 39,209 images of size 30 × 30 pixels and that the last three indicate that the data comprises colored images (RGB value) after being resized to 30 × 30 pixels.

3.2 Preprocessing

In the preprocessing of the images are initially cropped to get only the signs. The cropped image is resized to 30 × 20. After this process, the noise will be removed from the image by using the orderly filters [12]. We applied the canny edge detection algorithm to get the edges of the sign images properly.

3.3 Splitting of the Images

Training and testing data will be considered in the ratio of 80:20. The trained model should be classifying 43 different classes, ranging from 0 to 42. The different types of classes of the images are as shown in Fig. 3.

3.4 CNN Deep Learning Architecture

In this module, the machine learning or training function and testing of the images are performed. The images present in the database are spitted, as mentioned above. The module building blocks are as shown in Fig. 3. The performance of the network

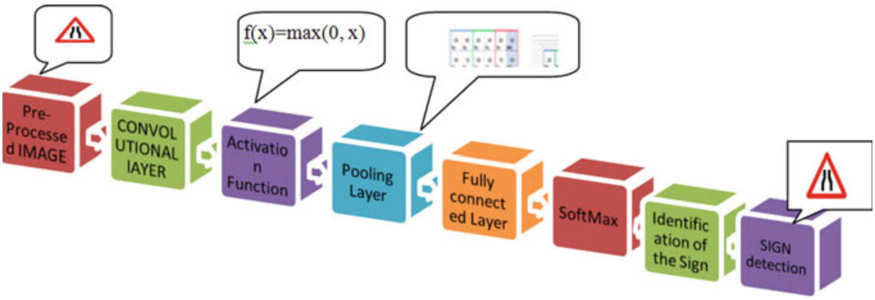


Fig. 3 Shows the building blocks of CNN in the proposed model

is directly impacted by the right selection of several design hyper-parameters, such as nonlinearity and pooling variants. This module undergoes the process of convolution, applying the activation function, pooling layer, fully connected layer and applying softmax and identifying the output.

3.5 Convolutional Layer

Convolution is a constant process in which a series of weights is multiplied with the input in a convolutional neural network, equivalent to a standard neural network. The multiplication is performed between an array of data input and a two-dimensional array of weights, referred to as a filter or a kernel, because this approach was created for two-dimensional input. The choice of a smaller filter than the source data is decisive since it enables the same filter (set of weights) to be multiplied by the source data array many times at various positions on the source data. The filtering is employed consistently to each overlying segment of the incoming data from bottom to top and right to left. The filter was designed to measure a certain characteristic in the source data. By applying filter to the entire image gives the filter the chance to identify that characteristic throughout the image. Translation invariance is a quality that refers to the general interest of whether or not a feature exists instead of where it exists. A CNN is made up of numerous convolutional layers that extract features from the network's input. The same transformation is applied at all places, which is one of the basic ideas of CNNs. The input image has been converted into a stack of feature maps at the conclusion of convolution. Each feature map represents a visual feature that can be seen in certain areas of the input image. The number of nodes (i.e., filters) in the convolutional layer corresponds to the size of this feature stack. The relevance of a particular node in a neural network is determined by its activation functions. A node will "fire" after it has passed through an activation function and is important to the model's prediction. These functions are computationally cheap functions which are part of regular neural networks. A rectified linear function in some form is required for CNNs (e.g., ReLU). The rectified linear activation function, also known as ReLU, this function returns zero for the negative input. The vanishing gradient problem is solved by using a rectified linear activation function, which allows models to learn faster and perform better. It is common practice to add a nonlinear layer after each convolution layer (or activation layer).

This layer's goal is to provide variability to a machine that exclusively computed basic operations throughout convolution layers. Researchers observed that ReLU layers perform much better than nonlinear functions like tanh and sigmoid since the network can train quicker (because to the computational efficiency) without compromising performance. It also aids in the resolution of the shrinking gradient challenge, which arises when the gradient decreases exponentially across layers, causing the network's basal layer to train very rapidly. The function is applied by the ReLU layer. To all of the entries in the input matrix, apply $f(x) = \max(0, x)$. The activations that are negative are set to 0 in its simplest form. Figure 3 shows the function $f(x) = 0$ when the value of x is 0 and $f(x) = x$ when the value of x is ≥ 0. This layer improves the model's nonlinear qualities as well as the overall network's nonlinear features without altering the convolution layer's activation functions. The algorithm for the featured extraction is shown below.

3.5.1 Algorithm

Step 1: Convert the image into .jpg and resize the image to into 20×30.

Step 2: Use the kernel of size 5×5. Apply the kernel to the input image.

Step 3: Calculate the featured the image or the resultant image, which is done pixel-wise as featured image = Image pixel * kernel pixel.

Step 4: Calculate the total sum of the featured image. This is done as the sum of all the pixels present in the featured image.

3.6 Pooling Layer

A volume is spatially downsampled in the pooling layer of a CNN. Downsampling was selected individually in each sample point of the input volume. In CNNs pooling, it is used to decrease the size of parameters in the network and make feature identification more scalable and robust, and also change in the orientation. It permits the conversion of high-resolution data to lower-resolution data. Pooling, in conjunction with convolutional filters, seeks to recognize objects in an image. A downsampling layer is another name for it. There are various layers in this area, with max-pooling being the most prevalent. This consists of a filter (often 2×2) and with same length. It then applies it to the input volume that has the highest number of the output in each of its sub-region of filters. $L - 2$ norm pooling and average pooling are two further choices for pooling of layer. The obvious idea for this layer is that once we know a feature is in the original input volume (high activation function), is in its precise location than its relative location is which not considered. This layer dramatically lowers the input volume's spatial dimension. This achieves two objectives. It may be the weights or size of parameters which is decreased to 75%, cutting computing costs. The other benefits full control over the process of fitting. A model that achieves accuracy of 99% on the training set but only accuracy of 50% on the test data is stated as over fitting [11, 13, 14].

3.7 Fully Connected Layer

Fully connected layers identify the objects obtained from the results of the convolutional pooling layers. In a nutshell, it is a normal neural network. Classifier with a high-level feature extractor is connected to the end. To link the convolution layers to the completely connected layer, the final convolution layer's outputs have many channels of $X \times Y$ matrices that should be compressed into a unique $N \times 1$ tensor. This is the final layer, and it is here that the image classification takes place. We receive a 2×2 matrix for each filter after repeating the operation and converting it to a vector matrix [15, 16].

4 Implementation

For this research, we utilized Anaconda Navigator and Jupyter Notebooks, a robust Integrated Development Environment with debugging, introspection features advanced editing, interactive testing, to access, manipulate, and build the CNN model using multiple Python libraries and modules. For image conversion and processing procedures, Numpy and Python imaging library (PIL) are utilized. The images are divided into test and training images using the built-in libraries.

The neural networks are formed using some of the built-in functions. Each cell in a layer accepts data from all cells in the layer above it. As a result, they are tightly linked. Figure 4 illustrates this. A tensor's flatten operation reconfigures it to have a shape equivalent to the total of elements in the tensor, with the exception of the batch dimension. The dropout approach is used to keep a model from fitting too tightly. At each update of the training phase of a neural network's function, randomly, the edges are set to zero for hidden units (neurons that make up hidden layers). We examined the problem of overfitting in the last section, where the training instances are tuned to the network such that the network does not function well when given fresh examples after training.

The concept of dropping out is straightforward. It will remove a random group of activation functions in this layer by adjusting it to zero. It ensures that the network

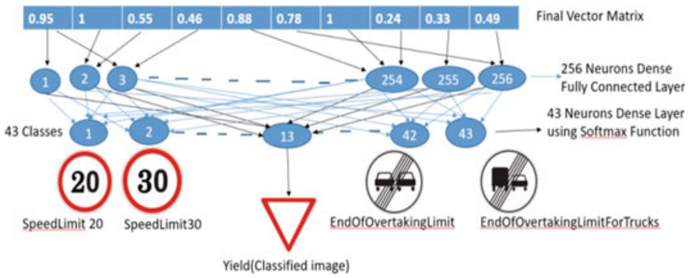


Fig. 4 Shows the processing in the dense layer and final classification of the image

does not get overly "adapted" to the training data, hence avoiding the over fitting problem. This layer has been utilized throughout the training, but not just during the testing.

The description of the simplest CNN architecture is shown in Fig. 5. It accepts as input a 30 × 30 grayscale image with a single channel. In order to speed up training and convergence, we used adaptive momentum (Adam) [12, 17], which updates each network parameter with a separate momentum parameter that functions as a sort of average of prior gradient changes. The loss function is categorical cross-entropy.

4.1 Training Time

It took 70 ms to run each epoch NVidia GT920M graphics card. Training accuracy of this architecture was > 5% after running 10 epochs. This is very bad because this architecture helps to find digit not complex patterns. The Softmax function is used as the input signal in the output units of our neural network models that forecast a multinomial probabilistic model. For multi-class classification problems requiring class membership on more than two labels, this activation function is used.

5 Results and Discussion

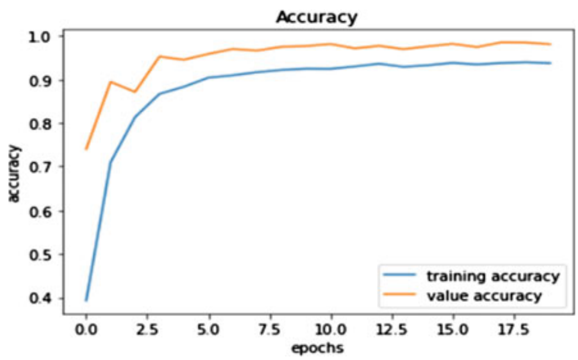
Validating the accuracy and quality of data is important before using, importing, or processing it. Different types of validation may be carried out depending on the constraints or goals of the destination. Data purification includes the process of data validation. In order to train and test the model, the available Kaggle data has been divided into two datasets: a train dataset and a test dataset. The data is in the shape (39,209, 30, 30, 3), which denotes that there are 39,209 images that are 30 × 30 pixels in size, and the final three denote that the data consists of colored images (RGB value) that have been shrunk to 30 × 30 pixels.

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 128, 128, 32)	856
conv2d_1 (Conv2D)	(None, 126, 126, 32)	9248
max_pooling2d (MaxPooling2D)	(None, 63, 63, 32)	0
dropout (Dropout)	(None, 63, 63, 32)	0
conv2d_2 (Conv2D)	(None, 63, 63, 64)	17996
conv2d_3 (Conv2D)	(None, 61, 61, 64)	38928
max_pooling2d_1 (MaxPooling2	(None, 30, 30, 64)	0
dropout_1 (Dropout)	(None, 30, 30, 64)	0
dense (Dense)	(None, 1024)	2198176
dropout_4 (Dropout)	(None, 1024)	0
dense_1 (Dense)	(None, 10)	10450

Fig. 5 Summary of the CNN model

The graph in Fig. 6 depicts the training accuracy value. From 74% accuracy in the 1st epoch to 98% accuracy in the 20th epoch, the model recognizes the images. As shown in Fig. 7, the value loss has decreased from 1.0187% in the first epoch to 0.0734% in the 20th epoch. The model correctly verifies the test dataset 95% of the time.

Fig. 6 Accuracy-epoch graph: training and value accuracy loss



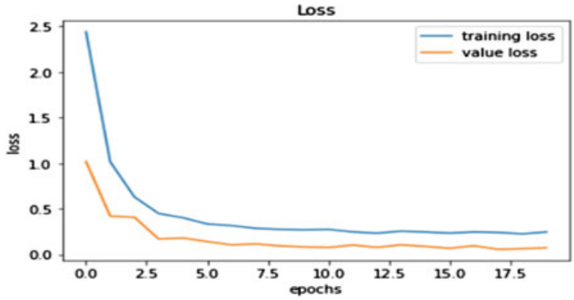


Fig. 7 Loss-epoch graph: training and value

6 Conclusion

CNN is the most effective artificial neural network method. CNN can outperform humans at visual recognition images when given a well-prepared dataset. CNN's idea is still being refined, and it will soon allow CNN to assess new items that are substantially different from those on which they were trained. This paper proposes the framework to detect the traffic sign and classify them into the different category. The proposed work consists of the modules as identification of road signs, classification, and recognition. The model correctly verifies the test dataset 95% of the time.

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Power Quality Conditioner with Fuzzy Logic Controller

M. Balasubbareddy, P. Venkata Prasad, and Kowstubha Palle

Abstract To mitigate power quality issues like voltage sag, swell, and voltage flickering, a unified power quality conditioner (UPQC) is used. In this, combination of DVR and STATCOM is used to minimize power quality issues. Many of the authors are proposed different mitigation techniques in the literature. Fuzzy logic controller is used to diminish the power quality issues. The proposed system results compared with existing methods and evidence that the proposed method is superior when compared with literature.

Keywords UPQC · PI controller · DVR · STATCOM · Fuzzy controller · Power quality issues

1 Introduction

UPQC is power device used to mitigate disturbances occurred in power system [1, 2]. This device is used to compensate sag, swell, harmonics, and reactive power [3–6]. In [7] authors are described PQ theory. To control three-phase UPQC synchronous reference frame, DQ theory [8] is used. In [9], PI controller scheme has proposed to control UPQC parameters. In [10–12] the authors proposed, the fuzzy logic controller (FLC) instead of conventional PI controller to control the UPQC parameters. In [13–20], authors proposed different optimization techniques for optimal power flow problems.

In this paper, proposed fuzzy logic controller to mitigate power quality issues also compared with PI controller.

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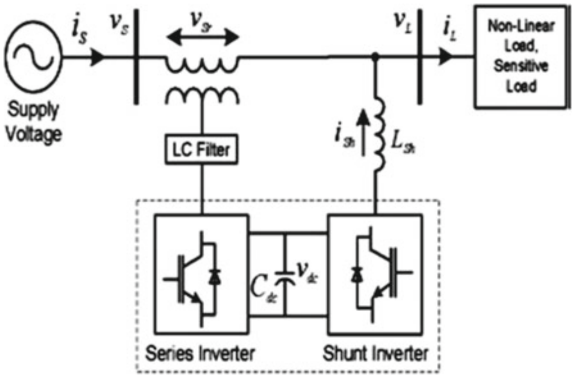

Fig. 1 VSI-based UPQC

2 Basic Block Diagram of UPQC

D-STATCOM is of the effective device for mitigation of the current harmonics, reactive power compensation, balancing and unbalanced currents. The DVR is for mitigation of the voltage harmonics, sag, swell, flicker, and balancing the unbalanced voltage at the point of common coupling PCC. Both the D-STATCOM and the DVR connected with the common DC bus that make the universal device solve almost all the current and voltage-related problems is called as the UPQC [21]. The UPQC is connected near common coupling from the point the nonlinear loads that are connected. The voltage source inverter-based UPQC is shown in Fig. 1.

3 Mathematical Modeling of the Reference Generation Techniques

The UPQC performance depends on the control algorithm. For the designing controller to UPQC, there is need to sense the voltages and the currents according to control strategies that we are using to reference current and the voltage generation techniques. The firing pulses for the valves are then generated by the comparing the reference signal to actual signal. Thus, the control strategies of the UPQC are then implemented in the three stages.

The time domain approach is based on the instantaneous calculation of reference current and the voltage signals from the sensed distorted current and the voltage signals. As instantaneous in the nature, the time domain approaches faster than frequency domain approach. The time domain approach to reference signal generation is studied and then simulated in the MATLAB/Simulink environment. As the control techniques are being explained below

(a) The unit vector template (UVT) reference generation techniques
(b) The instantaneous power (p-q) reference generation techniques.

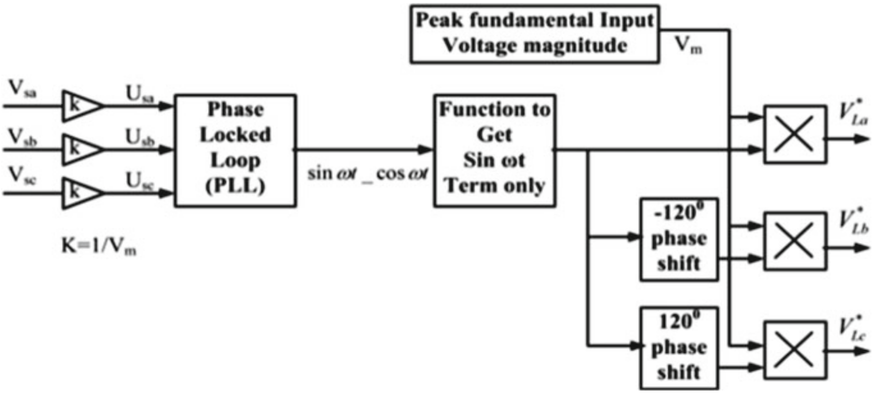

Fig. 2 UVT technique implementation

3.1 The UVT Reference Generation Techniques

For these techniques, the unit vector templates extracted from the input voltage using phase locked loop. Templates are then balanced with the unity magnitude. The current generation by the shunt inverter and the voltage generation by the series inverter on the unit vector templates that are generated by use of the PLL (phase locked loop) are being used.

Maximum value of fundamental input voltage magnitude is then multiplied by the unit vector templates that are calculated by the PLL block for generating the reference voltage required for load side. That we directly compare reference load voltage to the actual load voltage using the hysteresis voltage controller. The implementation of UVT technique is shown in Fig. 2. This will eliminate the supply harmonic components. Series filter voltage equation is given in Eq. (1) [10].

$$V_{ah} = V1_{na} + V1_{pa} + \sum V_{kn}\alpha k = 2\sin(k\omega t + \theta kn) \tag{1}$$

Comparing the DC link voltage to fixed reference voltage, then passing it through the PI controller and the limiter we get required peak magnitude to sinusoidal source current that drawn from source.

3.2 The p-q *Theory Reference Generation Techniques*

Instantaneous reactive power (*p-q*) technique was then first introduced by the Akagi in the 1984. In the 3-phase, 3-wire system is zero sequence component voltage, and the current is then not present. This technique takes use of the Clarke's transformation ABC to αβ0. The implementation of *p-q* theory is shown in Fig. 3

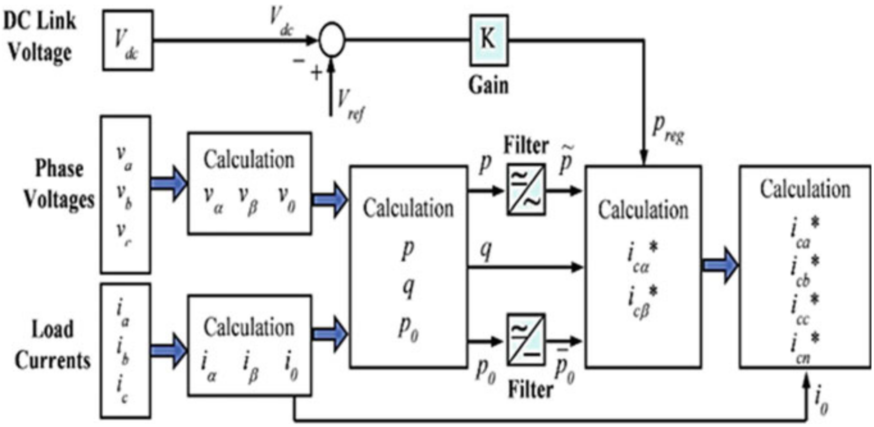

Fig. 3 *p-q* theory implementation

$$\begin{bmatrix} i_\alpha \\ i_\beta \\ i_o \end{bmatrix} = \frac{\sqrt{2}}{3}\begin{bmatrix} 1 & \frac{1}{2} & -\frac{1}{2} \\ 0 & \frac{\sqrt{3}}{2} & \frac{-\sqrt{3}}{2} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix}\begin{bmatrix} i_{sa} \\ i_{sb} \\ i_{sc} \end{bmatrix} \tag{2}$$

$$\begin{bmatrix} p_\alpha \\ q_\beta \end{bmatrix} = \begin{bmatrix} v_\alpha & v_\beta \\ -v_\beta & v_\alpha \end{bmatrix}\begin{bmatrix} i_\alpha \\ i_\beta \end{bmatrix} \tag{3}$$

$$p = \overline{p} + \tilde{p} \text{ and } q = \overline{q} + \tilde{q} \tag{4}$$

So, reference current signal that can be achieved, to have the fundamental the active power component, i.e., unity power factor the harmonic compensation as: αβ0 to ABC

$$\begin{bmatrix} i_{sa}^* \\ i_{sb}^* \\ i_{sc}^* \end{bmatrix} = \frac{\sqrt{2}}{3}\begin{bmatrix} \frac{1}{\sqrt{2}} & 1 & 0 \\ \frac{1}{\sqrt{2}} & \frac{1}{2} & \frac{\sqrt{3}}{2} \\ \frac{1}{\sqrt{2}} & -\frac{1}{2} & \frac{-\sqrt{3}}{2} \end{bmatrix}\begin{bmatrix} i_0 \\ i_\alpha \\ i_\beta \end{bmatrix} \tag{5}$$

4 Results and Analysis

In this analysis, section clearly analyzed the performance of with and without UPQC compensation. Different control techniques of UPQC, such as PI controller and fuzzy logic controller (FLC), are analyzed.

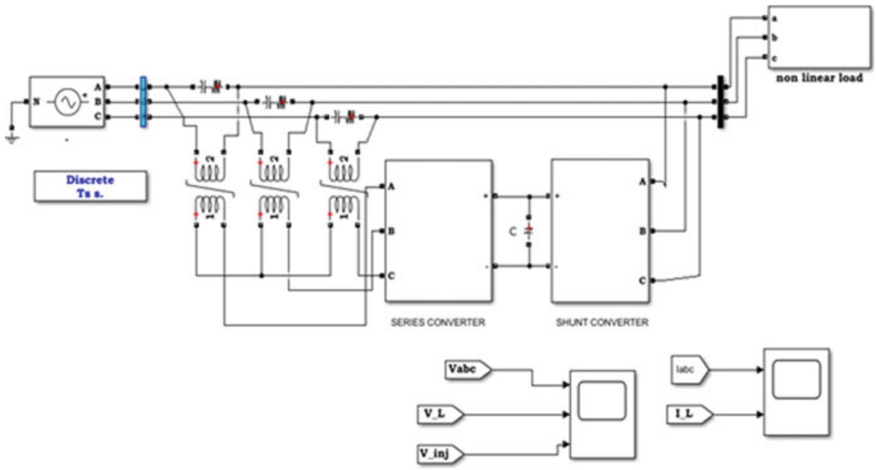

Fig. 4 Simulation of UPQC with PI controller

4.1 PI Controller

This is the feedback control loop; it will used to calculate error using DC link voltage and reference voltage. The values of Kp = 10 and Ki = 0.1 for the PI controller are designed. The *p*-*q* theory implementation block diagram is shown in Fig. 3. The main simulation circuit diagram of UPQC with PI controller is shown in Fig. 4.

4.2 Shunt Filter Operation

Simulation results are shown in Fig. 5 when shunt filter is on operation. From Fig. 5, after activating shunt active filter at 0.4 s, the source current is made sinusoidal.

4.3 Series Filter Operations

Simulation results of UPQC with series filter operation are shown in Fig. 6. From this figure, the series active filter has eliminated the voltage harmonics from 0.4 to 0.5 s. Sag compensation results are shown in Fig. 7. Now, the voltage sag is created from 0.9 to 1 s with 30% sag compensation. However, this voltage sag is eliminated by the series controller that is active from 0.9 to 1 s. Figure 7 shows the source voltage, load voltage, and the voltage injected by the series controller for sag elimination.

Simulation results of voltage swell compensation are shown in Fig. 8; from Fig. 8, it is observed that the voltage swell is created in the source from 1.6 to 1.7 s by

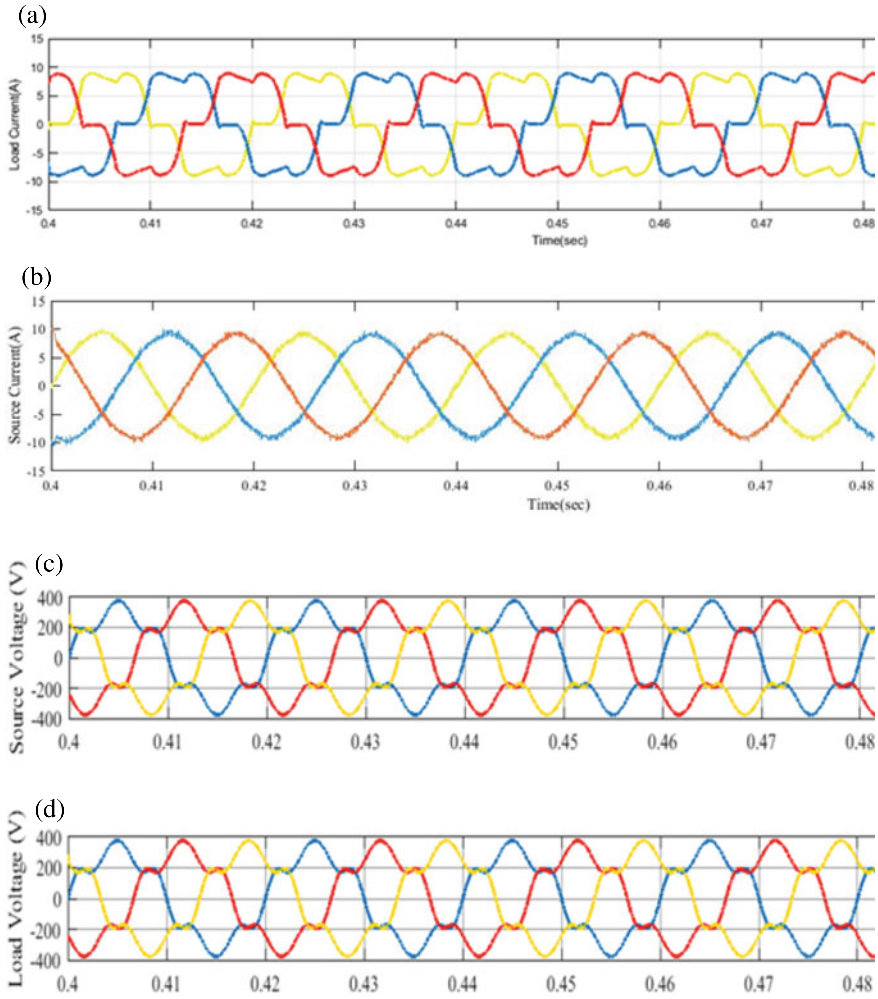

Fig. 5 **a** Load current with shunt filter operation. **b** Source current with shunt filter operation. **c** Source voltage with shunt filter operation. **d** Load voltage with shunt filter operation

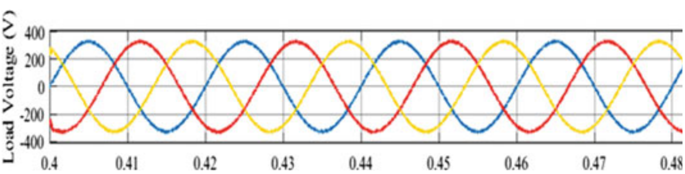

Fig. 6 Load voltage with series filter operation

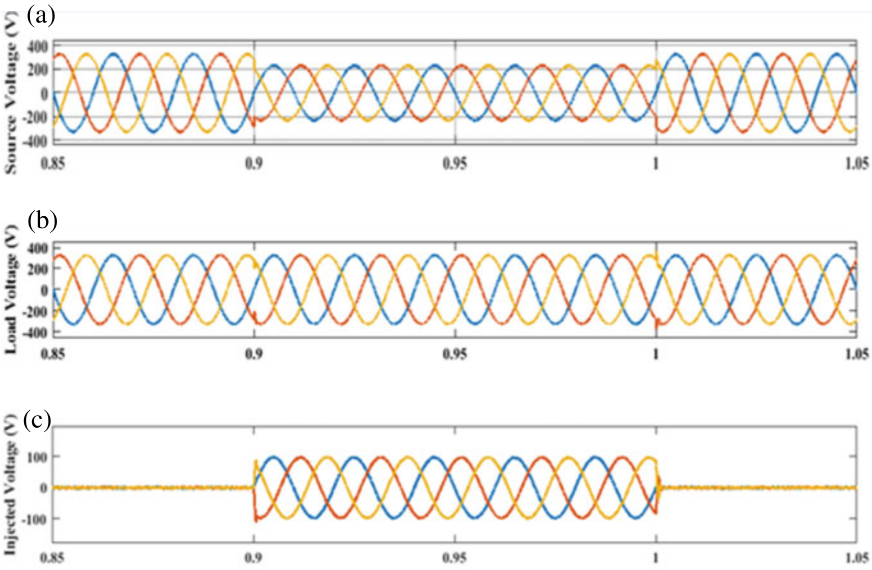

Fig. 7 **a** Source voltage sag compensation. **b** Load voltage sag compensation. **c** Injected voltage with voltage sag compensation

30% swell compensation in the source voltage. However, the voltage swell is being eliminated by the series controller as it is active from 1.6 to 1.7 s. The load voltage has become sinusoidal with the elimination of voltage swell. The source voltage with voltage swell, load voltage, and injected voltage by series controller is shown in Fig. 8.

It is observed that source current THD without UPQC is 22.28% and with UPQC is 2.51%. Load voltage THD with UPQC is 0.74%.

4.4 Fuzzy Logic Controller (FLC)

The FLC basically contains three parts such as fuzzification, decision-making, and the defuzzification.

Figure 9 shows the sag and swell compensation with UPQC-FLC. The voltage swell is created from 0.3 to 0.4 s with increase in voltage of 30% shown in Fig. 9a. Then, this is compensated by injecting UPQC voltage shown in Fig. 9c. Figure 9b shows the compensated voltage.

The voltage sag is created from 0.9 to 1 s with decrease in voltage of 30% shown in Fig. 9a. Then, this is compensated by injecting UPQC voltage shown in Fig. 9c. The voltage after compensation is shown in Fig. 9b.

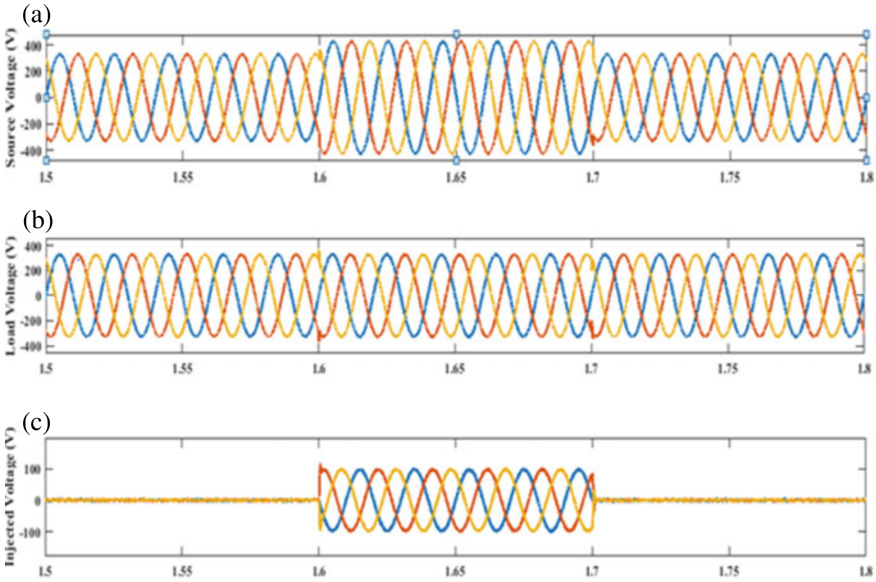

Fig. 8 **a** Source voltage with voltage swells compensation. **b** Load voltage with voltage swells compensation. **c** Injected voltage with voltage swells compensation

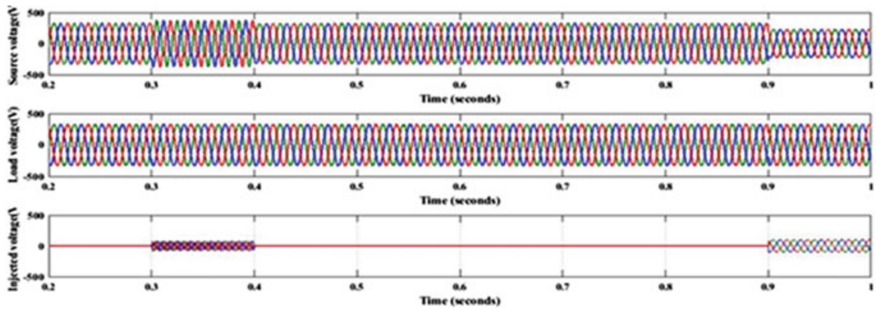

Fig. 9 Simulation results of sag and swell compensation using UPQC-FLC

The obtained results of the THD values using all the controllers that are studied are compared in Table 1 where the THD value of source current and the load voltage is within the IEEE standards by using UPQC.

Table 1 Comparison of source current THD

Source current THD%	PI controller (%)	FLC (%)
Without UPQC	22.28	22.28
With UPQC	2.51	2.24

From Table 1, it is observed that the current THD without UPQC is high, i.e., 22.28%; this is compensated by the UPQC very effectively and reduced to 1.90%, i.e., maintained with the IEEE standards (below 5%), and also observed that current THD is 2.17% with FLC-ACO, 2.24% with FLC, and 2.51% with PI controller.

5 Conclusions

The power quality problems are successfully eliminated using UPQC-PI controller, and the current harmonics are reduced, and the THD is brought to 2.51% from 22.28%. UPQC-FLC scheme is used for compensation of the source voltage and load current in the distribution systems by regulating the DC voltage. For signal generation, instantaneous reactive power theory is used. This technique has successfully mitigated the voltage sag and swell. The fuzzy logic controller updates the values for every control cycle unlike with PI controller. From this, UPQC-FLC scheme observed that the load current and source voltage harmonics are adequately compensated for improving power quality.

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Task Offloading Using Queuing Theory in Fog-Assisted IoMT

Nitish Kumar, Himanshu Verma, Naveen Chauhan, and Lalit Kumar Awasthi

Abstract The *Internet of Medical Things* has been helping greatly to reduce the pressure on medical resources and hospitals. Being a time-sensitive system, quick responses from the medical system are of utmost importance. The current system comprises wireless sensor networks and cloud computing. However, cloud computing faces the drawback of low latency, which could be fatal in healthcare. Fog computing can provide solutions to overcome delays and get real-time responses. In the fog-assisted IoMT, devices are deployed near the sensing devices at the network's edge. However, these fog devices could deal with massive data volumes and have minimal resource capacity for processing this data. Therefore, it may lead to offloading data from fog nodes to other nodes in the network for processing. Hence, designing efficient algorithms to ensure minimal delay in data processing and offloading is currently the need of time. This paper proposes a framework for data processing and offloading in the fog layer. The results are analyzed and compared in terms of latency and response time with the existing cloud systems using extensive simulations.

Keywords IoMT · Fog computing · Task offloading · Cloud networks · Fog-assisted IoT

1 Introduction

The Internet of Medical Things (IoMT) is becoming the next technological trend in cloud computing. Wireless sensor networks (WSN) significantly affect how patients are observed and monitored. Sensors, such as wearable devices or accessories, are

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embedded in a patient to collect information for health monitoring purposes by forming a wireless body area network (WBAN), generating a tremendous amount of data. This data collected from various medical sensing objects could be fresh or redundant. This massive volume of data can be burdensome for data analysis applications and storage systems. Filtering out inappropriate data must be sensitive to context. Therefore, sensors must send collected data to the computational devices to perform storage, aggregation, and analysis operations. Building an infrastructure devoted to the individual is inefficient and infeasible as, in various cases, an individual patient requires many medical sensors.

Hence, IoT offers a substitute approach where sensor accessories are used in the shared infrastructure. After that, data can be forwarded through these sensor devices to the cloud server. However, this simple sensor-cloud architecture is not feasible for most healthcare applications because of high latency, endangering patients' privacy, and lack of real-time feedback. Also, there is always a slight probability of a data node or network failure that could put a patient's health at high risk. And here, fog computing steps into the picture and aids healthcare applications.

Using only cloud computing may delay transferring the data from sensors to the cloud and then from the cloud to doctors or hospitals. Every healthcare system has an emergency response system that demands real-time operation where time and efficiency play a crucial role. It could badly suffer because of the delays caused by cloud computing. Transferring such enormous amounts of data up and down is not a practical option due to latency issues and security concerns. The risks involve breaching crucial data and danger to the patient's health. Henceforth, cloud computing architecture has to be extended to the distributed one from the conventional centralized one. A distributed architecture divides tasks into sub-tasks and offloads them to various nodes. It can also be referred to as "fog computing."

In fog computing, significant computation-intensive operations are preferred to be executed on the network's edge (near sensors where data is collected). However, edge computing would also need greater flexibility to manage the massive invasion of devices. In addition, it is difficult for edge devices to operate multiple IoMT applications competing for limited resources simultaneously, leading to increased processing latency and resource contention. Adding a distributed feature to this will be helpful in scalability and reduce the risk of data exposure, thereby increasing security and removing many privacy concerns.

The fog computing layer extends the existing infrastructure of the cloud by integrating cloud resources with edge devices. In this system model, in addition to the cloud, applications also exist in fog devices nearest to the users and infrastructure components between them. This infrastructure consists of routers, access points, and gateways. The primary objective of the healthcare application is to provide continuous supervision of patients' health. This requirement is successfully fulfilled by implementing the fog layer. Also, the continuous burden of maintenance, infrastructure, costs, and upgrades is relaxed as the cloud's data nodes are shared with the resources of the fog layer.

These studies encourage us to incorporate fog computing on IoMT and propose a task-offloading method for fog-assisted IoMT by employing the queueing theory. The remaining paper is structured as follows: Section 2 introduces state-of-the-art data processing in fog computing. In Sect. 3, the problem foundation is presented. Section 4 discusses the proposed methodology. Simulation results and analysis are presented in the Sect. 5. The last Sect. 6 finally concludes the paper.

2 Related Work

A sufficient volume of the literature review is available on data processing in healthcare IoMT systems [1]. Winky et al. [2] proposed a classifier to reduce the dimension of data and improve the original sensor's interface. Maghereni et al. [3] added an automated recognizer that records day-to-day activities, ensuring sensor data accuracy via model checking and propositional temporal logic. Wang et al. [4] presented the sound-related architecture to distinguish noise and acoustical signals. The focus of recent studies regarding real-time processing platforms and architectures [5] has been shifted to enhancing the accuracy of data analysis.

Existing literature can be broadly divided into two categories. One focuses on more precise tools, technologies, or analysis algorithms [6] that attempt to minimize environmental factors' effects, and the other focuses more on collecting comprehensive data [7]. Both of these approaches, however, increase the pressure and workload on healthcare IoMT systems. Fog computing is a relatively new concept as compared to cloud computing. To support geo-distribution services and low latency, it processes the data at the edge of a cloud [8]. For instance, Hiu et al. [9] improve the performance in many network conditions by proposing a hierarchical multi-access edge computing framework. Ciao et al. [10] detect falling by adopting fog computing. Azam et al.[11] used fog computing to optimize emergency alert services. However, existing literature studies paid little attention to the computation ability and transmission of fog computing.

The following sections discuss the problem foundation and proposed methodology.

3 Problem Foundation

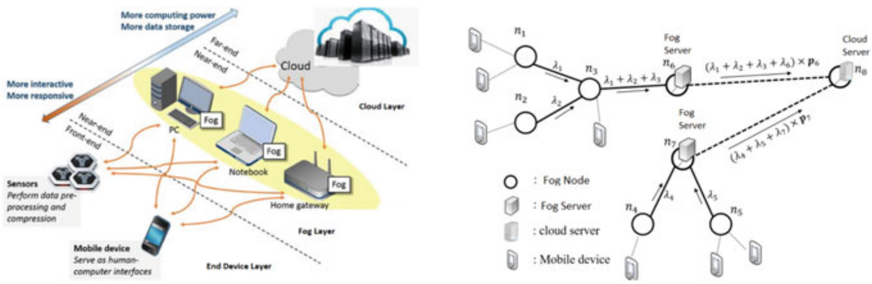
This section laid the foundation for the problem and proposed methodology. It commences by presenting the system architecture, then the system model, and ends by formulating the problem using mathematical modeling.

3.1 The Three-Layer Architecture

As shown in Fig. 1, the three-layer architecture includes the end device layer, fog layer, and cloud layer as follows: **End Device Layer** consists of the end devices and acts as the source of data for the fog computing layer. **Fog Layer** consists of the fog nodes situated near the end devices. Data gets offloaded to these nodes from the IoMT gateway (based on predefined criteria). As a result, there is a slight latency in data transfer between the end devices and fog nodes. Furthermore, fog nodes have limited resource capacity that hinders the parallel processing of tasks. Therefore, the waiting queue must buffer the tasks or offload the tasks to the cloud layer (depending on the task's priority). **Cloud Layer** consists of cloud data nodes with unlimited resources. The data node can use one VM server per user to process the task to achieve high performance. Data transmission latency exists due to the cloud node and fog node bandwidth. Moreover, it is no need to wait once it is offloaded to the cloud layer and can be completed immediately. This layer also acts as storage for later analysis.

3.2 System Model

The network is modeled as a connected graph G (N, E), where N and E denote a set of nodes and edges, respectively, as exhibited in Fig. 1.The network consists of IoMT devices connected wirelessly to the network. The collected data is first forwarded to the nearest Global IoMT gateway, where task classification is done. Out of N nodes, a few nodes in the network are fog nodes that help in the real-time processing of high-priority tasks. Then there are cloud servers, both public and private, which have unlimited resource capacity. The tasks are offloaded to cloud nodes either when tasks need more resources and no real-time processing is required or when the fog nodes are exhausted with other tasks.



(a) 3-layer architecture (b) System Model

Fig. 1 The architecture and the system model

3.3 Mathematical Modeling

The considered network is modeled using a network of queues; therefore, we applied queue theory to formulate our problem. In the proposed system, queues are mainly available at the Global Gateway (GG), Cloud Gateway (CG), the fog nodes, and the cloud nodes. The gateways are modeled as $M/M/1$ queues. $M/M/1$ queue is the queueing model where a single server serves the jobs arriving according to the Poisson process (exponentially distributed inter-arrival duration), and service times are exponentially distributed (M denotes a Markov process).

The load balancer at the cloud gateway distributes incoming traffic to different VMs in the cloud. Processing times of CG and GG are identical, independent, exponential, and randomly distributed variables, and their mean rates are $\frac{1}{\mu CG}$ and $\frac{1}{\mu GG}$, respectively. Each fog node is modeled as a $M/M/C$ queue having an identical service rate of $\frac{1}{\mu FC}$. Finally, a cloud node is modeled as an $M/M/\infty$ queue without any waiting buffer as it is assumed to have an unlimited resource capacity. It is assumed that the inter-arrival times of every health-related data packet are not dependent on each other and are also exponentially distributed with an arrival rate λ_i.

If all processors at any given fog node are busy upon the arrival of a request and the fog node cannot fulfill its request within a given deadline, then that request is offloaded either to a fog node or a cloud node. Let us assume that the arrival of requests at some fog node i from some node j follows the Poisson process and lets the arrival rate by λ_j from the jth node. Let λ be the total request rate allocated to fog node i from various nodes. Then $\lambda = \sum \lambda_j$. Where $i \in G_i$ and G_i represent a set of nodes, their requests are served by fog node i.

Offloading Probability Theorem: When all processors at the fog node are busy upon arrival of the health request, the request may be offloaded to the cloud server. Utilizing the Erlang-B formula, the following equation (1) gives the offloading probability on node i:

$$\mathrm{p_i} = \frac{\frac{\rho^C}{c!}}{\sum_{j=0}^{C} \frac{\rho^j}{j!}} \tag{1}$$

where $\rho = \frac{\lambda}{\mu}$, λ is the arrival rate from node j, μ is service rate of node i and c is the number of servers at fog node i. Mean response time (T_{GG}) and mean waiting time (W_{GG}) in the global gateway can be evaluated as:

$$\mathrm{T_{GG}} = \frac{1}{(\mu_{GG} - \lambda_{GG})}; \quad \mathrm{W_{GG}} = \frac{\lambda_{GG}}{(\mu_{GG} - \lambda_{GG})\, \mu_{GG}} \tag{2}$$

where $\lambda_{GG} = \lambda$. Similarly, Mean response time (T_{CG}) and Mean waiting time (W_{CG}) in cloud gateway can be evaluated as:

$$\mathrm{T_{CG}} = \frac{1}{(\mu_{CG} - \lambda_{CG})}; \quad \mathrm{W_{CG}} = \frac{\lambda_{CG}}{(\mu_{CG} - \lambda_{CG})\, \mu_{CG}} \tag{3}$$

where $\lambda_{\mathrm{CG}} = \mathrm{P}_{\mathrm{Cloud}} \times lambda \times P$. Server Utilization of U_{GG} of Global gateway can be evaluated as: $U_{GG} = \rho$. Where $\rho = \frac{\lambda}{\mu_{GG}}$. The public cloud layer is modeled as $M/M/\infty$. Therefore, the response time of the public layer can be evaluated as: $T_{cloud} = \frac{M}{\mu}$. The fog layer is modeled as $M/M/c/K$ queue. Thus, mean waiting time (W_{CG}) of a fog node can be evaluated as:

$$\mathrm{W}_f = \frac{P_0(c\rho)^c \rho}{\lambda_f c!(1-\rho)^2}\left[1 - \rho^{K-C} - (K-C)\rho^{K-C}\right] \tag{4}$$

And mean response time (T_{CG}) of a fog node can be evaluated as: $T_f = W_f + \frac{1}{\mu_f}$.

4 Proposed Methodology

This section describes the proposed offloading strategy for tasks in a cloud-fog environment. The primary goal of the proposed strategy is to minimize the delay. The proposed strategy consists of 3 phases. In the first phase, different tasks arriving at the IoMT gateway are divided into multiple classes (based on the task's priority). The second phase selects an appropriate data structure to store different tasks class-wise. In the final phase, the tasks are offloaded to a suitable computing node to minimize total latency and fulfill the tasks' requirements.

4.1 Classification of Task at IoMT Gateway

According to their priorities, the tasks are divided into three classes as follows: (i) **High Priority Class (HPC)** consists of latency-sensitive tasks that require real-time processing. Such tasks are processed using a fog node (near the user) for rapid processing. It should not be processed at the cloud node due to the latency involved in offloading. (ii) **Medium Priority Class (MPC)** consists of tasks with an intermediate priority that can have slight processing delays, do not require real-time processing, and are not delay-sensitive. Such tasks can either be processed on a fog node or can be offloaded to a remote cloud (based on the availability of fog nodes). (iii) **Low Priority Class (LPC)** consists of low-priority tasks requiring more computing resources. However, such tasks do not require real-time processing and are not time-sensitive. Thus, it should be offloaded to the remote cloud for further processing and storage.

4.2 *Choosing an Appropriate Data Structure*

The mere selection of a data structure can impact the overall system's performance, explicitly processing time complexity. Once the incoming tasks at the IoMT gateway are divided into three classes, it is essential to use an appropriate data structure to store these tasks for efficient offloading. Data structure selection depends on "what to do with data" rather than storing it. Since we have divided the tasks into three classes, the best data structure would be Multi-Level Priority Queues (MPQ). MPQ configures queues for various traffic classes by specifying priority levels for each class in a single service policy map. High-priority tasks are stored in the top queue; medium-priority tasks are stored in the middle queue, and low-priority tasks are stored in the bottom queue. Although each queue can follow different schedules, we used a first-come-first-serve (FCFS) scheduling.

4.3 *Z-Factor Offloading Algorithm*

Once the task classification is done and tasks are stored in appropriate MPQs. Then, the tasks need to be offloaded to an appropriate network resource for further processing. So, an efficient algorithm is required for offloading the tasks. The offloading can be done at various places in a network. Offloading of a task is done from a particular node when that node cannot fulfill the arriving task's requirements.

As shown in Fig. 2, we have considered two offloading methods (long-term and short-term offloading) based on the time tasks need to be spent in the network before processing (after offloading). After the task's classification, long-term offloading is done at the global IoMT gateway. It decides whether the classified task will be offloaded at the fog node or cloud node. Moreover, if offloaded to a fog node, which fog node should be offloaded? On the other hand, short-term offloading is done at some intermediate fog node when it cannot fulfill the arriving task's requirements. In short-term offloading, the task is offloaded to a private or public cloud. In this paper, we proposed algorithms for both long-term and short-term offloading.

Long-term Offloading: The significant factors influencing long-term offloading decisions are the number of links available between the global gateway and the destined fog node (i.e., hop count), buffer length, CPU frequency, and offloading

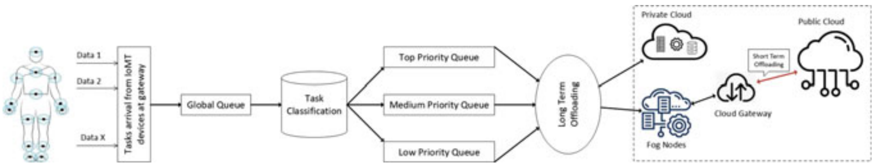


Fig. 2 Task classification and offloading

probability of the fog node. A fog node would be better offloading if all these factors have a high value. So, a Z-factor is defined as a product of these three factors. Algorithm (1) exhibits the long-term offloading algorithm.

Short-Term Offloading: The following tasks at the fog node are executed parallelly: (i) **Buffering of the task at fog node:** On arrival of any task at the fog node, it gets buffered and waits for tasks to complete execution at the fog node. (ii)**Allocation of resources at fog nodes:** Fog resources are allocated to head tasks in the waiting queue to execute scheduled tasks. (iii) Task offloading from fog node to cloud server. The short-term offloading algorithm is depicted in algorithm (2).

Algorithm 1 Z-Factor Long-term Offloading

Z = ($Hop\ Count \times Buffer\ Length \times Offloading\ Probability \times CPU\ Frequency$) of fog node
if ($Q1! = \phi$) **then**
    Consider the tasks with priority 1 in (FCFS order)
    Offload to fog node with minimum (Z).
end if
if ($Q1 = \phi$ && $Q2 ! = \phi$) **then**
    Then consider the tasks with priority 2 in (FCFS order)
    if ($Buffer\ Length\ of\ nearby\ fognode = \phi$ && $\min(Z)$) **then**
        Offload to that fog node
    else
        Offload to cloud node
    end if
end if
if ($Q1 = \phi$ && $Q2 = \phi$ && $Q2! = \phi$) **then**
    Offload to cloud node
end if

Algorithm 2 Z-Factor Short-term Offloading

Z = ($Hop\ Count \times Buffer\ Length \times Offloading\ Probability \times CPU\ Frequency$) of fog node
if ($Response\ time < t_{thresh}$) **then**
    if ($hop < ttl$) **then**
        hop = hop+1
        Offload to fog node with minimum (Z).
    end if
else
    Offload to cloud node
end if

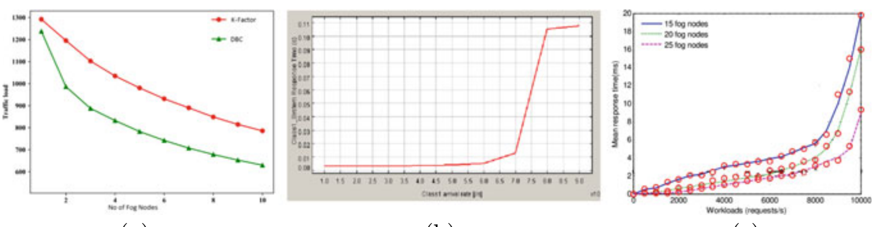
5 Results and Analysis

To compare the use and effectiveness of fog computing with conventional cloud computing technology in healthcare applications, MATLAB and JMT tools are used for simulating the cloud, and fog environment. Both tools were installed on a computer with an Intel Core i5 CPU @ 2.4 GHz, 8 GB SDRAM, and 512 GB of SSD storage. The proposed offloading algorithm is embedded in the existing class of the tool. The

JMT provides simulated outputs upon simulation with the specified algorithms and configuration. Observing and analyzing the results becomes easy and supports an excellent graphical user interface (GUI). However, sometimes the simulator can also add a bit of overhead time. Several tests are conducted for different configurations of the monitoring devices to overcome this. The simulation is run ten times for a particular result (keeping the same parameters), and the average of these is considered in the output.

The simulation of the fog environment started with the overall 1000 health requests arriving per second. The arrival rate was changed from 1000 req/s to 10,000 req/s with a small increment in every step, using the what-if analysis feature of JMT. CG and GG processing times are identical, independent, exponential, and randomly distributed with mean rates, i.e., $\frac{1}{\mu CG}$ and $\frac{1}{\mu GG}$ both equal to $0.0001 seconds$. Two possible paths for the incoming workload at the global gateway are GG to the private cloud with probability $Pc = \frac{1}{3}$ and GG to the fog layer with probability $Pf = \frac{2}{3}$. The fog layer consists of $20 fog\ nodes$, each node having a $maximum\ buffer\ size\ of$ 200. Service time of each fog node is taken as $\frac{1}{\mu FC} = 0.01 = 0.01\ seconds$. Health data from the fog layer is offloaded to the public cloud layer via cloud gateway with $offloading\ probability$ of 0.4. This public cloud center consists of 20 $cloud\ nodes$, with each node having four processors and each processor with a $mean\ service\ time$ of $\frac{1}{\mu pb} = 0.0002$. The private cloud center consists of 10 $cloud\ nodes$, with each node having three processors and each processor with a mean service time of $\frac{1}{\mu pr} = 0.001$. The $maximum\ buffer\ size$ for each private node is 400.

In Fig. 3, we have analyzed the network traffic load variation with the number of fog servers deployed under Z-factor and DBC schemes. The graph shows that the traffic load decreases with an increase in the number of fog servers. Moreover, for a specified number of fog servers, the Z-factor algorithm leads to less traffic load on a network than the DBC scheme. The reason for less traffic in our algorithm is the Z-factor, which ensures that once a task is offloaded to a particular node, there will be a significantly lower probability of it being forwarded to any other node. In the Fig. 3, the workload in the arrival rate is varied, and its impact on mean response time is evaluated. The arrival rate varies from 1000 to 10,000 requests per second. It



(a) (b) (c)

Fig. 3 **a** Network traffic versus number of fog servers; **b**, **c** mean response time versus arrival rate;

is clear that as the load on the network increases, response time decreases. One way to maintain proper response time in heavy traffic regions in the network is to design efficient network algorithms. Thus, the Z-factor algorithm that we have proposed is also an efficient offloading algorithm. Another way is to increase the number of resources in that network region.

For instance, In Fig. 3, we have analyzed the mean response time concerning the number of fog nodes. It can be observed that mean response time decreases as we increase the number of fog nodes. For example, in the network at 9000 $requests\ per\ second$, with 15 fog nodes, the $mean\ response\ time$ is $11ms$; with 20 fog nodes, it drops to $7ms$ and with 25 nodes, it further drops to $4ms$. It can be deduced from the graphs that the fog layer plays an essential role in minimizing the response time, which is very important in healthcare applications. Therefore, regions with heavy requests on the network can be equipped with an increased number of fog nodes.

6 Conclusion

The proposed system has three layers, i.e., end device, fog, and cloud. The network is modeled as a connected graph (N, E) using a queue network. Queueing theory is used for mathematical modeling to derive offloading probabilities. The incoming tasks at the global gateway are divided into three classes, i.e., HPC, MPC, and LPC. Multi-level priority queues are used to store packets of these classes. Two algorithms are proposed for long-term and short-term offloading. A significant factor, i.e., the Z-factor, is defined for these algorithms. simulation of the proposed model is performed using MATLAB and the JMT tool. The results show that introducing the fog layer and utilizing efficient offloading algorithms significantly reduces the response time. The proposed algorithm outperforms the DBC offloading algorithm mentioned in the literature.

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An Efficacy of Artificial Intelligence Applications in Healthcare Systems—A Bird View

Vikash Kumar Tiwari and M. R. Dileep

Abstract Increasing statistics and the availability of computing power have led to significant expansion in the way of (AI), and artificial intelligence (AI) technology and its implementation have been flooded with media publicity. Out of five, four executives are agree that AI is a reasonable time for a corporation, but only about one in five has integrated AI into any offering or process. AI is fully integrated into the offering or process by only 1 in 20 people. There is a slit between expectations and behavior, and now, we are in the first stages of adopting artificial intelligence in the enterprise. This paper surveys the path that companies require to complete this gap and build their AI capabilities to maximize the value of this troublemaking skill. AI is considered as a promising tool to support health management and is essential change in treatment. Artificial intelligence primarily denotes the surgeons and health centers that analyzes huge datasets of possibly life-saving data through artificial intelligence systems. These systems have multiple uses in clinical laboratories, hospitals, and research institutions. It provides an overview of AI applications for improving patient flow to and within the hospitals.

Keywords Artificial intelligence · Machine language · Patient flow · Predictive modeling · Patient nursing · Healthcare information

1 Introduction

As early as 1956, John McCarthy and his colleagues Marvin Minsky, Claude Shannon, and Nathaniel Rochester invented the jargon "Artificial Intelligence." Additionally, AI is termed as the science and technology used to create intellectual apparatuses. AI states the programs done by the computers that perform tasks such as especially intelligently, human intelligence, and self-sufficiently. The key goal of artificial intelligence is to advance machines that can demonstrate human ability.

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Fig. 1 Representation of healthcare system

AI is seen as a capable device to support healthcare management. After a long study, we show that artificial intelligence systems have the ability to keep patients low, which can improve medical care by reducing the organizational burden of health centers. AI is not only the job done by the robots and making humans obsolete. AI in medical aims to help healthcare institutions and shareholders to manage huge amounts of information and turn it into possibly life-saving data. In spite of the benefits, artificial intelligence claims in health care remain to look major tasks. This overview focuses on the part of artificial intelligence in managing the patients and predicting patient admission to hospitals.

KP (Kaiser Permanente) started in 1945 created in Oakland, California, one of the leading American health care provides a non-profitable health plan. The main aim is to offer first-class and reasonably priced facilities to health care which helps in improving the health of our societies and the members we assist. In 2017, there were 11.8 million associates, 211 thousand staffs, $72.7 billion in operating income, 39 medical centers, 682 clinics, and many other services. Figure 1 depicts the representation of various parametric aspects of healthcare system.

1.1 Problems

Hospitals today face many challenges that strain the capacity of existing beds and services and increase the need to improve patient movement administration. It includes the increased demand for facilities, lack of medical tools, staff, and technologies to properly manage patient flow and measure the risk of reduced patient numbers by extending hospital visits, availability. It includes a reduction in beds.

With the aging population of the United States and accelerating advances in medical skills, the demand for beds in patients is expected to increase nearly about 4–5% every year. Increment in supply is not putting pace. In short, medical centers require to control this appeal smarter.

In order to manage these problems, medical centers have traditionally used very top-down basic prediction methods. This is to identify the number of patients flowing through different channels and to see trends in time series and history.

2 Objectives

KP (Kaiser Permanente) aligned with provider soothing artificial intelligence to improve enduring movement models and anticipate the following to deliver visions for actual conclusion creation besides tactical arrangement.

- **Demand of Bed**—KP will predict the bed demand on an hourly basis and in actual period.
- **Safe Recruitment Levels**—medical facilities need to maintain a secure recruitment to serve patients.
- **Hospital Congestion**—once a time came when hospitals demand cannot be met by current capacity—when hospitals enter a "gridlock" situation then it took a lot of time, money as well as effort to come out of it.

3 Literature Review

The team began by investigating the way that inspires patient movement, by determining and answering questions. As we saw that the important issue was number of entrances from various doors of entrance—between which the Emergency Department (ED) entrances were the trickiest as everybody might arrive through the gates, a system is required to manage the crowd in an efficient manner [1]. Artificial intelligence in neuro sciences: A clinician's perspective. Now a day, AI acts as a very important character in the field of neuro science in the different way of laser operations as well as surgery. Other factors included the arrival of time (hour/day/whether holiday) also the entrance speciality like oncology, cardiology, etc., and various other factors.

Once the team were trying to get this data, it exposed that nearly most of relevant factors such as acuity level of the patient, pain, and ongoing treatment were only available within free text medical notes. All notes are really dependent on the willingness and capacity of the people those who is documenting the notes; standards and nomenclature for these notes vary from facility to facility. These feature some abbreviations and nonstandard language. Juhn and Liu [2] invented the concepts of AI approaches using natural language processing to advance EHR-based clinical research. Electronic health record (EHR) is necessary to keep the health records of a particular patient according to their diseases.

So, the challenges faced by the team were how to solve value from these notes, which is a natural language processing (NLP) problem. Tealby and Kulkarni [3] invented an approach on Spark NLP in action, which explains the improvising the patient flow forecasting using Kaiser Permanente.

Mesko et al. [4] were trying to know that the artificial intelligence will solve the human resource crisis in health care. KP approved the idea of a data factory, i.e., a stage that takes a pipeline outlook, by linking data of the producers to consumers and analysts [5]. They describe the potential for artificial intelligence in health care. Upcoming healthcare journal makes us to know the importance of artificial intelligence in life of human being by making the way of life so easy. Lin et al. [6] introduced 10 various methodologies by which the artificial intelligence will transform primary care into the secondary care with the help of AI. Analysts, engineers, data engineers, data operations, and scientist all peoples have their characters in the pipeline. Esteva et al. [7] invented a guide to deep learning in health care. A knowledge based on independent mobile robotic-assistive care given to people. Nadikattu [8] it tells that artificial intelligence in cardiac management has help the doctor to do the cardiac treatment in an easy way with doing major operations.

The platform lectures all queries related from how to productionize the model to how to get the data and addresses numerous challenges related to technical debt.

4 Methodology

Let's come back to the genuine NLP problem. Understanding ordinary language is difficult because languages could be subtle, ambiguous, appropriate, and media specific. See the three ER triage note examples below. Neither mentions the word "pain" or "patient," but it is the kind of language that the organization processes and these are information about how to extract symptoms. What kind and severity of pain started, where it occurred, and what the patient tried at home for solving this kind of problem need adding two healthcare exact components sourced from https://www.johnsnowlabs.com.

- Information: 300+ expert curated, linked, clean, enriched, and up to date datasets (including things like measures, clinical guidelines, terminology, etc.)
- Custom Procedures: Health specifies NLP annotators (e.g., doing entity recognition, word embeddings, sentiment analysis, etc.).

KP desired to privilege state of the art performance for this problem. If you need to do state of the art, you have to study up on academic literature to find out what that really is. The entire group was spending time on this initiative. Next, the team predicted that what they required to create and in what way they could create it on a large scale. Some can be reproduced well; others are not from academic investigation. The following image displays the three working mechanisms that the squad constructed and their inspiration for academic investigation.

4.1 Analytical Demonstrating AI in Health care

AI has multiple uses in treatment, including clinical laboratories, hospitals as well as research institutes. Healthcare management and clinical decision support, operations, healthcare predictions, patient monitoring, and healthcare interventions are key areas of application of AI.

Predictive modeling is a preventative step in health care to identify ill people at own risk of illness as well as side effects. The most familiar AI predictive models are the patient introduced into emergency department—admissions into emergency department disease or other outcomes and in-patient monitoring. An integrated patient monitoring system is used in combination with AI components for assistive decision-making.

Curtis et al. developed a combined wireless system, the Scalable Medical Alert Response Technology (SMART) system to watch over the unattended ambulatory patients. This gadget changed into included with Wi-Fi affected person video display units along with saturated oxygen, electrocardiography, geo-positioning, focused alerting, sign processing, and a Wi-Fi boundary for caregivers. Embedding AI system inside healthcare data systems can be helpful because of its potential toward improving patient's outcome, particularly in busy sections along with the emergency department. A new Web-based patient support system has been started to reduce the fee of treatment and improve the quality of life of patients. This Web-based patient support systems are planned to allow patient-centered decision-making and physician-centered health monitoring. Researchers have advanced scoring set of rules to predict cardiac arrest and severe cardiac headaches in sufferers with chest ache in emergency section.

5 Key Factors

The team began by investigating the way that inspires patient movement, by determining and answering questions.

An important factor was that it is difficult to predict number of arrivals from various ports of entry. Among them, the arrival of the emergency room (ED) was the most difficult because anyone could go through the door. Other factors include various factors such as arrival time (time/day/holiday) and hospitalization target (oncology, heart disease, etc.).

Therefore, there were more challenges for the team members to unleash the worth of these notes. This is a natural language processing (NLP) issue.

6 Benefits of AI in Health care

Nearly, the potential benefits of AI in healthcare systems are explained in the below sections.

6.1 Providing a User-Centered Experience

AI uses large datasets and machine learning to enable healthcare organizations to gain faster and more accurate insights, increasing satisfaction for both in-house and service providers.

6.2 Improvement of Operational Efficiency

AI technology helps healthcare organizations maximize data, assets, and resources, increase efficiency, and improve clinical and operational workflows, processes, and financial performance by examining data patterns.

6.3 Various Healthcare Data Connections

Health data are often used in a variety of formats. Using AI and machine learning technology, businesses can connect heterogeneous data to create a more unified image of the people behind the data. The benefits of AI in healthcare systems are modeled diagrammatically in Figs. 2 and 3, respectively.

7 AI Applications in Health care

Artificial intelligence has proved that the medical industry is useful for identifying connections between deploy surgical robots, genetic codes, and even maximize hospital proficiency.

7.1 Supporting Clinical Decisions

It is very exciting for medical professionals to consider all important information when diagnosing a patient. As per result, this leads to a search for several complex

Fig. 2 Benefits of AI in healthcare systems

Fig. 3 Patient self-service benefits with AI assistance

amorphous notes stored in health records. Any single error in tracking any relevant fact can endanger the patient's life.

With natural language processing (NLP) support, physicians can easily find out all the relevant data from patient reports. AI can store and process large amounts of data. This provides all the data, facilitates individualized testing and recommendations for each patient, and helps improve clinical decision support. This skill can be trusted by doctors for aid in sensing risk issues over unstructured notes.

7.2 Improving Primary Care and Triage with Chatbots

People tend to make appointments with their GPs with minor threats and medical concerns. This is often curable with false alarms and self-medication. Artificial intelligence enables the easy movement and computerization of primary care and allows physicians to worry about extra important as well as worse cases. Patients can save money on avoidable doctor visits and took an advantage of medical chatbots. Medical chatbots are the services powered by AI with intelligent systems which answer all health-related questions and concerns instantly, while showing you how to manage potential risk issues.

These chatbots are available 24/7 days and can treat number of patients at the similar period of time.

7.3 Robotic Operation

Artificial intelligence and compound machines have transformed operation in terms of depth and speed while making slight cuts. Machines do not feel uneasy, eliminating the problem of tiredness during important time-consuming procedures.

AI machines can use the information from earlier surgery to develop the new operational approaches. Careful use of the machine reduces the possibility of vibration and accidental movement during operation. An application of robotic operation in surgery is represented in Fig. 4.

Some samples of robots designed for surgery include vicarious operation, which combines practical certainty with artificial intelligence-enabled robots to enable surgeons to execute slightly invasive surgery and heart, a small mobile robot developed by Carnegie Mellon University's Faculty of Robotics. There is a lander and the heart. AI is intelligently useful for robotic surgery.

Fig. 4 Representation of robotic surgery

7.4 Virtual Nursing Assistants

The AI system allows virtual care assistants to perform tasks ranging from interacting patients to guide them toward the better as well as most actual care unit. Available 24/7 day, these virtual nurses can answer questions, watch the patients, as well as give immediate results.

Today, several artificial intelligence-powered virtual nursing assistant requests allow for additional regular connections among patients and nurses, and it reduces the unnecessary hospital visits of doctor. Care Angel, world's first computer-generated care associate, can also give health checks via vocal sound and artificial intelligence.

7.5 Support for Exact Diagnosis

The ability of AI is to exceed doctors, helping them predict, detect, and diagnose illnesses extra exactly and quickly. Similarly, AI algorithms have proven not only accurate in professional-level diagnostics, also cost-effective in detecting diabetic retinopathy.

For example, Path AI is emerging machine learning technology to help pathologists to make more perfect diagnoses. The current goals of companies are to include reducing cancer diagnosis errors and emerging personalized therapies.

Buoy Health is based on AI which is used to check symptom and treatment that uses algorithms to diagnose and treat illness. It is convenient here. Chatbots listen to a patient's health concerns and symptoms and guide the patient to appropriate treatment based on the diagnosis. It helps them get in touch with the relevant departments.

7.6 Minimizing the Burden of Using EHR

Electronic health record (EHR) has played a vital character in the digitalization path of the medical industry, but the changes have led to endless documentation, cognitive overload, and user experience. Many problems have occurred related to tension. Electronic health record (EHR) inventors were using AI to generate more instinctive boundaries and systematize some of the routine processes that take up most of the operator's time.

Speech dictation and recognition can help in improving the clinical documentation process, but natural language processing (NLP) tools can't be very advanced. AI can also help handle regular inbox requests. It also helps you prioritize tasks that require your doctor's attention and make it easy for the users to work with their to-do list.

8 Conclusion

Ultimately, the team wanted to demonstrate improvements beyond the baseline in forecasting hospitalization demand for emergency room (ED). This was an important prediction point for hospitals, as ED is a placeholder, but, for example, planning surgery and transfers from other hospitals as shown in Fig. 5.

The baseline is predicting human manual—what a huge majority of hospitals do, i.e., they talk people, and have number of meetings per day. The team saw that it was quite easy to beat this by using designed data. The structured data are represented in Fig. 6.

But, while using designed data improves the performance versus human manual prediction, the more important uplift came from adding features from the unstructured clinical notes.

Figure 7 shows the features extracted from natural language text.

This paper deals with reflecting various applications of healthcare systems using artificial intelligence techniques, which gives a detailed information to the society in various aspects. But, this article won't explain about the algorithms of AI techniques, implications, and implementations of algorithms are not the part of this paper. It is planned to resolve this drawback in the future studies.

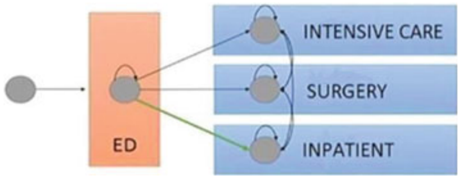

Fig. 5 Request predicting of admission from the emergency department

Features from Structured Data

- How many patients will be admitted today?
- Data Source: EHR data

Reason for visit	Current wait time
Age	Number of orders
Gender	Admit in past 30 days
Vital signs	Type of insurance

Fig. 6 Designed data

Features from Natural Language Text

- A majority of the rich relevant content lies in unstructured notes that are contributed by doctors and nurses from patient interactions.
- Data Source: Emergency Department Triage notes and other ED notes

Type of Pain	Symptoms
Intensity of Pain	Onset of symptoms
Body part of region	Attempted home remedy

Fig. 7 Features extracted from unstructured data

9 Future Scope

The AI has the better future in medical outcomes achieved by the advance treatment and more perfect diagnosis, as well as more known and engaged patients authorized with easy access to healthcare support and more effective administrative processes using robotic credentials and coding algorithm.

In future advances, decision support systems in assistance with clinical lab reports, helping primary and emergency aid for patients, incorporating the robotic assistance in healthcare systems, monitoring the diagnosis with the help of virtual nursing assistance, and minimizing the manual documentation of the patient records can be improvised to the next level of implementation, that in turn results in fully automated framework without intervention of the clerical staff. These automated operations are more accurate, appropriate, and efficient than the conventional way of maintaining records.

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Automation Testing Using Different Tools

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Abstract Today in automotive sector, product development of electronics embedded system is consisting of many phases like mechanical design, software design, development, integration, testing, etc. A huge emphasis is being given to increase the efficiency in product testing and to make the process more productive and increase the quality of testing while being cost-effective. Companies are seeking software testing tools that offer a comprehensive solution that helps in achieving this goal. This paper contains an automation tool that will reduce the testing time for various automotive products like power-operated tailgate, etc. To perform automation testing, we used TestStand as a software platform for sequence generation having backend support of LabVIEW; for real-time environment, during test, CANoe is used, and system is integrated using VT system. The outcome of this system gives successful testing of complex functionalities in cars with a short time.

Keywords Electronic control unit (ECU) · CANoe · LabVIEW · Test stand · Test automation tool · VT system

1 Introduction

Now a days, automotive industry experiencing that customer wants lot of comforting functionalities in cars. To accomplish that industry including many power modules to operate on those functionalities [1]. As a result of this, the electronics structure of cars becoming more and more complex with increasing number of I/O, and it is difficult to maintain the meticulous integration testing on the respective product manually. Moreover, device under test (DUT) should follow the standard protocols while software testing. The developed test automation tool will perform desired testing effectively with reduced test execution time in the company of accuracy, accessible

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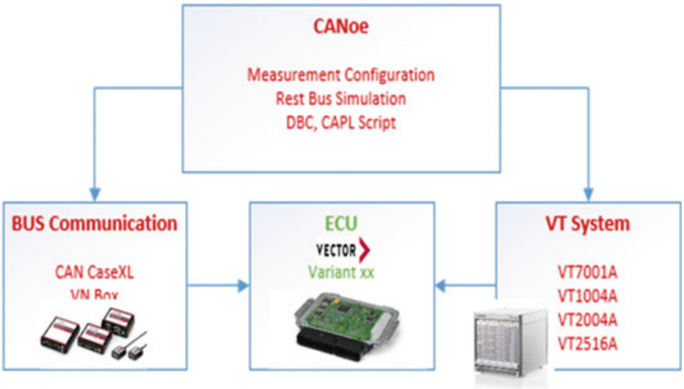


Fig. 1 Existing CANoe simulation system

precision, and more than 90% reuse in different projects [2]. However, multiple test case execution at the same time possible. Additionally, if any malfunction occurred in a car, ECU that will be get detected by reading the associated diagnostic trouble code (DTC).

2 Methodology

The proposed system has new agenda to use the existing CANoe measurement setup with Fast Data Exchange protocol (FDX) configuration. To automate the test case first, we must understand the requirements of original equipment manufacturer (OEM); according to the functionalities, they required test cases are written [3]. Testing parameters of test case include definitions written in "{ }," and we can reuse them, mapping signals written in "()" containing address of signal. While executing a test case, the export coverts file into comma-separated variables (CSVs). The existing CANoe simulation for testing and the new proposed system block diagram is shown in Figs. 1 and 2.

3 Procedure to Follow to Start Test Automation

See Figs. 3 and 4.

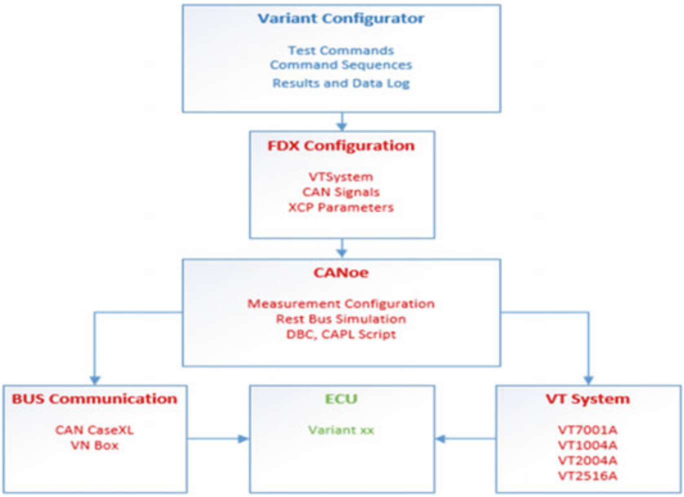


Fig. 2 Proposed system setup

4 System Architecture

4.1 User Layer

This layer is interacted with the user. The project files that are going to be under automation testing configured here. Users decide which files or script is going into the simulation that maybe CAPL files, files that are created interacting with the LabVIEW, for example, mapped signals. User layer also associated to generate the test report of the configured files under automated testing (Fig. 5).

4.2 Test Stand Layer

This layer is associated with test sequences and definitions. Definitions of different functions are loaded in this layer by the tester at very first time only once for a project. These definitions are then called in the test sequences which are also defined in the same layer. Stepwise execution of these test sequences happens in this layer.

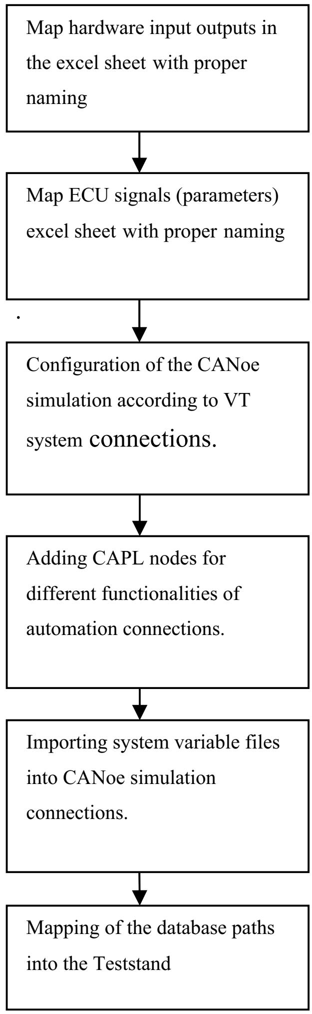
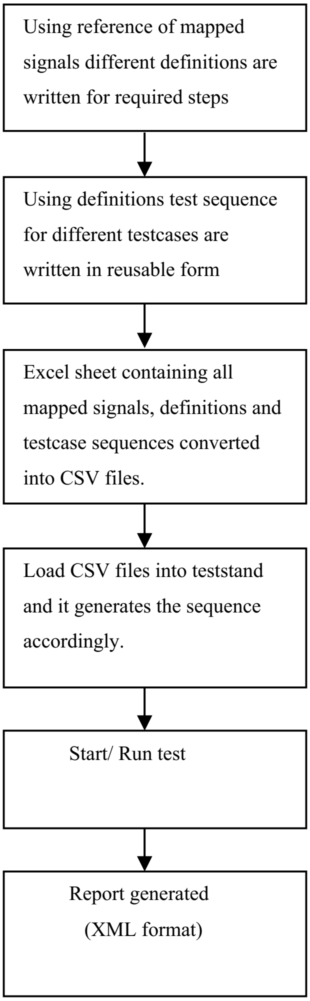


Fig. 3 Procedure followed by setup

4.3 LabVIEW

The backend communication with LabVIEW as well as CANoe takes place in this layer [4]. CANoe communication drivers, teststand communication drivers, data loggers, error loggers are taken care in this layer.

Fig. 4 Procedure followed for testcase



4.4 CANoe, XCP, CAPL

CANoe is used for simulation of vehicle environment [4]. Along with CANoe, XCP is also used for accessing internal ECU parameters for automation. CAPL codes are used for some operations which cannot be performed by automation scripts directly using LabVIEW, for example, requesting diagnostic codes on CAN bus.

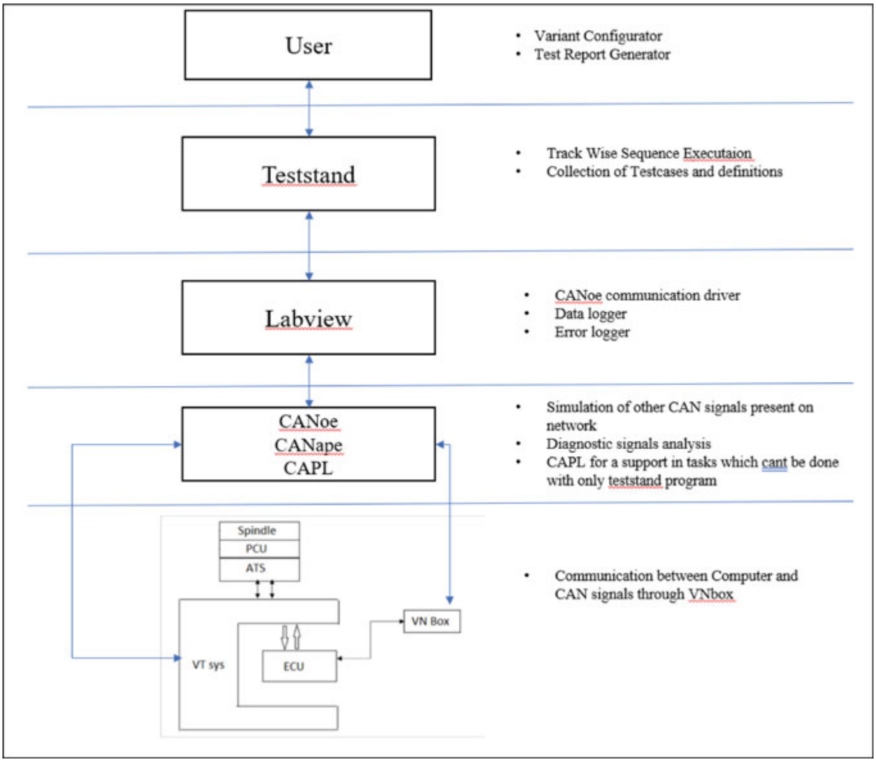


Fig. 5 System architecture

4.5 VT System, VNbox, Wiring Harness, ECU, POT System

It is the physical layer of the system where actual POT setup is connected to VT system. Different inputs and outputs can be simulated using VT system. Also, communication between computer and CAN signals that is ECU is done in this layer using VNbox. In some cases, CANcase also can be used. Connections which are coming from VT system and vice versa are arranged as a standard which can be used for different OEMs in same standard. So that the connection time is reduced for a tester, and no further configuration changes will be needed in future.

5 Results

A testcase example for sleep current is explained here with all steps mentioned above. When ECU is in sleep mode at that time, it should consume some specific amount of

#	TesterPresent	BasicUDS::TesterPresent::Active
#	TesterPresentCycleTime	BasicUDS::TesterPresent::CycleTime
#	Antipinch1Pressed	VTS::M2 Ch1::RelayShortCircuit
#	Antipinch1Unpressed	VTS::M2 Ch1::RelayShortCircuit
#	Antipinch2Pressed	VTS::M2 Ch2::RelayShortCircuit
#	Antipinch2Unpressed	VTS::M2 Ch2::RelayShortCircuit

Fig. 6 Mapped signals

DEF-17	{WaitTillBasicPosition}		[waitfor timeout=9000ms] {TailgatePosition}={BasicPosition}*0.95[inrange]{BasicPosition}*1.05,
DEF-18	{Antipinch1Trigger}		{Antipinch1Pressed}=1, [wait] 500ms, {Antipinch1Unpressed}=0,

Fig. 7 Definitions

current. For that in testcase, it should have some checks like ECU is in sleep mode and current consumption in specified limits.

5.1 Mapped Signals

This is the actual format in which signals are mapped in Excel sheet. Rest bus signals, ECU signals, and VT system variables have different address pattern. Accordingly, they are mapped in the mapping section (Fig. 6).

5.2 Definitions

Example of definition which is made by use of mapped signals is shown in Fig. 7.

Definitions are of different functionalities which are used again and again in most of the testcases. In development phase of automation tool, different types of keywords and writing formats can be made using teststand according to our need.

5.3 Testcase

Testcases are written as per the test description. Different checks are introduced in between steps. Example of testcase is given in Fig. 8.

TD no	Test case name	Test Initial Conditions	Test Sequence
55	Current Test	{XcpDisconnect},	{ManualLatchOpen}, [wait]1000ms, {AutoLatchClose}, (VDCA9Msg) = 0, [wait]5000ms, (NetworkManagement) = 1, [wait]10000ms, (Vout2_Active) = 1, [wait]10000ms, [waitfor timeout = 10000ms](PS1_AvgCurrent) = 0.000030[inrange]0.000100,

Fig. 8 Testcase

5.4 Teststand Execution Window

In this window, current step execution is displayed. In different tab, actual and expected value of particular variable at moment of execution is displayed (Fig. 9).

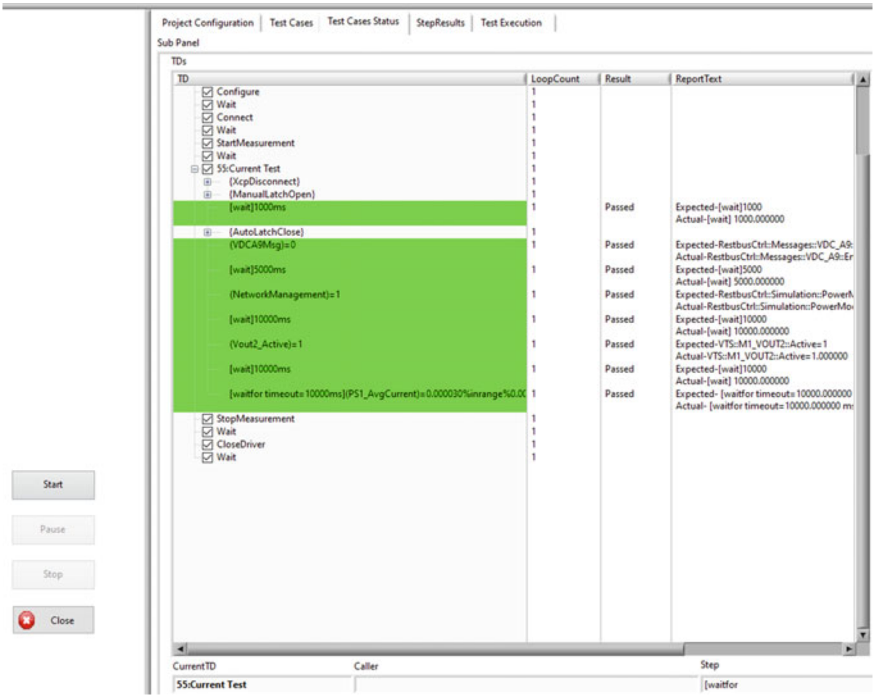


Fig. 9 Teststand execution window

Fig. 10 Report window

5.5 *Report Window*

After execution of the testcases, report is generated in the XML format. Format of the XML report can be changed according to the need. Example of report is shown in Fig. 10.

6 Advantages

- Automation tests get recorded, and this allows you to reuse and execute the same kind of testing and repetitive tasks multiple times.

Table 1 Comparison between manual and automated testing tool

Testing method	Time required (approx.)
Manual testing	8 weeks
Automated testing	2 weeks

- After scripts and configuration, test automation requires less time and resources to execute defined scope, compared to manual testing.
- Consistent test runs hence we get reliable and consistent results.
- Less error caused by human mistake.
- No manual error in the test.
- Overnight test is possible, and hence, resource utilization will be better for organization.
- High reusability of the test case reduces development time (Tables 1 and 2).

7 Conclusion

Initially, this mapped signals, definitions, and testcases are written for project "A." If the definitions and testcases are written in a generic way, then after some modifications, it is possible to use same testcases and definitions for other projects also which will reduce development time of the testcase and definitions.

In the end of the testcase, graph of selected variables can be introduced in the report which will be useful for identification of the exact reason of failure in case of failed testcase.

Automated testing tool provides robust ECU software logic to verify on vehicle. Smart and highly accurate as well as precise testing can be developed for body modules features across different OEM model's platforms.

Most importantly testing time will be reduced; hence, resource utilization will be better for organization.

Not only in automobile sector but also in many other sectors like robotics or industrial automation test automation is needed for manufacturing and development process.

Table 2 Comparison between proposed automated testing tool with other tools

Sr. No.	Comparison points	First tool	Second tool	Proposed new tool
1	Test case creation	Time-consuming	Time-consuming	Will be faster if tester understands the GUI, small upgrade needed
2	License cost	Present	Present	No license cost

(continued)

Table 2 (continued)

Sr. No.	Comparison points	First tool	Second tool	Proposed new tool
3	Interface with CANoe	Ok but requires more efforts to build it and more support in the start	OK but HAL knowledge required to understand the background scripts	Easier with .xml file and will be provided for every release of SW
4	Scripting language	Required	Required, additionally small talk knowledge required as well	Not required in test team
5	Programming skill	Basic programming skill needed, but for debugging and analysis efforts are more as execution happens too fast	Small talk programming was a bit complicated to learn	Not required in test team
6	Reusability of test artifacts and data	Reusability is possible but with more efforts	Reusability is possible but with more efforts	Functions will be common, and hence, reusability will be more
7	Ease of installation and use and maintenance	Patches coming and it is hard to maintain with CANoe versions	Installation seems same, but maintenance was not good	Not many efforts needed
8	Overnight execution	Possible but reports were not user friendly, need lots of time for report debugging	Overnight execution had issues due to overloading of the system and the bugs in the tool	Possible to execute overnight
9	Auto mode/manual mode	Not separately available	Not separately available	Separately available
10	Support from supplier	Support is there, but it should be fast and accurate. It is very time-consuming	Limited support	In-house solution hence support will be available from company's test team
11	Reports	Not user friendly	Not user friendly	Reports will be user friendly, and it will be as per test team definition

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Neural Network Design to Determine Variables Affecting Poultry Growth

Diany Hincapie, Santiago Triana, Hernando González, Hernan González, Carlos Arizmendi, Alhim Vera, and Cesar Valencia

Abstract This paper presents the prediction of poultry growth in relation to the environmental variables that most influence this process using LSTM networks. This required the installation of sensors in a warehouse of the company Nutravi located in Meta, to obtain real-time data on temperature, humidity, wind speed and weight of the chickens, where these measurements are reflected in ThingSpeak being a program focused on IoT. Subsequently, the data are used for the application of recurrent neural networks performing the prediction of the growth of the animals taking as inputs the environmental variables. With this, the definition of the network model and the parameters to be configured to ensure good learning, which is reflected in a web page designed in Python, being able to visualize the ideal weight of the bird and the weight generated by the prediction to validate that it is in the appropriate ranges of growth.

Keywords LSTM net · Poultry growth · IoT system · ThingSpeak

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1 Introduction

This project was developed in the company Nutravi, which is a leader in the poultry sector at regional level, located in the Department of Meta, Colombia. This company allowed the installation of sensors in one of the sheds to take measurements of the most important environmental variables of poultry growth. The sensors send the measurements every hour in real time to ThingSpeak (https://thingspeak.com/apps), this program can graphically show the behavior of the variables over time and export this information to a database that will allow training with neural networks to predict the growth of the bird.

For the development of the artificial intelligence model, long short-term memory (LSTM) recurrent neural networks are used, training the data that relate each variable to obtain the prediction of the bird's growth. LSTM networks have three gate structures: input gates, forgetting gates and output gates. These three gates provide read, write and forward operations to the memory unit of the network to retain and update the state of the memory unit improving the prediction results that are intended to be generated. The LSTM uses memory cells in the network with three built-in trigger mechanisms to correctly process sequence data. To do this, the base LSTM models introduce new sets of parameters into the signals of each gate. In addition, the architecture of this network allows training to be accelerated; these networks are more suitable for algorithm execution and inference on portable devices with relatively limited computational resources [1–3].

There are different machine learning approaches, of which LSTM is a type of recursive neural network (RNN), capable of handling a large dataset and overcoming the problem of long-term dependencies such as vanishing and gradient explosion. Google implemented the two-layer deep LSTM in speech recognition and the large-scale model achieved advanced results. Recently, some scholars have applied LSTM to action prediction and obtained good results, compared with RNN showed that the performance of LSTM is the best in data prediction [4–7].

2 Instrumentation and IoT Platform

The poultry farm used for the study is in the village of Sabanas del Rosario, 19 km from the urban area of the municipality of Castilla La Nueva, Department of Meta, Colombia, it is 320 m above sea level. In the area, according to reports from IDEAM, there are temperatures that oscillate between 20 and 35 °C, the relative humidity is from 50 to 85% depending on the time of year and time of the day. The shed has internal spatial measurements of 156 m long, 16 m wide and 2.2 m high, and it is a controlled environment type where there are temperatures between 19 and 32 °C, relative humidity 60–80% and speeds wind from 0 to 4 m/s depending on the day and time of the poultry's growth. For monitoring the variables, an Arduino nano V3 microcontroller, an ESP8266 Wi-Fi module, an AM2302/DHT22 temperature and humidity sensor, an anemometer and a weighing sensor are defined.

In the implementation, two measurement nodes and a Gateway with a chain connection type or Daisy-chain were stipulated. The first one is in the center of the shed, one 50 m of the first and the Gateway 80 m from the second node. Node 1 sends the information to the next one by radio frequency, and this second node sends the same way to the Gateway. Nodes 1 and 2 oversee collecting the data of the environmental variables, and node 3 (Gateway) sends the collected data to the web platform through an Internet connection. Once the measurement of each variable has been carried out, the data is stored, following the order of measurement, in a vector defined by separators to build the data package. When it reaches the last node, a separation of the data to display on the local display and then send them via serial communication to the wireless module where the data is sent over the Internet to the cloud storage, in this case, ThingSpeak was used, where variables are monitored every minute, but transmitted every hour (Fig. 1). In the Wi-Fi module, the address of the channel defined in ThingSpeak is determined together with the writing key to be able to store the data of each variable and to be able to visualize them graphically on this platform.

3 LTSM Net

Deep learning is an automatic learning method that was developed from the original neural network [8]. In recent years, more and more academics have attempted to solve time series problems based on deep learning methods. Recurrent neural network (RNN) [9] adds the concept of time to its network structure, focused on time series data. However, if the sequence is too long, the training will not be very good, due to the disappearance gradient problem during optimization [10]. To solve this problem, Hochreiter and Schmidhuber proposed a short-term and long-term memory network in 1997. LSTM is a special recurring structure that improves the ability of the RNN network to handle long-term dependent tasks and its architecture is represented in Fig. 2.

Figure 2 identifies three levels:

– Input gate consists of a sigmoid layer which determines the information to be removed from the memory unit.
– Forget gate has the function of deciding the new information to be stored in the memory unit. This process consists of two parts. First, the sigmoid layer door entry determines what information is updated giving continuity to the layer tanh responsible for creating new information.
– Output gate takes care of deciding the output information. This process also has two parts. First, the exit state is determined by the sigmoid layer. Then, from the tanh function, the output information is obtained.

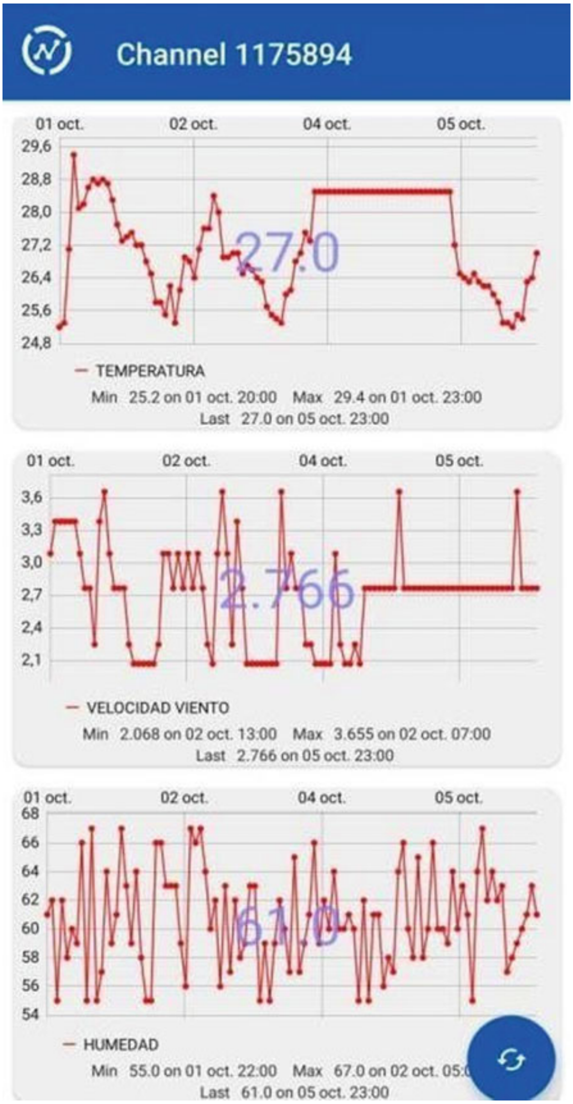

Fig. 1 ThingSpeak representation of variables

In this neural network, you must configure main parameters such as the number of neurons, the number of epochs, the batch size, the type of optimizer and the activation function and clearly the number of neurons and layers to use to obtain a good model. However, there are other parameters that are added to improve the training of the network, among them is patience, the factor and the early arrest before changes that do not improve the network. For the training, 2458 data were collected for each variable measured, taking as input the temperature, humidity and wind speed and as the output the weight of the bird. In this training, different neural networks

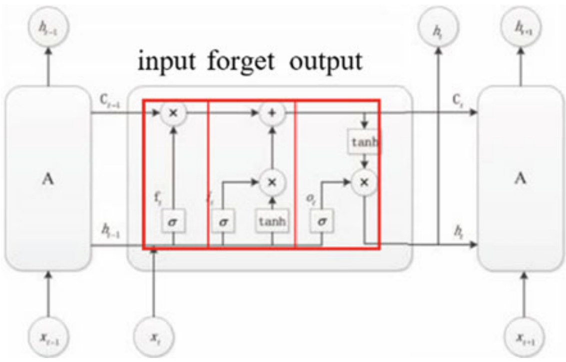

Fig. 2 LSTM recurring network model [3]

were executed where each variable was taken independently and together to obtain the prediction of weight, this was done to visualize with which training a better obtaining of future data was handled, comparing this with the *ideal graph* of the growth of the bird that the company Nutravi maintains. When performing this neural network, a percentage of data is taken for training and together with this a number of past values is selected to be able to predict the growth of the bird, in this case, a history of 60 samples is used to predict 40, taking into account these are defined in hours.

For training should be performed scaling entire database for variables can be correlated better since these maintain different ranges, for example, the temperature in the house is between 21.3 and 35.5 °C, humidity between 43 and 98%, the wind between 0.329 and 3.084 m/s and the weight of the bird between 35 and 2800 g. Later, the model to be used is defined. A sequential model is applied with the LSTM networks, in it, 3 layers and the number of neurons with which it is going to be trained were defined, allowing through return sequences to access the hidden state output for each input time step. Furthermore, it is highlighted that the dropout is established in the last layer of the network in order to generate codependency and adjust the model. Then, it leads to the execution of the model. In the first training, the temperature was taken as the input variable, varying the parameters until a good prediction was obtained, and in the same way, the network was trained with humidity and wind speed as shown in Table 1.

With this LSTM model for the prediction of the weight, a greater variation of data was obtained in the wind speed training; although it handles a positive trend, there is a limit in which the predicted data becomes decreasing. It can also be seen that the loss of this variable was higher, indicating with this result a greater deviation between the predictions. Having a prediction of the weight taking the variables independently was carried out or the prediction taking three variables together as inputs, configuring the network as shown in Table 2.

In this training, the loss was in a range between 0.1 and 0.25 indicating some dispersion in the data generated. However, by having more data for learning and the

Table 1 Network parameters with a variable

Parameters	Temperature	Humidity	Wind speed
Epoch	200	200	250
Batch size	256	256	256
Layer 1	32 neurons	25 neurons	40 neurons
Layer 2	10 neurons	10 neurons	15 neurons
Dropout	0.25	0.1	0.2
Patience	10	10	10
Optimizer	Adam	Adam	Adam
Function loss	MAE	MAE	MSE
Loss result	0.05 and 0.15	0.05–0.15	0.075–0.25

Table 2 Network parameters with the three variables

Parameters	Temperature, humidity and wind speed
Epoch	30
Batch size	32
Layer 1	64 neurons
Layer 2	10 neurons
Dropout	0.25
Patience	10
Optimizer	Adam
Activation	Lineal
Function loss	MSE
Loss result	0.1 and 0.25

set of the other parameters that allow improvements during training could get a good prediction where data corresponding weight amounted to so progressive.

4 Design of the Website

By having the prediction algorithm, it links with the web application made in flask and Python that allows web hosting in the cloud. Initially, the login design is done to restrict access to information. For this, there are two types of users: the administrator and the visitor, where the former has access to more information. By entering, both users can view the behavior of all variables in real time and together with this the prediction generated as shown in Fig. 3.

The purpose of the web application is to evaluate if the bird's growth prediction is in accordance with the ideal weight that the animal should have on the stipulated day, in order for the company to be sure that the animal is growing properly and, if this was not the case, to have the ability to take action at the right time. To make the

Fig. 3 Web page interface

comparison, a graph is established where the real weight with its respective prediction and the ideal weight of the bird are superimposed. In them, you can select the exact date and time to view the weight of the animal as shown in Fig. 4.

In general, HTML, CSS and JAVASCRIPT were used to make this application in order to create a dynamic interface with weight predictions that facilitated interaction with the user, unifying platforms such as ThingSpeak to group all the necessary information in a website and thus, the user himself had all the access to the data in real time of the variables and the growth of the bird in the future days so that they have the ability to improve the performance of the shed.

Fig. 4 Prediction of poultry growth

5 Conclusions

When installing the sensors in the shed, the environmental conditions that could affect the instrumentation had to be considered and, because of that, protection against dust, water and birds had to be used, so that they did not have access to these measuring instruments. On the other hand, the scope of the network was determined to be able to transmit the data in real time, since having a low signal in the place evaluated the option of transmitting the information by cable or with a wireless system in order not to have lost in the data frame. During the training of the network, it was observed that the loss function had greater variation depending on the input data and also on the configuration of the model parameters, knowing that in an iterative way and having the knowledge of how each influences parameter on the network gets good learning. This configuration was highlighted the number of neurons, since a large number of these does not refer to a better model as the network can be overtrained, affecting a desired prediction. During the training of the network, it was observed that the loss function had greater variation depending on the input data and also on the configuration of the model parameters, knowing that in an iterative way and having the knowledge of how each influences parameter on the network to get good learning.

Future work includes the incorporation of new variables for the recurrent neural network, such as the type of feed the birds receive, disease history and season of the year, in order to improve prediction. A second change is that the prediction system will modify in real time the actuators that regulate the environmental conditions of the poultry house, such as temperature, water supply and humidity. This will allow effective action to be taken on the environmental conditions of the birds, as currently, it is the farm veterinarian who is responsible for adjusting the plc parameters.

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Semantic Segmentation for Autonomous Driving

Usha Divakarla, Ramyashree Bhat, Suraj B. Madagaonkar, D. V. Pranav, Chaithanya Shyam, and K. Chandrashekar

Abstract Recently, autonomous vehicles (namely self-driving cars) are becoming increasingly common in developed urban areas. It is of utmost importance for real-time systems such as robots and automatic vehicles (AVs) to understand visual data, make inferences and predict events in the near future. The ability to perceive RGB values (and other visual data such as thermal, LiDAR), and segment each pixel into objects is called semantic segmentation. It is the first step toward any sort of automated machinery. Some existing models use deep learning methods for 3D object detection in RGB images but are not completely efficient when they are fused with thermal imagery as well. In this paper, we summarize many of these architectures starting from those that are applicable to general segmentation and then those that are specifically designed for autonomous vehicles. We also cover open challenges and questions for further research.

Keywords Semantic segmentation · Autonomous vehicles · Multimodal learning · Real-time inferences

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1 Introduction

Computer vision is a field of artificial intelligence that allows systems to obtain meaningful information from images, videos, and other visual inputs. Based on this information, they can take appropriate actions. It allows computers to see, observe, and understand. Computer vision works similar to human vision, but uses cameras, algorithms, and data to understand what objects are present in an environment and where they are. The two most successful techniques that have been able to achieve this are deep learning and convolutional neural networks (CNNs).

CNNs are able to break down an image into pixels and regions which are given tags and labels. These are used to perform convolution operations and make predictions on what the model is seeing. They work by first discerning hard edges and simple shapes and gradually learn to recognize more complex features. CNNs have been applied to a wide range of applications such as image classification, object detection and localization, and semantic segmentation.

Semantic segmentation aims to answer two questions—"what is in an image" and "where is it located". It differs from simple localization because here each pixel of the image is given a label corresponding to the class it represents. An example of the output is shown in Fig. 1, where each color is a different class. Because a prediction is being made for each pixel in the image, semantic segmentation is also referred to as dense prediction. This way of understanding images has special applications in autonomous driving vehicles.

Autonomous driving vehicles (AVs) are those that can navigate unseen environments without the need for human intervention. The most commonly recognized AVs are self-driving cars, which navigate roads and urban environments. Autonomous driving stands on four main pillars; perception, localization, planning, and control. Semantic segmentation is crucial for perception tasks since it can provide detailed information about the different objects in the surroundings and their exact locations. The motivation behind this paper is to compare the different techniques which are currently available to perform semantic segmentation and understand which one of them is the most suitable for autonomous vehicles. The primary contribution made by this paper is the consideration of factors such as inference speed and multiple modes of information when comparing state-of-the-art techniques being discussed.

Fig. 1 Example from Cityscapes dataset

The remainder of this paper discusses various segmentation architectures, their performance, and their disadvantages. Section 2 is about well-known segmentation models that have a wide range of applications—including, but not limited to, autonomous vehicles. Sections 3 and 4 are architectures specific to urban settings for self-driving cars—the former one goes over multimodal learning and the latter goes over real-time inference models. Finally, Sect. 5 is discuss some open challenges and areas of research regarding segmentation for autonomous vehicles.

2 Important Architectures for Semantic Segmentation

The task of segmenting surrounding landscape is extremely important for autonomous vehicles. However, the applications of segmentation go far beyond that and many models have been proposed for more generalized scenarios. Because of this, the last few years have shown significant improvement in results as more and more complex models are being developed. This section details a few of such important models and their architectures in brief in the increasing order of complexity.

2.1 Fully Convolutional Networks

FCNs [7] were one of the first widely used and efficient network architectures for semantic segmentation. This architecture proposes to replace the fully connected layers of any existing image classification model with convolutional layers. The output of these layers result in a feature map that can be upsampled to the original spatial dimension. Further, by combining the outputs from earlier layers, the model can infer finer details and make better predictions. This way the feature maps can be upsampled anywhere from 4 to 32 times and combined. The full architecture of the network is shown in Fig. 2.

Fig. 2 Fully convolutional network

Datasets such as PASCAL VOC, PASCAL CONTEXT, NYUDv2, and SIFT Flow were used to evaluate the performance of this model. Experiments showed that FCNs were able to detect objects mainly using foreground data but were able to adapt the shapes of objects masks by learning from context as well. Furthermore, the inference of various classes in the foreground was found to be more or less independent of the background. As a result, they were surprisingly accurate.

However, the model uses simple upsampling techniques to increase the spatial dimensions of the features map before producing an output. This is not effective in capturing finer details of the model. Other upsampling methods like atrous convolutions were not explored. Combining the outputs from earlier layers makes this more computationally expensive. Also this architecture was not extensively evaluated for autonomous driving datasets.

2.2 SegNet

SegNet [1] was one of the first models to introduce an encoder–decoder architecture for semantic segmentation as shown in Fig. 3. This architecture manages to outperform FCNs in all segmentation tasks and works well for autonomous driving environments as well. It also uses dimensionality reduction in the encoder module to reduce computational costs, the encoder and decoder modules in this model are symmetric in nature, and upsampling in the decoder blocks is done using max unpooling.

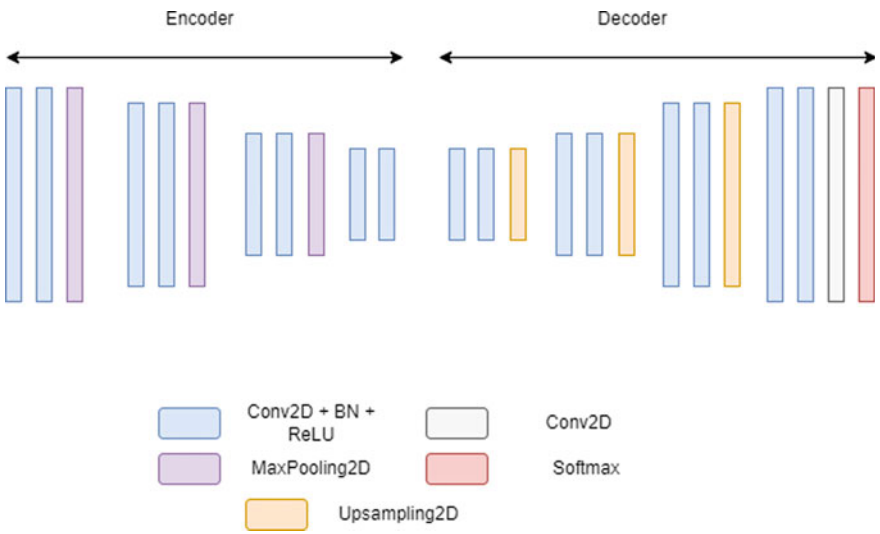


Fig. 3 SegNet architecture

This model was evaluated on datasets like CamVid and SUN RGB-D. Experimental results show that SegNet managed to outperform all other state-of-the-art models that were present at that time in identifying most classes in both datasets. It also had a lower inference time compared to existing models. But since the encoder and decoder modules in this model are symmetric in nature, the number of parameters increases significantly, and many of them are in fact redundant. The paper does not explore the use of asymmetric encoder–decoder architecture fully.

2.3 DeepLab

DeepLab [3] was one of the first well-known models to use atrous convolution to enlarge the field of view without any increase in the number of parameters. These convolution operation have a hyperparameter called dilation rate which determines the separation between pixels that are convolved with the filter as shown in Fig. 4. A dilation of 1 is the usual convolution operation, and a dilation of 2 will result in a 1 pixel separation in the kernel and so on.

It further uses pyramidal pooling to account for the difference in scale of objects across images. Here, kernels having different dilation rates are used on the same input feature map and then pooled together in a pyramidal structure. This is shown in Fig. 5. Finally, by using conditional random fields, it was able to achieve better detection of object boundaries and state-of-the-art scores on semantic segmentation datasets like CityScapes, PASCAL VOC, and PASCAL CONTEXT.

However, the smoothing of boundaries due to conditional random fields made detection of objects with thin and delicate boundaries difficult. It also does not use information from high resolution feature maps or an encoder–decoder architecture.

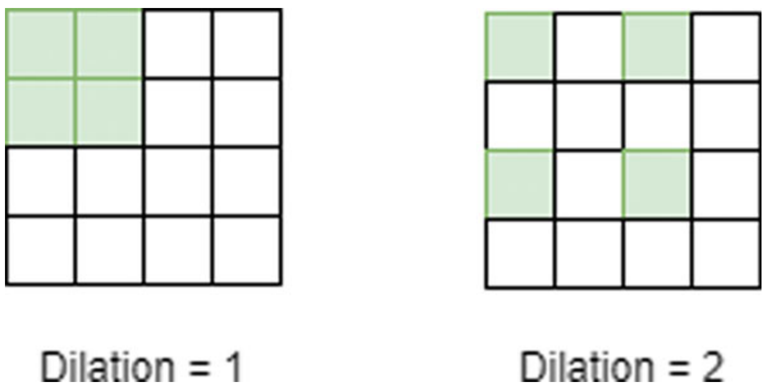


Fig. 4 Atrous convolutions

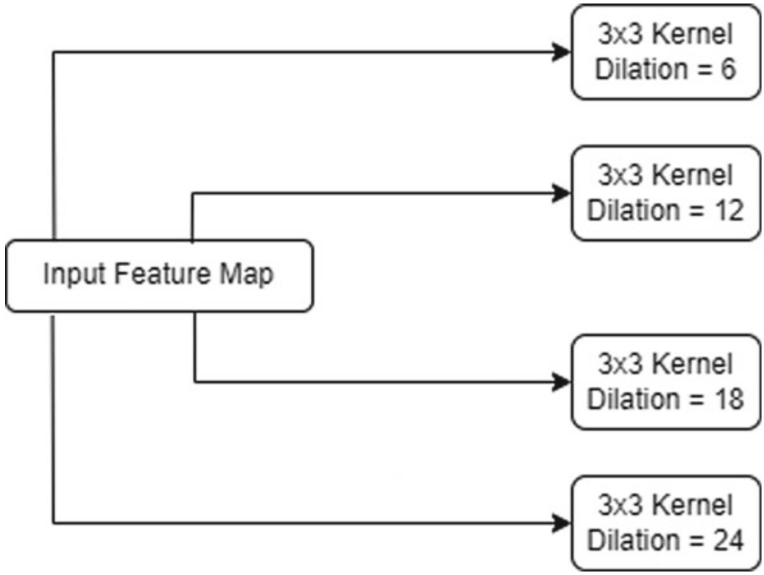


Fig. 5 Atrous spatial pyramidal pooling

3 Segmentation for Autonomous Vehicles

The architectures in the previous sections work for autonomous driving, but specialized models that take advantage of multiple sensors on board the vehicles have also been proposed. These models produce results that can outperform the general architecture and take into account the limitations of memory and computation power available on a vehicle as well as the time it takes to make inferences. These models in this section cover those architectures that take advantage of multimodal learning through thermal [4] and LiDAR data [5], and the next section covers those that perform real-time segmentation.

3.1 RTFNet

RTFNet [8] is a model that tries to fuse RGB data and thermal data of an urban surrounding to achieve better segmentation accuracy since thermal cameras are able to see under all lighting conditions and in more robust environments. The encoder–decoder architecture, which takes inspiration from ResNet fuses data in a novel manner to obtain state-of-the-art results, and its architecture is shown in Fig. 6.

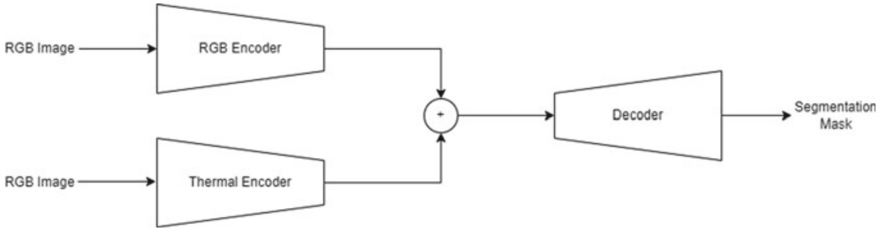


Fig. 6 RGB thermal fusion network

The model was trained and evaluated on a public dataset containing RGB + thermal images captured using an InfReC R500 camera and contains around 1600 pairs of images. The encoders used had architectures similar to that of ResNet-50 and ResNet-152 and the latter gave better results across all classes even though they were imbalanced. Most importantly, the model outperforms all other existing architectures when performing inference in poor lighting conditions and at night.

This model gives equal importance to RGB and thermal images to segment the environment, but this will not always yield good results. When there is a significant lack of information in either one of the images, the overall accuracy goes down. Methods to weight the images before combining are not explored. Furthermore, even though the model produces accurate masks, the time taken to make inferences is too large for it to be used in real-time scenarios.

3.2 FuseSeg

This paper [9] proposes another novel architecture for fusing RGB and thermal imaging to obtain better results for segmentation. The simple design of this network is one of the main advantages since it allows for minimal modification of existing architectures. The model uses one encoder each for thermal and RGB data but, unlike RTFNet that takes a simple sum of the outputs from each encoder at the end, the model adds the output of each of the layers in the two encoder parallelly. But, similar to RTFNet, it also uses transpose convolutions in the decoder.

This model was trained on the same dataset as that of RTFNet. For most classes, it achieved an accuracy that was at least comparable to RTFNet if not better. It had similar performance in low lighting conditions and night time and also in terms of inference speeds. However, this model does not explore the influence of the quality of images over predictions. A lower quality RGB image may only be detrimental to the prediction when it does not offer much information to the model. The same is true for poor quality thermal images. The paper does not discuss any way of determining this threshold.

4 Real-Time Semantic Segmentation Architectures

Deep neural networks are able to excel at the task of semantic segmentation as seen in the previous sections. They can be trained end to end to achieve incredible accuracy at the pixel level. However, all of them require a lot of computational resources to train and to even make inferences and such resources are simply not available onboard autonomous driving vehicles. In order to achieve the right trade-off between accuracy and computation cost, deep learning architectures that can give real-time segmentation masks have been developed. Two of such architectures are discussed in this section.

4.1 ERFNet

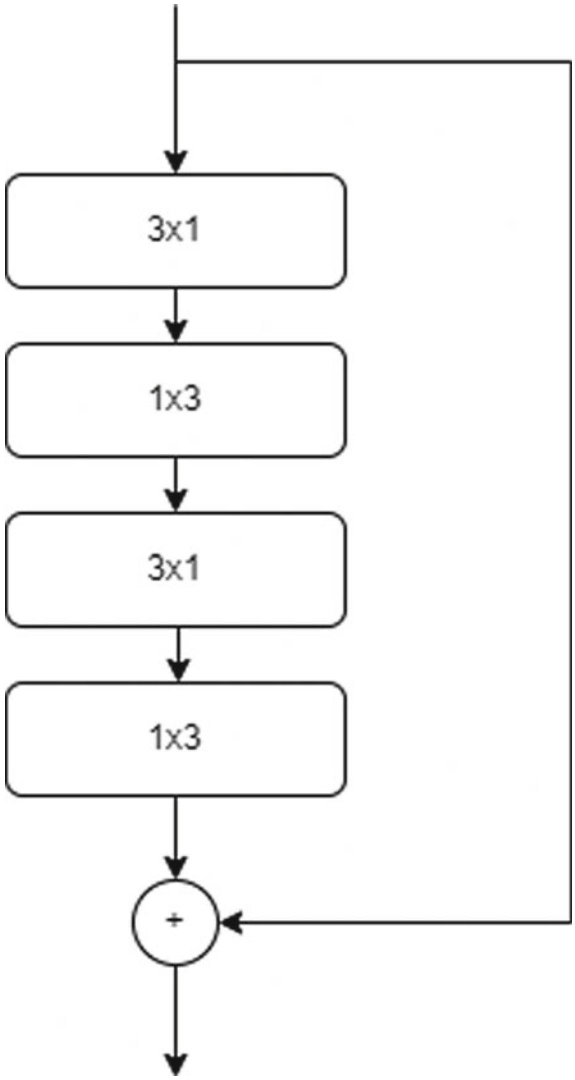
ERFNet [6] uses efficient residual factorization to address the limitations that are inherently present in commonly used versions of residual blocks. This is done with the help of a novel non-bottleneck 1D convolution block which is different from the non-bottleneck version originally proposed in the ResNet paper. It was observed that the "efficient" residual block did not achieve the same level of performance as the regular block when trained for an extended period of time despite using fewer parameters.

The proposed solution is able to fix this issue—it not only reduces the number of parameters even further, it also manages to achieve good performance at no additional cost. Furthermore, while this non-bottleneck solution has been implemented for the task of semantic segmentation, it is possible to incorporate it into models involving other computer vision tasks as well. Due to the nature of the design, it allows an increase in the width of convolutional neural networks since the number of filters can be increased while keeping the increase in computational cost to a minimum. This 1D non-bottleneck convolutional block is shown in Fig. 7.

The non-bottleneck block forms the backbone of the entire network which takes an encoder–decoder approach. The encoder block is able to obtain a compact spatially reduced feature map, and then, the upsampling done by the decoder is able to obtain the segmentation map of the same dimensions as the original image. The encoder and decoder are not symmetrical since the number of layers used in each of them is different.

Experimental results show that the proposed architecture can achieve remarkable results even compared to existing state-of-the-art models. It was able to obtain an accuracy of over 90% in important classes such as roads and buildings and similar performance on more challenging classes as well. Moreover, the model showed a very small difference between the train and validation accuracies indicating that it can generalize well to other datasets. The proposed architecture is also able to outperform

Fig. 7 Efficient residual factorized blocks



existing models in terms of inference speed as well and experiments demonstrated that it is possible to run this model on a single core GPU to provide real-time and accurate segmentation. This means that the model achieves a good trade-off between accuracy and computational efficiency.

4.2 FSSNet

Similar to ERFNet, FSSNet [10] was developed to create a model that is computationally efficient and accurate to allow for real-time segmentation in autonomous vehicles. Most other models improved accuracy by increasing the depth of the network, and while this worked, it also lead to a large increase in memory and time due to a significant number of redundant parameters. The architecture proposed in this paper is also based on residual blocks, similar to ERFNet. It introduces two important novel blocks called continuous dilated blocks and continuous factorized blocks.

Continuous dilated blocks use dilated convolutions to increase the receptive field of the kernel, and these blocks use 3×3 filters of dilation rates 2, 5, and 9 along with residual skip connections. This increased field of view means that the model can achieve better accuracy on classes of larger objects. Continuous factorized blocks are based on using 1D convolutions to reduce the number of parameters. These are stacked on top of each other along with skip connections.

The overall architecture of the model uses an encoder–decoder architecture, but the decoder does not mirror the encoder since its main goal is to simply restore the spatial dimensions of the feature map and the number of parameters need to be kept to a minimum. The model also makes use of max pooling layers, dropout regularization, and upsampling with bilinear interpolation.

The proposed architecture was evaluated using a variety of datasets such as CamVid, Cityscapes, and KITTI. Experiments show that the model is able to generate segmentation maps having very little noise, recognize challenging classes, and achieve a good accuracy which is comparable to, if not better than, existing state-of-the-art models. The most impressive feature is that it is able to do all of this using only a fraction of the parameters and computation cost and has a very high inference speed.

5 Open Challenges, Questions, and Research Gaps

Models that use data from multiple sources such as RGB, thermal, and LiDAR face several challenges in their construction and training. One of the main issues is the availability of a large public dataset. The KITTI dataset only contains around 80 thousand images which is very small compared to the ImageNet dataset that has over a million images. Moreover, the distribution of classes across the images in this dataset is also skewed and it is difficult to create a dataset that is more balanced. Another issue to be considered is the fact that these datasets are not representative of real life scenarios and problems that an autonomous vehicle may encounter. It is very likely that the data captured from one or more of the sensors may be noisy and may not be informative, but the publicly available datasets capture ideal scenarios. They also do not take into account the different weather conditions and lighting conditions that can affect the performance of the model. To a certain extent, it is possible to generate data through augmentation and cloning but producing a well-balanced realistic and large open dataset is still a challenge.

Another issue with the datasets itself is the task of labeling, especially for 3D data which can be very time consuming and resource intensive. Humans are prone to making errors, and the presence of mislabeled data can significantly affect the performance of the mode. It can become quite challenging when the signals received from different sensors are different from each other due to range of capture mismatches, lighting conditions, weather conditions, and more. There is always the possibility of encountering a scenario that was not previously present in the training dataset which means it is important to allow for life long continuous learning and updates and these are open challenges as well.

Even if large good quality datasets are available, there remains the question of choosing what data to fuse in the mode. Data from different sensors need to be preprocessed differently, and this is challenging in particular for LiDAR and 3D representations using ultrasonic sensors. Since the quality of data and amount of information from each of the sensors can vary based on external conditions, fusing data in a simplistic manner is not going to result in the best performance for any model. Finding the right neural network architecture to capture all this information and making accurate predictions is also a challenging task.

Finally, the question of creating a real-time computationally efficient model has not yet been fully explored. When fusing data from different sources, they need to be represented in efficient notations so as to reduce memory usage. Pruning and optimization in the network architecture is also important to reduce inference and training time. Finally, the evaluation of the models is also an important open challenge. Simple accuracies and losses will not give a complete understanding of the performance and so there is a need to come up with specialized evaluation methods such as [2].

6 Conclusion

Semantic segmentation is one of the most challenging tasks under computer vision since it requires dense pixel-level inference. For the task of autonomous driving, we need to build a system that can perform segmentation in a reliable and robust manner so that the safety of all parties is assured. We also want to be able to take advantage of the different modalities available and combine their information to achieve better results. Not only do we need systems that can work well all the time, but we also need them to work with limited resources and tight time constraints. Perception of the environment is the first of the four main pillars of autonomous driving. Without reliable perception, the other three pillars will collapse. Thus, segmenting the environment into distinct identifiable objects is a crucial task for the success of autonomous vehicles and is a promising area for research.

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Classification of Heart Signal Using Variational Mode Decomposition

Subhanshu Gautam and R. Shanmughasundaram

Abstract An Electrocardiography (ECG) signals, which represent the electrical activities of a human heart and provide data on its function and diseases, are crucial for the diagnosis of cardiac disorders and the identification of arrhythmias. The empirical mode decomposition (EMD) is extensively used for the classification of heart signal, although there are limitations such as noise sensitivity and sampling. In this paper, variational mode decomposition (VMD) is adopted for the extraction of features based on distinct intrinsic mode functions (IMFs). The features are fed to support vector machine (SVM) classifier with radial basis function (RBF) kernel. The VMD algorithm was implemented in Matlab and the SVM was trained with 80% data. A test accuracy of 95% was obtained from the classifier which classifies the data into normal or abnormal. This work can be applied for precise diagnosis of arrhythmia.

Keywords Pre-processing · VMD · Feature extraction · Support vector classification (SVM)

1 Introduction

Accurate detection of cardiac disease lowers risk factors and fatality rates. An ECG that determines the strength of human heart's electrical activity. The conventional methods for recording signatures were generally expensive, environmentally influenced, inconvenient for the patient. As a result, utilizing an indirect method such as ECG-derived respiratory signal (EDR) is an effective alternative for decreasing the aforementioned issues. Multi-resolution methods like empirical mode decomposition (EMD) can overcome the problem. However, if there were noise in the ECG data, the results would not be present. EDR could be extracted using variational

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mode decomposition (VMD) approach. The input signal is separated into independent intrinsic mode functions (IMFs) that are restricted by constraints. The VMD distinguishes the modes with differing centre frequencies using the adaptive Wiener filter bank.

2 Literature Survey

Nazari and Sakhaei used an EDR detection approach [1] based on VMD which has lower computing complexity and higher precision. The first mode of noise-affected ECG data was reconstructed. The performance of empirical mode decomposition (EMD) was compared with discrete wavelet transform [2]-based thresholding strategy. In [3], the performance of EMD and VMD were evaluated for cardiac abnormalities. The results show that the EMD method was more sensitive to the lowest frequency component of the signal. Choudhary et al. proposed a VMD-based heartbeat extraction methodology for seismocardiogram (SCG) signals [4]. The different processes involved were signal decomposition, HR envelope construction, low pass filtering of the resulting envelope, and smoothed envelope annotation. A morphological classification of heart beats [5] based on Variational Mode Decomposition as ventricular and normal heartbeats was studied. This method was intended for single-lead applications and combines temporal characteristics with features retrieved from the various modes. Two different strategies were tested: an intra-patient strategy in which the test and training sets consist of the same patients, and an inter-patient strategy in which the test and training signals come from separate patients. The method called variational mode extraction (VME) is suggested [1]. The approach is similar to VMD, but it adds a new criterion: after extracting a specific mode, the remaining signal should have less energy at the mode's centre frequency. VME is a useful tool for applications like EDR because of its large number of modes. To distinguish heart and lung sounds (HLS), the nonlinear decomposition method of phonocardiogram (PCG) signal was utilized. Because it is simple to set up and inexpensive, photoplethysmography (PPG)-based heart rate (HR) monitoring is becoming more widespread in wearable devices. Using wrist-type PPG data and VMD [6], HR was estimated during physical exercise. In order to identify arrhythmia ECG beats [7], the bandwidth features of the modes produced via VMD. Automatic detection of R peaks in phase space-based ECG abnormality diagnosis. The classification problem of normal and pathological ECG signals. RNN, LSTM, and GRU deep learning architectures were utilized to categorize different cardiac disorders such arrhythmia and myocardial infarction. These architectures were trained to diagnose atrial fibrillation from the ECG [8] data. Vibration signal analysis is used to diagnose bearing faults. Experimental data with outer race and roller faults are collected for [9] analysis. In [10] comparison of the decomposition of two statistical test functions used for spatial inhomogeneity, Doppler and Bumps. By taking use of the group sparse (GS) property of measured phonocardiogram (PCG) signals, the measured PCG signals are denoised using the group sparsity method [11]. The VMD technique is then used to decompose the denoised GS-PCG signals into successive modes with particular spectral properties.

3 Variational Mode Decomposition

The VMD method separates an input signal into k discrete sub-signals (modes), each with a specific spectral bandwidth. Based on this, the Hilbert transform can be used to compute the analytical signal for each mode, which can then be mixed with an exponential tuned to the estimated centre frequency to derive baseband frequency spectrum.

$$\frac{\min}{u_k, \omega_k} = \left\{ \sum_k \left\| \partial_t \left[\left(\delta(t) + \frac{\mathrm{j}}{\pi t} \right) * u_k(t) \right] \mathrm{e}^{-\mathrm{j}\omega_k t} \right\| ||_2 \right\} \tag{1}$$

$$\sum_k u_k = f \tag{2}$$

where k is the number of modes, t is the time script, f is the signal, u is its mode, ω is the frequency, δ is the Dirac distribution, and * stands for convolution. Low frequency components are represented by the mode u with high order k. The frequency domain definition of the 2D analytic signal (AS) is as follows:

$$\hat{u}_{\mathrm{AS},k}(\vec{\omega}) = (1 + \mathrm{sgn}(\vec{\omega} \cdot \vec{\omega}_k))\hat{u}_k(\vec{\omega}) \tag{3}$$

Use Lagrange multipliers to determine the optimal uk in the Fourier domain.

$$\widehat{u_k^{n+1}} = \arg\min \left\{ \begin{array}{l} \alpha \left\| j(\vec{\omega} - \vec{\omega}_k)\left[(1 + \mathrm{sgn}(\vec{\omega} \cdot \vec{\omega}_k))\hat{u}_k(\vec{\omega})\right] \right\|_2^2 \\ + \left\| \hat{f}(\vec{\omega}) - \sum_k \hat{u}_k(\vec{\omega}) + \frac{\hat{\lambda}(\omega)}{2} \right\|_2^2 \end{array} \right\} \tag{4}$$

As a result, Wiener filter is obtained:

$$\begin{gathered} \hat{u}_k^{n+1}(\vec{\omega}) = \left(\hat{f}(\vec{\omega}) - \sum_{i \neq k} \hat{u}_i(\vec{\omega}) + \frac{\hat{\lambda}(\vec{\omega})}{2} \right) \frac{1}{1 + 2\alpha|\vec{\omega} - \vec{\omega}_k|^2} \\ \forall \vec{\omega} \in \Omega_k : \Omega_k = \{\vec{\omega} \cdot \vec{\omega}_k \geq 0\} \end{gathered} \tag{5}$$

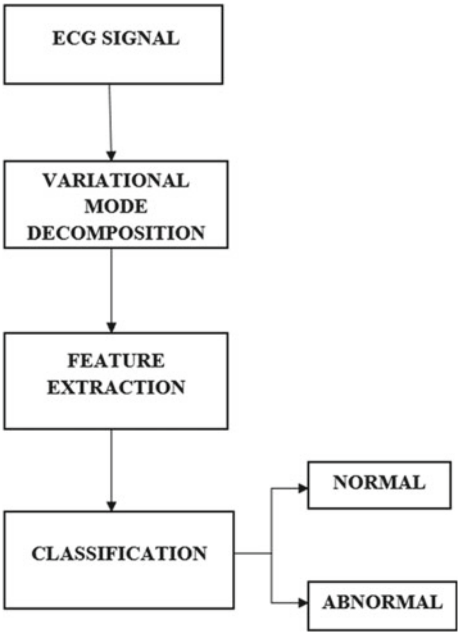
As a result, Wiener filtering is used to immediately update the modes in the Fourier domain.

4 Dataset and Methodology

In the MIT-BIH arrhythmia dataset is described for classification of heartbeats. It has 48 recordings of 47 persons dual-channel dynamic ECGs that are each half an hour long.

From Fig. 1 input ECG signal is decomposed into different intrinsic mode functions (IMFs) using VMD technique. The VMD divides the ECG data samples that it receives into N number of modes. If the number of modes provided is less than what is required, the signal components may be mixed into the given number of modes. In this proposed system after modes we are extracting the features such as Energy, Variance, Mean, and Standard deviation of the signal. Feature extraction is done based on features of the spectrum of each mode. After each mode has been trained, the cross-validation approach is used to train and test SVM classifiers. The characteristics are input into an SVM classifier, which is trained with 50% test data and an RBF kernel. Based on the person's classification, we check the person's heartbeat to see if it is normal or not. Based on the classification, we can compute the performance in terms of metrics like accuracy, sensitivity.

Fig. 1 Block diagram



5 Feature Extraction

5.1 Energy

The energy, frequency, and length of the major track are used to extract features using this method. The values are given in each segment, and the ECG signal is first separated into segments, after which a three-dimensional feature vector is constructed for each segment. Energy of each segment can be calculated as follows:

$$E_k = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \vartheta_k(t, f)\mathrm{d}t\mathrm{d}f \tag{6}$$

5.2 Variance and Standard Deviation

The standard deviation and variance both indicate how spread out a distribution. They demonstrate how distinct things are. The variance is calculated by averaging each number's squared difference from its mean.

$$S^2 = \frac{\sum(X - \mu)^2}{N} \tag{7}$$

"where μ is the mean and N is the number of scores".

"When the variance is computed in a sample, the statistics"

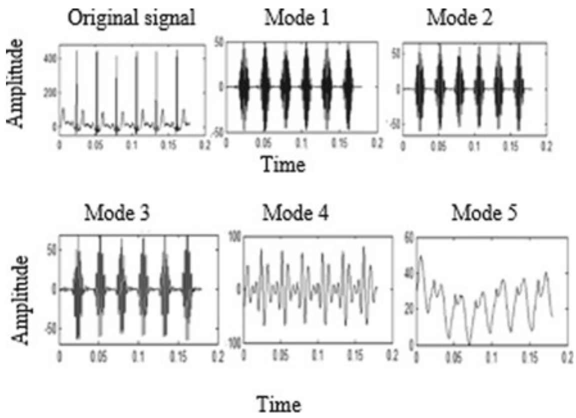
$$S^2 = \frac{\sum(X - M)^2}{N} \tag{8}$$

which gives an unbiased estimate of σ^2. The most used measure of variance is S^2, as samples are commonly used to estimate parameters.

6 Classification

In Support Vector Machine, which is essentially a binary classifier, is particularly effective at classifying data that can be separated linearly and non-linearly. It determines the appropriate hyper plane to divide the two classes with the best possible margin from the support vectors during the training phase. The classifier makes a decision based on the hyper plane when testing with new data. The use of numerous kernels, such as polynomial, Gaussian, and sigmoid kernels, can be substituted for

Fig. 2 VMD modes



the use of a single kernel. Based on their ability to discriminate, different kernels are paired with convex characteristics and kernel weight. Additionally, the kernel's parameters are tuned using tenfold cross-validation.

7 Results

ECG signal decomposed into different time domain signals, or modes, using VMD. The non-recursive VMD method is used to simultaneously decompose the modes about their centre frequency. Each of the five IMFs that are observed is distinct. Figure 2 shows the different VMD modes. Metrics like accuracy, sensitivity are shown in Fig. 3. A classification accuracy of 95% was obtained from SVM classifier.

8 Conclusion

In this paper uses ECG signals based on variational mode decomposition to classify healthy and disordered signal. It can be seen that this VMD-based technique significantly improved the system's accuracy. SVM classifier is used to classify the extracted features. The classifier's performance is additionally verified using the tenfold cross-validation approach. The accuracy obtained for SVM classifier was 95%.

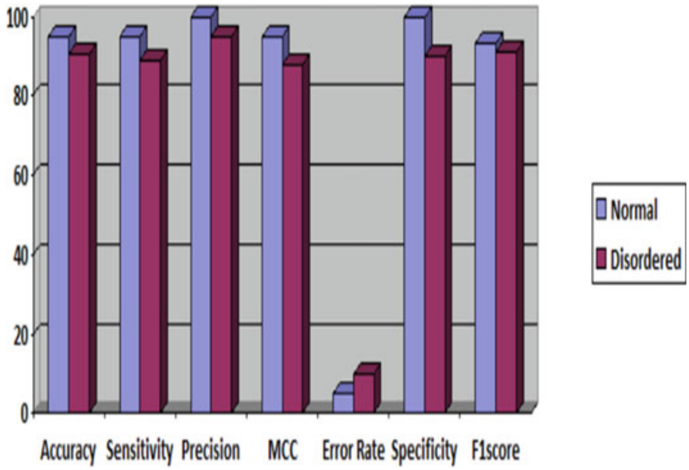


Fig. 3 Performance estimation

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N-Gram-Based Legal Parameters Retrieval: The State-of-the-Art and Future Research Trends of Indian Judiciary

Souraneel Mandal and Tanaya Das

Abstract Natural Language Processing techniques can help in deriving insights from unstructured text. In Indian Judicial System, implementation of natural language processing-based tools are found to be less in numbers. The majority of documents in Indian Judiciary are unstructured, and legal practitioners manually evaluate them to extract facts, information which requires time. Hence, natural language processing techniques like N-gram combined with some others text analytics approach can assist in analyzing a whole document to extract contextual meaning. Hence, in this paper the authors have proposed an N-gram analysis approach along with some text preprocessing technique and visualize extracted features from legal documents of Indian judicial system. The authors have primarily used techniques like count vector, Tf-Idf along with uni-gram and bi-grams and visualized them using various graphs, i.e., heatmap and cluster map. The graphs clearly visualize the significant parameters present in a legal document that help a legal professionals to extract ad understand the important facts present inside a case. The authors have used some other text preprocessing techniques like tokenization, lemmatization, stop words removal, names removal, numerical value removal, etc. Also, after preprocessing the authors *Tfidftransform* to extract the frequency and weighted mean, respectively. The most influential parameters serve the legal professionals in exploring the probable facts of the legal documents as mentioned in penal code sections of Indian Judiciary System.

Keywords Text analytics · Natural language processing · WordNetLemmatizer · Count vector matrix · Bag of words · TF-IDF · N-gram analysis

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1 Introduction

Language modeling is the approach for deciding the likelihood of any arrangement of words. Language modeling is utilized in a wide assortment of uses, for example, Speech Recognition [1], Spam filtering [2], etc. As a matter of fact, language modeling is the vital point behind the execution of many state-of-the-art Natural Language Processing models. One of the ways of carrying out is Statistical Language Modeling which is the improvement of probabilistic models that can foresee the next word in the sequence of given the words, for example, N-gram language modeling which can be characterized as the contiguous sequence of *n* items from a given sample of text or speech. The things can be letters, words, or base matches as indicated by the application. In Natural Language Processing, N-grams are used for variety of domains from Computer Science like auto completion of sentences [3], auto spell check [4], automatic new topic identification [5], Legal Data Retrieval [6], etc. to Biotechnology like Protein sequencing [7], DNA sequencing [8], microbial organisms' presence [9], etc.

In this paper, authors proposed their work in N-gram analysis to extract dominant keywords for Indian Legal System's any specific domain's all legal documents with the help of Bag of Words and Term Frequency Inverse Document Frequency (Tf-Idf) method. In case of Indian Legal System most of the documents are unstructured in nature. To understand the structural integrity, the authors have applied some advanced text analytics approach with the help of N-gram analysis on Indian Legal documents which will help attorneys to retrieve data automatically rather than by going through the documents manually which is a time-consuming.

Section 2 expressed the literature survey for multiple text analytics approach for N-gram analysis. Section 3 outlines the proposed methodology along with algorithm. Section 4 discusses the results of the proposed methodology using frequency matrix, correlation, heatmap visualization, and clustering methods to explore the major parameters. Finally, Sect. 5 concludes the paper and its future use in Indian Legal System.

2 Literature Survey

Text analytics approach and feature extraction are important techniques to retrieve meaningful information from unstructured textual documents. Among various techniques, N-gram analysis appear to be the important one to predict the vital features that frequently occurs in the corpuses of the documents.

In 2020, some researchers have examined the effectiveness of character N-grams and typed N-gram over domains like authorship attribution, sentiment analysis, and how they have been used to nurture very large number of parameters with distributed Apache Spark processing [10]. Another work has been done by some researchers on English e-newspapers using N-gram-based analyzing approach which is linguistic in nature to extract individual article. The authors have used the prior content and the probability of a word sequence to predict the next word [11]. In 2014, some pioneers have proposed a study on optimizing text feature extraction using N-gram analysis for commercial products in twitter. The researcher have used polarity lexicons for building the N-gram model and found that by merging dictionary-based weighing the initial dataset can be constructed and a naive-based classifier of sentiments can be applied to find the final result [12]. Whereas in 2011, another approach on N-gram to determine the similarity rate based on the frequency number of characters in the malicious code. Hex and Binary values can be used to compute a character's frequency rate. In addition, the value of *N* in N-gram might be 1 or any other integer [13]. In 2012 some researchers have proposed a text analytic visualization system that leverages the CNG technique for text categorization and compares texts at the sub-word level using variations in frequency values of frequent N-grams. The visualization approach gives a visual understanding of the CNG classifier's workings as well as insight into N-gram features of texts or classes of documents [14]. Text analytics can be a powerful analysis tool for legal documents. As the majority of legal documents exists in textual form. Text Analytics may become an useful aid in visualizing and extracting the context of judicial cases. Some recent literatures focuses mostly on extracting the primary context found in legal sections [15], help legal professionals to uncover the major context addressed in legal sections cited as charges against the accused in criminal proceedings [16].

From the overall literatures authors have found different N-gram features are applicable to the textual documents but very few are there regarding the legal documents. Text Analytics like *N-gram analysis*, *Tf-Idf*, *Count Vector Matrix*, etc. can assist legal professionals to visualize critical parameters found in legal cases. Hence in India judicial system, since most of the documents are unstructured in nature, that's why in this paper authors have analyzed and found most frequent parameters from legal documents using uni-gram and bi-gram analysis approach.

3 Proposed Methodology

In this paper, authors explain the proposed methodology of N-gram analysis to understand the contextual meaning of the sentences in the documents. The stepwise proposed algorithm along with diagram which is described in Fig. 1.

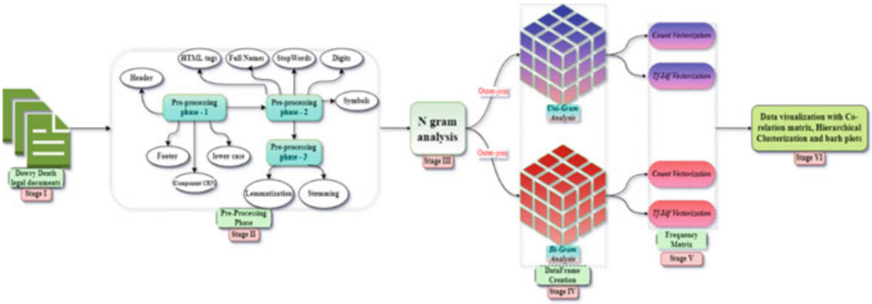

Fig. 1 Proposed N-gram analysis approach

Algorithm

Step 1: **Start.**
Step 2: Import the appropriate modules: *nltk*, *re*, *glob*, *pdftotext*, *pandas*, *seaborn*, *matplotlib*, *stopwords*, *WordNetLemmatizer*, *TfidfTransformer*.
Step 3: Store each dowry death legal documents in sorted manner with the help of *glob* module.
Step 4: Store all the Indian Surname in the text file for further work.
Step 5: The data(s) for each pdf document are collected page by page using the *pdftotext* module and stored all of the pages as a string in a list and merged the list in a string.
Step 6: Eliminate the header and footer across all pdf's pages.
Step 7: Eliminate Semantics Criminal Record Number.
Step 8: Apply lower case to all the string elements.
Step 9: Eliminate the any website's link, HTML tags.
Step 10: Eliminate the numbers and numbers along with any words.
Step 11: Eliminate the words with length of maximum two alphabets.
Step 12: Eliminate the unwanted blank spaces.
Step 13: Eliminate the numbers written in word.
Step 14: Eliminate the English and Regional month names.
Step 15: Eliminate the unprecedented words.
Step 16: Eliminate the *stopwords* after applying *WordNetLemmatizer*.
Step 17: Split the string and store in list.
Step 18: Eliminate all the Surname along with all the First name across all the documents.
Step 19: Apply N-gram with the help of *user input* in cleaned list for all documents.
Step 20: Apply *pandas DataFrame method* to store a list which stored a list of n_gram index.
Step 21: Apply *outer join* to make a DataFrame for each n_gram index inside list.
Step 22: Replace *NaN* with 0 inside DataFrame.
Step 23: Eliminate that instance where maximum attributes filled with 0 and stored in DataFrame named N_Gram_DF.

Step 24: DataFrame consists of *N-gram word frequency* across all the documents.
Step 25: Visualize the *frequency* across all the documents with the help of *barh plot*.
Step 26: Applied *TfidfTransformer* in N_Gram_DF and named N_Gram_DF_Tf_idf DataFrame to understand Term Frequency and Inverse Document Frequency.
Step 27: Visualize co-relation matrix with the N_Gram_DF_Tf DataFrame with the help of *heatmap plot*.
Step 28: Visualize hierarchical cauterization to figure out association in between words using *clustermap plot*.
Step 29: **End.**

4 Results and Discussion

As shown in Fig. 2, the authors calculated two count vector matrices that represents a bi-gram and a uni-gram analysis present in each document. The left matrix in Fig. 2 represents bi-gram analysis and the right matrix represents uni-gram analysis. In the case of bi-gram analysis, the most frequent bi-grams present in the raw documents have been found. Some of them are "cruelty harassment", "dowry death", "subject cruelty", "demand dowry", etc. In the case of uni-gram analysis, the most frequent uni-gram present in the raw documents have been found. Some of them are "result", "victim", "court", etc.

In Fig. 3, the authors have extracted 20 uni-gram with the frequency across all legal documents and visualized them as a bar plot in the left part of Fig. 3 and in

	word	Case1	Case2	Case3	Case4	Case5	Case6	Case7	Case8
0	cruelty harassment	22.0	1.0	2.0	6.0	4.0	9.0	0.0	3.0
1	dowry death	13.0	0.0	1.0	12.0	1.0	2.0	2.0	1.0
2	subject cruelty	11.0	2.0	2.0	4.0	2.0	2.0	1.0	1.0
3	demand dowry	10.0	7.0	10.0	12.0	9.0	16.0	5.0	2.0
4	connection demand	9.0	1.0	1.0	4.0	4.0	9.0	1.0	1.0
5	trial court	8.0	2.0	9.0	1.0	5.0	3.0	5.0	0.0
6	offence section	4.0	2.0	0.0	1.0	1.0	6.0	7.0	1.0
7	matrimonial home	3.0	1.0	7.0	0.0	3.0	2.0	3.0	1.0
8	section evidence	2.0	1.0	3.0	7.0	0.0	1.0	1.0	1.0
9	information solutions	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10	certify copy	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0
11	cause death	1.0	0.0	3.0	5.0	6.0	2.0	3.0	1.0

	Word	Case1	Case2	Case3	Case4	Case5	Case6	Case7	Case8
0	result	1.0	1.0	1.0	7.0	3.0	2.0	1.0	0.0
1	victim	5.0	11.0	34.0	39.0	22.0	5.0	22.0	9.0
2	cannot	4.0	5.0	10.0	2.0	3.0	3.0	0.0	1.0
3	court	25.0	12.0	12.0	23.0	31.0	20.0	11.0	16.0
4	cash	17.0	1.0	1.0	2.0	3.0	0.0	3.0	4.0
5	shall	12.0	4.0	1.0	11.0	3.0	2.0	2.0	0.0
6	send	1.0	4.0	1.0	6.0	3.0	1.0	4.0	1.0
7	occur	2.0	4.0	1.0	2.0	4.0	1.0	1.0	2.0
8	cruelty	42.0	6.0	7.0	11.0	5.0	14.0	7.0	4.0
9	suffer	2.0	3.0	0.0	3.0	2.0	2.0	9.0	4.0
10	burn	2.0	1.0	0.0	11.0	6.0	5.0	13.0	1.0
11	trial	15.0	5.0	9.0	4.0	8.0	12.0	7.0	2.0
12	cross	7.0	5.0	10.0	9.0	4.0	9.0	1.0	0.0
13	facts	4.0	1.0	6.0	9.0	4.0	4.0	1.0	0.0
14	find	3.0	17.0	8.0	4.0	10.0	13.0	8.0	5.0
15	default	2.0	0.0	1.0	1.0	3.0	1.0	5.0	1.0
16	come	3.0	0.0	6.0	5.0	5.0	8.0	8.0	5.0
17	submit	4.0	4.0	4.0	3.0	7.0	2.0	4.0	0.0
18	police	8.0	4.0	3.0	6.0	3.0	0.0	1.0	3.0
19	record	9.0	4.0	3.0	13.0	4.0	2.0	2.0	1.0
20	conduct	5.0	2.0	2.0	3.0	1.0	1.0	1.0	0.0

Fig. 2 Count vector matrix for N-grams

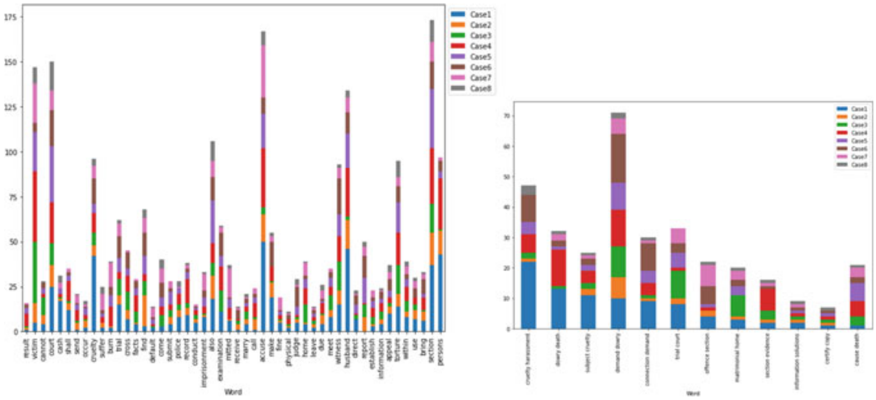

Fig. 3 Frequency visualization for N-gram count vector matrix

the right part of Fig. 3 the authors have visualized the top 11 bi-grams with their frequency across all legal documents as a bar plot.

As shown in Fig. 4, the authors have found two Tf-Idf vector matrices which show the Tf-Idf values or weighted mean of a bi-gram and a uni-gram present in each legal document. The left matrix in Fig. 4 is made after applying *Tfidftransformer* to the count vector matrix found after doing bi-gram analysis. And the right matrix is made after applying *Tfidftransformer* to the count vector matrix Fig. 2 found after doing uni-gram analysis. In the case of the Tf-Idf vector of bi-grams, the most significant bi-gram present in "case1" is "cruelty harassment" as its Tf-Idf value is the highest in the particular document, and the second most significant bi-gram present in "case1" is "subject cruelty". In the case of the Tf-Idf vector of uni-gram as shown in the right of this Fig. 2, the most significant uni-gram in "case1" is "cash" as its Tf-Idf value is the highest here. The most significant parameter has the highest Tf-Idf value, and the least significant parameter has the lowest Tf-Idf value.

In Fig. 5, authors represent Tf-Idf vector matrices and visualize using seaborn heatmap. It shows top most frequent bi-grams in the left portion and uni-gram in the right portion and their Tf-Idf values as a map plot. The higher values of the parameters are represented as lighter shades and lower values, darker the shade, shows how the parameters are correlated with each other, corresponding to any legal cases.

Figure 6 represents Tf-Idf vectors using seaborn cluster map. Clusters, also known as dendrograms, are used to represent each associated word. As shown in dendrograms, in the case of bi-gram, which is on the left part of Fig. 6, the merging of two closely clustered parameter like "subject cruelty" and "cruelty harassment" having minimum distance with respect to other columns, hence they can be merged into one cluster, which is further merged with another one "connection demand" cluster and again merged with "dowry death" which shows that there important parameters are mostly connected with each other. Similarly, other clusters shows that what are the parameters closest to other and is correlated with corresponding one present in legal documents.

	Word	Case1	Case2	Case3	Case4	Case5	Case6	Case7	Case8
0	cruelty harassment	0.868146	0.046053	0.085240	0.255719	0.170479	0.355151	0.000000	0.127859
1	dowry death	0.694956	0.000000	0.057737	0.692845	0.057737	0.106916	0.124777	0.057737
2	subject cruelty	0.866996	0.183969	0.170253	0.340506	0.170253	0.157636	0.091985	0.085127
3	demand dowry	0.344917	0.281776	0.372525	0.447030	0.335272	0.551867	0.201268	0.074505
4	connection demand	0.629533	0.081633	0.075547	0.302188	0.302188	0.629533	0.081633	0.075547
5	trial court	0.519313	0.151517	0.630990	0.070110	0.350550	0.194742	0.378791	0.000000
6	offence section	0.353987	0.206561	0.000000	0.095580	0.095580	0.530981	0.722964	0.095580
7	matrimonial home	0.307078	0.119459	0.773867	0.000000	0.331657	0.204719	0.358377	0.110552
8	section evidence	0.228594	0.133391	0.370338	0.864121	0.000000	0.114297	0.133391	0.123446
9	information solutions	0.568191	0.331555	0.306835	0.306835	0.306835	0.284096	0.331555	0.306835
10	certify copy	0.352937	0.411896	0.381187	0.381187	0.381187	0.352937	0.000000	0.381187
11	cause death	0.099960	0.000000	0.323885	0.539808	0.647770	0.199921	0.349978	0.107962

	Word	Case1	Case2	Case3	Case4	Case5	Case6	Case7	Case8
0	result	0.122684	0.126882	0.130130	0.851599	0.383854	0.247439	0.134602	0.000000
1	victim	0.077264	0.175798	0.557286	0.597618	0.354569	0.077917	0.372991	0.156518
2	cannot	0.298649	0.386085	0.791938	0.148075	0.233610	0.225878	0.000000	0.084026
3	court	0.429007	0.213067	0.218829	0.392113	0.555659	0.346749	0.207488	0.309575
4	cash	0.927403	0.056420	0.057864	0.106193	0.170691	0.000000	0.179559	0.245580
5	shall	0.692942	0.238884	0.061250	0.629880	0.180678	0.116465	0.126710	0.000000
6	send	0.107850	0.446165	0.114396	0.641686	0.337452	0.108761	0.473312	0.121376
7	occur	0.280432	0.580055	0.148726	0.278085	0.584960	0.141400	0.153838	0.315602
8	cruelty	0.879134	0.129888	0.155415	0.228322	0.109155	0.295519	0.160757	0.094225
9	suffer	0.164032	0.254467	0.000000	0.243989	0.171079	0.165417	0.809854	0.369208
10	burn	0.100844	0.052147	0.000000	0.549998	0.315529	0.254238	0.719164	0.056746
11	trial	0.593524	0.204611	0.377728	0.156948	0.330146	0.478828	0.303886	0.089062
12	cross	0.364466	0.269240	0.552266	0.464676	0.217214	0.472555	0.057125	0.000000
13	facts	0.304907	0.078835	0.485120	0.680300	0.318007	0.307482	0.083632	0.000000
14	find	0.106386	0.623480	0.300913	0.140660	0.369854	0.464897	0.311256	0.199547
15	default	0.287851	0.000000	0.152661	0.142721	0.450327	0.145141	0.789539	0.161976
16	come	0.180084	0.000000	0.383725	0.298951	0.314426	0.486431	0.529219	0.339283
17	submit	0.342252	0.353963	0.363024	0.254540	0.624673	0.172571	0.375501	0.000000
18	police	0.655315	0.338869	0.260658	0.487373	0.256801	0.000000	0.089872	0.276563
19	record	0.517913	0.238060	0.183115	0.741834	0.240073	0.116063	0.126273	0.064763
20	conduct	0.727714	0.305103	0.312995	0.438924	0.153082	0.148780	0.161876	0.000000

Fig. 4 Tf-Idf or weighted mean matrix for N-gram

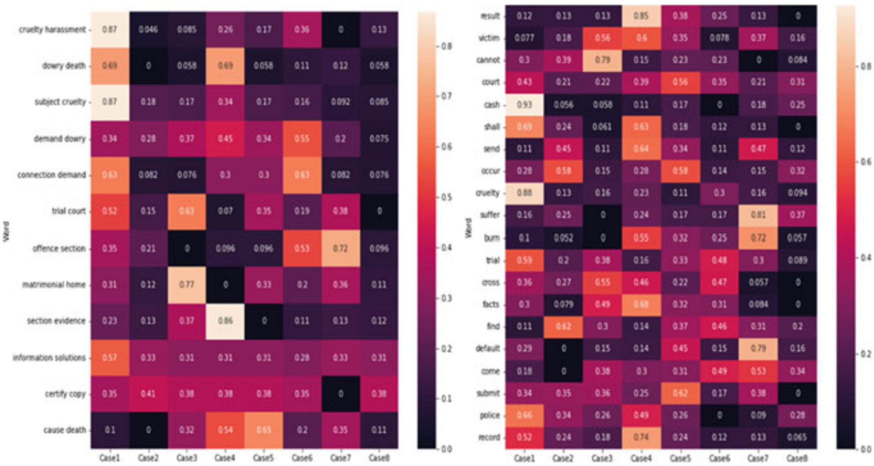

Fig. 5 Co-related matrix for N-gram's weighted mean

5 Conclusion and Future Work

Visualization helps to understand any meaningful information in structured manner. In this paper, the techniques like frequency matrix, bar plot, correlations matrix, heatmap visualization, and hierarchical clustering help to extract the major parameters present in legal documents. The legal professionals able to understand the dominant words present in legal documents using the statistical approach, i.e., N-gram analysis. The weighted mean and count vector matrix clearly displays the significant parameters present in any case, and these are the same parameters that legal

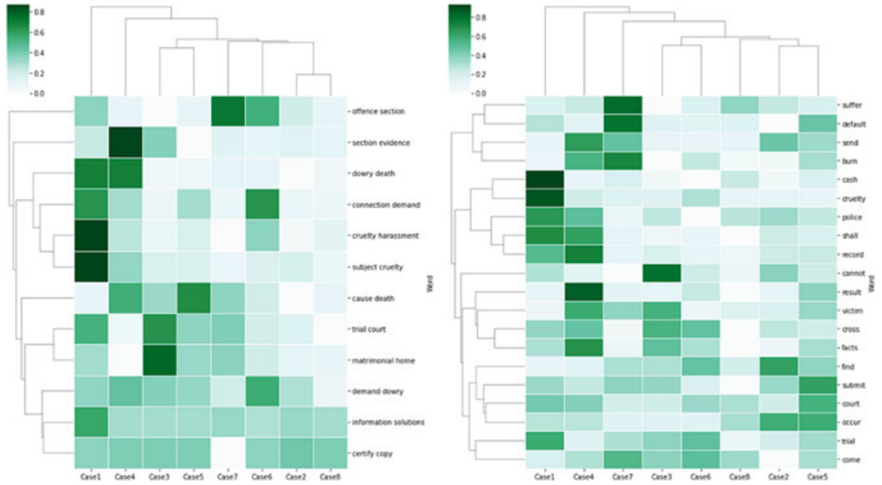

Fig. 6 Hierarchical cluster analyzation for N-gram's weighted mean

professional hunt while analyzing cases manually. The visualization techniques like heatmap, cluster map make those essential parameters more prominent. In future, this work can be extended to develop legal datasets on some specific domain that can lead to use some AI-based tools like machine learning, expert systems, etc.

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Differential Privacy and Its Challenges: A Literature Review

Nisha, Archana Singhal, and Sunil Kumar Muttoo

Abstract Now a days educational data has been produced in large amount by learners. Educational data contains online as well as offline learning resources of individuals, learning experience, attendance record, assignment records and many other records. Some useful information can be extracted from this available data which can be further used in improving teaching practises and learning experience of learners. It can also help in increasing the success rate of students. Sharing and analysis of data introduces risk of privacy. This is the responsibility of data curator to provide privacy to individuals data. There are many exiting privacy-preserving algorithms which are used by researchers to sustain privacy of the data. Differential privacy is one of the popular privacy-preserving techniques which tries to reduce privacy leakage of data by adding noise to data. Differential privacy protects individuals' information from attacker and also maintains accuracy of data. In the proposed work different techniques to implement differential privacy have been explored in detail with their comparative analysis. Different types of differential privacy, sequential decomposition and their comparison with other privacy-preserving techniques is also provided.

Keywords Differential privacy · Privacy · Educational data

1 Introduction

There has been an extensive development in the size of data. Educational institutes have large amount of data about learners which include sensitive information of individuals also like marks, grade, address, contact number, etc. Data analyst extract

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useful information from data which helps individuals to improve their learning experiences by providing on time feedback or suggestions. Privacy is the right of individuals to decide which data can be shared with others and also have right to restrict access control [1].

Differential privacy is a privacy-preserving technique which allows to share the information of users publicly without revealing personal information of individuals. Sharing and accessing of data which contains sensitive information always create risk of leaking information. ε-differential privacy reduces the risk of publishing and helps data analyst or researchers to extract data from database without revealing identity of individual. It provides data analyst a privacy-preserving interface through which data analyst can perform queries on database. Differential privacy does not limit the access of database. Data analyst can access any part of database whereas in other existing privacy-preserving algorithms access is limited to some part of database. To provide privacy to data random noise is introduced to the result of queries.

K-anonymization and l-diversity are two other popular existing privacy-preserving approaches. Problem with these approaches is that they consider that adversary have background knowledge of data which might lead to different knowledge attacks like background knowledge attack, and homogeneity attack. For avoiding these attacks data has to be differentiated in different types of attributes like quasi-identifiers and sensitive attributes. K-anonymization uses generalization and suppression tools for applying privacy and l-diversity use concept of equivalence classes to satisfy its definition. In contrast to these techniques the differential privacy protects the data from all background knowledge attacks [2] and it is also not required to divide data in different set of attributes like quasi-identifiers and sensitive attributes.

This paper comprised of five sections. In Sect. 1 introduction is provided. In Sect. 2 brief literature reviews of the authors working in the relevant area is discussed. In Sect. 3 differential privacy is defined and also different mechanism to implement differential privacy are also described. Section 4 provides tabular comparison of differential privacy with other privacy-preserving techniques. In Sect. 5 conclusion is given with some directions on future work.

2 Related Work

As larger amount of data is available in today's world which also include individual sensitive data like grade, marks, zip code, contact number, etc. Data has to be shared with data analyst for extracting useful information and helps in improving individual experience and providing prediction and recommendation for betterment of teaching practises [3]. Sharing leads to leakage of information and different types of attacks. There are different privacy-preserving techniques exist. Every technique has its own merit and demerits. K-anonymization is vulnerable to background knowledge attack and homogeneity attack [4]. L-diversity has drawback of similarity attack [1]. Differential privacy is free from background knowledge and homogeneity attack. Dwork et al. introduced the differential privacy as an effective privacy-preserving technique.

Dwork defines differential privacy in her book Algorithmic Foundation of differential privacy as "You will not be affected adversely or otherwise, by allowing your data to be used in any study or analysis, no matter what other studies, datasets or information sources are available" [5]. It sounds like promise from data owner to individuals that their identity will remain secure during analysis. Ha et al. [6] provides information about inference attacks.

Current work explores differential privacy in detail and all the techniques to implement it and also describes challenges with differential privacy. Current work also shows how differential privacy maintains accuracy of data with privacy.

3 Differential Privacy

Data privacy has been a serious issue. It is the serious concern for individuals whose data is used for analysis purpose. There are many existing techniques for privacy-preservation which provides privacy to data by modifying data and also has some restrictions. Existing algorithms also assumes about background knowledge of adversary to avoid different kinds of attacks. These approaches also divide data into different set of attributes to apply privacy. Differential privacy overcomes the disadvantages of other techniques. It does not consider adversary prior knowledge about data. It prevents data leakage by bounding the risk of disclosure.

Before discussing differential privacy, it is first required to understand concept of neighbouring datasets and sensitivity of a query function f.

Neighbouring Datasets: Consider two datasets $D1$ and $D2$ which are distinguished by one record. All datasets which are different by one record are called neighbouring datasets. There are three possibilities for creating neighbouring dataset like delete one record from datasets, add one record and modify one record. First two possibilities come under unbound differential privacy and third possibility called bounded differential privacy. Differential privacy tries to minimize the difference between results of set of queries executed on all neighbouring datasets [3].

Sensitivity of a Query Function *f* [7]: Given two neighbouring datasets $D1$ and $D2$ and sensitivity function f. Let f is a function $D1 \rightarrow R^d$ which maps databases to real numbers [7]. The sensitivity of the function f is defined as maximum difference between results of queries of two neighbouring datasets $D1$ and $D2$ [7]

$$\Delta f = \max_{D1,D2} \| f(D1) - f(D2) \|_1, \tag{1}$$

where $\|\cdot\|$ means l_1 norm.

f is the function that guide data analytical task. Domain of f is a dataset $D1$ and range is d dimensional vector of real numbers [3]. Δf is calculated on all sets of neighbouring datasets.

For example, "How many students are there in Mathematics Course?" The sensitivity of determining result of given query is 1 due to change of one record in neighbouring datasets. It may increase count by 1 by adding one non-Mathematics Course to Mathematics Course, or decrease the count with 1 by deleting one Mathematics record from the dataset.

Definition ε-Differential Privacy (ε-DP): Randomized algorithm R gives ε-DP if for all neighbouring datasets $D1$, $D2$ and for all possible outcomes of the algorithm $S \subseteq \text{Range}(R)$ [3],

$$\Pr[R(D1) \in S] \leq e^{\varepsilon} * \Pr[R(D2) \in S], \quad (2)$$

where Pr defines the probabilities over the randomness of R.

According to this definition R is the algorithm that includes disclosure control mechanism which satisfies ε-differential privacy. S is the result of all the statistical queries. The probability of the output produced by algorithm A for dataset $D1$ and $D2$ is bounded by e^{ε} for results of all the queries.

In differential privacy it is assumed that there is probability which is managed by parameter ε for getting same result if an algorithm runs for all neighbouring datasets. If algorithm produce same result for absence and presence of one record then that record does not have any privacy risk. It will provide assurances to all the individuals that their information is private and safe. Value of ε is generally lies within [0, 1].

In the first step to achieve ε-differential privacy an analysis function is defined to run set of queries on the model dataset. Second step is to fetch the results of queries and in third step add noise to the result of queries. The noise introduced in the dataset is determined by sensitivity of function and ε, which is the privacy parameter.

Result of query can be numeric or categorical, for example "How many students in Mathematics course?" query output is numeric and "Which is the most favourite subject of students?" output is categorical.

Next section provides detail about different probability distribution mechanisms discussed in literature (Fig. 1).

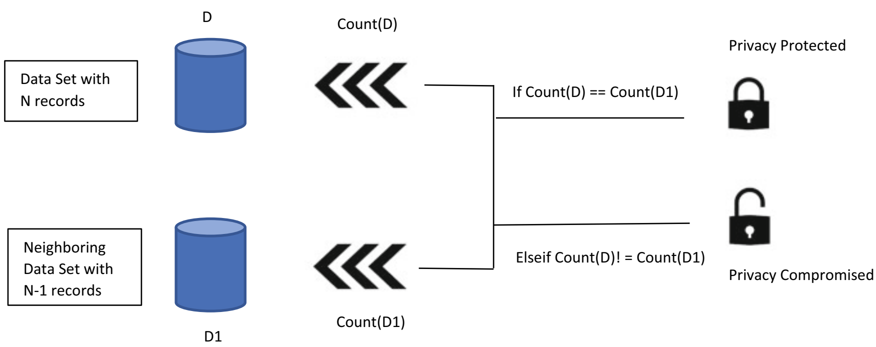

Fig. 1 Differential privacy concept

3.1 Probability Distribution Mechanisms to Satisfy ε-Differential Privacy

This section discusses about different mechanisms to satisfy ε-differential privacy by introducing noise in result of function.

Laplace Mechanism [8]: This mechanism is used to satisfy ε-differential privacy for numeric output queries. For a given dataset D and a function f, first step is to find the output of the function $f(D)$ and in second step introduce noise to the result $f(D)$ + Lap. Lap is the noise for ε-DP with mean 0 and scale $\Delta f/\varepsilon$.

Exponential Mechanism [9]: This mechanism is used to satisfy ε-differential privacy for categorical output queries. In this mechanism noisy response or randomness is selected from all outputs R of the queries instead of introducing noise to the output of the function f. For selecting an output from set of all outputs a utility function q is used which assigns probability of being selected to all the outputs $r \in R$. Exponential mechanism first calculates sensitivity of quality criteria Δq, secondly it calculates quality score of each queries output on dataset D, $q(D, r)$. In the next step output is selected from set R with probability proportional to $e^{(\varepsilon\, q(D,\, r)/2\Delta q)}$.

Gaussian Mechanism [10]: For given a dataset $D1$ which belongs to universe dataset D, a query function is defined as follows:

$f(D)$: $D \rightarrow R$ where R is set of all outputs.

In first step Gaussian mechanism find result of queries and in second step it adds $N(0, \Delta f^2/\varepsilon^2)$ to the results of the query, where N is normal distribution with mean 0 and scale $\Delta f^2/\varepsilon^2$.

Geometric Mechanism [11]: This mechanism is used to add noise to the result of query function which computes integer valued output. For given a dataset D, a query function is defined as follows:

$f(D)$: $D \rightarrow R$ where R is set of all outputs.

It adds noise (Δ) to result of query function $f(D)$; where Δ is a random variable with two sided geometric distribution $P(\Delta = \delta) = \frac{1-e^{-\varepsilon}}{1+e^{-\varepsilon}} e^{-\varepsilon|\delta|}$ for every integer δ [11].

P is the probability of discrete noise. Geometric mechanism is same as Laplace mechanism the only difference is in geometric mechanism discrete noise is used [11].

Next section provides comparison of different probability distribution mechanism used in Differential Privacy.

Comparison of Different Probability Distribution Mechanism

See Table 1.

Table 1 Comparison of different probability distribution mechanism

Mechanism	Noise	Result
Laplace	Add real value of Lap (0, $\Delta f/\varepsilon$) to result of query function	Provide privacy to dataset and query output
Exponential	Choose output with probability $e^{(\varepsilon\, q(D,\, r)/2\Delta q)}$ to result of query	Provide privacy to learning model
Gaussian	Add real value of $N(0,\, \Delta f^2/\varepsilon^2)$ to result of query function	Provide privacy to dataset and query output
Geometric	Add δ with probability $P(\Delta = \delta) = \frac{1-e^{-\varepsilon}}{1+e^{-\varepsilon}} e^{-\varepsilon\|\delta\|}$ to result of query function	Provide privacy to dataset and query output

3.2 *Types of Differential Privacy*

Differential privacy is of two types global and local differential privacy. In global differential privacy individuals trust data curator. Data curator adds noise only once to the output of data after collecting data from all the individuals. Whereas in local differential privacy every individual adds noise to their dataset before providing data to data curator due to lack of trust on data curator.

The next section provides detail description of local and global differential privacy.

3.2.1 Local Differential Privacy

In local differential privacy individual does not have trust on data curator. Every individual adds noise or randomized their data before submitting data to central data curator. For example, individual can add random value from − 50 to 50 in their dataset to every value and provide resulting values. It will preserve privacy of individuals data. Take another example in which randomness can be added to data with the help of coin flip, if head comes on flip of coin, then provide actual data otherwise on lands of tail again flip coin. For second flip if it lands on head then add some random noise X to data otherwise add random noise Y to data.

There are three steps in local differential privacy for data collection privately from individuals as shown in Fig. 2a. As illustrated in Fig. 2a, in step 1 every individual is required to submit the data after introducing noise to it. In step 2, data is collected and stored in the central database by data curator. In step 3, data analyst analyse data by querying the database to get the desired output. In this step it is not required to add noise to data because it is already added by individuals before submitting data. Local differential privacy provides good results in case individual responses are required to any feedback or survey system.

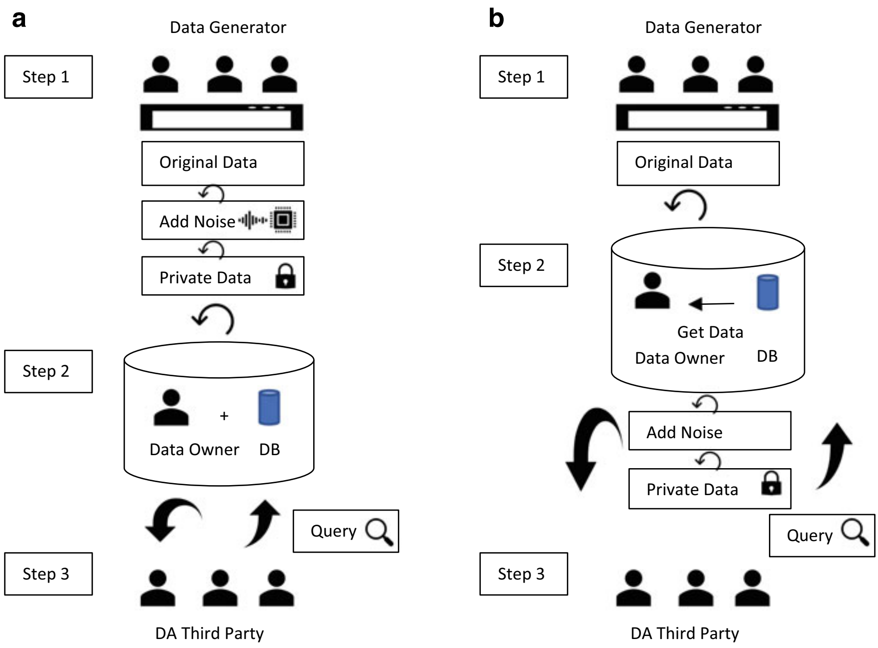

Fig. 2 **a** Local differential privacy. **b** Global differential privacy

3.2.2 Global Differential Privacy

In global differential privacy individuals trust data curator. Noise is only added once by data curator to the output of query before sharing result with data analyst. In this data curator preserves the privacy of individuals data from third party by introducing noise to the result. Data curator has access to the original data and can access private database. Global differential privacy is more accurate than local because noise is added only once and provides same amount of privacy as local differential privacy. For achieving more accuracy trusted data curator is required. Global differential privacy has risk of catastrophic failure because data is stored at one place only and it is difficult get trusted private companies who collect and maintain data of individuals.

3.3 Issues with Differential Privacy

One disadvantage of differential privacy is that privacy of two neighbouring datasets $D1$ and $D2$ decreases with composition of associated queries. Adversary could identify the belongingness of an individual with a dataset by some probability using interactive queries from database [7]. Therefore, Sequential queries reduces privacy. In composition of k queries each query require ε-differential privacy, so for k queries

Table 2 Comparison table

Differential privacy	K-anonymization	L-diversity
Does not consider adversary background knowledge	Consider adversary background knowledge	Consider adversary background knowledge
Does not divide user information in different attributes	Divide user information in different attributes. For example, quasi-identifier, sensitive attribute, etc.	Divide user information in different attributes. For example, quasi-identifier, sensitive attribute, etc.
Not vulnerable to homogeneity and background knowledge attack	Vulnerable to homogeneity and background knowledge attack	Vulnerable to probabilistic inference attacks
Add noise to data	Does not add noise to data	Does not add noise to data
Use Laplace, Exponential, Gaussian and Geometric mechanism to add noise to data and provide privacy	Use generalization and suppression method to provide privacy to data	Use generalization, suppression method and also consider diversity of sensitive attributes value within equivalence class to provide privacy to data
Utility of resulting data depends on value of ε privacy parameter	Utility of resulting data depends on value of k privacy parameter	Utility of resulting data depends on value of l privacy parameter
Suffers from sequential composition problem	Does not suffer from sequential composition problem	Does not suffer from sequential composition problem

privacy has to be at least $(k\varepsilon)$-differential private [6, 12, 13]. This issue has been taken care by Kairouz et al. [12]. Author introduced an upper bound for the privacy level and also introduced mechanism to achieve upper bound for querying database k times [7].

4 Comparison of Differential Privacy with Other Privacy-Preserving Techniques

In this section comparison of differential privacy with two other popular privacy-preserving techniques namely k-anonymization and l-diversity is provided in Table 2.

5 Conclusion and Future Scope

This work provides detailed literature review of differential privacy and mechanism to satisfy differential privacy on the basis of output of query function which is used to provide privacy to data. It also describes comparison of local and global differential privacy giving advantage and disadvantages of both the techniques. It has been observed that global differential privacy provides more accuracy than local differential privacy as noise is added only once. Comparison of differential privacy with other existing privacy-preserving techniques is also discussed in tabular form which can help to choose best technique for privacy of data. However, differential privacy has some disadvantages also. It suffers from problem of sequential composition. In future some new variants of differential privacy can be developed which reduce leakage of privacy and increase utility and accuracy of data.

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Determination of Resonant Modes of Equilateral Triangular Metallic Cavity

Sheershendu Bhattacharya and Manotosh Biswas

Abstract The simple and fast theoretical model for determination of resonant modes of an equilateral triangular shaped metallic cavity is presented in this article. Here, we have used the waveguide model for determining the resonant modes. The effect of cavity height and cavity side length on the resonant modes are thoroughly studied. We have obtained the interesting results by employing this model. We have also used electromagnetic software (CST) to validate our model.

Keywords Triangular cavity · Resonant frequency · Resonant modes

1 Introduction

Metallic cavity is essential for various applications, such as frequency selective component in microwave oscillator [1, 2]. The cavity can change the radiation characteristics of antenna [3]. The cavity backing can reduce the resonant frequency of the antenna. In other words, miniaturisation of the antenna is possible. Cavity can also increase the gain of the antenna. In recent days, cavity backed antenna are used in various applications, like broadband conformal phased array [4], array of antenna for K-band application [5], dual band antenna for 5G application [6], gain-enhanced V-band SIW array antenna [7], Air surveillance RADAR [8], etc. Thus, the determination of own resonant modes of a cavity is very important in order to observe the change of performance parameters of the antenna when it is enclosed by cavity.

Determination of resonant modes of rectangular and circular cavity were well-established [1, 2]. To the best of our knowledge, the analysis of equilateral triangular cavity has not been carried out so far. Hence, we have motivated to study on the equilateral cavity.

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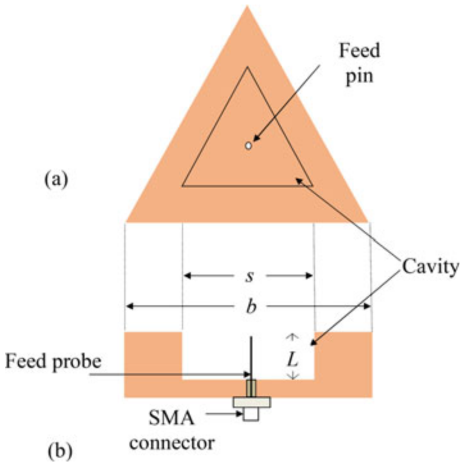


Fig. 1 Equilateral triangular cavity configuration. **a** Top view, **b** side view

In this article, an equilateral triangular shaped metallic enclosure or cavity is chosen to determine its resonant modes. For this cavity, theoretical analysis for determination of resonant modes is first carried out which is then validated with an electromagnetic simulator (CST).

2 Cavity Configuration

Equilateral triangular cavity consists of a metallic hollow enclosure with side length s and length (or wall height) L, whose upper side is open, as shown in Fig. 1. The probe is inserted from the centroid position of the triangle.

3 Theoretical Analysis

To determine the resonant modes of a cavity, understanding of mode configuration of the waveguide with same shape (equilateral triangular waveguide) is required. So, determination of modes for the equilateral triangular waveguide needs to be done. After having the mode configuration of the waveguide, the resonant mode of the cavity can easily be determined.

The mode configuration of rectangular or square waveguide is well-known. Modes of right angled isosceles triangular shaped waveguide can be determined by bisecting a square waveguide by a plane, diagonal to the square, and then by applying proper boundary conditions. To determine the modes of equilateral triangular cross-section waveguide, following procedure is followed.

By reflecting about the three parallel lines to the sides of the triangle that cross the opposing vertices, an equilateral triangle's mode function can be extended to three surrounding equilateral triangles, as shown in Fig. 2. As depicted in Fig. 3, this function defined in these new regions can be endlessly extended by analogous reflection.

With regard to the three dimensions normal to the sides of the triangle, the extended mode function is periodic. If h is the length of the perpendicular from an apex to the adjacent side, the periodicity interval will be $2h$ or in terms of cavity side length it will be $\sqrt{3}s$, as for equilateral triangle we can write

$$h = \frac{\sqrt{3}}{2}s \tag{1}$$

For an E mode,

$$\varphi(x, y) = -\varphi(x, 2h - y), \quad h \le y \le 2h \tag{2}$$

$$\varphi(x, y) = -\varphi(x, 4h - y), \quad 2h \le y \le 3h \tag{3}$$

Fig. 2 Reflected equilateral triangle

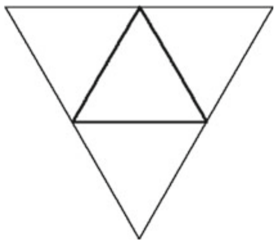
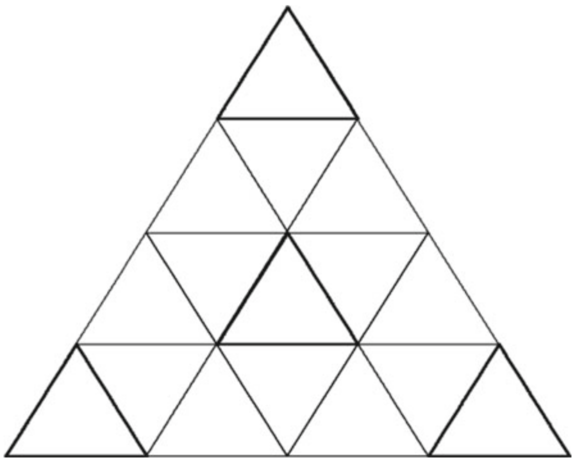


Fig. 3 Repeated reflection of equilateral triangle



which relates the values of the function in three successive rows parallel to the horizontal direction or x-axis. Elimination of the value of the function in the centre row yields

$$\varphi(x, y) = \varphi(x, y + 4h), \quad 0 \le y \le h \tag{4}$$

The specified periodicity is established by (4). Similar approach may be used for other directions. For H modes, the verification is also the same. Consider three unit vectors pointing at the centroid and normal to the sides of the triangle as shown in Fig. 4, in order to build a function with the needed periodicity properties. These unit vectors can be written as

$$\boldsymbol{p}_1 = \boldsymbol{j}, \ \ \boldsymbol{p}_2 = -\frac{\sqrt{3}}{2}\boldsymbol{i} - \frac{1}{2}\boldsymbol{j}, \ \ \boldsymbol{p}_3 = \frac{\sqrt{3}}{2}\boldsymbol{i} - \frac{1}{2}\boldsymbol{j} \tag{5}$$

So, the periodic function $\boldsymbol{F}(\boldsymbol{r})$ on the plane with position vector $\boldsymbol{r}$, can be expressed as

$$F(\boldsymbol{r}) = \sum_{u,v,w} f\left(\boldsymbol{r} - \lambda 2h\boldsymbol{p}_1 - \mu 2h\boldsymbol{p}_2 - \upsilon 2h\boldsymbol{p}_3\right) \tag{6}$$

Translation of magnitude $2h$ in either of the $\boldsymbol{p}_1, \boldsymbol{p}_2$, or $\boldsymbol{p}_3$-specified directions has no effect on this function. It is necessary to extend the summing to include all integral values of λ, μ, and ν. With the appropriate periodicity, $\boldsymbol{F}(\boldsymbol{r})$ will be a solution, if $f(\boldsymbol{r})$ is a solution of the wave equation everywhere. Again, if $f(\boldsymbol{r})$ is a uniform plane wave, then $\boldsymbol{F}(\boldsymbol{r})$ should be of same nature. The modes of the equilateral triangular waveguide can be created by proper combination of such simple fields.

Thus, assuming

$$f(\boldsymbol{r}) = \mathrm{e}^{i\boldsymbol{\gamma}\cdot\boldsymbol{r}} \tag{7}$$

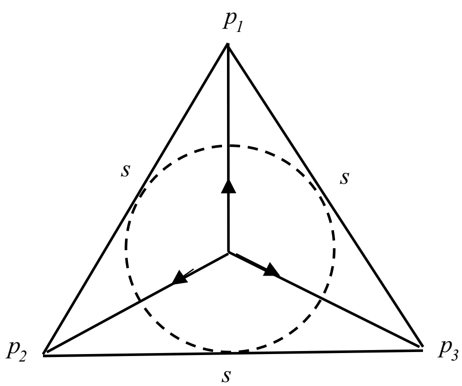


Fig. 4 Cross-section of equilateral triangular waveguide structure

where the magnitude of the real vector $\boldsymbol{\gamma}$ is the cut-off wave-number of the mode. Thus, we can write the expression of $F(r)$ using (6) and (7) as

$$F(\boldsymbol{r}) = \mathrm{e}^{i\boldsymbol{\gamma}\cdot\boldsymbol{r}} \sum_{\lambda=-\infty}^{\infty} \mathrm{e}^{-2ih\lambda\boldsymbol{e}_1\cdot\boldsymbol{\gamma}} \sum_{\mu=-\infty}^{\infty} \mathrm{e}^{-2ih\mu\boldsymbol{e}_2\cdot\boldsymbol{\gamma}} \sum_{\nu=-\infty}^{\infty} \mathrm{e}^{-2ih\nu\boldsymbol{e}_3\cdot\boldsymbol{\gamma}} \tag{8}$$

Each summation of (8) can be written in terms of a general form as

$$\sum_{\mu=-\infty}^{\infty} \mathrm{e}^{i\mu x} \tag{9}$$

Equation (9) is a periodic function of x, with the periodicity 2π. The series may be expressed as the Fourier series expansion of $2\pi\delta(x)$ in the range $-\pi < x < \pi$, given by

$$\delta(x) = \frac{1}{2\pi} \sum_{\mu=-\infty}^{\infty} \mathrm{e}^{i\mu x} \int_{-\pi}^{\pi} dx' \mathrm{e}^{-i\mu x'} \delta(x') = \frac{1}{2\pi} \sum_{\mu=-\infty}^{\infty} \mathrm{e}^{i\mu x} \tag{10}$$

Hence, for all x, we can write

$$\sum_{\mu=-\infty}^{\infty} \mathrm{e}^{i\mu x} = 2\pi \sum_{m=-\infty}^{\infty} \delta(x - 2\pi m) \tag{11}$$

Since (11) reduces to (10) in the range $-\pi \leq x < \pi$, all delta function terms except $m = 0$ are zero in this range, and since both sides of the equation are periodic functions with periodicity 2π. Applying this to (8), we obtain

$$F(\boldsymbol{r}) = \mathrm{e}^{i\boldsymbol{\gamma}\cdot\boldsymbol{r}} (2\pi)^3 \sum_{l=-\infty}^{\infty} \sum_{m=-\infty}^{\infty} \sum_{n=-\infty}^{\infty} \begin{matrix} \delta(2h\boldsymbol{p}_1 \cdot \boldsymbol{\gamma} - 2\pi l)\delta(2h\boldsymbol{p}_2 \cdot \boldsymbol{\gamma} - 2\pi m) \\ \delta(2h\boldsymbol{p}_3 \cdot \boldsymbol{\gamma} - 2\pi n) \end{matrix} \tag{12}$$

Hence, the function vanishes entirely unless the arguments of all three delta functions vanish simultaneously, which requires that

$$\boldsymbol{p}_1 \cdot \boldsymbol{\gamma} = \frac{\pi l}{h}, \quad \boldsymbol{p}_2 \cdot \boldsymbol{\gamma} = \frac{\pi m}{h}, \quad \boldsymbol{p}_3 \cdot \boldsymbol{\gamma} = \frac{\pi \boldsymbol{n}}{h} \tag{13}$$

where l, m, and n are integers that satisfy the condition

$$l + m + n = 0 \tag{14}$$

Using (13) and (14), we can determine the cut-off wavenumbers of all $\boldsymbol{E}$ and $\boldsymbol{H}$ modes in the triangular guide. Thus

$$\left(\boldsymbol{p}_1 \cdot \boldsymbol{\gamma}\right)^2 + \left(\boldsymbol{p}_2 \cdot \boldsymbol{\gamma}\right)^2 + \left(\boldsymbol{p}_3 \cdot \boldsymbol{\gamma}\right)^2 = \boldsymbol{\gamma} \cdot (p_1 p_1 + p_2 p_2 + p_3 p_3) \cdot \boldsymbol{\gamma} = \frac{\pi^2\left(l^2 + m^2 + n^2\right)}{h^2} \tag{15}$$

The term $(p_1p_1 + p_2p_2 + p_3p_3)$ is the vector dyadic. So, we can write according to the vector dyadic property

$$(p_1 p_1 + p_2 p_2 + p_3 p_3) = \frac{3}{2}(\boldsymbol{ii} + \boldsymbol{jj}) \tag{16}$$

Equation (16) is a multiple of the unit dyadic in two dimensions. So, we can write using (15) and (16) as

$$\gamma^2 = \frac{3}{2}\frac{\pi^2\left(l^2 + m^2 + n^2\right)}{h^2} = \frac{8}{9}\frac{\pi^2\left(l^2 + m^2 + n^2\right)}{s^2} \tag{17}$$

Using (14), l can be eliminated with the result

$$\gamma = \frac{4\pi}{3s}\sqrt{\left(m^2 + mn + n^2\right)} \tag{18}$$

From (18) we get

$$f_{rnm} = \frac{2c}{3s\sqrt{\varepsilon_{\mathrm{r}}}}\sqrt{\left(m^2 + mn + n^2\right)} \tag{19}$$

When the waveguide is used as cavity with finite length L as shown in Fig. 1, by applying the boundary condition at the open end, we can write the expression for resonant frequency of the equilateral triangular cavity as

$$f_{rnmq} = \frac{2c}{3s\sqrt{\varepsilon_{\mathrm{r}}}}\sqrt{\left[\left(m^2 + mn + n^2\right) + \left(\frac{3s}{4}\right)^2\left(\frac{q}{2L}\right)^2\right]} \tag{20}$$

4 Results and Discussion

The theoretical resonant frequency is compared with the result obtained from CST simulator. Table 1 shows the comparison of simulated and theoretical resonant frequencies for a particular cavity length $L = 15$ mm. Here the cavity side length s is varied from 10 to 45 mm. For simulation purpose, brass is chosen as material of the cavity, so that prototype can be made very easily.

Different modes are generated in simulated results. The simulated frequencies are then mapped with different modes of theoretical resonant frequencies. Table 1

Table 1 Comparison table of resonant frequencies for a cavity with length (or wall height) of 15 mm

Cavity side length s (mm)	Resonant frequency with CST simulation (GHz)	Theoretical resonant frequency (for different modes)			
		m	n	q	f_{rmnq} (GHz)
10	36.379	1	1	2	36.05551
	41.16	2	0	2	41.23106
	47.48	2	0	5	47.16991
20	17.7	1	1	1	18.02776
	21.576	2	0	2	22.36068
	28.456	2	1	2	28.28427
30	12.112	1	1	1	12.58306
	16.987	2	0	2	16.66667
	23.4	2	2	1	23.62908
	26.503	3	1	2	26.03417
	30.84	4	0	3	30.59593
	33.16	3	2	3	32.70236
	38.08	4	2	3	38.33333
40	9.4	1	1	1	10
	17.68	2	2	1	18.02776
	23.2	3	1	3	23.45208
	26.294	3	3	1	26.45751
	31.72	5	1	3	31.62278
	33.72	4	3	3	33.91165
	34.879	5	2	3	34.64102
45	8.48	1	1	1	9.179284
	15.785	2	2	1	16.18756
	20.68	3	2	1	20.00771
	28.001	4	2	3	27.8942
	31.04	4	4	1	31.19532
	33.8	4	4	3	34.25125
	35.879	5	4	2	36.12393

shows a good resemblance between theoretical and simulated resonant frequencies for different values of cavity side length.

Tables 2, 3 and 4 show the comparison between simulated and theoretical resonant frequencies for cavity side length 20 mm and 30 mm, respectively, for various cavity length or wall height starting from 10 to 45 mm. Both the tables show that the simulated and theoretical resonant frequencies for different modes are very close.

Table 2 Comparison table of resonant frequencies for a cavity with side length 20 mm

Cavity length or wall height L (mm)	Resonant frequency with CST simulation (GHz)	Theoretical resonant frequency (for different modes)			
		m	n	q	f_{rmnq} (GHz)
10	18.15	1	1	1	18.87459
	25.44	2	0	2	25
20	17.52	1	1	1	17.72181
	19.972	2	0	1	20.34853
	24.269	2	0	4	25
25	17.46	1	1	1	17.5784
	19.08	1	1	3	19.51922
	22.11	2	0	3	21.93171
	26.12	2	1	1	26.62705
35	17.37	1	1	1	17.45256
	18.267	1	1	3	18.47502
	19.981	2	0	1	20.11447
	22.32	2	0	5	22.68911
	25.175	2	0	7	25
	28.364	2	1	5	28.54463
40	17.37	1	1	1	17.4217
	18.06	1	1	3	18.211
	19.404	1	1	5	19.69494
	21.281	2	0	4	21.36001
	23.592	2	0	7	23.92207
	26.186	2	1	1	26.52387
	29.07	2	1	7	29.53414
50	17.31	1	1	1	17.38534
	17.79	1	1	3	17.89553
	18.678	1	1	5	18.87459
	19.976	2	0	1	20.05617
	21.527	2	0	5	21.36001
	23.48	2	0	8	23.32381
	25.526	2	0	11	25.92778
	27.9	2	1	6	27.94638

Figure 5 shows the presence of different modes in an equilateral triangular cavity with side length $s = 30$ mm and cavity wall height $L = 25$ mm obtained from CST simulation. The same data is available in Table 3, along with theoretical frequencies f_{rmnq} for comparison purpose.

Table 3 Comparison table of resonant frequencies for a cavity with side length 30 mm and wall height ranges from 10 to 35 mm

Cavity length or wall height L (mm)	Resonant frequency with CST simulation (GHz)	Theoretical resonant frequency (for different modes)			
		m	n	q	f_{rmnq} (GHz)
10	12.6	1	1	1	13.7689264
	23.76	2	1	2	23.1540733
	31.08	4	1	1	31.4576435
	36.06	4	2	1	36.0651417
20	11.919	1	1	1	12.1406686
	14.945	0	2	2	15.2979665
	23.28	2	2	1	23.3964919
	25.159	1	3	2	25.1799082
	28.646	3	1	4	28.3333333
	32.12	3	2	4	32.7023615
	34.942	3	3	1	34.8433997
	39.004	3	3	5	39.3898781
25	11.8	1	1	1	11.9303534
	13.847	2	0	1	13.6666667
	23.2	2	2	1	23.2880513
	24.449	2	2	3	24.7857486
	26.92	3	1	4	26.8659222
	31.6	3	2	4	31.4395363
	33.48	4	1	4	32.8227563
	36.299	4	2	3	36.4066538
	39.617	4	2	6	39.6035913
35	11.68	1	1	1	11.7441547
	12.88	1	1	3	13.2158944
	15.114	2	0	3	14.8021724
	23.16	2	2	1	23.1932139
	23.84	2	2	3	23.9720642
	25.16	2	2	5	25.4583827
	27.071	4	0	1	26.7526251
	29.49	3	2	2	29.3736581
	31.04	4	1	2	30.8496464
	32.12	4	1	5	32.3748244
	33.68	5	0	1	33.4021399
	35.569	4	2	1	35.3417074
	37.788	4	2	6	37.5466452

Table 4 Comparison table of resonant frequencies for a cavity with side length 30 mm and wall height 45 mm

Cavity length or wall height *L* (mm)	Resonant frequency with CST simulation (GHz)	Theoretical resonant frequency (for different modes)			
		m	*n*	*q*	f_{rmnq} (GHz)
45	11.64	1	1	1	11.6666667
	12.4	1	1	3	12.5830574
	13.84	2	0	2	13.7436854
	15.867	2	0	5	15.7233019
	23.12	2	2	1	23.1540733
	23.56	2	2	3	23.6290781
	24.4	2	2	5	24.5515331
	25.593	3	1	5	25.4405625
	27.16	4	0	3	27.1313677
	29.116	3	2	1	29.107082
	30.84	3	2	6	30.7318149
	31.52	4	1	5	31.6666667
	32.48	4	1	7	32.7023615
	33.756	5	0	3	33.7062474
	35.3	4	2	1	35.3160335
	37.04	5	1	1	37.155828
	38.867	5	1	7	38.9087251

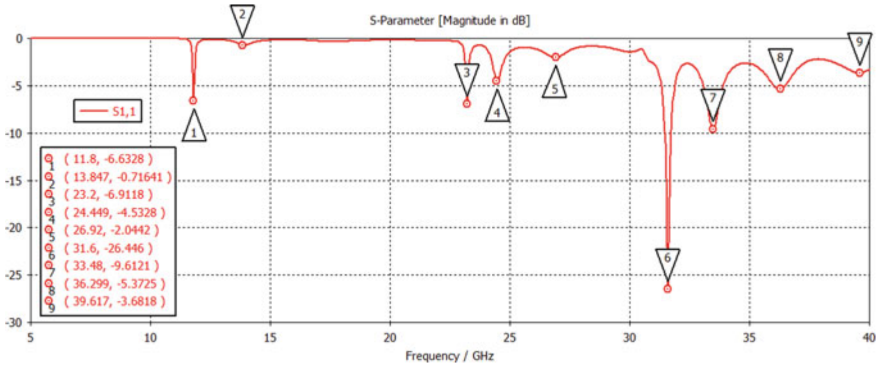


Fig. 5 Illustration of different modes in CST simulation for an equilateral triangular cavity with side length $s = 30$ mm and cavity wall height $L = 25$ mm

5 Conclusions

The theoretical analysis of equilateral triangular cavity is carried out to determine the frequencies of different modes. CST simulation is also performed for triangular cavity with various wall height and side length. Comparisons of simulated and theoretical frequencies for different modes are done for those cavities. The comparisons show very good resemblance between theoretical and simulated results.

The future scope of this work might be included the following aspects: (a) investigate the radiation pattern, impedance-bandwidth, (b) investigate the effect of cavity parameters on the performance parameters of the patch antenna backed by cavity.

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Investigation of Miniaturized Microstrip Patch Antenna for Metamaterial Application

Biplab Biswas, Sanjay Kumar, and Manotosh Biswas

Abstract In this article, we have designed a equilateral triangular ring resonator antenna using a finite element method software. Here, we have presented the variation of resonant frequency, input impedance, and gain with the variation of width of the equilateral ring. The resonant frequency deceases gradually with the progressively reducing the central conducting portion. Thus, the equilateral ring resonator antenna behaves like a miniaturized antenna.

Keywords Equilateral ring antenna · Resonant frequency · Input impedance · Gain

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1 Introduction

Today, miniaturized microstrip patch antennas have been employed in microwave components, missiles, satellites, radars, invisible submarines, spacecrafts, and among other applications due to their several attractive features such as low in cost, light in weight, reduce in volume, and easy to fabricate. The miniaturized microstrip patch antenna can be designed by using the high permittivity dielectric substrate, shorting pins, shorting walls, fractal geometry, and others. But these techniques have serious limitations such that low efficiency, low gain, and narrow bandwidth. In order to improve these parameters, a new material named as metamaterial was introduced first in 1968 by Viktor Veselago [1]. The antenna mimics by metamaterial are now used in satellite, MIMO antennas, broadband and UWB antennas, energy harvesting antennas, body centric antennas, reconfigurable antennas, electrically compact antennas, beam-tiled antennas, and leaky wave and resonant antennas [2, 3]. This new material has $-\varepsilon$ and $-\mu$. The metamaterial reduces dramatically the volume of the antenna. The main element of the metamaterial is ring resonators. This ring resonator provides $-\varepsilon$ and $-\mu$. Thus, the design of ring resonator is very important. The ring resonator reduces the volume of the antenna significantly. In various situations, ring type patches of various shapes have been explored in [4–9]. To the best of our knowledge, the equilateral ring resonator antenna has not yet been studied. Here, we have design an equilateral ring resonator using finite element method software (HFSS).

2 Antenna Configuration

Figure 1 shows the basic antenna structure. The substrate permittivity is ε_r, and h is the substrate thickness. Here, we have taken $\varepsilon_r = 2.33$ and $h = 1.575$ mm. w is the width of the ring which is variable. a_1 is the outer ring side length which is fixed = 50.00 mm, and a_2 is the inner ring side length which is variable. A co-axial probe was used to excite the patch and placed at a distance $\rho = 2.00$ mm from the tip of the triangle. The maximum resistance point is defined as the resonance.

3 Results

In Fig. 2, we have presented the variation of resonant frequency with the variation of side length of the inner ring. The resonant frequency gradually decreases with the ratio of $(\frac{a_2}{a_1})$, i.e. increasingly removing the central conducting portion. Thus, the lowing of side length of the antenna is observed. So the antenna miniaturization is occurred. For an example, when $a_2 = 30$ mm and $a_1 = 50$ mm, then $f_r = 1.924$ GHz which is corresponding to a solid patch of side length 65 mm.

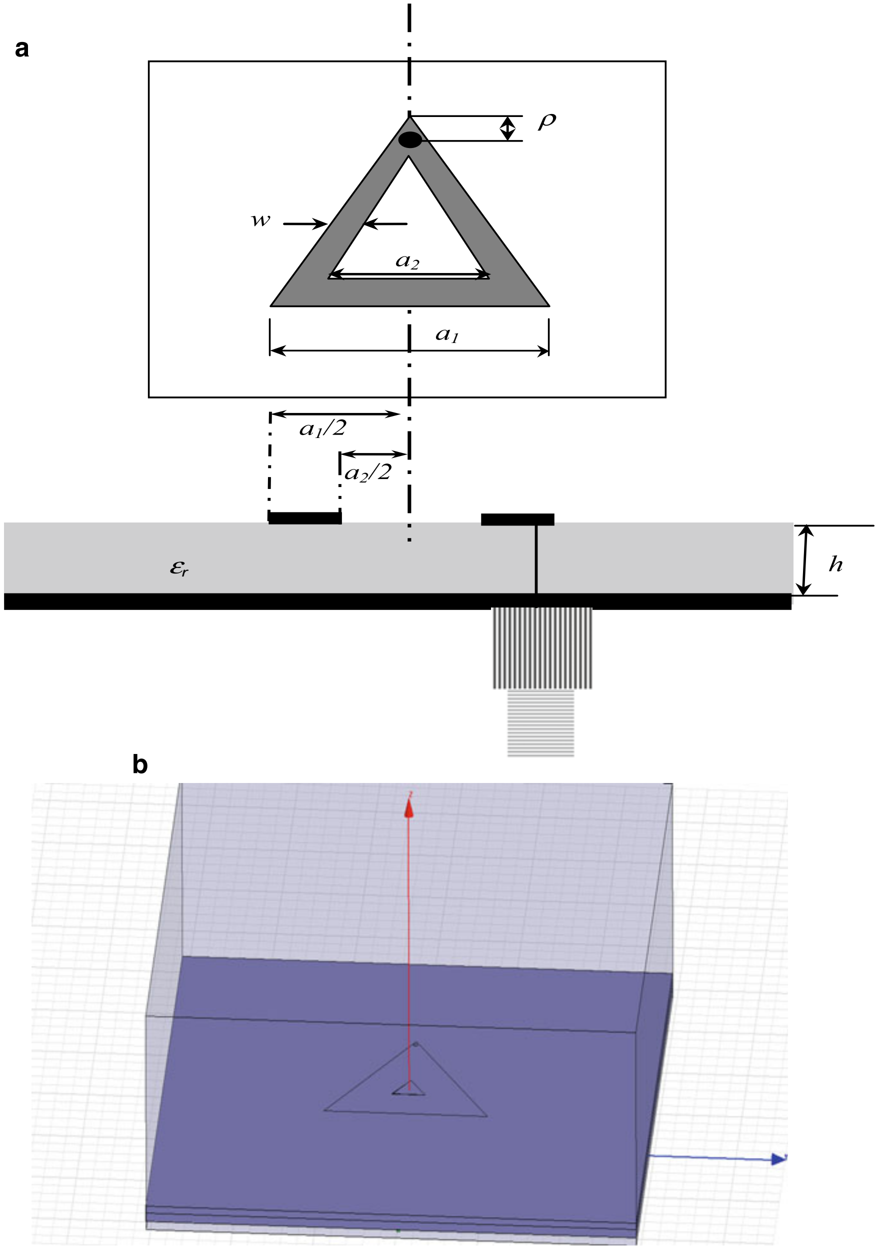
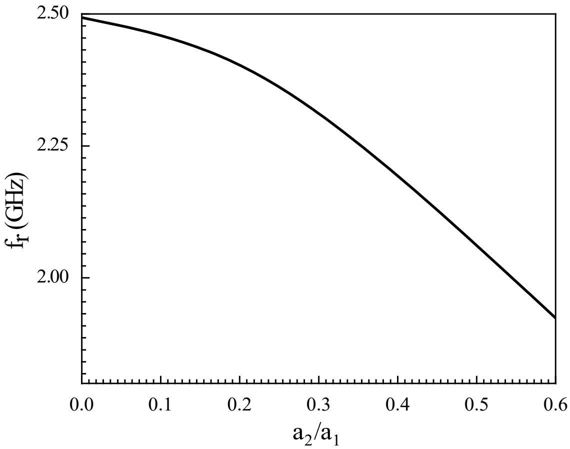


Fig. 1 **a** Schematic diagram of probe-fed equilateral ring antenna. **b** HFSS design structure

Fig. 2 Variation of resonant frequency with the variation of a_2/a_1 of an equilateral ring antenna. $a_1 = 50.0$ mm, a_2 is variable, $h =$ 1.575 mm, $\varepsilon_r = 2.33$



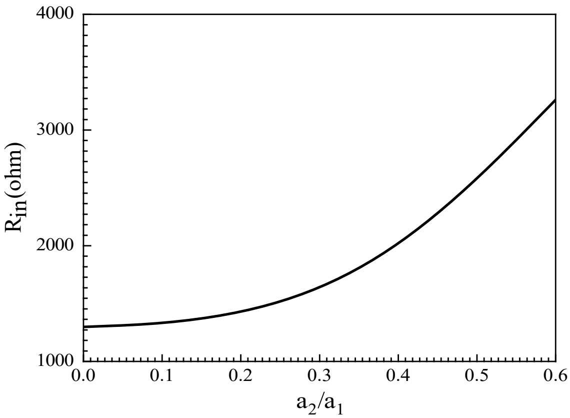
The variation of input resistance with the variation of $(\frac{a_2}{a_1})$ is depicted in Fig. 3. The input resistance gradually increases with the increase of $(\frac{a_2}{a_1})$, i.e. increasingly removing the central conducting portion.

Figure 4 shows the effect of a_2/a_1 on the resonant frequency and input impedance. The resonant frequency dramatically decreases with the increasing ratio of $a_2/a_{1,}$ but the input impedance increases with the increasing ratio of a_2/a_1.

Figure 5 shows the gain gradually decreases with the increase of $(\frac{a_2}{a_1})$, i.e. increasingly removing the central conducting portion. This is based on the fact that the side length of the antenna is reduced due to progressively reducing the central conducting portion of the patch; thus, the effective aperture area is reduced so the gain is reduced.

The radiation pattern of an equilateral ring is depicted in Fig. 6. The plots show that both the co and x-polarized gain are decreased with the increasingly reducing the central conducting portion.

Fig. 3 Variation of resonant resistance with the variation of a_2/a_1 of an equilateral ring antenna. $a_1 = 50.0$ mm, a_2 is variable, $h =$ 1.575 mm, $\varepsilon_r = 2.33$, $\rho =$ 2.0 mm, $\tan\delta = 0.0012$



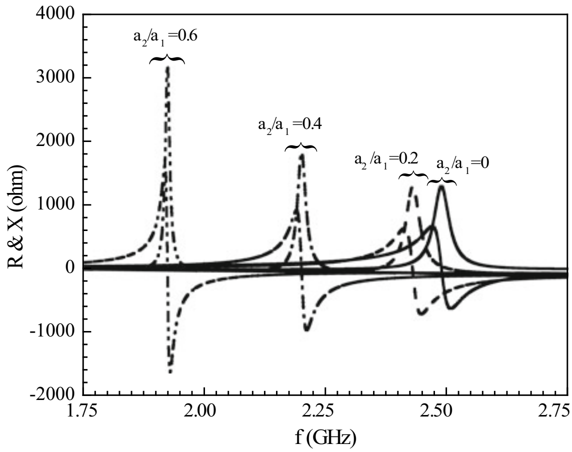


Fig. 4 Variation of input impedance with the variation of a_2/a_1 of an equilateral ring antenna. $a_1 = 50.0$ mm, a_2 is variable, $h = 1.575$ mm, $\varepsilon_r = 2.33$, $\rho = 2.0$ mm, $\tan \delta = 0.0012$

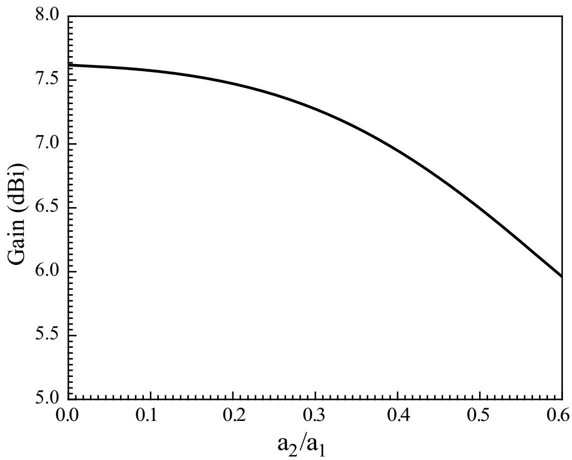
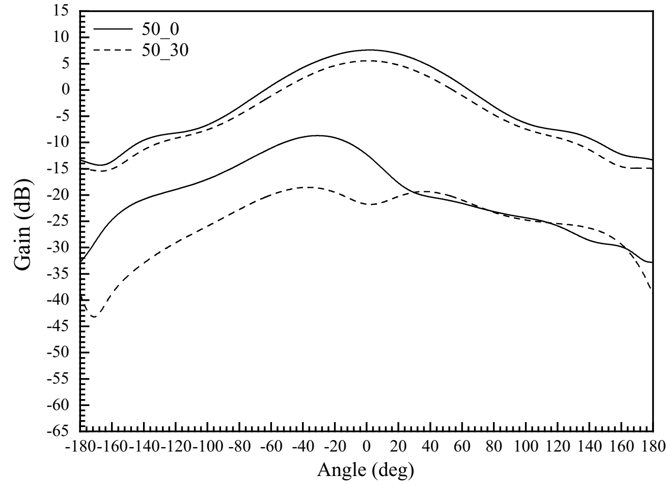


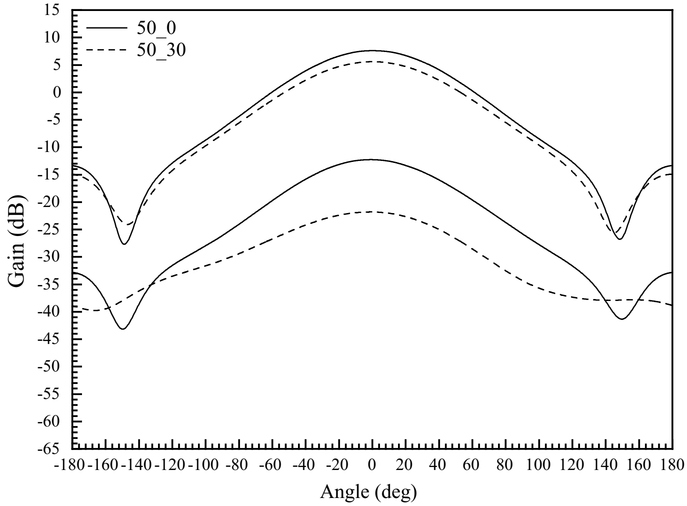
Fig. 5 Variation of gain with the variation of a_2/a_1 of an equilateral ring antenna. $a_1 = 50.0$ mm, a_2 is variable, $h = 1.575$ mm, $\varepsilon_r = 2.33$, $\rho = 2.0$ mm, $\tan \delta = 0.0012$

4 Conclusion

In this article, we have thoroughly studied the variation of resonant frequency, input impedance, and gain with the variation of dimensions of equilateral ring antenna. The resonant frequency and gain decrease, whereas input impedance increases with increasingly removing the central conducting portion of the patch.



(a) E-Plane



(b) H-Plane

Fig. 6 Variation of gain with the variation of *angle* of an equilateral ring antenna. $a_1 = 50.0$ mm, a_2 is variable, $h = 1.575$ mm, $\varepsilon_r = 2.33$, $\rho = 2.0$ mm, $\tan\delta = 0.0012$

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A Study of Breast Cancer Identification with Deep Learning Techniques

D. Sujitha Priya and V. Radha

Abstract Breast cancer is currently the utmost often analysed malice in females, and number of cases is steadily rising. If breast cancer is detected and treated early enough, there is a high possibility of a positive outcome. As a result, some researchers have developed deep automated algorithms for forecasting the development of cancer cells using medical imaging modalities for their efficiency and accuracy. There are currently just an insufficient review papers on breast cancer identification that synthesise about the previous trainings. These investigations, however, were impotent to report new structures and modalities in the discovery of breast cancer. The changing structural design for deep learning-based breast cancer identification is the subject of this review. This assessment explores the merits and drawbacks of existing deep learning structures, investigates the datasets employed, and assesses picture pre-processing approaches in the sections that follow. A detailed overview of several modalities of medical images, performance measures and findings, obstacles, and investigation prospects for forthcoming researchers is also provided.

Keywords Diagnosing breast cancer · Deep convolution neural networks · CNN · RNN · DBN

1 Introduction

Breast cancer was identified in more than 2 million women in 2020, with more than 6 lakhs deaths worldwide, making it the most frequent cancer. Breast cancer identification that is timely and accurate improves the forecast and increases the patient endurance rate to 50%. Early breast cancer diagnosis has been improved using deep learning-based diagnosis.

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Breast tumour stands the utmost common malignancy between women. According to the World Health Organization (WHO), it was detected in two million female worldwide in 2020, with 695,000 losses [1]. Moreover, the WHO forecasts a seventy per cent (70%) rise in new BrC patients during the next twenty years. Furthermore, amongst many cancer kinds, for lungs, colon, stomach, and liver cancers, BrC is the fifth-most lethal illness [2]. According to the Statistics of Global Cancer 2020, female breast cancer (FBrC) remains the utmost common growth (GLOBOCAN), by 2.5 million original circumstances (11.8% of the entire circumstances) expected now 2022 [2]. Male breast cancer (MBrC), on the other hand, is an extremely rare malignancy. Therapy is presently founded on data gained from FBrC treatment, despite the fact that MBC has different molecular characteristics [3]. Because of a lack of understanding about BrC, FBrC is becoming a major epidemic in Nations of South Asia. In a south Asian nation like Bangladesh, it is mostly concealed, and the mainstream of patients is detected at progressive phase of the disease [4–6]. Early and precise identification is critical in refining the prediction and increasing the patient endurance rate to 50% [1]. For a proper judgement of BrC, each stage of cancer must be correctly identified, as well as its categorisation. For successful BrC diagnosis, different medical pictures are typically employed rather than any other BrC testing procedure. BrC is diagnosed using a variety of modalities of various medical images, including histopathology (Hp), mammography, sonograms, and MRI [7, 8]. For a valid BrC diagnosis, a proficient pathologist knowledge and theme acquaintance are crucial.

Misdiagnosis is common without them, particularly in the initial phases of BrC. Though, diagnosing BrC at an initial phase is critical. Many digital technologies are utilised to assist clinicians in the timely discovery of BrC on mammograms in reality [9]. CAD was developed over the previous decade and has improved BrC finding accuracy to more than 20% [10]. An approach aids surgeons and radiologists in detecting problems using several modalities of medical images, lowering demise rates from 25 to 75% [11]. DL centred CAD schemes have progressive in the remedial industry for analysing data from cardiology [12], radiology [13, 14], pharmacology [15], pathology [16], genomics [17], and oncology [18, 19], and to diagnose and prognostic disorders. In recent decades, more complicated algorithms based on ML methods have been applied for cancer diagnosis. DL has been largely accepted as solitary of these methods, with evidence of its usefulness in tumour prediction and prognosis [20]. In breast cancer imaging, DL provides a greater accuracy of diagnostics for identifying breast cancer on ultrasound, mammograms, and DBT [21]. For now, therapeutic therapy of BrC focusses on DL since it is more accurate. Many publications employing deep learning on BrC have been published in the recent few years [22–24].

The majority of review papers on BrC focussed on general ANNs or classic machine learning (ML) techniques [25], where extraction of features is used for identification. Though there are a rare assessment publications on digital breast tomosynthesis [26], they are insufficient to include all modalities of medical images were utilised in BrC cataloguing.

The following is how the lingering part of the article is arranged: Sect. 2, we go through how to diagnose breast cancer. Section 3, we give an summary of dataset and widely utilised methods for pre-processing methods for images. Section 4, we go through all of the different types of various imaging modalities. Section 5 gives the enactment indicators for past study outcome analysis. Section 6 discusses obstacles and potential examination directions. Finally, Sect. 7 brings the article to a close.

2 Techniques for Breast Cancer Diagnosis

Deep learning algorithms have lately advanced significantly and generated remarkable results, prompting several academics to consider using deep learning in BrC diagnosis. One of the characteristics of our deep learning-based CAD technique [27] is the ability to diagnose breast lumps as cancerous or benign without the use of segmentation in lesion, calculation of image feature, or a mechanism for selection. Extant deep learning-based BrC diagnostic techniques presented in this field include ANNs, autoencoders, CNN, deep belief networks, generative adversarial networks, and extreme learning machines.

a. Artificial Neural Network

A accurate flawless created happening the erection and competences of a biotic NN is known as an ANN. It is important to note that ANNs are not meant to take the role of radiologists, but rather to assist them in maintaining their precision and trustworthiness. Those who utilise ANN quickly outnumber persons who do not. How to recognise the weaknesses of ANNs are identifies by the thoughts of radiologists, and how to take use of their benefits. For complicated situations, an ANN with several concealed layers works well; nevertheless, it takes longer to train. Figure 1 shows the architecture of ANN.

Abbass [28] presents one of the first efforts in this field. On a Wisconsin dataset with numerical characteristics, the researchers used ANN to detect BrC. This study found that the proposed Pareto ANN outperformed an model programming ANN method and classical backpropagation (MPANN) improved generalisation and greatly lowered processing costs (BP).

b. Deep Belief Network

This unsupervised model that is fundamentally reproductive. The DBN is a multi-layer network made up of restricted Boltzmann machines (RBMs) that are placed

Fig. 1 Illustration of artificial neural network for breast cancer

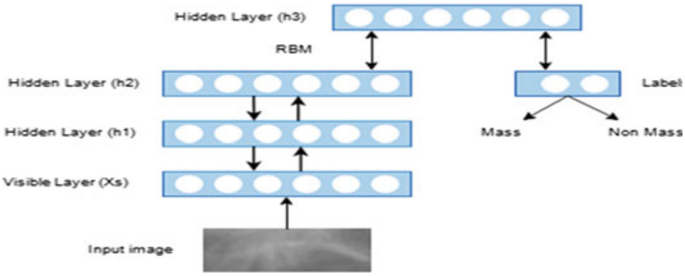

Fig. 2 Illustration of DBN model for breast cancer

on highest of each additional to produce the DBN. The contrastive divergence (CD) approach is used to study a collection of characteristics from visible units as the first step in training DBN. The instigations of formerly learned structures are then considered as visible units, and the DBN studies additional robust features from the previously obtained noticeable units in a second hidden layer [29]. Figure 2 depicts the illustration of DBN. For the identification of BrC, Eldeib and Abdel-Zaher [30] developed a technique that employed unsupervised phase of DBN was used first, monitored through a backpropagation neural network phase. In this study, data pre-processing not needed for this method. Because cancer is a genetic illness, another study by Nedialkov and Khademi [31] found that combining microcomputer array and proven statistics can enhance model enactment.

c. **Convolution Neural network**

A deep learning architecture called a deep NN (ConvNet/CNN) analyses a picture and applies weights and biases to numerous attributes in order to distinguish one picture from another. Three key design components underpin CNN architecture: receptive field, shared weights, and subsampling. The CNN was utilised to recognise two-dimensional visual patterns at first [32]. Convolution, at the very most layers, as well as an output layer is the three layers that make up a CNN.

Because the CNN is such an important tool in BrC classification, a thorough understanding of it is required. In earlier works [7], CNNs were used extra often to construct a dependable BrC cataloguing model. CNNs are used with a variety of imaging modalities because they function well with them. To train a CNN, however, a vast amount of pictures are required. It is tough to get decent results with a small number of photos. Figure 3 shows the illustration for CNN.

Now the BrC classification, de-novo representations remain separated into two categories: cross-origin models (COM), uni dataset models (UDM) and multi-database models. For image classification, the previous research used benchmark datasets using CNNs. CNNs are also used to extract features and segment images. Spanhol [33] used a CNN with union rules including max, product, and sum and

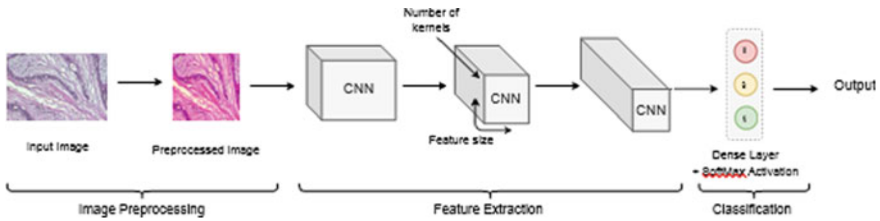

Fig. 3 Illustration of convolution NN for identification of breast cancer

found that it improved accuracy by roughly 6% when compared to other approaches using the same dataset.

d. **Extreme Learning Machine (ELM)**

The ELM is a type of artificial neural network with a lot of promise for BrC classification. ELM is a single-layer or hidden layer feed-forward NN that is frequently used on behalf of classification, grouping, regression, and design recognition. This approach is based on the analytic computation of output weights and the arbitrary initialisation of involvement loads and biases. As a result, the ELM is unaffected by manual parameter settings. ELMs have become well-known for addressing a wide range of challenging problems [34] because to their welfares of high wisdom speed and inexpensive processing rate. Although ELMs are not as correct as traditional NNs, it can be useful in circumstances when real-time network retraining is required. Figure 4 shows the illustration of ELM.

e. **Generative Adversarial Network (GAN)**

GANs are machine learning propagative representations. The generator model creates new pictures that are similar to the original image using characteristics learnt from the training data. This model determines whether or not the created image is false. GANs have been dubbed "the most exciting issue in machine learning in the last 10 years [35]" by AI research director of Facebook's Mr.YannLeCun. The disadvantages of having insufficient photos to give training a classifier are a famous problem.

To lower the mortality rate in BrC, Shams et al. [36] designed a deep reproductive multi-task based on an ensemble of CNN and GAN. To learn features, it combined a GAN by a deep learning classifier. Singh et al. [37] employed GAN for tumour

Fig. 4 Illustration of breast cancer using extreme learning machine

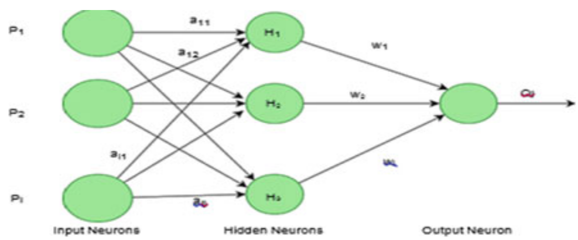

Table 1 Comparison of various algorithms

References	Dataset	Architecture	Strength	Limitations
Abbass [28]	WBCD	MP ANN	Better generalisation	Absence of feature engineering
Abdel-Zaher and Eldeib [30]	WBCD	DBN-NN	Tested against several train–test parti.	May determinate from over fitting issue
Arevalo et al. [7]	BCDR	CNN (UDM)	Comparison with a pre-trained model	Simple architecture
Lahoura et al. [34]	WBCD	ELM	Consideration of feature	Absence of image
Shams et al. [36]	WBCD	GAN	Enhanced learning feature	Only image generator is used in GAN

presence in the breast segmentation within the region of interest of a mammography (ROI). This model studies to recognise tumour area and creates a two cover that describes it. By way of a consequence, the confrontational network develops the ability to distinguish amongst real and synthetic separations [32] (Table 1).

3 Dataset and Pre-processing

a. **Dataset**

For the diagnosis of BrC, numerous datasets have been printed. A handful of research employed datasets of medical images, but just a few studies incorporated clinical data. The Wisconsin BrC dataset is the supreme well-known and generally utilised clinical dataset. The Wisconsin breast cancer database (WBCD) was developed at the University of Wisconsin Hospitals by Dr. William H. Wolberg [38]. This collection has 699 instances, each with 11 features. Clump width, size and cell uniform, cell homogeneity, border adherence, single epithelial size, naked nuclei, simple DNA, healthy nucleoli, and mitoses are some of the individual attributes.

The most important criticism expressed in our study is that researchers train and test the recommended approaches using such a limited sample [39]. To address this problem, the majority of studies employed transfer learning. Several research, on the other hand, relied on publicly available data.

The most often utilised database is the DDSM. It is the world's biggest free record, by 2620 examples having 2 photos since every breast, the medial oblique (MLO) then issues which are related (CC) views, and a maximum of 10,480 photographs spanning all kinds of results, from pictures to pictures with malignant tumours. It is, however, no longer maintained. CBIS-DDSM is an enhanced and basic version of the DDSM dataset that may be used to examine CAD processes in mammography and was recently published by Clark et al. [40].

The MIAS [41] is still actively utilised in investigation despite being the oldest public database. The MIAS database contains 161 cases and 322 digitised MLO pictures through a variety of answers, such as caring and malevolent grazes, as healthy as routine pictures. The resolution of this database has been reduced in order to create mini-MIAS [42].

b. **Pre-processing**

Augmentation, scaling, ROI removal, normalisation, and improvement to eliminate artefacts and structures are all common image pre-processing activities for BrC.

Furthermore, some experiments (20%) reduced the scope of photos earlier nourishing into DNNs. When pictures are sent straight into DNNs, such as CNNs, scaling is essential. Prior to BrC classification, however, fewer research used image-normalisation and -enhancement approaches. This approach helps DNNs develop correct structures for usual and pathological sections of BrC tissue by reducing high and low intensity noises, uniformizing all pictures, and assisting DNNs in producing correct structures for usual and irregular parts of BrC tissue. However, only few studies remove different blemishes from photos, such as labels, wedges, opacity, pectoral muscles, and markings.

This approach eliminates non-breast regions from the picture before doing a BrC diagnostic. In histological BrC pictures, a stain normalisation approach assists in the removal of discrepancies. Sert et al. [43] shown pre-processing has a significant impact on categorisation performance. Figure 5 shows the images from the BreakHis dataset.

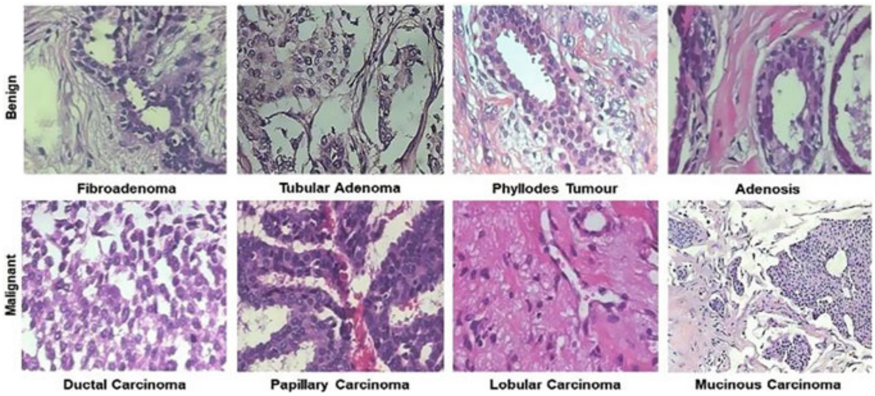

Fig. 5 Images from the BreakHis dataset that have been stained with H&E

4 Types of Image Modalities for Breast Cancer Identification

The use of imaging in the diagnosis and treatment of BrC is critical. As a result, this study shows that BrC analysis is dependent on 9 different types of medical imaging modalities. Ultrasound, MRI, histopathology, digital breast tomosynthesis, mammography, mass spectrometry, and computer tomography imaging are the nine medical imaging modalities, and the mixture is recognised as multi-modalities. The most fundamental and extensively utilised imaging modalities in breast imaging are two-view histopathology and mammography.

a. **Histopathology (Hp)**

The microscopic examination of tissue is referred to as histopathology. Histopathology can be defined as a pathologist's evaluation of a biopsy or tissue sample. Figure 5 shows histology pictures from the BreakHis dataset. Deep learning approaches are now the best tool for diagnosing BrC from a histopathological picture because of their excellent accuracy and efficiency [44]. The following sections explain and categorise several deep learning-based methods for identifying BrC histopathology images.

b. **Mammography (Mg)**

It is the next maximum collective and generally utilised technique for detecting BrC. This is due to the fact that it has a manual character, a wide range of mass appearances, and a low signal to noise ratio (SNR). We obtained data from a variety of well-known mammography imaging data sites, which includes MIAS, TCGA, INbreast, mini-MIAS, IBCDR, DDSM, CBIS-DDSM, and others, despite the belief that growing usage of novel adjunctive technologies like tomosynthesis may diminish recall rates. Figure 6 shows mammography results from the DDSM data.

In computer-aided diagnostic systems, US imaging is deliberated a critical step in identifying breast lesions. Breast elastography is a new sonographic treatment that, in toting to standard mammography and sonography, provides extra characterisation data on breast lesions. This approach, similar to a clinical palpation examination,

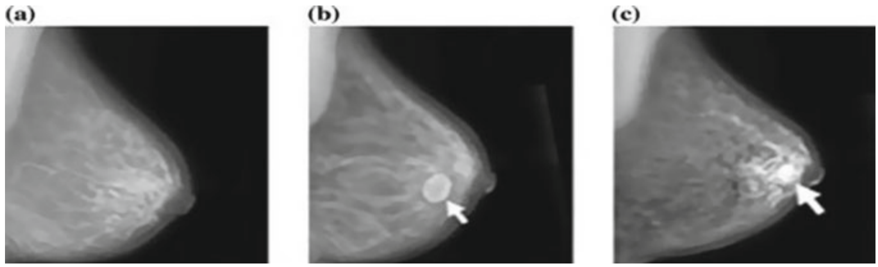

Fig. 6 **a** Normal, **b** benign (not cancer), and **c** cancer BrC mammography pictures from the DDSM dataset. Ultrasound (Us)

determines the A lesion's tension or stiffness. Yap et al. [8] projected using deep CNN to detect mammary ultrasonography lesions and evaluated three approaches There are 306 photos in dataset A (60 malignant and 246 benign), whilst there are 163 images in dataset MRI.

Because an MRI does not involve radiation, it is regarded as a superior evaluation. MRIs give pictures that are more detailed [45].

c. **Digital Breast Tomosynthesis (DBT)**

Traditional this double mammography photo shows a projection of breast attributes, culminating in composite intensities (the offer excellent of normal mammary glands from multiple breast places to imitate a mass) and illness obscuring (the overlaying of regular glandular tissue over diseased glandular tissue to resemble a mass).

d. **Infrared Thermal Imaging (ITI)**

Infrared thermography determines the temperature of a surface by detecting the radiated by it. In 1982, the food and drug certified X-ray imaging as a mammography substitute [46]. Apart from the small flaws, this one is harmless and sort out not came in communication with skin's exterior, giving slight distress to the patient. US, mammography, and MRI are all more expensive [47]. Mammography is currently the second most used method of detecting BrC. However, due of the low contrast created by the lighting,

e. **Computed Tomography (CT)**

CT is mostly employed in BrC performance as a whole-body assessment. CT scans are used to diagnose metastatic spread, evaluate therapy response, and estimate the risk of recurrence in patients with primary BrC. A CT scan be a kind of X-ray so as to perform on a big X-ray equipment. MRI, on the other offer, is thought to subsist better in conditions of picture feature [45]. Both gut and bone metastases can be detected with modern multidetector CT scanners.

f. **Mass Spectrometry Imaging (MSI)**

Patients with breast cancer who are discovered early, whilst their illness develops to the stage that existing therapies are no longer effective and have a very favourable prognosis; a reliable cancer cell target is required. Both atmosphere frame spectrometry imagery and liquids chromatography mass spectrometry (LC–MS) remain dependable then accurate procedures for breast cancer detection [48]. Protein expression data, notably in stage three of breast cancer, has been demonstrated by Al-Wajeeh et al. [49] to provide substantial ideas that might aid in the discovery of novel biomarkers in carcinogenesis. For the identification of breast cancer, this imaging approach, however, has not been combined with machine learning [50].

5 Evaluation Metrics and Result Discussion

The assessment of a models is a crucial step in the construction of a successful deep learning algorithm. After which was before validation and training, the testing images are delivered to the training model for categorisation in order to evaluate its performance. Other assessment measures include the matrix, pass, the ROC, the AUC-ROC line (AUC), and others. In confusion metrics, the following terms are commonly employed to compute assessment methods: true negative (TN), the testing process and the classifier's prognostication were both bad; true positive (TP), the testing process and the classifier's prognostication were both positive; completely untrue negative (FN), the testing process was positive, however, the classifier's prognostication was negative; false positive (TP), i.e., this same testing process and the classifier's prognostication were both positive; false negative (FN).

Accuracy (*A*): The amount of right calculations separated by the entire quantity of calculations made by the model yields the accuracy score. It just illustrates the proportion of usual participants who are correctly forecast and the proportion of aberrant BrC patients who are diagnosed correctly. An equation can be used to define accuracy (1).

$$\text{Accuracy } (A) = \text{TP} + \text{TN}/\text{Total} \tag{1}$$

Precision (Pr) is calculated by sharing genuine optimistic output by real positive outcomes, which includes those detected wrongly by the classifier. Equation can be used to express precision

$$\text{Precision (Pr)} = \text{TP}/(\text{TP} + \text{FP}) \tag{2}$$

Sensitivity (Sn) or Recall (R): By dividing this amount of true positive findings by the amount of actual specimens that should have been discovered, the recall is computed. To prevent malignant patient misdiagnosis, combined Sn and Pr ought to be great throughout medical image analysis. Recall may remain calculated by this Eq. (3).

$$\text{Recall } (R) = \text{TP}/(\text{TP} + \text{FN}) \tag{3}$$

***F*1-score**:

$$F1\text{-score } (F) = \frac{2 \times \text{precision} \times \text{recall}}{\text{precision} + \text{recall}} \tag{4}$$

Image recognition rate: To calculate the image recognition rate, use N all to show the number of cancer pictures in the test set. If the system accurately identifies N_{rec}

Table 2 Overview of datasets, references, and accuracy

Dataset	References	Accuracy
DDSM	Kumar et al. [52]	100%
BCC	Feng et al. [58]	98.27%
WBCO, WDBC	Ronoud and Asadi [54]	99.75%
DDSM	Mandala and Di [55]	93%
DDSM, PD (DBT)	Samala et al.	0.93 (AUC)
BreakHis	Spanhol et al. [33]	90%
MIAS	Ting et al. [59]	90.50%
BreakHis	Han et al. [60]	96.9%
WBCD	Lahoura et al. [34]	98.68%
DDSM, INbreast	Shams et al. [36]	89%, 93.5%
DDSM, INbreast	Singh et al. [37]	80%

cancer photographs, the detection accuracy at the ip level may be written as Eq. (5).

$$\text{Image recognition rate} = N_{\text{rec}} / N_{\text{all}} \tag{5}$$

Decision-curve analysis: A decision-curve analysis is used to analyse a forecasting models for an event, which often entails showing a graphical depiction of the net gain vs the threshold likelihood. The threshold likelihood is the smallest chance that a decision-maker will take a certain action. The financial positive, which would be a balanced mix of true/false positives, may be calculated using Eq. (6). The total sample size is N, and the cutoff probability is p_t.

$$\text{Net Benefit} = \frac{(\text{TP} - \text{FP} \times 1 p_{t/} - p_{t-})}{N} \tag{6}$$

Table 2 shows a compiled summary of assessment indicators and past study performance.

6 Research Directions and Challenges

For BrC diagnosis, ANNs, autoencoders, DBNs, and CNNs are currently being employed. Other types of deep learning networks, such as GANs, clustering, and RNNs, should be investigated in this sector. Because of its capacity to extract valuable characteristics from pictures, CNN is commonly utilised in BrC classification. We believe that tactics based on different CNN architectures, as well as hyperparameter tuning, should be looked at. The features and classifiers that are selected have a significant influence on model efficiency. A large amount of research built CNNs starting scratch, with some research freely revealing their technology. Implementations should be publicly available for re-use, allowing researchers to continue their study in the future [46].

7 Conclusion

Difficulty in correctly identifying the disease. In topical years, to aid radiologists, DL-based approaches for approved detection have already been established. The neural networks employed in BrC identification and tracking were investigated in this study. In BrC, the most often used CNN is categorised which is separated into 3 categories based on their knowledge and training procedures (De-novo, TL, and RL). The datasets used and their pre-processing technique be also described in this evaluation. The research looks at current BrC deep learning research and divided it into nine groups based on the imaging techniques used. The study also offered information on regularly used evaluation measures in the form of a table.

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Secure XML Parsing Pattern for Prevention of XML Attacks

Charu Gupta, Rakesh Kumar Singh, and Amar Kumar Mohapatra

Abstract XML document provides a platform independent data representation and transportation facility to enable communication among heterogeneous Web application and Web and cloud computing services. The wide usage of XML document and its parsing makes it prone to cyberattacks. The attacker exploits the hidden vulnerability in the document parsers and injects ever changing malicious payload posing a threat to confidentiality, integrity, and availability of Web resources. In this paper, the authors propose an approach to securely parse XML document and prevent large number of XML and XXE attacks. The detection rules for preventing malicious document are self-evolving and update its feature set using the incremental genetic algorithm. The secure XML parsing pattern will provide a security guideline and supplement the already existing parser by facilitating detection of malicious payloads.

Keywords XML parser · Security pattern · XXE · Billion laugh attack · Secure parsing · XML document

1 Introduction

Extensible markup language (XML) is widely used in data representation and transportation for Web and cloud computing services. The structure of XML easily integrates and operates among Web applications [1, 2] that are built on varied platforms. The wide usage of XML documents for data transfer has opened a plethora of ways for attackers to manipulate it and cause disruption in the services or gain confidential

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information. According to National Vulnerability Database [3], attacks due to vulnerable XML parsers reached 7600 as of 2022. The vulnerable XML parser processes the malicious XML document in a Web application and Web service leading to attacks that cause code execution, unavailability of service, and unauthorized access to confidential information with an impact score from high to critical [3], i.e., from 7.0 to 9.8 on a scale of 10. Web services require a secure XML parser to process the documents that have been validated and checked for the absence of malicious nature, character, over length, high nesting, and tampered schema.

The attacks on Web services via malicious XML documents occur due to vulnerable parsers written by software developers. The software developers focus on the functionality of the parsers and unintentionally ignore the security features exploited by attackers in due course of time. Consider the code snippet of a vulnerable XML parser as shown in Fig. 1. In the code while (!helper.endOfElements()), the while loop runs till the elements are available in XML document. The developer has not limited the number of elements that could be parsed. The attacker exploits this vulnerability and manipulates an XML document with tens and hundreds of billions of elements. The XML parser continues to parse such a large number of elements, resulting in high consumption of memory and CPU time, which subsequently crashes the system making it unavailable to legitimate users. Similarly, while parsing the child node, there is no check that will validate the node's name and the data contained in the node. The attacker injects malicious nodes and data that cause an injection attack on the Web services.

```
Public statuc Node parseXML(String xmld)
{
Node rootelement=new XMLParse().new Node();
      while (!helper.endOfElements()) //Vulnerable because loop runs till
      end of elemnts
      {
            rootelement.name=helper.getName(xmld);
            rootelement.name=helper.getValue(xmld);
            String[] childelement=helper.getChildren(xmld);
      if(childelement.length!=0) // Vulnerable no check for maximum
      length
            {
            rootelement.childList= new ArrayList<XMLParse.Node>();
                  for(int i=0;i<childelement.length;i++)
                  {
                  Rootelement.childList.add(parseXML(childelement[i]));
                  }
            }
      }
}
```

Fig. 1 Example of vulnerable open-source XML document parser code

This paper proposes an approach that will use the security pattern for validating raw XML documents. The raw XML documents are validated using the XML secure parser security pattern. The security pattern incorporates a genetic algorithm-enabled search engine that generates grammar rules for detecting and validating malicious raw XML documents. The grammar rules are updated and embedded in the secure XML parser security pattern for preventing and discarding the identified malicious XML documents. The proposed security pattern will reduce the load on the parser as malicious files and XML documents are discarded before reaching the XML parser. The XML secure parser security pattern will prevent maximum attacks due to malicious XML files and vulnerable XML parsers. The efforts required to identify and patch the hidden vulnerability in parsers are reduced as the proposed security pattern will validate the XML documents before forwarding them to the document parser of the Web application.

2 Related Work

Krishnamoorthy and Umarani [4] conducted experiments to prevent denial of service attacks in an XML document. They observed that the XML document structure had not limited the number of components in a message exploited by an attacker to execute the DoS attack. The attack was prevented by limiting the component size to ten in an XML document. Spath et al. [5] analyzed vulnerabilities in 30 XML parsers of six programming languages. Spath et al. [5] found that all the java parsers are vulnerable to XML attacks. Jan et al. [6] showed that billion laugh attack and XML external entity attacks are due to vulnerable XML parsers. The authors [6] also showed that vulnerable XML parsers consume a large amount of memory and processing time due to attacks via malicious XML documents and either make the system unavailable to legitimate users or risk the confidentiality of the information stored on the system.

Attacks due to inserting malicious characters and strings [2] occur as the XML parser does not validate the user-supplied data. These forms of attacks include shell-code injection [1], evaluation function [1], XQuery injection [7], code injection, [10] script attacks [6], injection of tags [6], Xpath injection [8, 9], and CDATA injection [8] that cause code execution and disclosure of information. SQL injection can be mitigated through automated code correction [23].

Oversized XML documents are crafted by an attacker by insertion of data with a large number of characters, nesting elements, or unexpected long names of XML nodes in such a manner that the document parser consumes the resources of the server and makes it unavailable to the end-users [2, 11]. The attacks due to unchecked lengthy XML documents are either recursive mode or non-recursive. The recursive mode includes billion laughs attack and quadratic blow-up, entity expansion, ping of death, and deeply nested XML structure that increases the size of the XML document in gigabytes [12–15].

XML parsers process an XML document referencing an external entity without authentication and leads to the disclosure of sensitive data or a DoS attack [18].

Another attack on XML documents occurs due to schema tampering by the attacker [16]. XML schema specifies the content of XML documents. XML schema is represented using (a) grammatical rules defining the order of elements, and (b) Boolean predicates defining the data type of elements and attributes, which is easily altered by an adversary [17].

Gupta et al. [2] surveyed various types of attacks on Web services through malicious XML documents and categorized them into five classes according to their method of manipulating the payload and mitigation approach. The five classes of XML attacks as proposed by [2] are attacks due to malicious characters and strings, oversized document, unauthorized access, tampered schema, and cryptographic failures.

Though various mitigation approaches exist in literature to detect and prevent attacks due to malicious XML payloads, the attacker crafts the payload in a newer pattern and combination to bypass the existing filters. The existing machine learning and neural network techniques have been used to detect injection and DoS attacks via malicious payloads [19]. These techniques require retraining of the algorithm as newer features are discovered, and the feature set is updated. Existing filters bypass a newer form of attack payload and send it to a vulnerable parser for processing. Security patterns solve recurring security problems and can be formally specified and verified [22]. The authors in [20] presented 32 security patterns that solve the top ten security problems reported by OWASP [21].

3 Proposed Approach: Secure XML Parser Security Pattern

The proposed approach consists of a pattern that has been extended using the factory design pattern and creating different factory classes and methods that will validate the raw XML document before being processed by the parser as shown in Fig. 2. The raw XML document is processed at the initial stage by the proposed secure XML pattern. The secure parser validates the document according to the grammar rules generated through the GeneMiner [19]. The GeneMiner proposed by [19] updates the feature set and detects malicious XML payloads with newer patterns and combination techniques adopted by the attacker. The proposed secure XML parser pattern will help in preventing four classes [2] of XML attacks.

Fig. 2 Utility of secure XML parsing pattern

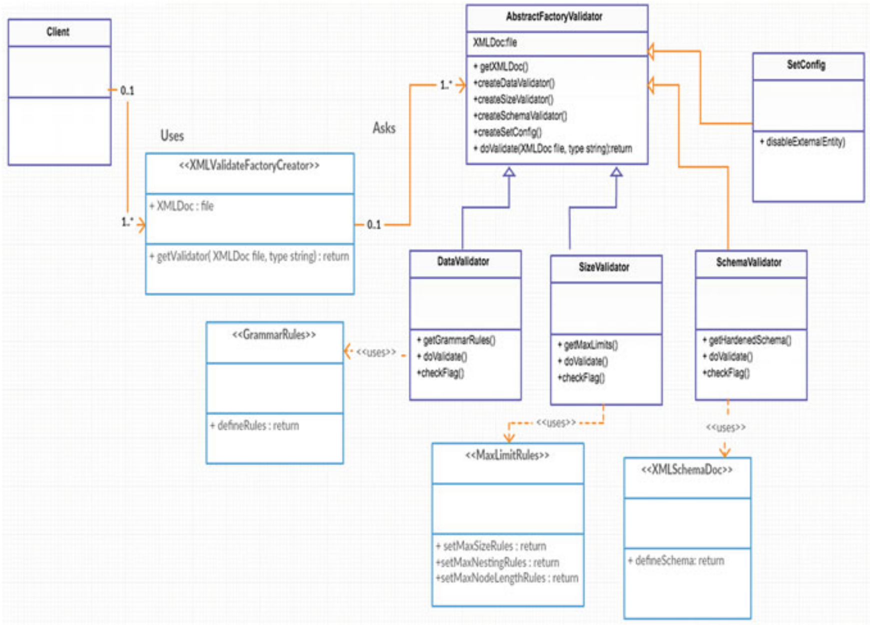

Fig. 3 Secure XML parsing pattern

The secure XML parser security pattern (Fig. 3) contains a class FactoryCreator with methods to read the incoming XML document. The FactoryCreator class calls the abstract class AbstractFactoryValidator. The AbstractFactoryValidator contains abstract methods that validate XML documents according to the concrete definition defined in concrete factory validator classes. The concrete classes for validating the absence of different categories of XML attack patterns in an XML document are created.

3.1 Detection and Prevention of XML Attacks Due to Insertion of Malicious Characters and Strings

A concrete class DataValidator is created that extends the AbstractFactoryValidator class. A class InputGrammar is created that associates with DataValidator class. The InputGrammar class defines various rules for classifying an XML payload as malicious and non-malicious. The function validate() will read the data and compare it with allowed grammar rules. The function validate() will either terminate the processing of XML document on detection of malicious entry with flag REJECT or return the validated XML document with flag ACCEPT for further processing by the parser. The DataValidator class of security pattern restricts the XML document that contains malicious characters and strings, causing various injection attacks, shell code execution, and XSS attacks.

3.2 Detection and Prevention of XML Attacks Due to Oversize Documents

A concrete class SizeValidator is created that extends the AbstractFactoryValidator class. A class, AllowedMaxLimits, is created that associates with DataValidator class. The AllowedMaxLimits class defines various maximum limits for document size, nesting of nodes, and length of characters in the name of the node that is allowed in an XML document. The functions such as sizeValidate(), nestingValidate(), and lengthofNodeValidate() are defined that checks the size, nesting, and length of each node's name in XML document and returns a value ACCEPT/REJECT. The function will exit the SizeValidator with a rejection message for any REJECT messages. For each ACCEPT, the function loops till all data nodes are accessed. The function returns a XMLReader factory that encapsulates the XML Doc if all validate() functions return ACCEPT. The SizeValidator class of security pattern restricts the XML document that contains an oversized document, unusual nesting, or unusual long names of the node. The class prevents denial of service attacks, billion laugh attacks, entity blow-up attacks, and other XML attacks due to deep nesting or unusual size of XML documents.

3.3 Detection and Prevention of XML Attacks Due to Tampered Schema

A concrete class SchemaValidator is created that extends the AbstractFactoryValidator class. A class XMLSchemaDoc is created that associates with SchemaValidator class. The SchemaValidator class defines the schema for XML documents and defines a function SchemaValidate() that validates with the schema of XML document and returns a value ACCEPT/REJECT. The function SchemaValidate() will either terminate the processing of the XML document on detection of deviation in the schema and template of an incoming XML document with flag REJECT or return the validated XML document with flag ACCEPT for further processing by the parser. The SchemaValidator class of security pattern restricts the XML document containing tampered schema and prevents schema poisoning attacks on Web services.

3.4 Detection and Prevention of XML Attacks Due to Misconfiguration

A concrete class SetConfig set is created that extends the AbstractFactoryValidator class. The function configValidate() is defined in the class to check the Auth() flag and credentials details. If Auth details exist, the method will create an XMLReader factory encapsulates the XML Doc and Auth Details. XMLReader factory will then use authentication and authorizer details and send the XML Doc for XML processing. If Auth Details are unavailable or validated, the disableEntity() function is called to disable the access of external entities and returns XMLReader factory object with validated XML Doc along with secure configuration and sends the object for XML processing. The SetConfig class of security pattern restricts the XML document from accessing the confidential resources and prevents many XXE attacks that arise due to misconfiguration of the parser.

4 Experiments, Results, and Analysis

The experiments were conducted to inject malicious XML documents into the Web applications and vulnerable parsers. The six Java-based parsers have been chosen as they are popular and extensive in their usage in Web services. The four vulnerable Web applications have been taken from the open source for testing the proposed approach are Bookstore, Classifieds, and Employee Directory [24, 25].

4.1 StAX

Streaming API for XML (StAX) [26] is a pull-type, stream, and event-based Java API parser for reading and writing XML documents. The StAX parser reads an XML document from top to bottom in the order of its appearance. The StAX parser does not allow random access to an element; hence, all the nodes must be read for accessing any node. A vulnerable code snippet of an XML parser built using StAX is shown below:

```
Characters characters = event.asCharacters();
        if(bookTitle) {
          System.out.println("Book Title:" + characters.getData());
          bookTitle = false;
        }
```

The developer has not incorporated any method to validate the incoming characters in the book title in the code snippet. The attacker exploits this vulnerability and injects malicious characters, tags, scripts, and strings, leading to different injection and code execution attacks.

4.2 SAX

Simple API for XML (SAX) [26] is a push-type, event-based API for parsing XML documents. The SAX parser reads the document event element sequentially and drops the events after receiving its callback from the server. It is used for processing large XML documents. A vulnerable SAX parser code that can cause a denial of service attack [27] is given below:

```
Html4SaxParserContext ctx
    = Html4SaxParserContext.newInstance(context.runtime, (DemoParseClass)
klass);
ctx.setIOInputSource(context, data, context.nil);
String javaEncoding = findEncodingName(context, encoding);
```

The code snippet is vulnerable to attacks due to the insertion of malicious characters and strings, leading to different injection and code execution attacks. The code was rectified by inserting validating string functions to detect vulnerability. However, it is tedious to patch similar lines of vulnerable code in an application with millions of lines and such vulnerabilities existing in thousands of lines of code.

4.3 Xerces

Xerces2 [26] is a high-performing, fully compliant XML parser in the Apache Xerces family that provides a modular and easy to program framework for building parser components and configurations. However, the recent version has been scanned for denial of service and parsing infinite loop vulnerabilities [28, 29].

```
matchexpression = /A(B + C);
```

The attacker injects payload containing a large number of "B" or "C" such as ABBBBBBBBBBBBBBBB.... 100 times. Such malicious payload consumes 99% of processor resources and makes the system unavailable. The Apache Xerces Java (XercesJ) XML parser waited for an infinite loop while parsing specially crafted XML malicious document payloads and consumed system resources for a long duration. An attacker forcefully targets the server to parse an FTP URL with an unchecked number of characters, consuming the resources, and leaving the process thread hanging in the attacked server [28, 29].

4.4 W3cDocument, Jdom, Dom4j

W3cDocument, JDOM, and Dom4j are Java-based libraries to parse XML documents in a tree-like structure. Document object model (DOM) parsers are faster than stream-based parsers [26]. However, they consume memory in case of deeply nested documents. It loads the document entirely in the memory and parses it from root to node.

```
for (int length = 0; length < ListOfScholar.size(); length + + ) {
Element scholar = scholarList.get(length);
System.out.println("\nCurrentElement:" + scholar.getName());}
```

The vulnerability in the parser lies that the for loop runs continuously till the length of the scholarList. The attacker manipulates the document and inserts millions of names of scholars, thereby making the parser run for a longer duration and consuming the memory completely. The parser scans the document and its child nodes without checking the limit, causing denial of service attacks, billion laugh attacks, and other attacks due to oversize documents.

It becomes challenging to rewrite the complete parser or patch vulnerabilities that lie deeply hidden in the parser. The patching of vulnerabilities and rewriting the complete parser may come with a new form of vulnerability that is harder to test and identify [19, 30–33]. Moreover, with increased use of software applications, the number of security attack incidents also grows [34]. The proposed secure XML parser security pattern is used to validate the incoming XML documents. Only the documents that have been validated are then forwarded to the parser for processing. The proposed secure XML parser security pattern also comes as an approach for the software developer community to write the parsers securely starting from the initial stage. The proposed security pattern has been implemented for six Java-based XML parsers and verified by taking various raw XML documents. The malicious XML documents were injected into each Web application's Web forms and parsed using vulnerable XML parsers. It has been found that all Java parsers were prone to one or the other category of XML attacks. The malicious XML documents were then forwarded to the proposed secure XML parser before sending it to processing parsers. It is found that the proposed parser detected and prevented the malicious XML document and forwarded only the non-malicious XML documents to the existing parsers for processing. The results are shown in Table 1.

5 Conclusion and Future Work

In this paper, a security pattern is proposed that will prevent the vulnerabilities due to XML parser. The security pattern works as an additional layer and validates the input raw XML document before sending it to the parser for processing. The security pattern also resets the misconfiguration of the parser by setting the properties and

Table 1 Performance of secure XML parser security pattern

S. No.	Parser	I	II	III	IV
1	Java StAX	√	√	√	√
2	Java/SAX	√	√	√	√
3	Java/Xerces	√	√	√	√
4	Java/w3cDocument	√	√	√	√
5	Java/Jdom	√	√	√	√
6	Java/dom4j	√	√	√	√

Category I: characterValidator; Category II: sizeValidator; Category III: SchemaValidator; Category IV: configManager

returning the document with secure configuration details. The proposed security pattern incorporates genetic algorithm-based grammar rules to detect malicious XML raw documents. The XML secure parser security pattern was applied to six Java-based XML parsers and four Web applications that process XML documents. Experimental results showed that the proposed security pattern reduces the load on the parser as malicious files, and XML documents are discarded before reaching the XML parser. The XML secure parser security pattern prevented maximum attacks due to malicious characters, strings, oversized documents, malformed schema design, and unauthorized access due to misconfiguration of XML parsers. The efforts required to identify and patch the hidden vulnerability in parsers are reduced as the proposed security pattern will validate the XML documents before forwarding them to the document parser of the Web application. In future, the authors intend to prevent XML attacks due to cryptographic failure and embed the approach in the secure XML parser security pattern.

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Performance Evaluation of CNN Models for Face Detection and Recognition with Mask

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Abstract Face recognition is widely used across many biometric applications. In recent times, where COVID-19 has impacted manufacturing, travel, tourism, hospitality, and crippling the global economy, wearing a mask is necessary for many establishments and public places for its widespread and safety of an individual. Under this scenario, person recognition for security functions is been difficult for the present face recognition systems in which most of the facial features are covered. Our work relies on computer vision and deep learning models which intend to make an impact and solve the real-world problem of safety measures at some significant level. In our work, we propose a framework for masked face recognition using Inception v3 and FaceNet architectures, which can be easily integrated into various embedded devices with limited computational capacity. We aim to detect the face with a mask and recognize the person in images as well as in real-time videos. We demonstrate the results with an overall accuracy of 88% for masked face recognition within the defined scope.

Keywords Face detection with mask · Face recognition with mask · Inception v3 model · FaceNet model

1 Introduction

In this new era where we are experiencing a pandemic, people are advised to wear masks to shield themselves and to cut back the unfold of the coronavirus. In this case, masked face recognition could be a terribly troublesome task since certain face elements are hidden. A primary focus is to cite a fast and efficient solution to address this problem. Since the majority of the systems are ineffective for this new constraint

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of face recognition with mask technique which has been less effective and inaccurate in recognizing masked face recognition that is crucial for face authorization or authentication for wide-region following for security and surveillance, facilitating secure payments, contact tracing of COVID-19 suspects, etc.

Even though the government has taken a good step by doing lockdown and wearing masks compulsory and also fine if someone is not wearing a mask. But still, people are careless and violate the rules. Hence, we develop a computer vision-based solution with deep learning features to solve this problem.

In our work, we propose a framework for an efficient masked face recognition, initially a face mask is detected and then the facial feature-based extraction is performed for identifying the person with a mask on the face. Using this framework, we can detect people wearing or not wearing masks in public places and recognize the person and authenticate accurately, this would be helpful in increasing the safety measures.

Our work can be extended to authenticate people at public places such as airports, offices, hospitals, and schools to ensure that the safety standards are maintained and people abide by the rules and regulations.

In the literature, we find some related works toward the face detection and recognition with a mask on the face. In what follows we brief about these works:

Jiang et al. [1] discussed RetinaFaceMask and ResNet models. They have also included MobileNet as a backbone for comparison and to reduce computation and model size in deployment scenarios with limited computing resources. For extracting high-level semantic information, FPN is applied as neck in the RetinaFaceMask model. Then, the information is fused into the previous layers feature map by adding an operation with a coefficient. Here, in their model, classifiers, predictors, and estimators are considered as head, which achieves the final objectives of the network.

Cahyono et al. [2] compared two deep learning architectural models, namely FaceNet and OpenFace. The pre-processing of the face follows the flow of detect, crop, and resize the face using MTCNN model. Then, facial features were extracted into 128-dimensional vector embedding using the FaceNet along with OpenFace. To obtain better accuracy, SVM is used for facial feature classification. The accuracy obtained from FaceNet model was higher compared to OpenFace model.

Wang et al. [3] proposed an approach for detecting the facial regions. The occluded face detection problem has been handled using multi-task cascaded convolutional neural network (MTCNN). The facial features were extracted using the FaceNet embedding model, and finally, the classification task was performed using support vector machine (SVM). The experimentation provided better results on masked face recognition.

Ge et al. [4] discussed about LLE-CNNs, where the extraction and characterization of face candidates is performed by cascading two CNNs for proposal generation and feature extraction, respectively. In proposal generation, P-Net was adopted to build first four layers of CNN's, those are three convolutional layers and a softmax layer, and VGGFace model is been applied to those proposals. In the end, for transferring the output into similarity-based vectors, the embedding module is applied. Finally, the verification module picks up the output having the minimum value among all the similarity vectors and hence, identifies the person. The model works well for face detection, but it lags when it comes to detecting faces with occlusions.

Aswal et al. [5] proposed masked face detection and identification using two approaches, namely single-step process using a pre-trained YOLOv3 model on a dataset of known people and a two-step process, the RetinaFace localize the masked faces and VGGFace2 for generate the facial feature vectors. Authors used a dataset of real-world video examples consisting of seven individuals with various orientations, illuminations, and occlusions. Experimental results show that RetinaFace and VGGFace2 provide an accuracy of 92.7% in overall performance, 98.1% for face detection, and 94.5% face verification accuracy, respectively, on their custom dataset.

From the above works, we observe the challenges in face detection and recognition with the mask on the face for various cases such as masks worn inappropriately or in case of occlusions and in-crowd scenarios. Toward this, we have addressed a few cases and the following are the contributions:

- We build a non-masked and masked face dataset for face recognition.
- We propose a framework using deep learning models for face detection and recognizing the person with a mask on the face.
- We compare different models for face mask detection and achieve 98% accuracy for Inception v3 and demonstrate the results on our dataset with an accuracy of 88% for face recognition with a mask.

Further, the paper is organized as in Sect. 2, we provide the proposed methodology. Section 3 discusses the dataset, sample results, and system performance. Section 4 presents the conclusion of the proposed system.

2 Proposed Methodology

This section gives a brief description of the implementation details of how the masked face detection and recognition is performed and which CNN architecture is applied. The workflow of our proposed methodology can be seen in Fig. 1, which is composed of three modules, face mask detection, face recognition with mask, and finally, masked face recognition.

2.1 Face Mask Detection

Face mask detection is a process in which we can detect whether the person is wearing mask or not by using facial landmarks which consists of face, eyebrows, eyes, mouth, and jawline. And to get the facial regions, we select the region of interest (ROI). We extract the features of nose, eyes, and face from it and compare with the image in the dataset to show the accurate output.

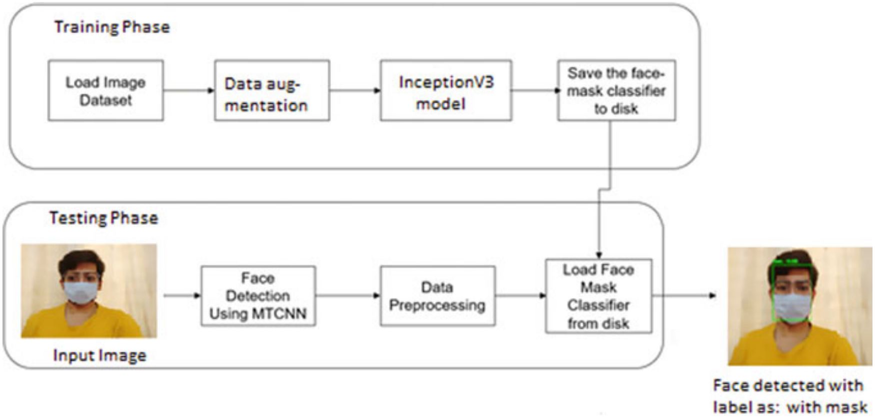

Fig. 1 Proposed framework for face mask detection using Inception v3

Figure 1 depicts that, in the first phase, the image dataset is fed and data augmentation is performed. Here, augmentation is used as an image generator for increasing the dataset for training. While input acquisition, we are removing the blur images, dark images, and resize the images which are required for the Inception v3 model. Then, train the face mask detection model where we divide our dataset for training and testing in the ratio of 20:80, respectively. Here, we use the pre-trained weights of the model and use the dropout in between the layers with a value of 0.5. Finally, save the face mask classifier model to the disk.

In phase two, we load the input image and detect the face using MTCNN model. And extract the region of interest (ROI) like the nose, mouth, eyes, eyebrow, and jawline. Then, apply the data pre-processing for the image and then the pre-processed image is given to the face mask classifier. This classifier (Inception v3 model) matches the trained features and labels the input image as "With_mask" or "Without_mask".

2.2 *Face Recognition with Mask*

Face recognition is a process of identifying or verifying the identity of a person based on their face from a digital image. It is used to recognize people from images, videos, or in real time. In our proposed work, we aim to recognize the face with a mask. Thus, face recognition with a mask can be divided mainly into three categories namely face detection, feature extraction, and lastly feature matching. And the output of each method will be the input to the next method.

Face recognition with a mask is a complex task that relies majorly on eigenvectors. The traditional or early methods [6–8] for implementing face recognition use PCA for feature extraction and feed forward backpropagation neural networks for recognition. Later on for small training set examples and for large categories, the similarity metrics [9] were being used for recognition and verification. Now there are modern techniques or methods for implementing face recognition such as DeepFace [10], which employ a four-stage pipeline that follows the flow of, detect, align, represent, and classify. This model has an advanced approach since it is combined with 3D face modeling and piecewise affine transformation to achieve the task of face recognition. VGGFace [5] is another neural network model that can be used for face recognition with a mask model, where a 2048 vector dimensional descriptor face embedding is produced. Then, these are L2 normalized and using the cosine distance the similarity between the faces is calculated. Authors in [11] use VGG16 model image retrieval, and authors in [12] perform face liveness detection before recognizing the person which is a useful component in the authentication.

FaceNet [13] is a face recognition model that is introduced by Google researchers by integrating machine learning in processing face recognition. It is also referred to as one-shot learning model. FaceNet provides unified embedding for face verification, recognition, and clustering tasks. It directly trains the face by mapping every face image into the Euclidean space wherever the distance consists of facial model similarities. FaceNet training method uses triplet loss that helps in minimizing the gap of anchor and positive and maximizes the gap of anchor and negative image. FaceNet uses deep convolutional networks to optimize its embedding and fetches 128 vector embedding as a feature extractor. FaceNet is trained using training face thumbnails ranging from 100 to 200 M, which consist of 8 M different identities with varying input sizes from 96×96 pixels to 224×224 pixels. It is widely used in cases where there is a scarcity of datasets, and still, it attains a good accuracy.

Figure 2 shows the framework of how the face recognition takes place for masked faces using the FaceNet model. This process has two major phases, in first phase generation of 128-dimensional vector embedding of the masked face from database takes place. And the face recognition for the masked faces using the FaceNet model is performed in the second phase.

From Fig. 2, we observe that in the first phase, we will consider only one masked face image of each person from our dataset. Then, the image is passed to the Haar cascade classifier for face detection which helps in the extraction of facial landmarks and features. These extracted features are passed to the pre-trained FaceNet model for the generation of 128D vector embeddings. And finally, the face embeddings of every person in the database are saved.

Now, after the completion of phase 1, we have the corpus of 128-dimensional embeddings corresponding to the names of the person. In the second phase, the input image will be the masked face image which is the output of the Inception v3 model. This image is then passed through the Haar cascade classifier for feature extraction and then through a pre-trained network of FaceNet model for generating 128D vector embeddings. These generated 128D vector embeddings are in turn compared to the stored embeddings using Euclidian (L2) distance. If the lowest distance between the

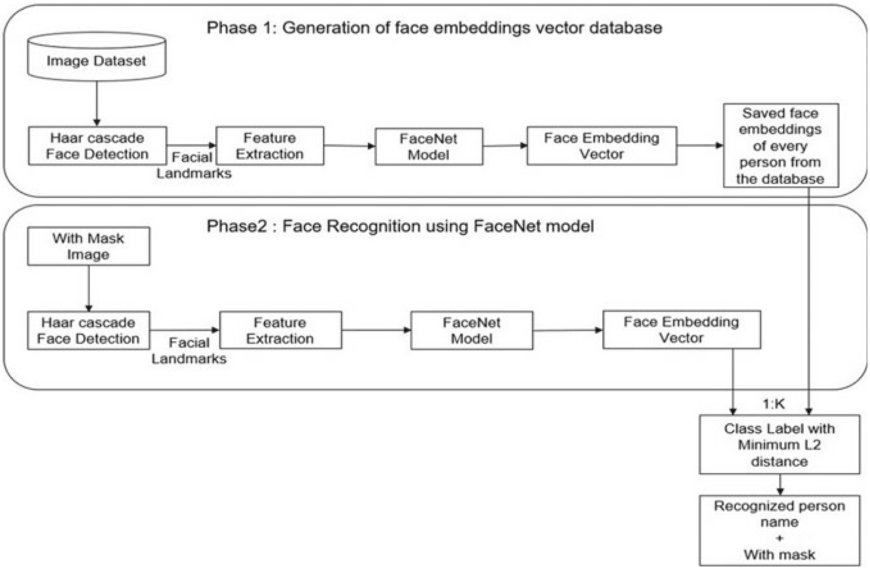

Fig. 2 Proposed framework for face recognition with a mask using FaceNet

captured embedding (i.e., the embedding obtained from the input image) and the stored embeddings (i.e., the embedding of the person which is already stored on the disk and is the output of the first phase) is less than a threshold value, then the system will recognize the person with his name corresponding to that lowest distant embedding.

3 Results and Discussions

3.1 Dataset Description

We have built a dataset containing 2520 images captured from 42 people having masks on their faces (1260 images) and without a mask on the same person (1260 images). Each person's 30 images with and without a mask have been captured with different angles and postures. As we need more images for training, we have applied the data augmentation techniques and a total of 50,400 images were generated for training.

The sample augmented images without mask and with mask are shown in Figs. 3 and 4, respectively.

Fig. 3 Sample images without mask on the face

Fig. 4 Sample images with mask on the face

3.2 Results of Face Mask Detection

We tested our proposed framework for face mask detection on the Kaggle dataset and on our dataset for **varied** cases of input scenarios. We implemented three models, MobileNetV2, YoloV4, and Inception v3, and compared them. From Table 1, we can observe the obtained accuracy for these models are 96%, 97%, and 98%, respectively. Thus, the Inception v3 gave better accuracy than the remaining models. Sample results of face mask detection for positive cases are shown in Fig. 5a and b. We also gave the negative test cases, i.e., faces without masks as shown in Fig. 5c and d. The model has correctly detected in these scenarios where face-pack was applied on the face and in the case of multiple persons in the image.

Table 1 Comparison of CNN models for face detection with mask

Model	Accuracy (%)
MobileNetV2	96
YoloV4	97
Inception v3	98

Fig. 5 **a** Sample input images with a mask on the face. **b** Sample results of detecting the face with a mask. **c** Sample results detecting no mask on the face. **d** Sample results detecting no mask on the faces of multiple persons in the image

3.3 Results of Face Recognition with Mask

We evaluate our proposed framework for face mask recognition on 100 test images and calculated the accuracy of the model. For recognition training purpose, we need both with and without mask images of the person. We were unable to find a standard dataset for face recognition with mask. Hence, we built and used our own dataset for recognition. We observed that 88 images out of 100 have recognized the persons correctly. Hence, we can say that the model is giving about **88% accuracy on our own dataset**.

Fig. 6 Sample results of face mask detection and face recognition with a mask

Figure 6 shows the obtained results for face mask detection and masked face recognition on our dataset. The input is fed to face mask detection Inception v3 model where a person with mask or without mask is detected with the score. If the person is detected with mask, then the same image is carried to face recognition model where the person is recognized and then output generated with label as "Person name + With_ mask". If the person is detected without mask, then the system terminates and gives just the output label as "Without_mask".

4 Conclusion

We have proposed a framework for detecting and recognizing a person with a mask on the face. A dataset containing 2520 images of 42 individuals was generated. We experimented with three CNN models (MobileNetv2, YOLOv4, and Inception v3) for face mask detection and obtained 98% of accuracy for the Inception v3 model, which gave better results when compared to other CNN models. FaceNet model is used for face recognition with a mask and obtained 88% of accuracy on our dataset. Our work can be extended to authenticate people at public places such as airports, offices, and hospitals to ensure that the safety standards are maintained and people abide by the rules and regulations.

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Crop Specific Cultivation Recommendation System Using Deep Learning

P. Parameswari and C. Tharani

Abstract Agriculture is a vital part of each country's economy, as it determines the gross native pay. Crop yield prediction is one of agriculture's most intriguing challenges. At the global, regional, and field levels, it plays a critical role in decision-making. Soil elements like nitrogen, phosphorus, potassium, humidity, rainfall, and other factors play a major part in cultivation. The proposed model in this research is a hybrid model by combining decision tree, SVM, and RNN algorithms. This paper examines the data and assists farmers in anticipating harvest, resulting in increased profitability. The results were analysed, and the future perceptions were drawn with the gained result.

Keywords Machine learning · Deep learning yield prediction · SVM · Decision tree · RNN

1 Introduction

Agriculture's importance is not confined to our daily lives; it is a practical subject that contributes to a country's economic prosperity. As a result, increasing the value of crop yields using current technologies is a critical step in producing high-quality crops. Data mining is currently a growing research field in agriculture, with applications in crop yield prediction and analysis. Cultivation is one of the most common jobs in the country. Performing diverse farming activities results in a significant financial boost for the country. As a result, it is known as the most versatile money-making strategy.

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Agriculture's prolonged-term viability is crucial to make sure food security and starvation eradication for the world's rapidly expanding population. By 2050, it is anticipated that universal food production will need to grow by 60–110% to feed 9–10 billion people [1]. Crop recommendation is one of agriculture's most difficult challenge, and various versions have been put forward and proven thus far.

Because yield production is affected by a range of issues such as climate, weather, soil conditions, and seed diversity, this challenge necessitates the usage of some information. This demonstrates that crop recommendation is not a simple operation; it involves a number of difficult phases. Crop recommendation models can now accurately estimate the true yield; however, a better crop recommendation procedure is still required.

Since remote sensing data can be very much useful for agricultural decision-making, it can be further enhanced using machine learning techniques. As a preliminary stage in traditional machine learning techniques, feature concept is used, numerous normal machine learning algorithms used in the yield recommendation task. It is still tough to locate suitable features, and standard approaches' capacity to extract information from data is limited.

The world's population is increasing every day, and as a result, the need for food will increase as well. The amount of agricultural land and other resources available to meet demand is insufficient. In India, villages account for almost 70% of the entire population, and agriculture is a source of income for farmers. Farmers' livelihoods are dependent on the agricultural crop. The option includes nutrients to the soil like nitrogen. Crop and present datasets, collected from kaggle.com that have different information, taken as static data, and are examined in the handling phase. The static data represents crop formation and data gathered from several government websites on varied yields. The three machine learning approaches decision tree, support vector machine (SVM), and recurrent neural network will be explored and compared in this study (RNN).

2 Literature Review

Crop yield forecast is a great challenge for decision-makers both in national as well as regional. Farmers can use a precise crop prediction model to assist and decide on crop pattern, specific time to grow and to determine what to grow and when to grow it. Crop prediction can be done in a variety of ways [2]. Existing projects available to assists farmers in determining the crop to cultivate in a certain area [3]. Artificial neural networks, cluster models, normal methods for forecast like decision trees were discussed, and their performance was tested. Rainfall and soil behaviour were studied using K-nearest neighbours, multivariate, and linear regression prediction models [4].

Crop yield forecasting is a science. Different calculations and strategies have been established that can be used for this purpose, including linear, logistic regression, and others. Artificial intelligence (AI) advancements may lead to new arrangements that provide more precise forecasts than traditional methods, allowing for better decision-making. DL approaches are now being used to solve complicated problems in a reasonable amount of time. In hyperspectral analysis, various types of deep neural networks (DNNs) have achieved outstanding results [5].

3 Proposed Method

Learning techniques used in the proposed work is to know the best algorithm for crop recommendation. The proposed model is put to the test on a crop dataset. Deep learning is utilised to complete various effective computations, such as growing suitable crop in the case of many options. The algorithms employed in this study can be correctly predicted using the following methods.

Support Vector Machine (SVM)

SVM is a supervised learning technique which helps to solve both classification and regression issues.

Step 1: Import all of the necessary packages.
Step 2: Using a.csv file, to input data.
Step 3: From dataset, select the needed number of features.
Step 4: Use the dataset to train the data.
Step 5: For the test dataset, predict the response.

Decision Tree (DT)

The most effective and generally used tool for grouping and prediction is the decision tree.

Step 1: Bring in all of the necessary packages.
Step 2: Using a.csv file, load input data.
Step 3: From the dataset, select the needed number of features.
Step 4: Use the dataset to train the data.
Step 5: For the test dataset, predict the response.

Recurrent Neural Network (RNN)

RNNs are a type of neural network.

Step 1: A specific time, input is delivered to the network.
Step 2: Compute the present state using the prior state and the input.
Step 3: For the following time step, the current state ht becomes ht − 1.
Step 4: Based on the problem, the data is combined from the earlier states.
Step 5: Finally, current state is used to compute the result.
Step 6: The error is backpropagated towards the network in order to update the weights. As a result, RNN has been trained.

Table 1 Sample dataset

Crop	N	P	K	T	H	PH	RF
Rice	91	43	44	21.8	83.0	6.6	202.9
Maize	80	53	16	26.3	69.4	6.6	96.4
Chickpea	44	78	78	20.4	19.9	7.9	80.2
Kidney beans	18	78	24	25.5	21.8	5.7	64.1
Pigeon peas	28	58	23	31.9	53.7	7.1	170.9

4 Results and Discussion

The execution of the research activity begins with the input of the acquired crop dataset. Execution starts after importing the necessary libraries and packages. Data pre-processing starts before execution. The data is divided into two groups: training and test data. Final, model is created to the specific machine learning algorithm, and as a result, it provides the classification accuracy. The goal is to develop the optimal algorithm for recommending crops depending on weather and soil characteristics.

4.1 Dataset Description

The Kaggle repository provided the data for this investigation. The rain, climate, and fertiliser datasets for India were supplemented to create this dataset. These records were acquired by the ICFA. In this dataset, there are 2200 records. The collection contains eight properties, each of which represents a crop cultivated in the given climate. A list of the dataset's properties can be found in Table 1 which provides the relevant values for several variables for a certain crop as a sample dataset. The complete dataset is split into two parts: training and testing. Figure 1 elaborates architecture of the proposed model.

4.2 Experimental Results

In Table 2, the four algorithms were evaluated based on model construction time, and the same is depicted graphically in Fig. 2. The support vector machine algorithm, it concludes, takes less time than others.

From Table 3, decision tree classified 97.27% of data, SVM with 98.39, RNN with 98.85, and proposed hybrid method classified 99.45% of instance correctly. In terms of accuracy, hybrid method which correctly classified 99.45% of incidents is the best method for crop recommendation than other three algorithm. Terms of accuracy hybrid method which correctly classified 99.45% of incidents is the best method for crop recommendation than other three algorithm (Fig. 3).

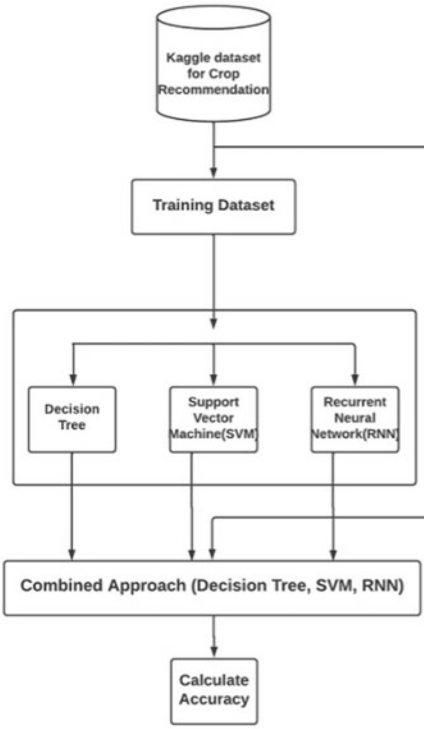

Fig. 1 Architecture of the proposed model

Table 2 Model building time

Algorithm	Time (s)
Decision tree	3
Support vector machine (SVM)	4
Recurrent neural network (RNN)	17
Hybrid model	20

5 Conclusion

This review delves at how machine learning techniques were used for crop recommendation and how well they worked. The major goal is to advise cultivators on the good quality crops to plant based on a range of characteristics and to help them make a decision before planting. According to our findings, the decision tree classifier correctly classified 97.27%, the SVM algorithm correctly classified 98.39%, the RNN algorithm correctly classified 98.85%, and the proposed hybrid methods correctly classified 99.45%. It is also the most accurate. Farmers will benefit from this research since it will help them establish a clear image of how to grow a certain

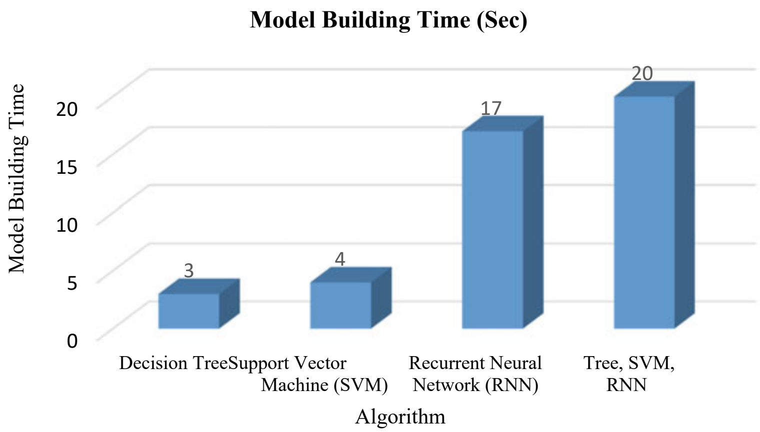

Fig. 2 Time taken for model building

Table 3 Prediction accuracy

Algorithm	Prediction accuracy (%)
Decision tree	97.27
SVM	98.39
RNN	98.85
Hybrid model	99.45

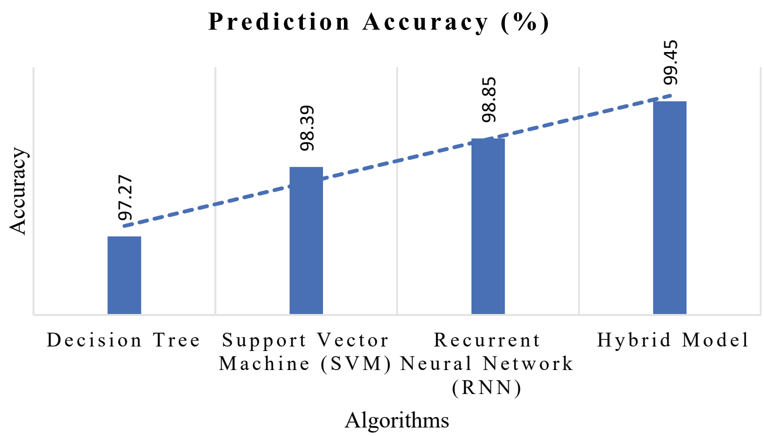

Fig. 3 Prediction accuracy

crop while taking into account weather, soil, and water requirements. According to the researchers, the new hybrid algorithm beats existing methods.

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Information and Communication Technology in Transit Signal Priority Systems: A Review

B. P. Ashwini, R. M. Savithramma, R. Sumathi, and H. S. Sudhira

Abstract Prioritizing transit vehicles at signalized intersections is an important step toward reducing the overall person delay at intersections and in turn reducing the total travel time of passengers. For several decades researchers have proposed solutions to provide Transit Signal Priority (TSP), and recent advances in Information and Communication Technology (ICT) and its application in traffic management have triggered its usage in TSP. In this article, a review of existing TSP systems is conducted emphasizing the role of ICT in its implementation. It is observed from the review that TSP is being adopted worldwide at various levels. Most of the solutions proposed are location specific, and the implementation is demonstrated through simulations. TSP systems for heterogeneous traffic are scanty. The state-of-art technologies for data collection such as sensors and GPS, for computation such as cloud, fog, edge, and technologies for V2X and I2I communications are the base to implement the solutions currently. Overall, the ICT plays a cardinal role in the implementation of TSP, with the long-term benefits, TSP is expected to penetrate every city that aims at providing sustainable and smooth commuting for its citizens.

Keywords Transit signal priority · Artificial intelligence · Information and communication technology · Smart traffic management · Signalized intersections · Smart transportation

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1 Introduction

Technology has made people's life easier and improved their quality of life; smart cities are the best illustrations to uphold the statement. The smart city frameworks involve various elements including smart-education, smart transportation, smart-health, smart-grid, etc. Researchers across the globe have applied different technologies to implement smart city components and the authors in [1] have presented the role of artificial intelligence in design and development of smart city applications. Among various smart city components, smart transportation is of interest in the current article. Further, smart transportation involves various sub-components such as traffic signal control system, passenger information system, smart-parking system, route-navigation system, and e-ticketing system, and are reviewed in the article [2].

Traffic signal optimization is a prominent area of research and a variety of solutions are available currently. A review of existing solutions to implement the Traffic Signal Control System (TSCS) is presented in [3, 4]. TSCS can be of two types; prioritized and non-prioritized. In the case of a non-prioritized, each lane is treated at the same level and the green time is allocated based on traffic volume on each lane. Whereas in the case of prioritized TSCS, the lanes are focused based on policies to prioritize emergency vehicles, incident handling, and vehicle occupancy. In a few existing works [5] the Transit Signal Priority System (TSPS) is implemented where the bus lanes get priority over other lanes as the bus occupancy is larger. The TSPS seeks to enhance the overall quality of urban transportation by allocating signal configurations that favor mass transit over low occupancy private vehicles.

Traffic controller with bus priority is implemented in various stages such as bus detection, bus arrival time estimation, bus arrival mode identification, priority strategy selection, and its activation, followed by phase compensation if necessary, and finally, delay computation. A bus detection system [6] is used to recognize the bus in a particular lane. In most cases, the On-Board Devices (OBD) in a bus that is arriving at a junction will communicate with the Road-Side Device (RSD) about its arrival. The time required by the bus to reach the stop-line at an intersection from its current location is estimated so that signal optimization and prioritization strategy are decided priorly. The travel time of the bus is estimated in two ways namely through the analytical method [7] or using machine learning [8]. A bus arrival mode is a time interval of a cycle during which a bus arrives at an intersection. There are various possible bus arrival modes and the authors in [9] have considered eight; (1) beginning of green, (2) between green, (3) end of the green, (4) during yellow, (5) beginning of red, (6 and 7) between red, and (8) end of red.

The TSPS is of two types; passive and active [10]. A passive TSPS usually regulates the signal lengths manually or by using standalone software applications like TRANSYT and is well suited for locations observing a large number of buses [11] with predictable dwell times [12]. Whereas active TSPS dynamically detects the bus presence on approaches and configures the signals accordingly to provide possible

Table 1 TSP strategies and definitions

Type	Strategy	Definition
Passive	Manual schedule	Manual configuration of signal lengths as per traffic volume
	Standalone estimation	Use of standalone software application to compute the signal lengths as per traffic demand
Active	Green extension (GE)	Extend the green time if the transit vehicle is detected in the current green phase
	Red reduction (RR)	Truncate the red time and provide early green if the transit vehicle is detected in the current red phase
	Green reallocation	If the arrival of the bus is delayed for a few seconds, then the provisioning of green time for that phase is shifted forward
	Phase insertion	It is applicable for intersections provided with dedicated bus lanes and this lane/phase is activated with green only on arrival of buses
	Green truncation	Green time of current phase will be truncated on the exit of the bus
	Phase reservicing	The same phase is provided with green time twice in a cycle

early exit signals for those approaches. The various strategies used in the existing works are summarized in Table 1 and one of the strategies is activated accordingly.

The objective of traffic signal prioritization for buses is to minimize the delay at intersections thereby reducing the overall travel period. The implementation of TSP has several benefits [13] such as; reduced travel time of buses, greenhouse gas emission, and fuel costs; improvement in schedule adherence, headway maintenance, road network efficiency, reliability and quality of service, and so on. Though TSP has several benefits it has a few disadvantages such as increased waiting time for non-priority vehicles and initial investment cost for the implementation, but studies reveal that the negative impacts of TSP are negligible and its implementation is cost-effective in the long term.

Transit signal prioritization is a well-explored area of research across the globe. Advancements in technologies have led researchers toward formulating several improved versions of traffic signal optimization solutions. In this direction, *a comprehensive review of existing solutions to design prioritized traffic signal strategies for public transit buses is discussed in this article with an emphasis on the role of Information and Communication Technology (ICT).*

2 Transit Signal Priority and ICT

The application of ICT [14] in TSP is state-of-art and is gaining adoption worldwide. The TSPS needs sensing devices, communication modes and protocols, computational devices to process the data, intelligent methods to take instant decisions, and other tools to implement the solution.

Road Infrastructure: The infrastructure set up for the road network and traffic management plays a vital role in TSP. As shown in Fig. 1, the type of intersection, the type of road design, and the proximity of the bus stop are the key parameters in the design of TSP strategies. In a few of the existing works, isolated n-legged intersections [15] are studied while in most research works, a set of intersections [16, 17] on a corridor are synchronized to collaboratively provide TSP. In some studies, the position of the bus stop [18] from the intersection is considered as one of the criteria in designing TSP strategies. According to the road design [19], discrete strategies are implemented for roads with mixed traffic, dedicated bus lanes [20], and the transitway for buses.

Information Technology: Data is the backbone of any smart solution. Data collection and pre-processing are important stages for developing a smart solution. The role of ICT [14] in the data collection and pre-processing is cardinal, where this stage requires tools and resources for transmitting, sharing, and storing the information. The sources for data collection [21] are presented in Fig. 2. The data sources are classified based on the location of their installation like OBD, and RSD [23].

Among the OBDs, Global Positioning System (GPS) is the major source of data as they provide location details using which the bus arrival time is estimated. The passenger counter [24, 25] and the ticketing data provide insight into the dwell time

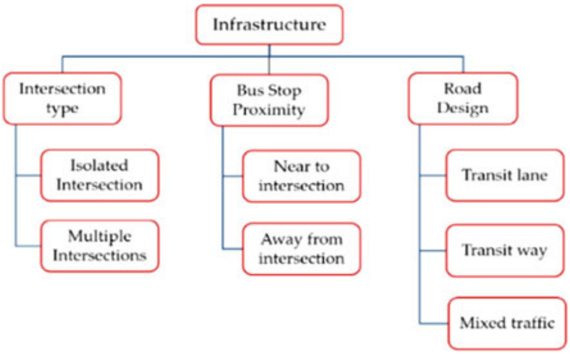

Fig. 1 Road infrastructure

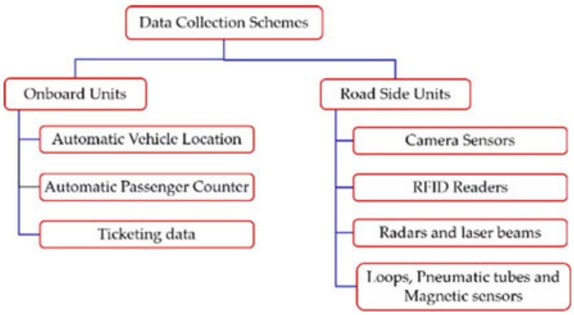

Fig. 2 Data sources for providing TSP

estimation at bus stops. The sensors [26] are the core part of RSDs. In several works where intrusive sensors such as pneumatic tubes and loops sense the presence of a bus at a control point. Non-intrusive sensors such as surveillance cameras capture the traffic, and the supporting software technology detects the presence of a bus. Other non-intrusive sensors include RFID readers, lasers, radars, etc. Recently a few research has shown the possibility of using crowd-sourced [27] data for collecting traffic-related information. This source is yet to be explored for TSP.

Communication Technology: There are three probable types of communications [26]; Vehicle to Vehicle (V2V), V2I, and I2I. The information sharing between the OBDs to the control center is an example of V2I, and the communication between RSDs to the control center is of I2I type. In V2V one vehicle communicates with another moving vehicle within a fixed range of distance and exchanges information such as speed, heading, location, etc., to gain a complete view of its surroundings. The sharing of information happens in two ways; wired and wireless. The OBDs communicate to vehicles and RSDs wirelessly, and the RSDs communicate to the control center in both modes [26]. Several protocols [28] are used for wired and wireless communications. Some of the predominant technologies for I2I, V2I, and V2I are depicted in Fig. 3 including protocols for short ranges such as 10 Kb/s (LIN) to high ranges exceeding 1 Mb/s (Wi-Fi). There are several standards defined for short-range communication such as Wireless Access in Vehicular Environment (WAVE) and IEEE802.11p [29], J2735 (Society of Automotive Engineers) [30], etc.

Computational Technology: TSPS needs to take several decisions in real-time to prioritize bus transit. The incoming data from the vehicles and RSDs are analyzed to take on the fly decisions. The location of a computational device is of prime importance in such applications. The computing agent is either a centralized server or a decentralized edge [31]. The fog [32] and edge [33] servers can process the incoming data and take instant decisions at the location without any communication overhead, and later the data are shared with the centralized server [34]. In several studies, edge and fog computing are used over a centralized server.

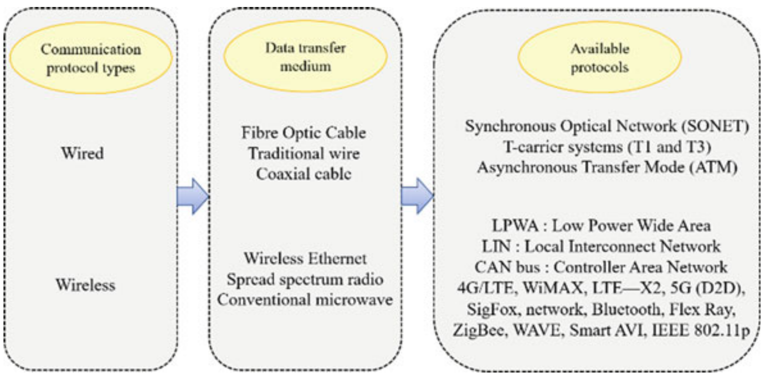

Fig. 3 Communication protocols for TSP

3 Results and Discussion

The existing literature on the TSPS is explored in this article to emphasize the importance of ICT in its implementation. The summary of the study is presented in three folds including road infrastructure, technology, and performance as shown in Table 2. The researchers have proposed various theoretical and empirical works to implement TSPS. Among the articles reviewed, 58% of articles are location specific, where authors have chosen a study area to propose a solution, whereas in 42% of articles hypothetical intersections are considered for developing solutions. Most of the works are implemented through simulation tools such as SUMO, VISSIM, etc. Active TSPS is the most used approach for TSPS implementation, and only 9% of the reviewed articles proposed TSP for the Passive TSPS type.

Among the papers reviewed 47% of works are implemented for isolated intersections and 55% for a network of intersections on a link. The presence of a bus stop in the vicinity of an intersection has a high impact on implementing TSPS and among the works studied 52% of the authors have addressed this scenario. The composition of traffic is an equally important parameter for implementing the TSPS. 13% of the reviewed articles have proposed the TSP with dedicated lanes for the buses, whereas 87% of the works have proposed the study area with mixed traffic lanes. But most of the works are limited to two types of vehicles, i.e., cars and buses. Proposals for highly heterogeneous traffic scenarios are limited.

It is noticed that 75% of works implemented their strategy through an analytical approach whereas in recent times Artificial Intelligence (AI) is gaining popularity and 25% of the works implement their strategies based on AI. Green extension and red reduction are the conventional methods to handle TSP. Among the reviewed articles 14% of works have handled the conflicts (buses on multiple lanes). V2I and I2I communication is a widely used technology in TSPS and few works have demonstrated the importance of V2V as well. 81%, 50%, and 16% of the articles used V2I, I2I, and V2V communication, respectively. Overall, 41% of the articles use both V2I and I2I technology. The authors have illustrated the performance of their proposed models using metrics including person delay, vehicle delay, and travel time experienced in a road network. Reducing person delay is popular among the three metrics used.

Though there are challenges and issues in implementation, the benefits of TSP in long term override the challenges and TSP might be a part of every intersection in the future. The overall summary of the study is presented in two folds; general observation and ICT perspective observation.

General observations: Several solutions are available for implementing TSPS but are in the form of simulation than realistic, and very few works have been implemented in practice; Most of the research on TSP is conducted by countries like the United States of America, European countries, and China, and very little research is showcased by other countries. Hence, there is a need for awareness of the long-term benefits of TSP to motivate other countries to propose location specific solutions; There is a need to propose solutions for intersections that witness multiple vehicle compositions.

Table 2 Review—transit signal priority

References	Road infrastructure						Technology					Performance		
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
[8]	Greater Vancouver	✓	✓	–	–	✓	–	✓	✓	✓	–	–	–	↓ 33%
[15]	Chennai	✓	–	–	✓	–	✓	–	✓	–	–	↓ ≈ 22%	–	–
[19]	Florida	–	✓	✓	✓	–	–	–	✓	✓	–	–	–	↓ 3.4–7.4%
[24]	Canada	–	✓		✓	–	–	✓	✓	✓	–	↓	↓	–
[17]	Shanghai	–	✓	✓	✓	–	–	✓	–	✓	–	–	–	↓28%
[35]	China, Greece	–	✓	–	✓	–	✓	–	✓	✓	–	↓ 31.63%	–	–
[36]	Charlottesville	–	✓	✓	✓	–	✓	–	✓	✓	✓	↓ 57%	–	–
[37]	US	–	✓	✓	✓	–	✓	–	✓	✓	–	–	–	↓10%
[11]	Jinan, China	–	✓	✓	✓	–	✓	–	✓	✓		↓	–	–
[9]	Jinan, China	–	✓	✓	✓	–	✓	–	✓	✓	–	↓ 25.27%	–	–
[16]	Arizona	–	✓	✓	✓	–	✓	–	✓	✓	–	–	↓ 50%	> 25%
[38]	Chennai	✓	–	✓	✓	–	✓	–	✓	–	–	↓ 16.72–42.8%	–	–
[12]	California	–	✓	✓	✓	–	✓	–	✓	✓	–	↓ 14%	–	–
[39]	Pennsylvania	✓	–	–	✓	–	✓	–	–	–	–	↓ 4–9%	–	–
[40]	Changchun	✓	–	–	✓	–	✓	–	✓	–	✓	↓ 11.88–18.96%	–	–
[41]	Beijing	✓	–	✓	✓	–	–	✓	✓	–	✓	↓ 11.4%	↓ 4.6%	–
[42]	ZiboZhangdian	✓	–	–	✓	–	✓	–	✓	–	–	↓	↓ 26%	–
[43]	–	–	✓	✓	–	✓	✓	–			–	↓	↓	–
[44]	–	–	✓	–	✓	–	✓	–	✓	✓	–	–	↓ 25%	–
[45]	–	✓	–	✓	✓	–	✓	–	✓	–	✓	–	–	–

(continued)

Table 2 (continued)

References	Road infrastructure						Technology					Performance		
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
[46]	–	–	✓	✓	–	✓	–	–	–	✓	–	–	↓ 59.8%	–
[47]	–	–	✓	✓	✓	–	✓	–	–	✓	–	↓ 49%	↑ 8%	–
[48]	–	–	✓	✓	✓	–	–	✓	–	✓	–	–	↓	
[49]	–	✓	–	–	✓	–	✓	–	✓	✓	–	↓49.1%	–	–
[50]	Shanghai	✓	–	–	✓	–	✓	–	–	–	–	↓ 6%	–	–
[51]	Theoretical	–	✓	✓	✓	–	✓	–	–	–	–	↓		↓
[52]	Rome	–	✓	✓	–	✓	–	✓	✓	✓	–	↓ 44%	–	–
[53]	Chengdu	–	✓	–	✓	–	✓	–	✓	–	–	↓	↓	↑ < 1%
[54]	–	✓	–	–	✓	–	✓	–	✓	–	–	↓ 54.6%,	–	–

Note (LC) lane conflicts, (↓) decrease, (↑) increase, (A) location, (B) isolated intersection, (C) networked intersection, (D) consideration of bus stops, (E) non-dedicated lanes, (F) dedicated lanes, (G) analytical method, (H) AI, (I) V2V, (J) I2I, (K) V2V, (L) passenger delay, (M) vehicle delay, (N) travel time

ICT perspective observations: Connected vehicle technology needs to be explored more in the future, as V2V communication brings in more information about the current scenario of the road than other technology; AI solutions have been adopted recently but have yet to prove their efficacy compared to the conventional analytical approach; Technology for big data has to be adopted to handle TSP in the future, as the data collected through multiple sensors at various scales account for big data; Edge, Fog, and Mist computing will be crucial as the computations are decentralized and the decisions are taken on the fly.

4 Conclusion

Providing priority for buses reduces the overall person delay at intersections thereby reducing the total travel time of passengers. Transit Signal Priority (TSP) improves the reliability of the transit service and thereby attracts passengers to public transportation. For several decades researchers have proposed solutions to provide TSP, and recent advances in Information and Communication Technology (ICT) and its application in traffic management have triggered its usage in TSP. In this article, a review of existing TSP is conducted emphasizing the role of ICT in its implementation. Initially, the common stages of TSP implementation are discussed. Recent works on TSP are reviewed and it is observed that most of the works are conducted in developed countries as against developing countries. Most of the TSP solutions are presented for networked intersections as compared to isolated ones. Mixed traffic (car and buses) lanes are well-explored as against dedicated lanes and transitways. Conventionally, the TSP strategies use an analytical approach but recently artificial intelligence-based solutions are gaining attention. V2X and I2I communications are the base technology for information collection and sharing, but very few articles have exploited connected vehicle technology. V2V will be the base communication mode in the future for TSP. The performance of the proposed solutions is measured through person delay, vehicle delay, and travel time, and most of the works have demonstrated a reduction in person delay to illustrate their efficacy. Overall ICT plays a vital role in the implementation of TSP, with its long terms benefits, it is expected to be adopted by cities that aim at providing sustainable and smooth commuting for its citizens.

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