Lecture Notes in Networks and Systems 392

Vishal Goar
Manoj Kuri
Rajesh Kumar
Tomonobu Senjyu *Editors*

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Preface

The 3rd International Conference on Advances in Information Communication Technology and Computing (AICTC 2021) was held at Bikaner, Rajasthan, India, during December 20–21, 2021. The aim of AICTC 2021 is to present the ongoing research in the field and hence to foster research relations between the universities and the industry and to give participants a review of the latest and upcoming trends in the next few years. It also provides a leading edge, scholarly forum for researchers, engineers, and students alike to share their state-of-the-art research and developmental work in the broad areas of pervasive computing and communications.

Around 247 researcher papers were received from the different parts of the world in the conference that includes paper from countries like Russia, Algeria, Oman, Nigeria, Germany, UK, Vietnam, South Korea, etc. Those papers are reviewed by the experts of the field, and finally based on the reviewers' comments and decision, 55 papers were accepted for the presentation at the conference. AICTC 2021 thanks and acknowledges the efforts made by the reviewers for giving their time and suggestions for selecting the research papers for the conference.

The selected papers were presented by the respective authors in the sessions of the conference, session chairs along with audience discuss the methodology and results of each paper in detail, and suggestion was incorporated to make the paper more useful. A total of 9 sessions were held in the conference along with inaugural and valedictory function. The presence of the keynote speaker in every session also enhances the quality of each session, and the talk of the speaker was related to the theme of each session, thus making the event enriched with the knowledge and innovation related to the theme of the conference.

The selected and the presented papers in the conference are sent to the Springer for the purpose of publication in the reputed LNNS series. The CSI Udaipur Chapter, Rajasthan, India, gave the technical support for the proper organization of the conference. We are thankful to the speakers: Prof. Francesco Benedetto, University of Roma Tre, Rome; Dr. Enkeleda Lulaj, Ph.D., University Haxhi Zeka Peja State of Kosovo; Dr. Jitendra Pandey, Department of Computing, Middle East College, Knowledge Oasis Muscat, Sultanate of Oman; Dr. Manolo Dulva Hina, ECE Paris; Dr. Beatriz Lucia Salvador Bizotto, Unifacvest University Center, Brazil; Dr. Rajiv Ratan, Founder of MIDAS Lab, IIIT-Delhi; Dr. Nonita Sharma, NIT Jalandhar; Dr. Nilanjan Dey, JIS University, Kolkata, and Prof. Tien Anh Tran, Ph.D., Marine Research Institute, Vietnam Maritime University, Haiphong, Vietnam. We are thankful to the delegates and the authors for their participation and their interest in AICTC 2021 as a platform to share their ideas and innovation. We are also thankful to Dr. Amit Joshi, Director, Global Knowledge Research Foundation, and Mr. Aninda Bose, Senior Editor, Hard Sciences, Springer, India, for providing continuous guidance and support. Also, we extend our heartfelt gratitude and thanks to the reviewers and technical program committee members for showing their concern and effort during the review process. We are indeed thankful to everyone directly or indirectly associated with the conference organizing team, for leading it toward success. We hope you enjoy the conference proceedings and wish you all the best.

Bikaner, Rajasthan, India — Organizing Committee
AICTC 2021

Bikaner, India — Vishal Goar
Bikaner, India — Manoj Kuri
Jaipur, India — Rajesh Kumar
Nishihara, Japan — Tomonobu Senjyu

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About the Editors

Vishal Goar (Senior Member, IEEE) is currently working as Assistant Professor (Department of MCA) in Government Engineering College Bikaner, Rajasthan since July 2008. He received the MCA degree from IGNOU, New Delhi and also qualified UGC-NET (Computer Science) in 2012. He received a Ph.D. degree in Computer Science in 2013. He has wide experience of 17 years as an academician, researcher and in Industry. He has published 46 research papers in international journals (SCI/Scopus/WoS) and presented 41 papers in national/international conferences. He has been editor/ authored 11 books including reference, text and edited books of Springer, Singapore, ACM USA and Scholars-Press, Germany. He has published two patents and 3 patents grants in his credit. He supervised 6 Ph.D. research scholars in the area of cloud computing, software development, Neural Networks and Deep Learning. He also served as Organizing Chair, Convener, Publicity Chair of various Springer/IEEE/ACM internationally renowned conferences. His research area includes Security, Cloud Computing, IOT, Sensors and Deep Learning. He is the Life Member of Professional Bodies such as IEANG, ACM, ISTE, IACSIT, UACEE, CSTA, SDIWC and CSI. He has served as Technical Programme Committee (TPC) Member and a Reviewer in various Springer, IEEE international conferences, ICACE, ICCECT, ICCSIE and many more. He was invited to be an invited speaker/ Resource Person in TEQIP III Faculty Development Programs and delivered Keynotes in International conferences such as SmartCom-2020. He is also serving as Member of Board of Studies for prestigious universities as Bikaner Technical University, Bikaner, Maharaja Ganga Singh University, Bikaner and Tantia University, Sriganganagar. He is Member of the Research Board in Bikaner Technical University, Bikaner. He is also working as Editorial Board member, Advisory Board member and reviewer of many international journals

Dr. Manoj Kuri is B.Tech. (ECE), PG Diploma in Advance computing (CDAC Pune), M.Tech. (Digital Communication) and Ph.D. in the field of microwave satellite imaging from Indian Institute of Technology (IIT) Roorkee. He is presently working as Assistant Professor and Head (ECE, AI&DS) at the Government Engineering College, Bikaner, Rajasthan (India). He has teaching and research experience of 20 years. He has held many academic, research and administrative responsibilities in the past, such as Head (Computer science and IT department) and In-charge (Technology Business Incubation Center) and Registrar of the institute. He has many research publications in esteemed journals and renowned conferences. He is a member of many scientific and professional societies/bodies such as IEEE, ISTE, ISRS and IGRSS. He is also a member of IEEE Rajasthan subsection (2019–20). He has travelled to China, Spain, Bangkok, Dubai etc. and presented research papers there. His field of interests are in the field of image processing, machine learning and IoT.

Dr. Rajesh Kumar received the Bachelor of Technology in Engineering degree with honours in Electrical Engineering from the Department of Electrical Engineering, National Institute of Technology Kurukshetra, India, in 1994, Master of Engineering with honours in Power Engineering from the Department of Electrical Engineering, Malaviya National Institute of Technology, Jaipur, India, in 1997 and Ph.D. degree in Intelligent Systems from Department of Electrical Engineering, Malaviya National Institute of Technology (MREC, University of Rajasthan), India, in 2005. He is currently Professor in the Department of Electrical Engineering; Adjunct Professor at Centre of Energy and Environment at Malaviya National Institute of Technology, Jaipur, India. He has been Research Fellow (A) in the Department of Electrical and Computer Engineering at National University of Singapore from 2009 to 2011. He has been Reader from 2005 to 2009, Senior Lecturer from 2000 to 2005 and Lecturer from 1995 to 2000 in the Department of Electrical Engineering, Malaviya National Institute of Technology. He is the Founder of ZINE student innovative group. His background is in the fields of computational intelligence, artificial intelligence, intelligent systems, power and energy management, robotics, bioinformatics, smart grid and computer vision.

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Smart Society Development Analysis and Control Based on an Inductive Inference Method

Nickolay Gubanov, Evgeniya Dodonova, and Anton Ivaschenko

Abstract The paper presents the results of the development of an integrated methodology for the creation and operation of monitoring systems for a Smart Society. There is presented a new categorical model of a Smart Society as a complex multi-level system of inductive inference, with a dynamic and situational generated description. Multi-level representation and analysis of heterogeneous data are considered at the parametric, structural, and semantic levels of stratified system models of extended objects that meet the requirements of mathematical categories. Implementation is illustrated by an example of automated decision-making support in the area of medical health care.

Keywords Smart Society · Complex systems · Big data · Artificial intelligence · Decision-making support

1 Introduction

Modern processes of information technologies economy-wide implementation contribute to the integration and interpenetration of all the branches of material production, social and cultural life, and the sphere of services. Under the process of digital transformation, most spheres of human life become enhanced linkages and transubstantiate into a solid information space called Smart Society.

This trend necessitates the development of an integrated method of modeling and control, which would operate with universal categories of system analysis and allow implementing a unified approach to the design and implementation of a Smart Society in the process of digitalization. Below in this paper, a possible solution is proposed.

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2 State of the Art

Smart Society is a comparatively new paradigm that explores different aspects of human life from the viewpoint of social, economic sciences, and information technology [1, 2]. It addresses various social and environmental problems, particularly those connected with sustainability, usually by means of an intelligent connection with the network society. The concept of Smart Society studies the interconnections between the facets of "smart living" and their relationship to the notion of the Smart Society as a whole.

From the system analysis point of view, Smart Society is a large-scale infrastructural complex that forms the basis of the modern economic development of the region. Successful management and development of such a system determines the prospects for the development of industry, largely determines the structure of the economy, the investment attractiveness of the region. Information and analytical complexes for the collection, processing, formation, and information support of technical, technological, and managerial solutions for Smart Society are the main tools for system research in this area.

Due to this fact, the problems of Smart Society monitoring and analysis require processing big data [3, 4]. The implementation of artificial intelligence in this sphere requires automated data scheduling and analysis using smart applications, a smart infrastructure, smart systems, and a smart network. Effective formation and selection of information technology and organizational solutions require the analysis of multiple parameters that need to be consolidated by a unified topological structure that imposes additional complications.

For example, new technologies in the medical sector are one of the drivers to support the development of a Smart Society [5, 6]. In the healthcare sector, medicine can be considered as an example of a smart tool, strongly tailored, that embeds the innovation of materials, devices, and smart technology. A link between technological innovation and the healthcare sector allows adopting several outlooks on how to combine science with social science in order to remain human-centered.

The creation of an integrated methodology for the analysis and construction of information and analytical systems for assessing the state of Smart Society development is relevant in line with modern trends toward the integration of information and measurement systems, simulation and data mining, knowledge engineering systems, etc. Some experience in this area is presented in [6–9].

Therefore, information monitoring systems are the main tools for Smart Society development analysis and control. Smart Society as a complex system is characterized by a number of properties such as large dimension, the structure complexity, and the behavior complexity [10]. The development of this concept made it possible to formulate the requirements for the knowledge engineering technology. The proposed concept for the development of the Smart Society in the form of a complex system necessitates the solution of scientific and technical problems inherent in the development of systems of this class such as

- the development of methods of representation, data, knowledge, and models;

- the creation of a complex of methods and algorithms for inductive inference;
- the development of a system for integrating inductive inference methods;
- the formation of a unified system of numerical criteria for inductive inference.

This problem is closely related to the issues of choosing the concepts of system modeling and intelligent data processing technologies [11, 12]. The analysis of data presentation tools for the formation of multi-model complexes shows the prospect of using the categorical and function apparatus based on a homomorphism mapping, which allows one to describe objects invariantly to their internal structure.

The main challenge in the existing studies consists in the lack of a tool capable of modeling of the Smart Society development states and processes using the terms of categorical descriptions. To cover this gap below, a new model of a Smart Society as a complex multi-level system of inductive inference is presented, with a dynamic and situational generated description and its implementation in the area of medical health care.

3 Smart Society Categorical Model

The categorical modeling apparatus was used to describe the basic trends of Smart Society development for multi-level presentation, analysis, and processing of heterogeneous data and models. This approach provides formalization of parametric, structural, and semantic levels for all stages of operation, including the measuring telemetry parameters, processing measuring information, formation of algorithms for calculating target parameters before the formation of models of knowledge bases.

Within the framework of this apparatus a number of constructive conclusions and methods are proposed. They contain a set of categorical descriptions, identifying the structure and properties of relations and knowledge models, form algorithms for formal decomposition and aggregate the elements of data structures.

Based on the generalized scheme of inductive output systems, Smart Society is represented by a categorical system:

$$S = \left\langle M_I^{(S)};\, M_I^{(E)};\, R_I^{(J)};\, Q_I^{(J)} \right\rangle \Big| I \in \{\text{name}\},\, J \in \{\text{level}\},$$

where the source and generated literals are represented by category objects in the form of system situations $M_I^{(S)}$ and system samples $M_I^{(E)}$, rules for their transformation R_I^J, and criteria Q_I^J for evaluating conversion options.

The system situation $M_I^{(S)}$ represents the complex state of the computational model that determines the state of the study object or its fragment, covering a certain area and reflecting some regularity of its state dynamics. The system sample $M_I^{(E)}$ generalizes a certain set of system situations and is a computational model, which consists in the calculation of target monitoring parameters.

Processing of these parameters gives a further assessment of the Smart Society state, based on the information from the study objects measuring tract, taken as the only objective source of the processed data. Combination of the models is implemented by the concatenation operation. Algebraic properties of this operation are described by the algebra $\Theta\left(\oplus; m_i^j\right)$. The formed category of system models is defined as follows:

- computational models $\mathrm{Ob}\left(M_i^K\right)$ are defined as objects of category M;
- for each pair of objects $\mathrm{Ob}\left(M_i^K\right)$ and $\mathrm{Ob}\left(M_j^K\right)$ a set of morphing is defined $\mathrm{Hom}\left(M_i^K; M_j^K\right)$;
- the composition of three objects is defined for any three objects $\mathrm{Ob}\left(M_i^K\right)$, $\mathrm{Ob}\left(M_j^K\right)$ and $\mathrm{Ob}\left(M_\partial^K\right)$;
- morphing $\varphi = \mathrm{Hom}\left(M_i^K; M_j^K\right)$ and $\psi = \mathrm{Hom}\left(M_j^K; M_l^K\right)$ composition is defined $\varphi\psi = \mathrm{Hom}\left(M_i^K; M_l^K\right)$;
- for every object $\mathrm{Ob}\left(M_i^K\right)$ a unit morphing is defined $1_x = \mathrm{Hom}\left(M_i^K; M_i^K\right)$.

A formal representation of the problem of inductive inference is proposed as replacing system situations with a systemic model of the form:

$$
\begin{aligned}
S^{\mathrm{Obj}} &= \left(s_{\langle n_1\rangle}^{\mathrm{Obj}}, s_{\langle n_2\rangle}^{\mathrm{Obj}}, \ldots s_{\langle n_k\rangle}^{\mathrm{Obj}}\right) \to E_{\langle n\rangle}^{\mathrm{Obj}} \\
&= \left(M_{\langle n\rangle}^{\mathrm{Obj}}, D_{\langle n\rangle}^{\mathrm{Obj}}\right) | n \in \{\langle \mathrm{name}\rangle\}; \mathrm{Obj} \in \{\mathrm{Kunc}\},
\end{aligned}
$$

where S^{Obj} is a set of system situations; $E_{\langle n\rangle}^{\mathrm{Obj}}$ is a system sample; $M_{\langle n\rangle}^{\mathrm{Obj}}$ is a model; $D_{\langle n\rangle}^{\mathrm{Obj}}$ is residuals of the system model.

A generalized criterion for the procedure of inductive inference is formulated: based on the apparatus of information theory and developing methods of the minimum description length:

$$
m_i^E = \underset{m \in M}{\arg\min}\left[I\left(m_i^E\right) + I\left\langle M_I^S \mid m_i^E\right\rangle\right].
$$

Therefore, the situation, formed by the concatenation of system samples, selected as a result of the analysis of system situations makes up a network-based categorical model.

4 Multi-level Analysis

Three system levels are distinguished using the Smart Society model:

- Parametric level (p-level) determines the quantitative characteristics of the system situation. The situation is determined by the subcategory of the category of sets. The objects are finite sets of parameters of the computational model of the sub-objects, and the morphing of the mapping of the corresponding sets.
- Structural level (s-level) determines the transition to the next hierarchical level of model representations and is associated with the allocation of invariants for the model of the current level. For the category of the parametric level, the order relations are the invariants. The presence of the structure of the parameters of the objects allows you to specify the basic elements, on the basis of which the topological structure and topological space are subsequently determined.
- Semantic level (c-level) is defined by the society system, in which s-level objects are defined as initial and generated literals.

A resulting society structure is formed by a hierarchical structure, the elements of which are linked by a general-particular relationship of classes (see Table 1).

The proposed interrelated multidimensional methods of inductive inference provide a technology for Smart Society development analysis and control.

Analysis task solution is based on the implementation of the life cycle of knowledge engineering and consists in a step-by-step procedure for the selection, generalization, alienation, and subsequent use of information. Inductive inference approach consists in the procedures for the formation (selection) of system samples of a given level and a given generalization indicator as a result of generalizing system situations of a certain level.

The specificity of this procedure is determined by the peculiarities of the subject area and consists in the high computational power of the problem, the need to introduce interpretive procedures of various inductive algorithms. The strategy for solving the listed tasks in this study is reduced to the artificial development of a complex, multi-level hierarchical structure.

On the basis of multi-level inductive inference algorithms, methods of processing computational models of the corresponding levels are developed, and on the basis of the adaptive resonance algorithm, an inter-level interaction of objects is formed for the purpose of formation.

5 Implementation in Smart Society Medical Health Care

The proposed method was implemented in a situational center based on a geographic information platform, including the information widgets that describe the dynamics of the current indicators of the development of the Smart Society. The system was developed by SEC "Open code" and is capable of processing the input data from both official information systems and open sources. The example that illustrates the case of monitoring the provision of the population with high-tech medical services is presented in Fig. 1.

Table 1 Levels of system elements formation

Function	Existing knowledge engineering problem	Formal model
Comparison of p-situation with p-sample	Classification and recognition without learning	$\mathrm{Ind}_1^p = (D, H, q(h\|D)); D \in X = \{x_1, x_2, \ldots x_n\}; H \in A; q(h\|D) = \arg\min\big(x_i, a_j\big); R_{kl}^p;\ S^p \cup E^p \exists e_j \cup O_{kl} \to$ $E_j^p; j = j+1, 1 \le j \le l, S^p, E^p \in \mathrm{cat\,P}; e_i^p = \underset{e_i^p \in E^p}{\arg\min}\big[l\big(\langle e_i^p\rangle, q\big(p\|\langle e_i^p\rangle\big)\big)\big]$
Formation of p-samples on the basis of s-situation learning	Recognition, learning with a teacher	$\mathrm{Ind}_2^p = (D, H, q(h\|D));\ D \in \big((x_i, a_i)_n, n \in N, \|N\| = \mathrm{lern}\big);\ H \in \{q : X \to A\} R_{\mathrm{Lern}}^p;\ E^s \cup E^p \exists e_j \cup O_{\mathrm{Lern}} \to$ $E_l^p; j = j+1, 1 \le j \le l, E^p \in \mathrm{cat\,P};\ E^s \in \mathrm{cat}\, SM = \underset{M}{\arg\min}\Big(l(M) + \sum_{i=1}^{M_{\mathrm{lern}}} K(m_i\|M)\Big)$
Formation of p-samples	Clustering, learning without a teacher	$\mathrm{Ind}_3^p = (D, H, q(h\|D)); D \in X = \{x_1, x_2, \ldots x_n\};\ H = \{x_j\}_{j=1}^N$ $j = j+1, 1 \le j \le l, E^p \in \mathrm{cat}\,(P); R_{\mathrm{taxon}}^p;\ \exists e_j \cup O_{\mathrm{taxon}} \to E_t^p;$
Comparison of s-situation with s-sample	Grammar analysis, parsing	$R_{kl}^s;\ S^s \cup E^s \exists e_u \cup O_{kl}^s \to E_j^s;\ e_i^s = \underset{m \in M}{\arg\min}\big(L\big(m_i^S\big)\big)$ $j = j+1, 1 \le j \le l, S^s, E^s \in \mathrm{cat}\, S; \mathrm{Ind}_1^s = V_T, V_N = \{M\} P_M = \left\{\begin{array}{l} m_1 m_2 \ldots m_{n-1} M \xrightarrow{P(m_n\|m_1 m_2 \ldots m_{n-1})} \\ a_1 a_2 \ldots a_{n-1} a_n M \| m_i \in V_T, n = 1, \ldots, N \end{array}\right\}$
Formation of s-samples on the basis of p-situations learning	Formation of generative grammar	$\mathrm{Ind}_2^s = \{M\} P_2^s = \left\{ S \xrightarrow{P(M_{i\|}\|M^S)} M_1^E \ldots M_n^E, M \right\} R_{\mathrm{lern}}^s;\ E^c \cup E^s \exists e_l \cup O_{\mathrm{lern}}^s \to E_j^s;$ $j = j+1, 1 \le j \le l, E^s \in \mathrm{cat}\, S;\ E^c \in \mathrm{cat}\,(C);$

Fig. 1 Automated decision-making support based on Smart Society monitoring

The electronic map in the implemented system is organized in the form of a categorical model, which makes it possible to superimpose several levels of description. Comparison of the dynamics of diseases by region is based on registries and displays the location of medical organizations on a map that provides the corresponding services. On its basis, the annual planning of their equipment resourcing is carried out in real time based on the monitoring of patient satisfaction. At the top of the screen, three filters are set that determine the direction of monitoring: nosology, ICD-10 code, population category.

The system has the ability to describe the situation using the system samples as shown above providing a detailed display of information. Thus, it becomes possible to track the distribution of medical organizations on the scale of individual regions. The analysis of coverage by medical healthcare services of the relevant territories considers the balance of demand and supply. This tool can be used to assess the effectiveness of financial and staffing of medical organizations, whether or not meeting the objectives of combating diseases in specific regions.

For each medical organization, various indicators are displayed, for example the availability of personnel and medical equipment. Comparison with the incidence rate makes it possible to determine the required volume of staffing and high-tech support. For this, several options for additional financing are calculated, considering the equipment of other medical organizations of the same system sample. If possible, the system recommends the redistribution of financial, human, and technical resources in such a way as to fully meet the demand for a given type of medical services.

The system collects and analyzes information about performance indicators and parameters for assessing the quality of work of various types of medical institutions as well as displays the distribution of resources and the level of patient satisfaction depending on the type of institution. Taking into account periodic seasonal fluctuations in time, as well as peak jumps in diseases associated with epidemics, the system can model their level of development as part of a Smart Society and, thus, control the provision of the population with medical services.

The forecast is carried out using modern intelligent technologies that allow assessing the development of demand for medical services, taking into account the construction of new residential and industrial quarters, population migration, and the influence of environmental factors. Optimization methods can be also applied here including the stochastic gradient method, etc. As a result, additional healthcare support measures are planned with an appropriate funding program.

6 Conclusion

The new model of a Smart Society as a complex multi-level system of inductive inference allows developing an efficient solution for knowledge engineering, e.g., in the area of medical health care. The proposed methods of multi-level formal representation, recognition, and generalization of Smart Society elements can be further used as a knowledge engineering technology in various systems for monitoring, analysis, and decision-making support.

Next steps are planned to further implement the proposed method in various areas of decision-making support for the Smart Society development.

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The Emergence of Sustainability Adoption in the Healthcare Sector During COVID-19

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Abstract The world is struggling to get rid of a coronavirus pandemic that has captured the whole world. It has not only changed the overall picture of the world but also the overall economy is in the toss. The whole economy was affected due to this pandemic. The various healthcare informatics have played an important role in the fight against COVID-19. There are various digital tools for pandemic preparedness and response such as screening of infection, quarantine and self-isolation, contact tracking, medical supplies, planning and tracking, clinical management, etc. Also, the APPS with the update, Civil Society's with the COVID response, contact tracing, identity and COVID-19, immunity passport, location (GPS) data, migration ants, quarantine administration, telecommunication data, temperature scanning, and social media updates are the concern in the digitalization used for fighting COVID-19. Technological advancements have given a new direction to the healthcare industry. Sustainability in health care not only leads to economic but also social and environmental equality. The government has started thinking in that line so that all can be benefited from these technological advancements in the healthcare industry.

Keywords COVID-19 · Health care · Digitalization

1 Introduction

COVID-19 is an infectious disease as defined by the World Health Organization (WHO). It was caused by a newly found coronavirus. COVID-19 emerged in Wuhan located in China in December 2019 and spread to nearly 160 countries in less than three months. The total cases confirmed across the globe are more than 5,703,887

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with almost 353,628+ deaths. It is the sixth pandemic that has been declared in about a century [1]. According to WHO, COVID-19 is a pandemic declared on March 11, 2020. Most COVID-19 infected patients show fever as the first symptom. Cough or fatigue is also common symptoms at the onset of illness. Symptoms that are less frequently recorded include palpitations, vomiting, and diarrhea [2]. After hospitalization, a group of patients experiences dyspnea symptoms at days 5–8 [3]. From days 7 to 10 after hospitalization, 15% of patients have experienced pneumonia, which is acute respiratory distress syndrome (ARDS), which leads to heart attack, kidney attack, or multi-organ failure**.** A subset of COVID-19 patients may require ICU admission and respiratory artificial support with noninvasive ventilation or invasive ventilation, or probably extracorporeal membrane oxygenation [4]. The main mortality risk factors among COVID-19 cases are old age and underlying respiratory disease. The reasons behind these age groups are unclear, but some hypotheses can be extrapolated from host–pathogen biology. Immunosenescence can lead to increased risk among older adults [2].

At the same time, even when reacting to established antigens, aging immune cells have less proliferative and functional ability. These age-related changes in cellular immunity indicate reduced vaccine effectiveness, worse influenza results, respiratory syncytial viruses, and herpes zoster infections and have been seen in coronavirus infection models of the mouse [5]. As the lungs mature, the restorative potential of the airway epithelium is also reduced. The frontline workers are working very hard and facing many troubles while saving our lives against coronavirus. Many of them have even lost their lives. Most of the frontliner workers are not even allowed to go back to their homes. There is no definite solution to this problem right now and with no or few proper types of equipment being provided lots of issues are being faced by the frontline workers [6]. The hospitals have divided themselves into many zones such as COVID zone, fever zone, and OBA zone. All the patients entering the hospital are given masks, and their temperature is also being checked first. All the doctors, staff nurses, paramedics, housekeeping, and patient attendants are provided sufficient PPE in the workplace [3]. Separate lifts are being made, separate ways are being constructed to the isolation wards for the COVID patients. Separate ICU with separate ventilators, multipara monitor for each bed is being made available. Separate doffing and donning are also being made available in the ICU. Entry areas for doctors are made separately to demarcate clean and contaminated areas finished [7].

In this COVID-19 scenario, it has not only brought the world together but also people have started thinking of each other and helping each other despite distance and other barriers. In this pandemic India, Israel, the USA, and Mexico have come forward to help many other small countries. They have also shared the medicines and other equipment. This will be the highest level of sustainability [8].

2 Literature Review

All the yearly and quarterly objectives become irrelevant. The economy comes under stress as there are very low demands and low investments, and in a medical crisis like this, it becomes very difficult to stimulate sustained economic activities [9]. Regarding COVID-19, the FDI is expected to drop by 30–40%, and there has been an estimate that due to the global crisis, the economy will shrink by 6–7 lakhs crores which is a huge loss for developing countries like India where the risk of resurgence is also uncertain. It was also predicted that there will be remittances loss, the prices of the crude oil will also fluctuate and all construction industries will be bleeding heavily, as all projects will stop or move at a very slow pace. There are a few pillars that should be kept in mind while making the strategies namely people, demand, supply, and cash flows. India is a major startup hub, so post-COVID-19 startups can help in boosting up the economy. Some other opportunities that can be created from this current crisis are, for example, the government coming up with special packages, lowering up the stamp duty charges, relaxation is given to the railways and other means of transport, or providing technological development funds to push digital infrastructure [10]. Literacy will no longer be only about reading and writing but it will be about learning, unlearning, and relearning, and it is very important to implement such revolutionary changes into the grassroots, which means changing the policies because, in the end, this will outlast the crisis. Today coronavirus has pushed everyone into some sort of discomfort, the fear of the unknown which is keeping everyone awake and we all should try to just minimize the risk which in other words means having a "strategy." The strategy is all about making choices, building new skills, being around the good skills that you have strengthened [11–13].

Sustainability is a need of today. Sustainability will help everyone be sustained and also use their skills to upgrade and be more economical in every sense. As the COVID-19 pandemic, people are experiencing a wide range of feelings, thoughts, and reactions such as anxiety, feeling stressed, sadness, frustration, feeling disconnected from others. This is due to the loss of many lives in just 2 months, changes in our way of living such as travel restrictions, social gatherings, and work from home. The strategy to cope with anxiety, stress is that when everything is going beyond our control in such a situation, we need to focus on the things that we can control such as we can do meditation exercises to keep ourselves calm, by doing something creative such as drawing and painting by doing so we can eliminate all negative thoughts and starting adopting positive thoughts. Physical distancing does not mean social disconnection, uses technology to keep in contact during the stay at home by video-chat with friends and family and joins an online group. Media consumption overtime has become inelastic such as television, print media during COVID-19. COVID-19 pandemic results in a cut in advertising expenditure across all the media. However, the consumption of digital media is increasing as people are housebound. This has achieved economic and environmental awareness among all [14, 15].

COVID-19 pandemic affected the hospitals' duties very badly. Precaution needs to be taken for every aspect whether it is the testing of any disease, any surgeries that will be going to take place during the pandemic of COVID-19. COVID-19 also impacted the supply chain concerning the shortage of ventilators, personal protective equipment (PPE) kit that the demand for such is the rise in hospitals during the COVID-19 pandemic. Lack of various other equipments such as gloves, face shields, hand sanitizer led to big problems as doctors are not able to treat patients. Without these types of equipment, all these types of equipment are essential for hospital staff to give treatment to patients. Nowadays, this equipment is like tools just like, i.e., army wants guns to fight on the border just like doctors want this equipment to treat a corona-infected patient.

3 Healthcare Sustainability Framework

S. No	Level	Pillar association	References
1	Basic material, drugs, and medical devices	To support process-based clinically relevant applications, research on healthcare product materials	[16]
2	Clinic care pathways	Clinical bottom-up research is essential to understand both drivers of and solutions to environmental emissions, as clinical activities are the major driver of resource utilization in health care	[16, 17]
3	Medical facility (hospital and clinic)	Discussed sustainability benchmarking and helps in the research area for strategic decision	[18]
4	Heath system	The industrial ecology framework seeks to develop solutions and strategies that eliminate waste and pollution from human systems, keep products and materials in use, and regenerate or renew natural systems	[19]
5	National health care	A comprehensive approach to healthcare environmental emissions research, including analytical methods and tool development, is needed to better evaluate clinical materials and processes, and aid in the development of performance metrics to guide and track progress	[20]

(continued)

(continued)

S. No	Level	Pillar association	References
6	Global supply chain	Healthcare sustainability studies are beginning to draw lessons from a be sustained global comparison of clinical practices, including between developed nations as well as between developed and developing nations	[21]

There are four pillars of sustainability such as social, environmental, economic, and human. This has been seen during pandemics and emerged during pandemics. Sustainability has been studied at various levels in the healthcare system. Economic rising is demand in financial crisis. Waste destroys the environment and pollutes air and water also. A focus on sustainability offers us a way to go at least some way to tackle all of these issues social inequalities, safety/quality of the patient and it will be also an experience to staffing and morale of the individual.

4 Sustainable Healthcare

Sustainable governance in the healthcare industry sustainability, health care has two words. The first word is sustainability and is defined as meeting the needs of the present, without compromising. The ability of future generations to meet their needs sustainability and adds the value to the organization employing customers and community. It helps the organization to help the employees. It will also grow automatically, the customer will be benefited out of it, and it will help the community. Also, it has an environment surrounded by it, which will also be beneficial. There are five reasons for investing in sustainability.

- It contributes to society.
- It has a competitive financial advantage.
- It also considers the environment.
- It saves money in operational costs and reduces waste.
- It also considers the health and safety of the employee and the customer.

Sustainability. Having customer citizenship it is, it also has volunteers, a voluntary system. It is human well-being. It explores the great outdoors. It chooses the option for a meal on the go. It locates the farmer to the market in their area. It plants the vegetable garden and within the boundary walking instead of using a bike or car. So sustainability in health care is connected to health responsibility, living, and improved health care is connected.

Sustainability building in health care is improving the air quality, natural light, and comfort. They have increased the number of patient's visiting the hospital because of the new facility and happy employees, sustainability makes the business model.

So, the use of nature reduces stress, improves sleep, reduces depression, recreates anxiety, and reduces happiness. The Grecian pro-social behavior lowers the blood pressure better birth outcomes, reduces obesity, reduces diabetes, improves eyesight, improves health, and quiche. The benefits of sustainability health care are increasing brand and customer loyalty, reducing the cost and attracting more business, increasing employee retention and recruitment success, and reducing health and safety concerns.

Electronic health records (EHR): Over the years, technology has improved health professionals and medical treatment in key ways. It has started keeping the electronic records of the patient. Keeping electronic records means the patient does not have to take a copy when he/she visits the doctor. During COVID-19 time, when the patient is not able to visit the doctor, it has helped everyone to just to tell a number of its electronic card called electronic health records (EHRs). The doctors can see all the history of that particular patient along with the treatment that happened in the past and update the date with his consultancy. The electronic card not only keeps the records of a patient but also can be linked to its history records with genetic features, which can be stated in the report.

Personalized Treatment: The health care system can increase patient engagement. It will be with different devices called wearable technology. This can be further analyzed and used by the researcher in healthcare analytics which gives a reasonable plan for your health recommender system. It helps to increase the lifestyle of the individual and also improves your mental and physical health. This will help you to manage critical conditions in advance, and one can refer to the doctor at a very early stage.

Telehealth is again a virtual health care that improves the efficiency by communication between the health providers, clinic and patient by using the technology of electronic communication. This will allow the clinic or clinician, patient to exchange the information. The urgent waiting care rooms can be used for taking care of the patient. So, if the doctor is not able to visit a particular waiting room, then it can be disgusted or can be seen or it can be briefed to the clinical person working there.

Surgical technology. This is based on plastic, and it is reconstructive to the surgeon, which is technology-based and will be in the operation theater. This technology has the data, and all the reactions will tell and the surgeon will follow. It is believed that the technology is hand-in-hand with medicine, steps, and also the details of tests required for pre-operational planning. In cancer, especially the robots are helping in surgical technology in a vast range. This surgical technique is helping the doctor where the doctor cannot have to go to the operation theater, not examine the patient physically but virtually digital surgeon or the robot to play an active role and examine the patient in the presence of medical staff.

Artificial Intelligence and Augmented technology In many cases, the combination of two evolving technologies has opened the possibility of medical treatment, where artificial intelligence and the augmented technology are used in health care. AI helps to study the accuracy and study the consequences placed beforehand by directly applying to the patient. The size of plastic liver and kidney plantation is the best example of it [15, 22, 23].

5 Conclusion and Future

The healthcare industry has set the future, and there are many innovative practices such as smart inhalers, teletherapy, precision medicine for cancer treatment, artificial pancreas, and medicine for arthritis. Smart inhalers can be fitted in the nose and will be helpful to the patient. Teletherapy is a web-based solution where the doctor does not have to physically visit the patient. The physician will suggest the patient dose or medicine based on the required and specific to study the genetics of the patient by using precision medicine for cancer treatment. It is designed to automate the blood sugar level and stabilizes the sugar blood vessel level. Medicine for arthritis is based on genes and will be more authentic and gives fruitful results. This can only be possible due to the extensive use of data in healthcare systems. The digital technology is used in a pandemic helped to control the infection. It also integrates into different countries, and their response can be in the form of different characteristic features that have flattened their incidence of COVID-19. In health care, the sustainability models emerge as creating financial sustainability, new care delivery models and regulatory compliances, and cybersecurity.

It also maintained low mortality rates. There have been races between various countries that have helped globally to mitigate the risk of infection of this virus. The highly transmissible virus has spread very quickly. The deployment of digital technologies such as tracking and tracing has facilitated planning for action in countries. The use of digital technology in their day-to-day routine has managed greatly and also has controlled the corona pandemic. The investigation and testing that happened in the country are very essential for any country. The tracing of contacts through a mobile application, wearables, etc., has managed the disease. The immunity and oxygen level in an individual play an important role. The mutation of the virus is not fixed, and it is changing. The symptoms' behavior is changing over time. Also, there will be a need for post-COVID care required for all who were infected by the coronavirus. Personal care is needed to all so please take care of all your loved ones. The inclusive responses of countries that have been successful at inhibition can provide insight into other countries.

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Ultra-Wide Band Radar System for Respiratory Detection and Localization of Static Multi-targets in LOS Confined Environment

Zohra Slimane, Abdelhafid Abdelmalek, and Ibrahim Yassine Nouali

Abstract This work focuses on the study and implementation of 2 GHz-bandwidth ultra-wideband pulsed system radar for static multi-targets LOS indoor detection and localization based on multilateration. UWB technology is an emerging technology in the field of indoor positioning that has shown better performance as compared to others. The detection of static targets is possible thanks to respiratory movements. When the breathing frequencies are detected, target can be located using TOA estimation and multilateration. In LOS conditions, even if there are no obstacles, multipaths exist, and subsequently direct paths are submerged by an impulsive multipath noise. This leads to significant decrease in accuracy. In order to extract detection and location information and handle LOS error, a data acquisition protocol and specific processing algorithms are used: clutter suppression, direct path detection algorithm, low frequency and correlation spectral analysis, and finally multilateration. Through simulations conducted under MATLAB/Simulink, respiratory movements of three targets at maximum range of 10 m, were detected and successfully located with high precision for less than 5 dB SNR.

Keywords UWB · Radar · Indoor localization · LOS · Multilateration

1 Introduction

Indoor positioning or localization is a technology that allows knowing the location of a person or a product in a closed environment, where GPS data is not available, for example in factories, warehouses, buildings, etc. [1–3].

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In recent years, the positioning of human targets in indoor environments has become a critical function in many applications. Nowadays, positioning of human targets in indoor environments has become a critical function in many civilian and military applications. Various indoor positioning technologies exist today. Due to its exceptional properties (penetration and resolution), ultra-wideband (UWB) has been identified as the best technology for accurate indoor positioning. UWB technology is a very interesting alternative that makes it possible to meet the high precision requirements, but also the compactness and low consumption requirements. In practice, UWB signals effectively measure the distance between two targets with an accuracy of 5–10 cm, compared to an accuracy of about 5 m for Wi-Fi and Bluetooth; in this paper, we are interested in a feasibility study of radars based on this technology for the indoor localization of static multi-targets. To do this, the radar is implemented and evaluated over a Gaussian LOS multipath channel environment (LOS-AWGN), using MATLAB/Simulink. Localization techniques in internal environments face two major challenges: multiple paths due to diffusion and loss of propagation due to several factors and phenomena at transmission levels and characteristics of the internal environment.

The UWB technology is specifically adapted for the estimation of TOA and TDOA parameters thanks to its wideband. It is on this principle, as we will see in the next section that the proposed radar will operate. By using very short pulses (<1 ns), UWB technology is able to provide accuracy and resolution of a few centimeters in radar location and imaging applications.

The remainder of this paper is organized as follows: Sects. 2 describes the model of the proposed solution. We present the radar system implementation in Sect. 3, and simulation results in Sect. 4. Finally, Sect. 5 concludes the paper.

2 Proposed Approach

This section describes our proposal for a UWB radar system for the indoor location of static people and summarizes its implementation. Radar and target modeling will be presented. Then, the signal acquisition and processing steps for the extraction of location information, namely the spectral analysis in slow time for the detection of the presence of the target, and the correlation of the transmitted and received signals for the measurement of TOA, and finally, the localization by multilateration will be described.

2.1 System Model

In the architecture of the monostatic UWB radar, we propose that the transmitter contains several blocks necessary for generating and transmitting the UWB signal, and the most important of which are described below.

The PRF generator allows realizing pulsed radar, by rhythming the generation of UWB pulses by a pulse repetition period (PRP) equal to 1/ pulse repetition frequency (PRF). The choice of PRF is determined by the maximum distance before ambiguity, given by (1):

$$\mathrm{PRF} = \frac{C}{2D_{\max}} \tag{1}$$

$D_{\max}$ is the maximum radial distance before ambiguity in the case of free space propagation.

The generator delivers the UWB pulsed radar signal. The RF modulator transposes the UWB baseband signal into frequency. The carrier frequency F_c is set to 4.2 GHz. The receiver consists of several blocks, including RF and digital processing operations involving: the step of detecting the presence of human beings, which is possible thanks to respiratory movement; this includes clutter suppression, direct path detection algorithm, low frequency, and correlation spectral analysis, and then the step of localization is done by multilateration based on TOA measurements.

Human respiration can be considered as a certain periodic movement of the TOA arrival time. The breathing frequency may change slowly over time but it is almost always in a frequency range of about 0.2–0.8 Hz.

2.2 *Detection of a Static Target*

The respiratory movement is modeled by a periodic function (a sinusoid in the simplest case).

$$d(t) = d_0 + d_m \sin(2\pi f_b t) \tag{2}$$

$$\tau_b(t) = \frac{2d(t)}{c} = \tau_0 + \tau_m \sin(2\pi f_b t) \tag{3}$$

Subsequently, we model the propagation system by a dynamic channel: The respiratory movement, in a static environment, is translated into a time-varying channel impulse response. Data acquisition consists of a matrix slow-time and fast-time. To detect the presence of a human being, the Fourier transform (FFT) is performed along the slow-time axis after removing the DC component. The corresponding spectrum is a discrete function, consisting of a set of Dirac functions centered on the harmonics of the breathing frequency [4, 5].

2.3 Time of Arrival (TOA) Measurement and Target Positioning

TOA measurements are performed at different locations of the radar. The TOA is obtained by correlating the transmitted signal with the echo. The purpose of the location phase is to determine the coordinates of targets in the defined coordinate system in which the target location is estimated. In this case, the position of the target is determined by the multilateration technique (intersections of the circles formed by the radar positions and the distances associated with the estimated TOAs) [6, 7].

3 Radar System Implementation

Implementation and simulation are conducted under Simulink. In the implementation of our model, we consider three parts: the UWB transceiver, the LOS propagation channel under the hypothesis of a Gaussian noise, and the static human target (Fig. 1).

3.1 Implementation of the UWB Transceiver

For the transmitter, we use a monocycle UWB pulse generator (pulse width 0.6366 n, Fig. 2) with a pulse repetition period equal to 100 ns (from Eq. 1, take maximum range 10 m). The next stage allows the signal to be converted into frequency, thanks to I/Q modulation. At the receiver level, after I/Q demodulator step, the following

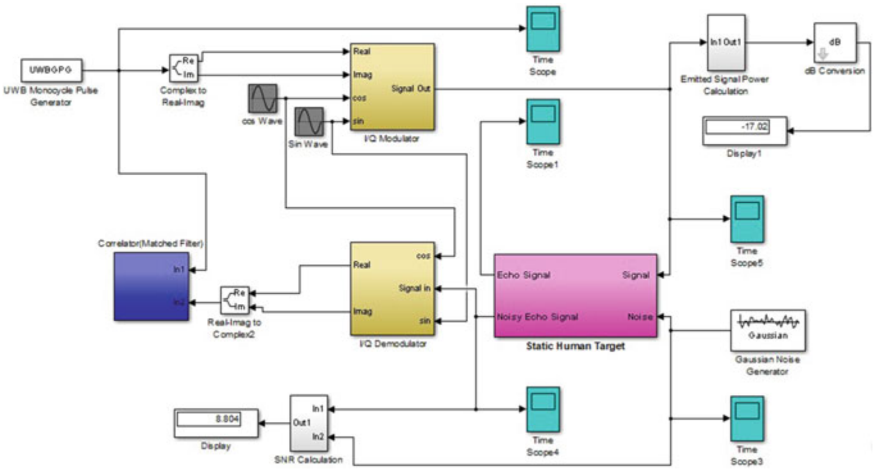

Fig. 1 UWB radar implemented in Simulink

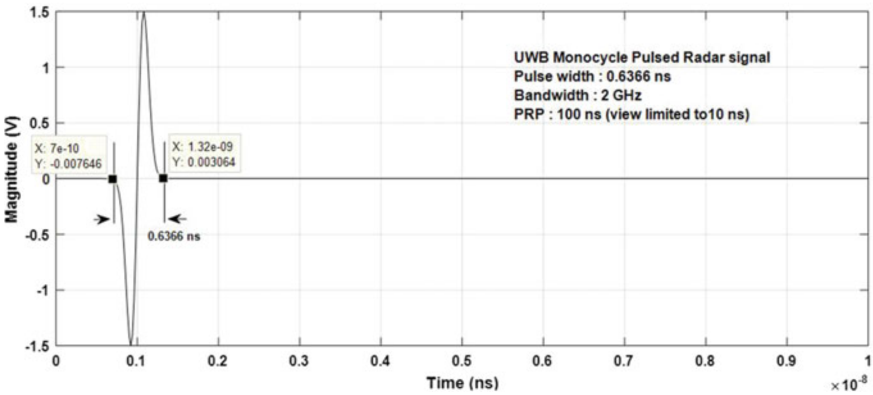

Fig. 2 UWB monocycle pulse

processing operations are carried out: clutter suppression, matched filtering (correlation), slow-time spectral analysis, direct path detection algorithm (singular value decomposition) and TOA estimation, and finally 2D multilateration based on TOA measurements.

3.2 Implementation of the Channel and Target Reflection

The breathing movement is implemented by the "Variable Time Delay" block which translates the sinusoidal model presented above (Fig. 5). The breathing frequency will be set between [0.2 and 0.8] Hz. We adopted IEEE 802.15.3a channel model CM1 for The LOS multipath model (Fig. 3) [8].

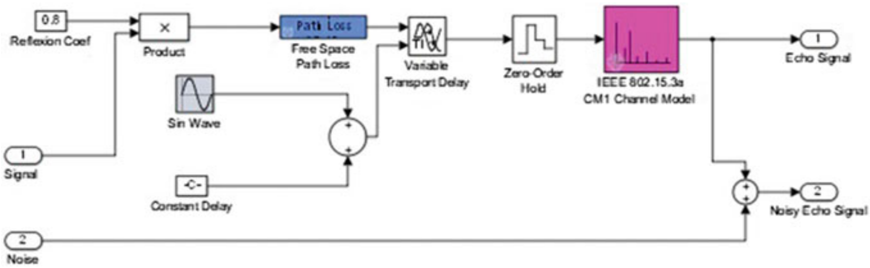

Fig. 3 Simulink implementation for target and LOS-C1 channel model

4 Simulations and Results

For data acquisition, we filled the slow-time and fast-time matrix, using the following parameters:

- Time measurement: 4 s
- Slow-time frequency sampling Fslow = 100 Hz
- Recorded frames in slow time: 4 * 100 = 400
- Fast-time frequency sampling Ffast = 50 GHz
- Fast-time recording delay: 100 ns (corresponding to a range of 10 m).

Therefore, each recorded echo signal contains $N = 100 * \text{Ffast} = 5000$ sample points. We then get a matrix $M \times N$ (400×5000) of data points. The background clutter represents the average of the echoes in slow time, so it can easily be removed. Figure 4 represents the noisy echo received signal for which the clutter is suppressed (i.e., one row of the above matrix).

For an optimal receiver, a matched filter is essential to get maximum SNR. To do so, we correlate the transmitted and received signals as a function of time; the result is shown in Fig. 5.

The detection of respiratory is then done by the treatment explained in Sect. 3.2, and the result is shown in Fig. 6. Thanks to singular value decomposition technique (SVD), [9, 10] echoes corresponding to direct paths are easily identified (Fig. 7). This allows us to estimate TOA for each target. The location is carried out by considering two reference positions of the radar (multilateration); the position of the target is given in a 2D plane by the intersection of two circles centered at these reference positions (Fig. 8).

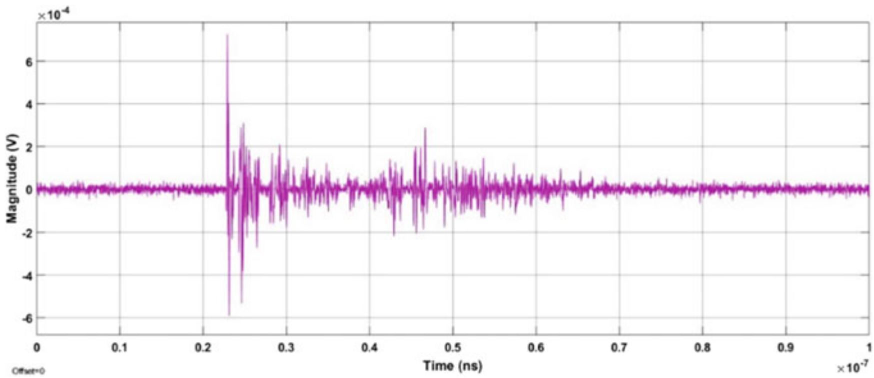

Fig. 4 Time representation of the noisy received signal (without clutter)

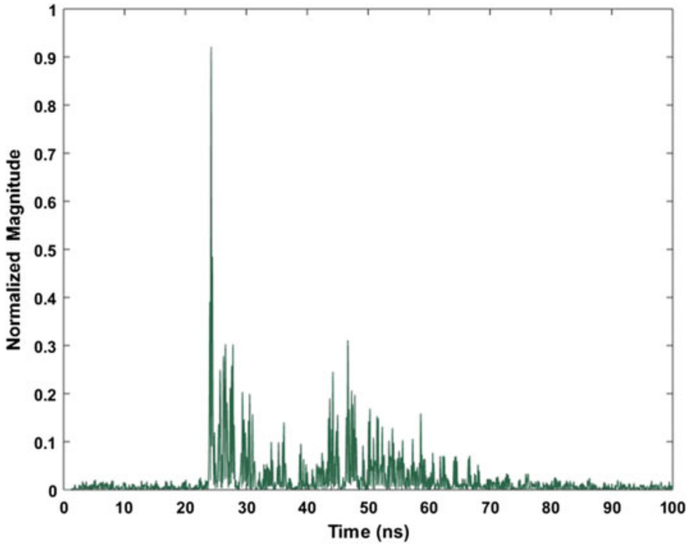

Fig. 5 Correlation of transmitted and received signals (without clutter)

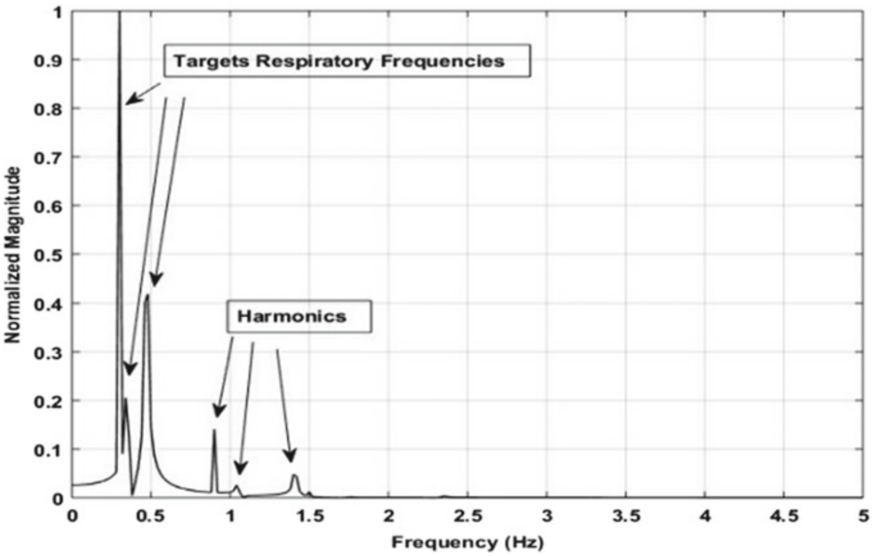

Fig. 6 Spectral analysis in slow time (breathing detection)

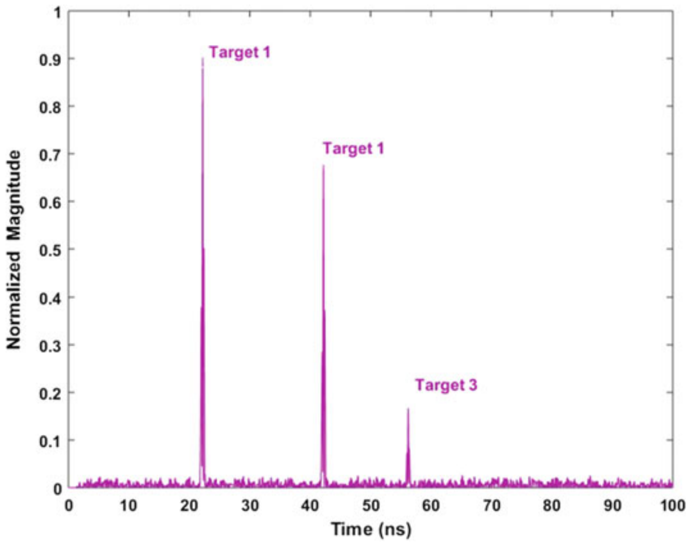

Fig. 7 Single value decomposition-based direct path estimation

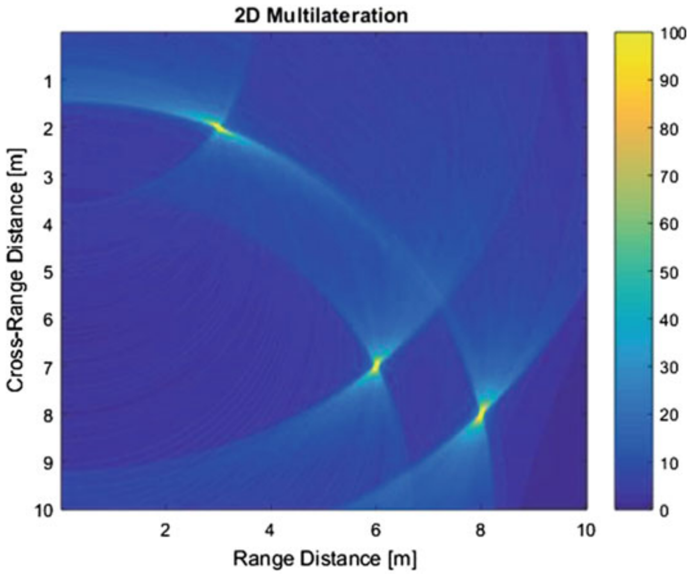

Fig. 8 2D localization of targets by multilateration

5 Conclusion

This paper presents the study and implementation of an UWB system radar (center frequency: 4.2 GHz; bandwidth: 2 GHz) for static multi-targets detection and localization in LOS indoor environment. The detection is based on respiratory movements and the localization on TOA measurements. A data acquisition protocol and some specific processing algorithms are used to extract detection and location information as well as mitigating errors due to AWGN and LOS noise. In the simulations, we conducted under MATLAB/Simulink, the breathing movements of three humans were detected and the targets were successfully located. Interesting ranges (up to 10 m) and high accuracy (~5 cm) with low signal-to-noise ratios (<5 dB) have been obtained. In this work, we have so far considered LOS UWB channel, the immediate extension of this work would be a performance evaluation in non-line-of-sight (NLOS) conditions for which the accuracy of UWB positioning systems decreases significantly.

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Omnichannel Integration Quality, Perceived Value, and Brand Loyalty in the Consumer Electronics Market: The Mediating Effect of Consumer Personality

Charles Asare, Mohammed Majeed, and Nana Arko Cole

Abstract Multiple channel system has emerged as a strong tool for competitiveness. The purpose of this study is to investigate impact of omnichannel integration quality on brand loyalty and perceived value through consumer personality in the consumer electronics market. Quantitative research method and a Web-based questionnaire survey were used. The sample size was 500 retail customers of consumer electronics products. EFA and SEM were used for the statistical analysis of the data using AMOS. Three of the hypotheses, integration quality and consumer personality, consumer personality and brand loyalty, consumer perceived value and brand loyalty, are strongly supported and established strong links in the studied constructs. In addition, all the model fit indices were strong. This study is unique since it assesses the role of consumer personality through the theory of Big Five in achieving brand loyalty in the omnichannel integration quality context.

Keywords Consumer electronics retailing · Omnichannel integration quality · Omnichannel perceived customer value · Consumer personality · Brand loyalty

1 Introduction

Consumer sophistication has risen globally due to advances in technology and information availability. Consumers no longer buy in-store but through platforms. The Internet, smart apps, and social media are redefining consumer contact by connecting outlets through networks [13, 19]. Merchants have understood the value of combining

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data and resources from many channels to reduce data disparity and promote seamless engagement rather than maintaining multiple platforms individually [40]. While multichannel marketing promotes a retailer's presence across several networks, omnichannel emphasizes platform convergence and alignment to expedite customer engagement and retail market management [27]. In recent years, more merchants have tried to establish omnichannel strategies [36]. Omni-channel shops should accept both click and brick and employ technology to improve customer experience, according to International Council of Shopping Centers research. In other words, to maximize Omnichannel shopping, businesses must establish platform convergence to eliminate consumer uncertainty [3].

As a result of the foregoing research, Omnichannel strategy is gaining global acceptance. Juaneda–Ayensa [20] argue that the modern consumer seeks consistency and unification across all delivery channels, leading to the creation of omnichannel strategies by merchants. A consumer is expected to initiate and complete a transaction using many channels simultaneously [18, 44]. According to Britt [4], people begin their purchasing journey on one site and end it on another. As more consumers demand cross-platform buying, many retailers are turning to omnichannel marketing to stay successful [32]. Multichannel marketing focuses on optimizing performance for each channel, while the goal of omnichannel marketing is to maximize consumer profitability across all channels [44]. While merchants recognize the value of omnichannel initiatives, there is a significant gap between what consumers want and what shops provide [13]. Clients expect value-added input to meet their needs [4]. According to research, most omnichannel customers are not satisfied since firms cannot match their needs with current channel setups [18]. This affects brand loyalty and client happiness. Clearly, the quality of channel integration impacts brand loyalty [37]. Omnichannel integration aims to improve customer buying experiences and boost brand loyalty. Brand loyalty is the positive attitude that people feel toward a business. Given the availability of alternatives, this influences consumer desire to repeat transactions [1]. Brand loyalty generates positive ratings, influences buying decisions, reduces price volatility, and increases potential repurchase for self-perception association with the brand name [30]. Loyalty is the pledge to buy from the same company in the future while ignoring competitors' brands [19].

Academic research on omnichannel is fairly young [37]. Recent studies have either looked at the phenomenon from the standpoint of the firm [2, 6, 19, 38] or presented analysis theoretically [19, 31, 44]. Academics and professionals must, however, investigate the subject from the standpoint of the customer and, above all, comprehend the outcomes of omnichannel consumer behavior adoption and management [37], such as satisfaction or loyalty. With the exception of a few recent studies that attempted to study the usage of consumer intent, there hasn't been much research done in this area [40] and some customer response in the omnichannel area, but from the customer's standpoint, there is still a scarcity of scholarly literature on omnichannel [44].

Apart from establishing a link between omnichannel integration and brand loyalty, this study also sought to establish a mediation link between brand loyalty and consumer personality. Specifically, the study seeks to look at omnichannel integration quality (IQ), omnichannel perceive customer value (PV) and the mediating effect of customer satisfaction and consumer personality (CP) on brand loyalty (BL).

The study focused on the consumer electronics retail market which is witnessing an entrenched competition in every part of the world. Retailers in this market are increasingly becoming more innovative in their offerings, due to growing consumer sophistication. This study is unique in the sense that it combines two theories: (Consumer personality theory and brand equity theory), with specific emphasis on the theory of Big Five of consumer personality and brand loyalty under brand equity theory. This will continue to enrich the minimal exiting omnichannel literature and offer feedback to practitioners deploying strategic innovative channels to meet modern sophisticated consumer demand. In omnichannel integration, the study considered as follows: consumer perceived channel value (PV) and channel integration quality (IQ). All the scale items of consumer personality under the Big Five theory were considered, and brand loyalty was the focus under the equity theory.

The remainder of the paper is laid out as follows: First, it will review extant omnichannel retailing literature, omnichannel retail consumer perceived value, omnichannel integration quality, brand loyalty, and consumer personality. The next section looked at research methodology, data analysis and finally discussions of results, conclusions, and consequences for science and practice, as well as limitations and future research direction, respectively.

2 Literature Review

2.1 Brand Equity Theory

[11] conceptualized the brand equity model. Keller describes brand equity as the differential effect of brand awareness on a consumer's response to a company's marketing. According to the notion, consumer brand knowledge may be described in two ways: (brand awareness and brand image). Whereas, image addresses the numerous connotations linked with a brand name. The image construct relies on consumer attitudes such as degree of like. The possibility of choice, consumer loyalty, and vulnerability to competitive marketing actions are all increased when brand knowledge (awareness and image) is strong. In every market, consumer brand loyalty is critical. In a highly competitive climate, brand loyalty is clearly non-negotiable. The study focuses on the brand loyalty feature of the brand equity theory. The study links omnichannel integration to brand loyalty via consumer personality.

2.2 Theory of Consumer Personality

The antecedent of consumer personality is known to have originated from human psychology literature. Personality is the "essential component of a person's psychological world that is constant over time and consistent across settings." The most widely accepted theory of personality is the Big Five model of Goldberg Costa Jr and McCrae [12]. The theory of Big Five was propounded by [12]. The theory holds the view that human personality could be categorized under five main headings (extraversion, openness, agreeableness, conscientiousness, and neuroticism). The term agreeableness is used to refer to a person's demeanor when interacting with others [11]. A conscientious person, on the other hand, is organized, prudent, goal-oriented, responsible, punctual, dependable, self-disciplined, and willing to form long-term relationships [44]. Extraversion is of the belief that people are more likely to have self-assured behavior, conclusive reasoning, and a desire to engage in social activities [31]. Neuroticism thinks that people are passionate, apprehensive, and aware of negative information in their surroundings [31]. Individuals that are prepared to be open to new experiences are inventive, intellectual, open, broad-minded, creative, analytical, and curious; this term is referred to as openness [11].

2.3 Omnichannel Retailing

The retail industry has gone into significant developments due to technology development. While the sector started from a single channel (Mono-channel), over the past many decades, it has developed further in two stages (from multichannel to omnichannel), in recent times. In the era of multichannel approach, different channels touchpoints were seen to be operating separately [2]. This channel strategy was considered as mere different streams of network information functional entities [39]. Scholars have argued that retailers should not concentrate on multichannel but should rather focus on omnichannel [4]. With the advancement in omnichannel, a recent study by [40] defined omnichannel as a unified approach that manages channels as interspersed touchpoints to allow consumers to have seamless experience within the ecosystem [18]. Suggest that the inception of omnichannel presents a big task to retailers in the area of the modification of business models that integrate customers' use of digital and physical platforms concurrently in their purchase decisions. It is therefore clear that channel integration quality cannot be underestimated in consumer shopping experience.

2.4 Omnichannel Integration Quality

To provide a cohesive consumer experience across numerous channels (Web sites, social media, physical stores, sales routes, and agents) without isolating them is critical (IQ). Saghiri [37] defines omnichannel integration in three ways. The first is channel-level integration because customers can easily transfer between channels during their contact phase without misunderstanding, loss of command, or ambiguity about the product or service they receive. It ensures close coordination with the organization's various platforms (online, offline, and Web networks), giving rise in coherent choices and actions. Finally, it guarantees that channel agents work in close collaboration, ensuring that the information transmitted and the products and/or services given by each channel agent are similar. Multichannel consumers or consumers that use many channels place a high value on each channel's quality and consider it when evaluating overall service efficiency [4]. Saghiri et al. [37] concluded that multichannel operation would never become omnichannel without total network convergence. The channel integration standard is thus critical for the creation and execution of the omnichannel network [4, 40]. The importance of channel integration quality has been established in the literature. Previous research shows that channel integration quality influences firm/brand customer assessments, resulting in beneficial effects for retailers [35]. According to empirical research [16], new technologies are changing the way customers interact with products/brands and the companies that supply them (retailers). Retailers will continue to connect consumers via these platforms, by building high quality channels, in hopes of changing their perceptions, attitudes, and beliefs, especially in this period of "new normal." Part of the theory is brand loyalty. The study links omnichannel integration to BL via CP.

2.5 Customer Satisfaction

Customers are the primary source of revenue and profit generation for a company, according to [23]. Customers have needs and wants, and businesses will recognize and capitalize on those needs and wants in order to earn revenues [24]. Customers are accounted for the majority of the company's revenue [23]. Generally, customer contentment is used as a slogan by businesses to encourage customers to buy their products or use their services [24]. However, customer satisfaction is not always the case [23, 28]. Customer satisfaction, according to [31], is a state in which customers are satisfied with a product, or with the whole engagement, they have with a company or organization. On the overall, it is a favorable representation of the customer's attitude toward the corporate organization [24, 26].

2.6 Consumer Brand Loyalty

The modern consumer, due to growing competition is offered a wider room to operate in product/service choice [26]. The deployment of digital channels has also resulted in a high level of volatility in brand loyalty. According to Levy [26], brand loyalty is the positive attitude that consumers have toward a brand by making a repeat purchase. It concerns the consumer's willingness to repeat transactions from the same company given the existence of alternative [1]. BL results in strong word of mouth (WoM) and becoming a supporter of the brand, with an effect on buying decisions, low price volatility, potential repurchase, and self-perception association of the name of the product [29]. Loyal customers, according to [30], have a positive attitude about the firm, buy from it frequently, and promote it to others.

There are two dimensions of loyalty [2]: behavioral loyalty and attitudinal loyalty. Consumer brand loyalty is the dependent variable of this paper and the conceptualization is adopted from the retail banking sector. The justification is that IQ is highly prevalent in the retail banking sector. Furthermore, multiple studies have found a link between bank customer loyalty and customer perceptions of service quality, and one of the dimensions used in measuring quality is availability of multiple channels of service deliver [33]. This paper therefore proposes that, omnichannel integration and consumer personality could play a positive role in achieving BL.

Conceptual framework and hypothesis development

2.7 Omnichannel Perceived Value and Brand Loyalty

Customer perceived value concept has been significantly active in academic circle since it was defined by [47]. It is also clear that perceived value definition is highly subjective in context. In a multichannel sense, erceived value refers to "the cumulative estimation by consumers of the advantages they receive from the use of multi-channels to satisfy their needs, taking into account the varying costs and disadvantages involved with the use of these channel structures" [22]. Customer perceived value in multichannel context is increasingly becoming more important in both academic and industry circles. Several researchers have argued that multichannel IQ influences the multichannel customer perceived value [28, 46]. [46] backed up this claim by predicting that a customer-valued omnichannel will likewise influence loyalty. Furthermore, consumer behavior is not static, likewise consumer personality. It could strongly be argued that environmental factors could influence consumer personality, especially when it comes to technology. While studies [22, 46] have investigated the role of consumer personality traits as the originator of online consumer engagement, this study looks at the multiple channel availability and the perceived value ascribed to these channels by the consumer as a positive influence on CP.

2.8 Consumer Personality and Brand Loyalty

Consumer personality traits originate from the traditional psychology literature. Researchers dealing with consumer personality have always referred to the origin of such theories. The most widely used personality theory in marketing research is what is famously referred to as the "Big Five" model of human personality [12]. The model holds the view that human personality could be categorized under five main headings (extraversion, openness, agreeableness, conscientiousness, and neuroticism). Extraversion is associated with gregariousness, high excitement, assertiveness, optimism, and ambitiousness. Openness indicates fascination toward novelty, esthetics, and new ideas such as warmth, friendliness, and cooperativeness in social interactions are all indicators of agreeableness. Neuroticism is a state of emotional instability associated to excessive anxiety and stress, whereas conscientiousness reflects an individual's reliability, trustworthiness, industriousness, and tenacity. According to Kim [24], consumers are attracted to a brand because successful brands usually demonstrate and express the consumer's own personality. This paper, therefore, asserts that there is a link between CP and BL.

2.9 Omnichannel and Customer Satisfaction

Customer satisfaction in omnichannel retailing is dependent on businesses' ability to operate channels in a seamless manner across all channels [22]. Consumers have more choices in searching, actually buying, collecting, and returning products as a result of the introduction of current channels and touchpoints (mobile phone apps, websites, social media, and so on) [22], and as a result, people may want to do transactions over multiple channels. Consumer happiness can be influenced by parts of the seamless experience, such as last-mile fulfillment, in an omnichannel mechanism. In contrast, [14] proposed that online and offline store images be seamlessly integrated to ensure consistency, in order to provide positive experiences that generate satisfaction.

Based on the above discussions, the following hypotheses were proposed in consumer electronics retail market:

H1a: *There is a positive relationship between IQ and CS*
H1b: *There is a positive relationship between IQ and CP*
H2a: *CV will correlate positively with CS*
H2b: *CV will correlate positively with CP*
H3: *There is a positive relationship between CP and CS*
H4: *There is a positive relationship between omnichannel IQ and BL*
H5: *Omnichannel CV will positively correlate with BL*
H6: *There is a positive relationship between CS and BL*
H7: *There is a positive relationship between CP and BL*
H8: *CS will positively mediate between IQ and BL*
H9: *CP will positively mediate between IQ and BL*

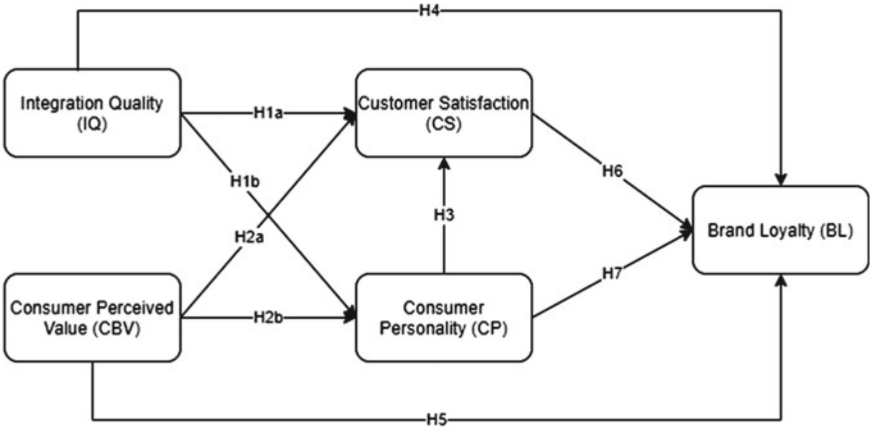

Fig. 1 Conceptual model

H10: *CS will positively mediate between CV and BL*
H11: *CP will positively mediate between CV and BL.*

3 Conceptual Framework

See Fig. 1.

4 Methodology

4.1 Sample and Data Collection

The study was a quantitative, deductive, and cross-sectional survey, since it intends to establish relationship and verify the proposed hypothesis. Based on the goal of this study, it was appropriate to choose customers who purchased from electronic firms that have being omnichannel. Qualtrics platform was used to design the Web survey. The identification and the distribution of the survey were done via social media pages (WhatsApp, Telegram, Facebook, and Instagram), short message services (SMSs), and emails. The questionnaire were only sent to those who accepted to take part in the survey from the initial social media and email contacts. This was done through two screening questions: (a) Have you used electronic products in the last three years? (b) Have you interacted with the company/brand using more than one channel in the last three years? Data for the study were collected given consideration of age (more than 18 years), gender, marital status, and occupation of respondents. We gathered primary data using an electronic version of a standardized, self-administered questionnaires. Before the main data collection, we conducted a pretest with professionals and marketing academics to assess the understanding, clarity of items and scales, the required time and length in order to enhance the quality of the instrument as proposed by Lee, Chan, Chong, and Thadani [27]. The final sample of the study was 500 useable respondents of consumer electronics products who have used more than one channel in their interactions and transaction with consumer electronics retailers. Data were collected from February to March, 2021, a two-month period. The postulated linkages were examined through the eyes of the study's target demographic, Ghanaian electronic retail customers who used a variety of service channels. It should be highlighted that while being one of the countries that provide banks with numerous client service channels, Ghana is not technologically advanced [17]. Because the target population's universe is unknown, the sampling mechanism employed for accessibility was non-probabilistic. Although this sampling method does not allow for behavior confirmation, it does provide evidence of behaviors, which is adequate to achieve the research objectives.

4.2 Data Analysis

The data were analyzed, and the findings were generated using SPSS-Amos. To evaluate the estimate technique, we did a confirmatory factor analysis (CFA), generated factor loadings for the construct factors, and evaluated the average variance extracted (AVE) and composite reliabilities (CR) of the constructs analyzed. These criteria allowed it to analyze convergent validity. The discriminant validity was tested using Fornell and Larcker [5]. SEM with PLS estimation was used for the hypothesis test, allowing us to concurrently assess the variables' interdependencies and the constructs' relationships inside the proposed model [14]. We used the method proposed by Hair et al. [14] to assess the significance of indirect links, their direction, and their kind (complementary or concurrent).

4.3 Measures

The study adopted a measurement scale from existing literature in measuring the strength of each variable. Omnichannel integration quality (IQ) and omni-channel perceived customer value (PV) scales were adopted from [22], measures but was slightly adapted to suite the study. Omnichannel integration quality scale items were five, and omnichannel perceived value was also measured using five items. Consumer personality was scales was adopted in the following order: agreeableness [43] conscientiousness [21], openness [42], neuroticism [43], and extraversion [43]. Even though different scales from different researchers were adopted, the study put all of them together to define consumer personality. Five-point Likert scale items were used but also slightly adapted. Finally, customer satisfaction and brand loyalty scale items were also be adapted from [29], and were also made up of seven items. All the scale items were evaluated using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

5 Results and Analysis

By performing reliability scale analyses for the two independent and one dependent variables, it was established that the four-component alpha coefficients (α) of the Cronbach alpha shown in Table 1 were all higher than the required α 0.70 criterion.

5.1 *Exploratory Factor Analysis (EFA)*

If the following conditions are met, EFA is acceptable: 0.5 Kaiser–Meyer–Olkin (KMO) value ≤ 1 and significant <0.05 (factory correlation of observed variables). The KMO number must be at least 0.5 to qualify for the analysis, and the closer the KMO value is to 1, the more acceptable the factor analysis will be [33]. The KMO is acceptable as a result of the findings.

5.2 *Confirmatory Factor Analysis (CFA)*

CFA was utilized using Tucker and Lewis index (TLI—Tucker and Lewis index), chi-square indexes (CMIN), chi-square adjusted by (CMIN/df), RMSEA (root mean approximation error), and appropriate comparison index (CFI-comparative Fit Index). In order for the model to be accepted, the value of the chi-square test

Table 1 Reliability statistics

Variable	Cronbach's alpha	N of items	Description
Integration quality (IQ)	0.775	5	Independent
Consumer value (CV)	0.832	5	Independent
Brand loyalty (BL)	0.818	7	Dependent
Consumer personality (CP)	0.871	5	Mediator
Customer satisfaction (CS)	0.923	5	Mediator

Table 2 Model fit measures

CFA model	Measure	CMIN	DF	CMIN/DF	CFI	SRMR	RMSEA	PClose
	Estimate	786.93	203	2.091	0.936	0.047	0.053	0.145

includes p-value >0.05, GFI, TLI, CFI values >0.9, CMIN/df [2.0] (in some situations the value of CMIN/df [3.0] is temporarily acceptable [9]; and RMSEA 0.08, RMSEA upper 0.05 [10]. A model has been approved with values of GFI, TLI, CFI some 0.9, CMIN/df some 2.0, RMSEA some 0.08 models [14]. The summary of model fit measures as shown in Table 2 shows acceptable fit. Research studies use structural equation model to assess each scale's contribution, to check the conceptual scale relationship and to estimate the relationship between independent and dependent variables [25].

According to Table 3, all components are dependable. Strictness of 0.8 for basic research and Cronbach alpha coefficient of 0.7 for the first phase are higher than predicted [34]. Table 3 shows that AVE must be greater than 0.5 to calculate 50% of the variance in indicators [5]. This criterion was met by all model architectures (Table 3). The discrimination is evaluated by comparing the square root of the AVE (the diagonals in Table 3) to the correlations between the combinations (the bottom triangle of the matrices in Table 3). Generally, each relationship is more closely related to its measures than others [5]. Table 3 displays the correlation matrix's means and standard deviations. Table 4 has problems with discriminant validity because the HTMT test is less than 0.90.

The study employed hypotheses testing method by resorting to the bootstrapping procedure [41]. Table 5a shows the summary results of the model. As seen in Table

Table 3 Model validity measures (Fornell & Larcker Criterion)

	CR	AVE	MSV	MaxR(H)	CP	BL	CV	IQ	CS
CP	0.963	0.668	0.576	0.964	**0.818**				
BL	0.929	0.726	0.576	0.944	0.759	**0.852**			
CV	0.820	0.533	0.372	0.826	0.474	0.610	**0.730**		
IQ	0.920	0.699	0.011	0.935	0.071	0.043	0.104	**0.836**	
CS	0.882	0.726	0.576	0.944	0.450	0.672	0.525	0.081	**0.852**

Table 4 Discriminant validity by HTMT

Construct	CP	BL	CV	IQ
CP				
BL	0.675			
CV	0.468	0.618		
IQ	0.103	0.077	0.112	
CS	0.568	0.468	0.668	0.612

Table 5a Standardize regression weights

Predictor	Outcome	Std beta
IQ	CP	0.078†
CV	CP	0.527***
CP	BL	0.363***
IQ	BL	−0.042
CV	BL	0.602***
IQ	CS	0.565***

Significance of Correlations: ***p < 0.001, **p < 0.010, *p < 0.050, †p < 0.100

5a, IQ has a direct significant positive relationship with CP ($\beta = 0.078$, $p < 0.10$) at 10 percent level of significance. Also, CV has a direct and positive relationship with CP ($\beta = 0.572$, $p < 0.001$), and CP has a direct positive relationship with BL ($\beta = 0.363$, $p < 0.001$). Further, there is no significant relationship between IQ and BL ($\beta = -0.042$, $p < 0.05$). From Table 5a, there exists a direct significant positive relationship between CV and BL ($\beta = 0.376$, $p < 0.001$). Given the above results, all direct relationships are significant except the relationship between IQ and BL.

For the mediation hypotheses, the significance of the specific indirect effect of CV, IQ, and CS, CP on BL was assessed shown in Table 5b. The path coefficients show a relationship between IQ and BL was a negative one ($\beta = -0.33$), but a test of its significance showed insignificance ($p = 0.133 > 0.05$) similar to the outcome in Table 5a; hence, the hypothesis (H4) was rejected. All other path relationships had positive coefficient to BL was significant at 5% significance level. The coefficient of CV had the strongest relationship with BL ($\beta = 0.495$), with the coefficient of CS ($\beta = 0.382$) and CP ($\beta = 0.372$) presenting a weak cause deviation in BL but acceptable. We therefore fail to reject H5, H6, and H7. Also, the coefficient between IQ and CP ($\beta = 0.060$) shows a very weak relationship between the two variables at

Table 5b Unstandardized regression weight

Hypothesis	Path relationship	Estimate	S.E	C.R	*P*-value	Decision
H1a	IQ → CP	0.060	0.034	1.752	0.080	Accepted
H1b	IQ → CP	0.060	0.034	1.752	0.080	Accepted
H2a	CV → CP	0.422	0.035	11.900	***	Accepted
H2b	CV → CP	0.422	0.035	11.900	***	Accepted
H3	CP → CS	0.455	0.052	12.21	***	Accepted
H4	IQ → BL	-0.033	0.022	−1.504	0.133	Rejected
H5	CV → BL	0.495	0.027	18.424	***	Accepted
H6	CS → BL	0.382	0.044	12.048	***	Accepted
H7	CP → BL	0.372	0.034	11.048	***	Accepted

Significance of Correlations: ***p < 0.001, **p < 0.010, *p < 0.050, †p < 0.100

Table 6 Specific indirect effects

Indirect Path	Hypothesis	Unstandardized etimate	Lower	Upper	*P*-value	Standardized estimate
IQ → CS → BL	H8	0.022	0.003	0.049	0.057	0.028†
CV → CS → BL	H9	0.157	0.118	0.204	0.001	0.191***
IQ → CP → BL	H10	0.074	0.125	0.251	0.000	0.180***
CV → CP → BL	H11	0.156	0.004	0.203	0.000	0.091***

Significance of Correlations: ***$p < 0.001$, **$p < 0.010$, *$p < 0.050$, †$p < 0.100$

10% significance level ($p = 0.080 < 0.10$), with CV having a stronger effect on CP ($\beta = 0.422$). For hypothesis H1a, H1b, H2a, and H2b, we fail to reject. CP and CS also had a fairly strong relationship ($\beta = 0.455$) implying a 0.455 deviation in CS with a unit change in CP. We therefore fail to reject H3 since its p-value is significant. The procedure for mediation used result of bootstrapping (500 sub-sample, two-tailed) as shown in Table 6 that IQ has indirect effect at 10% significance in the relationship between CS and BL ($\beta = 0.028$, $p = 0.057 < 0.10$) but not significant at 5% level. In the case of significant relationship of the specific indirect effect, CP mediated the relationship between CV → BL ($\beta = 0.191$, $p = 0.0001 < 0.001$). As the authors computed IQ and BL parameters values in their consumer prospects model, they need to introduce a parameter which can measure consumers' sentiment of goodness (customer satisfaction); CPV → CSP → BL = $\beta = 0.191$, $p = 0.0001 < 0.000$) and (IQ → CSP → BL = $\beta = 0.180$, $p = 0.0001 < 0.000$). We fail to reject hypothesis H8, H9, H10, and H11 as they are significant.

5.3 *Discussion*

The study was set out to test five hypotheses in all, using retail shoppers of consumer electronic products. The goal was to see how strong the correlations between the variables in the research constructs were. Customer happiness and brand loyalty were the main dependent variables, with omnichannel integration quality as the independent variable and channel perceived value as the independent variable. As could be seen from the results, three of the hypotheses, integration quality and consumer personality, consumer personality and brand loyalty, consumer perceived value and brand loyalty, are strongly supported. This could be seen from Table 5b. This empirical study also confirms the earlier findings of [36], in the customer value frameworks which stated that, in the context of omnichannel retailing, there is a positive association between omnichannel perceived value and customer brand loyalty. PV is said to be a major driver of customer loyalty and has a significant impact on customer satisfaction [45].

It could also be seen that the introduction of consumer personality positively influenced the result of brand loyalty. One can therefore appreciate the strength of the mediator (consumer personality). In developing marketing channel strategy, it is expected that consumer personality should be fully appreciated. Brand loyalty is key for staying in competition due to the unique value placed on repeat purchase in the marketing literature. To summarize, our data show that electronic retailers who invest in channel convergence get benefits in terms of customer confidence and shopping intent. Retailers are also enabling consumers more than ever before by fully integrating their retail channels for omnichannel retailing, enhancing brand loyalty, and purchasing intention. In line with researchers including [13, 15], as more retailers adopt full omnichannel strategies, we expect this characteristic to become increasingly important in the coming years.

5.4 Practical Implications

This research has practical consequences for practitioners. First, this study advances managers' knowledge of the impact of omnichannel retailing. Despite the fact that many retailers have attempted omnichannel selling, many still operate their many channels independently [34]. Their major problem is if channel integration pays off in terms of consumer satisfaction and behaviour [7]. Then practical implications resulting from the study's findings might be presented to consumer electronics store managers in order to encourage them to embrace omnichannel strategy as a strategic tool for establishing a competitive advantage in this ever-competitive industry. The key to achieve competitive advantage is been able to improve customer shopping experience, and therefore, such experience could be achieved through omnichannel experience. Also, knowing who the consumer is, it is a necessary step to meet his requirements and making him loyal to the firms' brands. Also, this study helps retailers better assess the impact of convergence of networks by focusing on customer perception and responses. Previous studies focused primarily on firm results, such as market share, operational efficiencies, and revenue growth [8], when assessing the channel integration impact. This research shows that retailers should also pay attention to the personality characteristics of customers such as openness, extraversion, and agreeableness. Retailers should be offering consumers more channels and value even during their shopping processes to improve consumer brand loyalty.

5.5 Theoretical Implications

From a theoretical standpoint, this study adds to the growing body of knowledge in emerging markets about omnichannel. The paper provides an understanding of omnichannel from the perspective of the customer, which is under-explored in many businesses. Most of the studies sighted are centered on omnichannel systems but not on the customer.

5.6 Conclusion

In today's competitive retail industry, omnichannel retailing is a novel notion. This research sought to link omnichannel integration and brand loyalty. It also aimed to connect customer personality to brand loyalty. Customer satisfaction and consumer personality (CP) as mediating factors on brand loyalty (BL) are examined in the study. The findings show that the other constructs strongly influence the concept of loyalty (omnichannel integration quality, perceived interest, and personality). Moreover, the data suggest that customer personality influences both the quality and loyalty of integrated interactions as well as the perceived value and loyalty. This means that consumers are more likely to be loyal to a brand when the service channels they use give an integrated and quality engagement as well as value in transactions. As a result, beneficial effects on customer loyalty in the consumer electronics retail industry might be extrapolated.

5.7 Limitations of the Study

There are a few limitations in this study that should be addressed, and these could be used as a starting point for future research. First and foremost, the study was conducted in a specific nation (Ghana), with a focus on omnichannel retailing in the consumer electronic retail market. As a result, considerable caution should be used when projecting the results of this study to other industries or cultures. In order to strengthen the generalizability of the findings of this study, it is highly recommended that the relationships proposed in this study be studied using data from diverse cultures in the future.

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Examining the Impact of Incorporating Big Data Analytics in Agriculture

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Abstract Incorporating big data analytics (BDA) into agriculture can help mitigate the impact of global warming. Several data-gathering processes and technology exist. Scalability, accessibility, sustainability, and affordability were the main factors considered in the selection. Climate change has altered typically predictable agricultural practices. But, with the advent of hi-tech solutions like BDA, such changes could be predicted and mitigated. The framework developed as part of this study is one of the ways BDA could be used for maintaining and increasing crop yield even in the face of uncertainty. The proposed framework considers the challenges smallholder farmers in sub-Saharan Africa will encounter in adopting technology in farming practices. The conceptual framework created at the end of the study contains modalities for implementing an analytics-driven and user-friendly solution that could help increase crop yield among rural subsistent farmers.

Keywords Big data · Agriculture · Analytics · Climate · Crop yield · Framework

1 Introduction

Big data can be defined as data that exceeds the storage capacity of the medium in which it is traditionally supposed to be housed. Numerous researchers proposed definitions and explanations that reflect the expansiveness of big data. From the literature studied in preparation of this study, the simplified primary characteristics

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of big data that distinguish it from ordinary data are, big data are data that are "too big," "too fast," and "too complex" [1–4].

Data that are "too big" relates to big data means data sizes in the realm of a terabyte, petabyte, zettabyte, etc. For a dataset to be considered big data, the dataset must have volume. An enormous amount of information is being generated from sources ranging from handheld devices to the Internet of Things systems. Video and audio streaming services, customer shopping patterns, search queries, Web site visits, satellite data, sensors data, and bank transactions are a few ways terabytes are generated daily. Logically speaking, all big data are datasets, but not all datasets are big [4]. Volume is just one of the characteristics of big data. Data from satellites, energy consumption readings from meters, the click-through rate of adverts, field sensor reading, etc., are generated almost in real time. Delay can be configured to enable delivery in batches, but such data can be useful when read in real or near real time or in streams. The speed of data generation is an important component in the classification of a dataset as big data. A more formal literal connotation is the velocity of data generation.

With the ever-increasing barrage of devices generating data in different formats that are not the traditional alphanumeric representation of data, a new context of storage and analysis has to be devised. Video, audio, images, clicks, logs, etc., are unstructured datasets that cannot easily be organized in the conventional database management systems (DBMS). These, in turn, will make such data hard to organize and analyze. Even in structured datasets (easily representable in a DBMS), the algorithmic efficiency of traditional DBMS in analyzing datasets of great volume is very low [5]. A combination of structured, unstructured, and semi-structured characteristics of a dataset is a feature of big data. The above-elaborated characteristics are the most prominent recurring features that researchers in big data seem to have formed a consensus. Kitchin and McArdle [4] have suggested the inclusion of veracity (quality), volatility (rate of change), and value as part of the characterization of big data. Analytical processes are employed to derive important insight from big data. Application of statistical methods, data mining, artificial intelligence, natural language processing, predictive analytics models on big data to derive insights is termed big data analytics (BDA) [6]. The government uses BDA to draft policies that would have the widest impact and enhance processes and procedures.

2 Big Data Analytics

At least, 2 exabytes of data are generated across all industries per day. 80% of that comes from IoT devices [7]. Also, with the increased proliferation of Internet access to more remote locations, FinTech services are increasingly being adopted. According to gartner.com, information gotten due to the adoption of Internet-enabled services could account for at least 60% of organizations' overall human-related information assets. Such enormous data constitute an excellent justification for the adoption of BDA. Service providers can now develop customized services that are needed and will be adopted by demography due to the insights gotten from the analytics. Artificial intelligence and natural language processing have made BDA approachable to managers and less technical users alike. The increased ease in usage has a domino effect in its approachability, which in turn increases adoption. The increased awareness and discovery of creative application areas gradually change the narrative and increase confidence in BDA adoption across most portfolios [3, 8–10]. Some areas of examples of applications of BDA includes:

- Education: By adopting learning management systems, schools and institutions are increasingly leveraging big data technologies to monitor student engagement, teacher performance, track student's performances, etc.
- Manufacturing: Sensors on automobile/aircraft engines monitor their state in real time, generating a huge amount of data. Determining the response to certain conditions and operations at different conditions, manufacturers optimize parts, discover other more efficient materials or create entirely new, more effective, and efficient engines. Due to the adoption of BDA, manufacturing processes are being enhanced; alternative materials are being discovered, and new alternative manufacturing methods are being developed.
- Government: Determining the individuals' eligibility for social services, picking out projects for more significant economic gains, knowing the impact of certain policies are some of the ways governments have adopted or can adopt BDA into their operations.
- Insurance: Analyzing and predicting customers' behavior through individuals' social media profiles, CCTV footage, and GPS have greatly aided in fraud detection, management, and prevention. Claim management and tracking have been greatly enhanced through BDA.
- Transportation: Governments have successfully used BDA in traffic control, route planning, and congestion management. Private sector operators have incorporated BDA into logistics management and fleet management.
- Energy and Utilities: Incorporating smart meters into smart grids for energy generates lots of data almost in real time. Utility companies have used this data to forecast demand, schedule maintenance time, and perform general revenue forecasting.
- Healthcare: Healthcare providers like hospitals could predict patient volume and organize personnel shifts using big data. Personal historical health records are being used to hasten diagnosis and treatment. Also, DNA sequencing and analysis have been instrumental in developing personalized drugs or choosing the most effective treatment method based on the individuals' genetic makeup.
- Agriculture: Data gathered from satellite imagery, GPS sensors, soil sensors, and other sources have greatly enhanced farming productivity. Information acquired is being used in pest control, efficient fertilizer application, yield prediction, etc.

The above applications are by no means exhaustive. Innovative new areas of applications are on the rise. Due to the increasing incorporation of NLP, artificial intelligence, and machine learning, BDA is getting more accessible and easier to implement.

3 Methodology

This study aims to identify accessible applications of big data in agriculture. Among the identified applications, those that could be quickly adopted, affordable, and have the most significant impact would be isolated and outlined. The incorporation of big data in agricultural practices requires acquiring some resource-intensive equipment and very technical procedures. These requirements are not tenable by smallholder farmers, and as such, governments, corporate bodies, and non-governmental organizations need to intervene and provide accessible interfaces for adoption. The study's outcome could be used as a guide by policymakers and organizations trying to deploy big data services on a wider scale. To achieve the stated aim, the authors intend to review literature about factors affecting the yield of smallholder farmers and applications of big data in increasing yield. Yield maximization is the focus of this study. A review of other parts of the application of big data in the agricultural value chain can be the subject of further study. The primary demographical focus group is peasant farmers in developing countries with a preferential focus on Africa.

The study's subjects of interest include areas of intervention by the government to increase the farming yield of smallholder farmers, the applicability of big data in agriculture, affordability of big data services, and challenges to the adoption of BDA. The study intends to adopt a review methodology. Previous studies and research papers relating to the subject matter will be thoroughly reviewed. Findings from these studies will form the basis of analysis. Using both review outcome and deductive reasoning, the author intends to bring out a conceptual framework that outlines the findings that conform with the key constraints: affordability, accessibility, ease of use, and scalability. Continuous emission of greenhouse gases as a result of industrialization has severely altered climatic conditions globally. Temperature is on the rise year on year. According to the world meteorological organization, at least, one year between 2021 and 2025 will be the hottest on record. The impact of global warming varies across several regions. Drought, floods, and wildfires are a consequence of increasing temperature.

Planting and harvesting seasons have all been impacted by the erratic nature of ecological phenomena due to global warming. In sub-Saharan Africa, wet seasons come late, and rainfall is erratic [11]. As a result, farmers find it hard to pick the right time to plant crops. Any wrong timing could result in poor yield at the end of the season. Increased rainfall is an enigma to flood-prone areas. All farm management processes like fertilizer application performed on the farm will be of no consequence in flooding. Weather and seasonal advisory could help in anticipating and making efforts to mitigate the impact of the flood.

According to Che et al. [12], high temperatures weaken the biological defense systems of plants, making plants more susceptible to diseases. Such conditions also encourage mutations of diseases that are resistant to previous preventive measures. Adverse temperature also affects pests and pest control. A decrease in food availability has forced previously less harmful pests to seek alternative sources of nourishment. Increased evaporation and little rainfall have increased drought incidences across the West Africa sub-region [11]. The amount of rain falling on some of the driest regions cannot sustain plant growth. As a result, farmers in such areas have to either change the type of crops they produce or change livelihood entirely.

The above-outlined outcomes are some of the ways global warming has impacted crop yield. Stopping or reducing global warming is a subject of intense debate and is not easy to handle. Intense research is presently ongoing on how to reduce emissions and find alternate sources of energy. On the small-scale farming stage, mitigative methods against the impact could be implemented by adopting and incorporating technology into farming and farming processes. The advanced predictive analysis could forecast the amount of rainfall that could fall within a season, the particular timing of the start of a season, the possibility of flood within the season. Also, possible is estimating the nutrient needs of the crops, preventing diseases, determine the fertilizer needs and location on the farm, the right time to harvest, and many other factors. Geographic information systems (GISs), remote sensing, IoT device deployment, drones, and satellite imagery are some technologies that could help small-scale farmers mitigate the impact of global warming and increase crop yield [13]. Data from all these technologies could be captured and analyzed using BDA processes, and the insight generated would be used for farmer training and process adjustments.

4 Proposed Conceptual Framework

Setting the needed infrastructure for the data-gathering process and techniques above is capital intensive. The majority of the farmers in the sub-Saharan region of Africa are either illiterate or semi-literate [14]. These are major constraints when interacting with the platform or setting up an independent platform. The poor economic condition of the region invariably implies that most of these farmers are financially incapable of independently implementing these systems. However, with the intervention of relevant organizations, such facilities could be implemented and an interface provided for the farmers to interact with the system. The design of such a system should be so that it requires little training to interact with it.

Tseng et al. [13] proposed an IoT solution for monitoring farm data. It comprises sensors monitoring environmental variables in real time, and an embedded system transmits the data, cleaned, stored, and analyzed using a custom-made system. All components involved in making the system are cheaply available. The sensors could easily be used as an expansion to increase the variables that the system could measure. Such systems are increasingly becoming popular in the world's regions with higher literacy rates and financial stability. Also, apart from the DIY-styled systems, ready-made solutions exist that could be bought and installed directly [13]. Insights derived from data analysis from these systems are more reliable because of the specificity of information relating to the different farms adopting it. However, farmers in the sub-Saharan region of Africa have neither the technical ability nor the financial capacity to develop these systems. Despite the advantages of these systems, it does not fit into the constraints in this study. Implementing these systems as a form of intervention for smallholder farmers in the region will not be financially wise.

Geospatial data generated by satellites gives insight into the environmental conditions used in agriculture and agricultural practices (Weersink et al. 2018). Climatic patterns are observed using satellite imagery, which can form the basis of disaster prediction and emergency planning. Satellite imagery analysis has been used in predicting pest and disease outbreaks, amount of rainfall, the state of crops on the farm, etc. Such information is being used in precision agriculture to determine the specific water requirement in irrigation, the fertilizer needs of sections on farms, estimate harvest times, predict crop yield, etc. Drones and specialized aircraft have also been deployed to enhance precision or as an alternative to the deployment of satellites. Drone adoption for other purposes such as pesticide and fertilizer application has become popular. The popularity could be traced to the increasing affordability of drone technology. The addition of specialized cameras and sensors could transform the drone into a significant data source for BDA. Geographical mapping based on the analysis of data gathered from remote sensing could be used as an advisory for the type of crops to plant on each mapped area. Following these guidelines, farmers can be confident that the types of crops they are growing are the type that is suitable for that area. Doing so will result in a good yield at the end of the farming season.

Nigeria's government has invested in about five satellite so far (one ill-fated) (NSRDA). Two of those are for weather monitoring and disaster prediction. According to WMO, satellites for weather and disaster prediction are equipped with remote sensing capability. Though the data obtained are for monitoring weather, it could be used for agricultural purposes. NigeriaSat-2 can cover two-fourth of the West Africa sub-region (NSRDA). The ministry of agriculture or other corporate entities could be given access to the data generated by the satellites. The application of BDA processes on the data could reveal valuable insights that the smallholder peasant farmers need. Due to the potential for wide-area coverage, remote sensing data gathering is a suitable technology for helping farmers enhance crop yield. Remote sensing data are reliable due to the semi-real-time nature of the data. Insights delivered through user interfaces could be affordable for the farmer on a larger scale. A weather station serves as a data-gathering point for a large land area that could comprise several farms (Rao 2018). Areas under the coverage of weather stations could be joined to form clusters. Such clusters could be interconnected or connected to a central station that analyzes the field data. Clusters could be as large as a state or as vast as a country. Given each cluster's potentially large coverage area, the number of stations to be built will be relatively small.

Temperature variations, pressure, moisture content, humidity, and other vital environmental factors that affect plant growth are monitored [15]. Analyzing the data using BDA could give insights into the area's potential to produce a good yield. Insights could be delivered to the farmers using Web interfaces, mobile applications, SMS, or in-person delivery. Tokens given by farmers to gain access to the insights are a great motivator for investors. Governments could also invest in the infrastructure to increase farmers' yield, which has a domino effect that could reduce poverty and a high tax-paying percentage of the citizens. Weather station data gathering means are affordable, less capital intensive, sustainable, and insights will be very reliable due to its closeness to the farms [16].

5 Conclusion

The conceptual framework developed can serve as a policy guide for the deployment of BDA in agriculture. Setting up the mechanisms starts with acquiring the necessary data-gathering infrastructure by governments or other financially capable institutions. Areas to be monitored are identified and the infrastructure deployed. Central BDA stations should be set up to receive data from the data-gathering systems installed on the field or deployed in space. The component systems of the BDA stations contain data processing and analysis packages such as Hadoop, MapReduce, artificial intelligence, Apache Spark, and natural language processing systems. Insights from the BDA are accessed by a host of interface back end-deployed applications on a server. For the intended user, the farmer, to have access to the insights, front-end interfaces are deployed. API and SMS gateway could be adopted as the channel by which the front-end interface retrieves data from the back end. Insights are delivered to the farmer on a smartphone, feature phone, or both depending on the coverage and preference. For extremely remote locations, however, GSM infrastructure might be lacking. In these situations, agricultural extension workers could be deployed for on-the-field information sessions.

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Online Teaching Strategies for IT Education

Anita Venugopal and Mukesh Madanan

Abstract Virtual classroom platform for online teaching and collaboration has emerged as a crucial field of study in the area of research and education. The main objective of online teaching is to be able to integrate new learning methods and technologies keeping in mind that active learning takes place in both synchronous and asynchronous mode without affecting the goals of the curriculum and student learning environment (Auster and Wylie in J. Manag. Educ. 30:333–353, 2006). Many effective teaching methods are practiced by the educators to deliver the course online during class hours and outside class. In this paper, we focus on our experience in building student's self-efficacy as well as building their peer learning abilities through proper structuring of the modules, use of specific software's that assist at better structuring the competencies in learning using an approach where students learn lessons themselves and instructors check students understanding during class hours. The efficiency of this approach is analyzed by comparing student's satisfaction rate at the start and end of the semester.

Keywords Online education · Self and collaborative learning · Online strategies

1 Introduction

Teaching online is a challenging job, and there are several challenging factor instructors have to face to effectively being prepared to teach online, especially when it comes to teaching practical sessions of information technology (IT). Many research studies have been carried out, and there are different approaches that are used to train students online. In this paper, we present an approach that requires students to follow certain protocols prior to appearing the online class. Students do self-learning before

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class hours (LBC), and their level of understanding is checked by instructors during online session by solving activities in class (AIC). The main objective of this approach is to enhance students self-learning abilities by giving them the ownership of learning so that students develop the ability to tackle unstructured real situation problems independently. Instructors provide adequate learning materials and activities. The main challenge faced by teachers in this regard is to clear the misconceptions, fear, potential problems regarding self-directed learning as opposed to traditional learning and in the preparation of teaching materials, collection of resources such as video lessons, activities, quizzes, establishing clear communication, developing grouping strategy, and selection of media.

In this paper, Sect. 2 is literature survey; Sect. 3 focusses on the strategy used, its workflow, preparatory materials uploaded, and resource collection; Sect. 4 discusses the results obtained, and Sect. 5 presents the conclusions and future study.

2 Literature Survey

Research studies show that the main aim of flipped teaching is to prepare students to learn themselves by asking them to go through the preparatory lesson prepared by their instructor [2, 3]. One of initial attempt made was to teach economics subject [4]. This technique was also implemented in teaching other subjects like English, Mathematics [5], Biology [6], Business Management [2], Industrial Engineering [3], and Computer Science [7]. Results show that this method can be practiced to handle any level of students, graduate, or undergraduate, as well as, any class of size small or large [2]. Studies show that students find peer learning almost as comfortable, effective, and fun as studying from instructors at times for certain portions of the lessons [8, 9].

To promote learning, educators record their online sessions with audio for offline learning [3, 8, 10]. Students are able to listen and understand lessons only for short time. Studies show that an estimated length of video lessons can be no more than 15–30 min [3]. Preparation of materials is time consuming. It also depends on the topic, type of learning aid prepared as well as the efficiency of the person to use technology [11, 12].

3 Online Teaching Strategies

3.1 Online Teaching and Learning

Learning is an experience which involves many different contexts. Learning can occur individually, with peers, inside class, outside class, in small, large, or ad-hoc groups. In order to have an active online learning, face-to-face teaching and learning inside classroom are just not enough [1]. Instructors need to explore the software prior to the session, and special attention is given to use up to date technologies. Training sessions are useful to get accustomed to new software's. Interactive modules and activities are prepared for the course.

Online studies bring a feel of remoteness [1]. So, in order to build the sense of community for students, the first few sessions of class are dedicated for self-introduction and knowing other students. A self-introductory video of the instructor is uploaded. Interested candidates are also given opportunity to introduce themselves with short videos. Course structure, course plan, grading, and assessment methods are introduced and explained through presentations or videos. Students are brainstormed about the importance of taking the ownership and control of learning the course so that it will help them get equipped with lifelong learning skills, acquire digital literacy, use of various technologies to foster the learning environment, self-regulate learning, structure the timing, create timetable, and study as per the schedule, peer-support learning so that students can socialize and learn and so on. To make learning simpler and easier, students were initially asked to watch the simpler portions of the video, for example, go through the characteristics or applications or features, etc., and simple and direct questions were asked during the online session. Those who practiced found it easy and were able to answer the quiz easily in the class. This motivated others and learning became fun. Toward the end of the course, students were able to comprehend almost all the topics by themselves. Students were more positive and appreciated the LBC videos lessons/activities and admitted that they found this method easier and could understand more or less in the same manner how they would learn in presence of an instructor.

3.2 Preparatory Materials

Presentations are beneficial to a great extent in face-to-face traditional teaching, but students may not find it attractive for online studies [1]. So, video lessons of each topic are prepared and uploaded in the Web site. Student response shows that they prefer teacher prepared videos more effective for self-learning. Advantage of such video lessons is that students can listen any number of times and learn from these video lessons at their own pace [14, 15]. Online sessions are basically used for knowledge checking. This approach facilitated independent learning which was revealed in the responses obtained from students at the end of the semester. However, students with language difficulties and technological issues were found lagging behind as they failed to follow the protocol of going through the prep materials in the Web site, prior to attending the class. Small groups were formed specially to take care of such students so that they feel free to discuss and clear doubts from their friendly peers at their own time. It is mandatory to attend online classes. To make the online session easy and comfortable, students are guided to how to access the software, course lessons, and activities. Special support centers are provided to students to tackle software and other online issues. Simulation exercises were introduced which was structured to be self-directed. To access such activities, students must get registered and log in directly. Deadlines are kept, and grades are assigned for such activities. These activities have built-in teaching aids in the form of practice by watching video, etc. This enabled student to watch the video lessons, understand and follow the instructions to solve the questions by themselves. Simulation exercises were also used to explain and solve practical questions. Generally, while practical assignments are given, students have issues related to having the same version/platform as per the course structure or may have other software-related issues. Simulation exercises overcome this problem as it provides everyone with the same working platform for the practical work. These exercises are graded. Students were given more attempts so that they can improve their score. This practice made the learning less stressful and pleasant as they could score better grades with more attempts.

3.3 Resource Collection

Preparing video lessons is time-consuming process for an instructor, especially when it is prepared for the first time. Instructors take different time to develop, record, and customize video lecture sessions. Some instructors prepared video lecture session-by-session, while others prepared on weekly basis or lesson wise. Minimum 1–2 h is required to record a half an hour lecture session, but once prepared, the same can be reused for other sections and semesters with little or no modifications. The preparatory work in the form of videos prepared by instructors is the only way for students to get the needed instructional content for their self-study. More and more new videos and activities are included in each semester. The videos are sometimes curated from other sources. Videos are prepared for each section by the instructor. Videos from other sources are also incorporated. Materials uploaded and an estimate of time taken to create chapter-wise instructional video lessons for certain chapters of information technology are given in Table 1.

Table 1 Chapter, materials uploaded, and estimated time taken for video preparation for online class

Lesson	Materials uploaded	Video parts Video creation time
Hardware, software	Handout, PPT slides, videos, quizzes, simulation exercise, h5p activities	Video with 5 parts 15 h
Networking, mobile devices		Video with 3 parts 10 h
Security and maintenance		Video with 3 parts 8 h
Application software		Video with 10 parts 35 h

In-class activities are designed to be collaborative in nature. In order to meet the objectives of AIC learning, peer communication was given importance for the following reasons: The social aspect of peer communication helps students get to know other students; making friends is important; when students are socially relaxed, they are likely to learn more; some students have an easier time learning from peers than from instructors; learning from peers exposes students to different perspectives, and teaching peers helps students clarify and solidify their own understanding of course concepts.

As part of building self-study habits and perform self-analyzation, activities are designed where students have to first watch audio or video lessons prior to solving the activities in the form of quizzes, test your knowledge, etc. To make it comfortable for students, simulation activities with all the steps solved in the form of audio or video instructions are provided. These are self-work activities where students can first watch the video instructions and then practice. Peer help or instructor help is also provided in case of any difficulties. Assessments are conducted based on these audio–video lessons in the form of quizzes to check their level of understanding and self-study ability and was found that a very good number of students scored above average. It is found that assessment based on simulation exercises also helped students in promoting independent learning, especially in online mode of teaching.

Team study activities are selected from the course handout's question bank. For a new batch, forming small groups of 5–6 students proved efficient. Larger groups or ad-hoc groups are formed for group study once students get familiarized with each other. At least, one session per week is reserved for team study which is given either in the form of do in class or do before class activities. Table 2 shows the types of preparatory materials/resources and type of group formed to promote collaborative learning for some of the chapters in the introductory course.

Some of the noteworthy responses about video lessons given by students are as follows: 'Can study when they are free, active, and in relaxed mode'. 'The option of rewind, go forward, go back, and pause are extremely useful'—this helped them to recollect information as and when they required.

'The step-by-step video explanation of activities helped to learn self-work activities'—This remark shows that shy students not willing to seek help from others could benefit from video lessons and simulation activities.

'Hold conference meetings with friends to clear doubts'—this proves that students have gained digital literacy.

'Confidence to read, comprehend, and solve problems'—this states that students are confident at self-learning.

Few drawbacks of the system were also noted by students like 'Miss class rooms and miss real contact with their teachers, classmates, and the system'. 'Sometimes feel sleepy watching video lessons'. 'Time consuming as network is slow'. To overcome these problems, video lessons were made interactive so that students are not just listening, they are also thinking and answering the questions in it. Moodle H5p interactive videos were used. It helped students to great extent to remove the monotony of just watching videos. Short videos were prepared with many parts like part 1 and

Table 2 List of preparatory materials, group activities, and nature of group to promote self- and group-learning habits

Chapter	Materials that promote self-learning habits	Materials that promote group-learning habits Type/size of group
Hardware, Software	Handout, PPT slides, videos, end of chapter quiz, check your understanding quiz, test your knowledge quiz, simulation exercise, oral questions, lesson handout activity	Lesson handout activities, identify the device, fill in the blanks, match the following, MCQ Large group
Network, mobile devices		Lesson handout activities, name the device, fill in the blanks, match the following, MCQ Friendly group with 6 members
Security and maintenance		Lesson handout activities, MCQ, true/false Ad-hoc groups
Application software	Simulation exercises, test your knowledge quizzes, output questions, peer questions	Lesson handout activities, predict the output, explain steps to solve a given problem Friendly group/pair/ad-hoc group

2 depending upon the length of the lesson so that it is short and easy to download [12].

Review centers engaged students who needed more attention. Peer tutors or instructors took review sessions prior to any scheduled assessments. Instructors prepared the content materials for such sessions. This also lead way to students to gain confidence by being able to deliver and help peers and gain confidence in their use of computer skills.

4 Results

In this paper, we compared the response obtained from students, at the beginning and at the end of the semester, on how confident students were with ‘learning before the class and do activities in class’ (LBC-AIC) and peer study. The course enrollment and the class overall confidence rate for taking the ownership of learning and collaborative learning is shown in Table 3.

Table 3 shows that the main objective of LBC-AIC approach to develop self and collaborative learning skills of students is met. Satisfaction rate of 94.6% proves that this approach has helped student gain confidence by the end of the semester. It was

Table 3 Comparison of confidence rate on self-study and collaborative learning

Response	Enrolled	Confidence rate (%)
Beginning of session	35	63
End of session		94.6

Table 4 Ratings by students on LBC-AIC objectives

Questions	End of semester
LBC-AIC objectives are clear?	4.92
LBC video lessons and activities are useful for self-study?	4.56
Able to go through the video lessons prior to the class?	4.36
LBC promotes self-learning?	4.34
AIC helps peer interaction?	4.60
AIC strategy is better than traditional teaching methods?	3.59
Comfortable with AIC strategies?	3.54
Comfortable to study with any peer group?	4.01
Yes, I also learnt from peers which was as good an experience as to learn from a teacher?	4.78
Simulation exercises developed self-learning ability?	4.61
AIC approach helped me improve myself in self-learning, interacting with peers, and helping peers?	4.47
I could help other students to understand the topics/questions?	3.20
I did peer tutoring, and it helped me to build my confidence in self-learning and interacting with others?	3.84
LBC-AIC helped me get better grades?	4.07

noted that students were eagerly waiting for the lesson uploads so that they can go through it, prior to attending the class and prepare themselves for the online session.

Table 4 displays the rating given by students on LBC-AIC objectives in detail. The questions are based on the approach objectives, materials by the instructors, student achievement etc., and were on 5-point rating scale. Rating 5 was given for 'strongly agree'. It is noted that most of them had positive response showing 4 or 5. Results also show how much a student has acquired knowledge in terms of self and collaborative learning after the completion of the course.

Results in Table 4 shows that students benefited with this approach. Some students maintained a graph to portray their self-learning skill week-wise for each chapter. In the beginning of the semester, students expressed their fear about going through lessons in video format and answering quizzes and activities prior to teacher teaching lessons. But, Table 4 results show that by the end of the semester, they had overcome all the fears and has met all the objectives of online learning and teaching. The increase in the satisfaction rate is mainly due to the structured workflow which was well communicated and followed. Students were able to accept and approve LBC and AIC approach and got blended with this strategy.

5 Conclusions and Future Work

In this paper, we discuss teaching an introductory course for 35 students enrolled in an IT class for a particular semester. Course is designed to be taught using traditional lecture methods with hands-on activities, but after the pandemic, transition to online mode took place. The platform used was Moodle, and online sessions were conducted using Zoom, BBB, or MS Teams applications. In this introductory course, students learn about hardware, software, networking, mobile devices, security and maintenance, different application software's, etc. Supplement course materials were added from other library add ins/additional resources and instructional sites. Features in these software's were useful to bring control while doing activities as it allowed to specify the start date and deadline dates. Preparatory work, activities, quizzes, and assessments followed in a specific order which progressed only after the completion of a particular skill and was graded.

We compared the responses obtained from students at the start and end of the course. The results display that the structured workflow strategies enabled students achieve the chief objectives of online learning.

In future, more focus will be given to forming student groups where each group takes another group's quiz and the group that created the quiz grades the answers. In this way, each group creates a quiz based on videos, takes a quiz, and grades a quiz.

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Smart and Intelligent Health Monitoring System

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Abstract The new era of smart devices and mobile health care has brought several opportunities to the public. Alongside, the worldwide urbanization process is bringing formidable challenges and issues in the same field. In this research work, we have proposed a system that the elder people or the person with a chronic disease can wear a health tracker wearable device equipped with a number of sensors for cardiovascular activity rate, blood pressure measurement, and temperature degree. This device will also be equipped with a small LED display module that will show immediately the detected values. Furthermore, the signals collected will be sent in real time to a back end through the Internet. The back end is a Web application having few artificial intelligence features in order to detect as soon as possible the eventually infected people. Machine learning will process these data and generate predictions and the risk level.

Keywords Smart health · Data analytics · Machine learning

1 Introduction

Rapid transformation is undertaking in the field of well-being from traditional to smart health. This rapid advancement of health care has seen several technological improvements as well in the last decade [1]. Many of such technologies like IoT and sensors are vital technologies offer great potential in detecting critical conditions at the right time [2]. In the current situation of unseen diseases and emerging technologies, most of the people are very keen about the health issues. Active health is directly proportional to the two key elements such as diet and exercise. Smart way of

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taking care about these vital factors are smart health monitoring system and applications, which are gaining popularity under the umbrella of advance technologies like IoT, Big Data, data analytics, and artificial intelligence with machine learning. [3] Such innovative smart health management systems and applications are helping and controlling the necessary diet calories as per their needs and use for a day. As well as, predicting the number of proteins, vitamins etc. consumption with fat reduction for Smart health management systems and application need expertise while designing and careful planning with implementation and testing. Let suppose heart patients are facing several issues in taking quick decisions today, thus, in order to remove complexities of taking decisions, improved care and prompt actions could be best possible by using such smart health applications by integrating emerging technologies with IT systems. In current situation of COVID-19, such advanced clinical decision support tools and applications helped practitioners and clinicians in informed care decision. It gives on-the-move care virtually anywhere, anytime visibility to a patient's vital signs, wave forms and alarms, etc., to decide for the best course of care [4].

COVID-19 pandemic has caused and presented many unprecedented issues around the word. Due to this extraordinary situation and the concept of social distancing measures are disproportionally affected the individual lives. General patients are advised against visiting the doctors in order to reduce the risk of spreading the corona virus. Such smart health monitoring applications can help to take better decisions and cure [5].

With the development of Smart Cities and smart health systems such as Oladoc.com, it is trying to ensure detail information about various human health issues as well as timely detection of several chronic conditions and diseases [6]. Research reveals that from initial bonding to subsequent stages of life, modern technologies are playing vital role for people's peace of mind, improve health care and satisfaction. Diagnose and treat illness as soon as patient is suffering with some symptoms. Train medical staff to keep safe, improve efficiency, and protect everyone visiting hospitals. Through a combination of latest wearable monitoring technologies, personalized technology is establishing a new era of medical industry, profoundly changing how and when medical decisions are made, and treatment is delivered. The healthcare industry has begun to acknowledge the necessity of remote treatment through telemedicine, home diagnosis, and even pop-up retail locations. By 2018, 70% of healthcare institutions had invested on medical mobile applications, with 1.5 trillion dollars spent on wearable health monitoring devices and mobile apps relating to this [7]. This growing trend of remote mobile health care allows for more rapid treatment of patients at their homes, lowering the cost of intervention while also provides good care of patients. Pilot programs have so far yielded remarkable results, lowering hospital admission rates by 18% in the United States [8]. The trend toward patients embracing wearable and other personalized technologies as an alternative to hospital-run healthcare programs is gaining traction. In short, the ultimate purpose is to make decisions on how to improve well-being and avoid bad health practices. Health care is evolving in such a rapid pace, the pace of change that were experiencing some of the most challenging that we are facing day to day.

In order to help the communities around the world to limit the extent of virus spread, we propose to design a smart and intelligent health monitoring system based on Internet of Things technology and artificial intelligence features.

2 Literature Review and Analysis of Related Work

2.1 Smart Systems for Patient Monitoring

Chronic disorders such as cardiac arrhythmia, high blood pressure, diabetes, and others affect many patients. Without monitoring them and giving early treatment, the patient can lose their life. Traditional ways of measuring blood pressure, glucose level, and heart activities are time consuming. Thanks to the technology, all these vital signals can be read using a variety of sensors. Applying the Internet of Things to healthcare sector can improve the well-being of some citizens by monitoring the patient's health and generating better traceability of information [9].

2.2 About COVID-19 Pandemic

COVID-19 is a new type of coronavirus. It was found for the first time in Wuhan, China on December 31st, 2019 [10]. Recently, it has been declared officially as a pandemic by the World Health Organization [11]. Although strict and judicious measures that have been taken by the Sultanate of Oman to fight COVID 19 spread is useful and helpful to fight with COVID -19 [12].

It is characterized by a rapid spread among the community. Elder people and those having previous medical issues such as heart disease, diabetes, or respiratory disease are at higher risk of having critical health status which can lead to death after being infected by this virus if they are not quickly detected. One of the main factors that emphasized the impact of this pandemic is that around 60% of infected people with COVID-19 shows mild or no symptoms. Furthermore, many countries are facing an issue of testing a big number of patients given the high demand and the equipment shortage. As no specific treatment for this virus has been announced till today, researches across the world are focusing on emerging technologies such as Internet of Thing and artificial intelligence in order to detect and follow the infections spread [13]. Researchers and scientist around the world are restlessly working on developing the potential vaccine in order to improve the immune system that would teach the body in identifying and blocking the virus to damage. As so far, several different types of vaccines are under testing phase, i.e., RNA and DNA vaccine, which is supposed to be a cutting edge approach to generate protein by using genetically plotted RNA or DNA, which will be safety prompt itself to the immune system.

Many strict protection mechanisms are in place also to ensure safety, e.g., rigorous multistage process of testing [14].

Technology also played a crucial role in fighting COVID-19 spread. Indeed, it reshaped the form of public health services by adding more scale, agility, and responsiveness. Artificial intelligence (AI) helped considerably in understanding the virus nature and spread behavior and also in developing the necessary treatments [15]. Along with AI, the Internet of Things (IoT) has witnessed a wide popularity in the health care and other sectors during this pandemic which is considered to be a catalyst for its development. Many countries have invested widely in IoT and other technologies in order to fight viruses, their spread, and tracking [16].

The healthcare quality criteria are taking into account that how much a country is spending on health care to make sure of quality services, availability, population's health and upfront cost, and meeting the health needs of population. It is not only that people being able to access health services in the place but it also about putting everything in appropriate locations to avoid people from getting unwell. Programs are put in place to encourage and facilitate good life choices that are healthy and processes employed so that the population does not catch environmental and infectious diseases. Thus, health needs of a population are health services, protection, and promotions as well as require leadership, management, and governance with finance [17].

2.3 IoT Technology in Healthcare Systems

IOT technology demonstrated its efficiency in improving the quality of healthcare services. It has also other advantages such as the low cost. This innovative technology was discovered by advanced science, and it has aided in the improvement of healthcare services. IoT technology is used to connect available medical materials in order to provide seniors and patients with reliable and intelligent health services. It can keep track of the health of people who have chronic illnesses. In order to have a successful implementation of IoT, we must first comprehend and seek for stages and restrictions.

Health tracker wearable devices are now having an increasing popularity and availability in the marketplace. These devices are used for different purposes such as losing weight, improving sleep, or getting a best picture of the person's health [18].

2.4 Watch for Health Monitoring

A smart watch is a wearable device that appears like a traditional watch but has additional features such as collecting physiological data and sending alert notifications. The data are collected through bio-sensors, and the connection to other devices is in general ensured via Bluetooth which is a short-range wireless connectivity.

Smartwatches proved their efficiency in different healthcare applications and fitness. They have a strong effect on motivating their users to be more engaged in healthy lifestyles and improve their health by monitoring chronic diseases. Recently, they gained a great popularity, especially with the launch of Apple smart watch in 2015. The advantages are enormous such as portability, unobtrusiveness, ease of use, and ability to transmit large amount of monitored data to smartphones and tablets [19].

3 Requirement Analysis

In order to get wider understanding of the most important factors that need to be monitored among elder people and measure the social awareness about COVID-19 pandemic with consensus on smart health wearable devices, a survey has been conducted by 21 participants with different age categories. Most of the people were agreeing to have smart wearable devices, which can reduce the risk of health issues.

4 Design

4.1 Methodology

The methodology selected consists in four stages. It starts by an analysis of the requirements and design. In a next stage, the implementation is achieved through a prototype and then its deployment. By applying this methodology to the proposed system, the analysis relies on the data collected from the conducted survey. The design focuses mainly on the architecture and the static aspect of the system. The implementation is done through a prototype which is evaluated in a following stage by the user and deployed in case of its success (Fig. 1).

Fig. 1 Design methodology for SIHMS

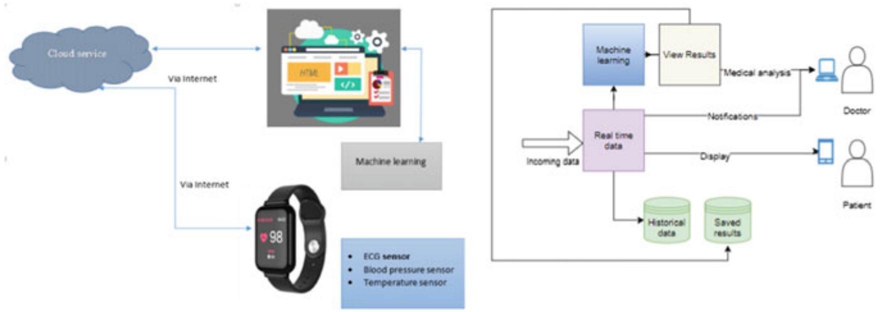

Fig. 2 Architecture of SIHMS and architecture of back-end app

4.2 General Architecture of the System

In the proposed system, the elder people or the person with a chronic disease can wear a health tracker wearable device that monitors constantly the most important symptoms of infected persons and sends the collected data to the cloud.

The back end is a Web application having some artificial intelligence features in order to detect as soon as possible the eventual infected people from the collected statistics and by comparing them to previous infected people's statistics. A machine learning will process these data and generate predictions on the probability of infection and the risk level for one patient. The proposed system is a smart and intelligent health monitoring system (SIHMS) that will help the elder people and others with chronic disease to monitor constantly the most important symptoms of viruses. The system will then send the collected data to the cloud using wearable device (Fig. 2).

4.3 Architecture of the Back-End Application

The back-end application will be accessed by two types of users: the patient who can get real-time display of the monitored data and the doctor who can receive notifications about the urgent cases and hence execute prompt interventions. The doctor can also get more analytical results about the health of the patient after applying artificial intelligence features on the historical data. The more users will be using the health monitoring device, the more accurate will be the predictions determined by the machine learning's units.

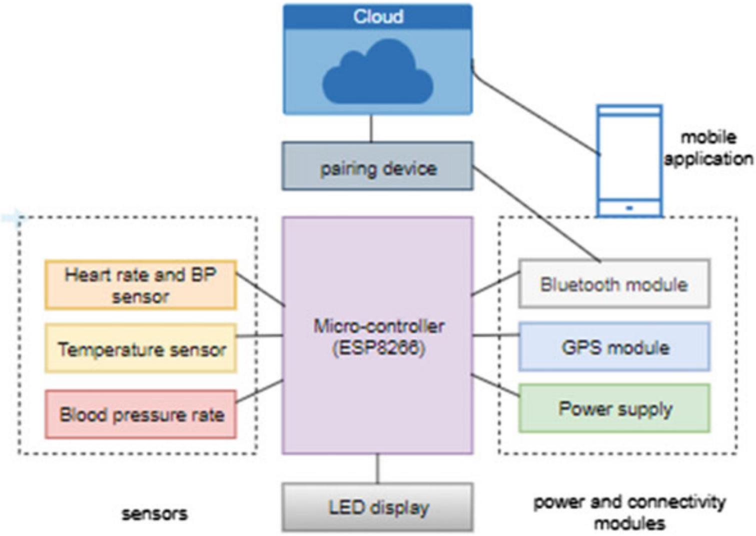

Fig. 3 Block diagram of SIHMS

4.4 Block Diagram

The smart watch is mainly formed by an ESP8266 micro-controller which is very suitable for wearable devices since it has a small size and embedded wireless fidelity [20]. The system has also three sensors that detect the cardiovascular activity rate, blood pressure measurement, and the temperature degree. This device will also be equipped with a small LED display module that will show immediately the detected values (Fig. 3).

Furthermore, the signals collected will be sent in real time to a back end through Bluetooth connectivity to Internet. The input consists also of a global positioning system (GPS) for location tracking. The data collected by the different sensors will be sent to the micro-controller which executes small filtering in order to send only important updates. The important updates are sent after maximum intervals of times or by exceeding the fixed thresholds for each sensed data. After the applying the necessary filtering the resulting data along with the system location send it to the cloud. End users such as patient and doctors can be notified and get access to historical data by installing the mobile application developed for this system.

5 Conclusion

Many patients suffer from chronic diseases such as high blood pressure, cardiovascular disease, and others. Without a prompt detection and intervention, these patients may lose their lives, especially in case of various infections and viruses.

In this paper, we proposed and designed a smart watch for health monitoring which can continuously monitor the heart rate, blood pressure, and body temperature. The result can be sent immediately to the patient's smartphone or tablet. Notifications can also be sent to the doctor. The back-end application has artificial intelligence features that can analyze the historical data and generate more meaningful information to the patient and doctors. It is a cost-effective and accurate solution that can save the lives of many patients and help to improve the well-being of citizens.

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Energy-Efficient OLSR Routing Protocol for Flying Ad Hoc Networks

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Abstract Routing protocols of ad hoc networks take its position and responsibility to monitor and to accomplish the information of the network topology effectively; also, it manages the scalability of network and to manage network scalability promptly and to increase the network era. One of the most efficient OLSRs (a proactive protocol) finds the shortest path among the available nodes or UAVs in highly dynamic networks. A small modification in the multi-point relay selection procedures of OLSR protocol improves the network lifetime, and also, it does not compromise the network performance. As mentioned, the modification is done by the parameter variations such as willingness and TC interval. Deploying routing protocol to a fast-changing network is highly complicated. It is very essential to analyse the performance of protocol from the point of energy. Battery life of a node usually affects the network communication performance, and sometimes it may lead to network partitioning also to heavy traffic loads. Modification of OLSR protocol in terms of willingness ensures good quality of service.

Keywords UAVs · Drones · Routing DSR · AODV · OLSR · GRP · TORA

1 Introduction

Unmanned aerial vehicle is very famous nowadays for its adventures [1]. It does not need support from a human. It flies basically on a condition of preprogramed flight plans [2]. This unmanned vehicle is commonly named or called as drones [3]. It shows its high performance nowadays in many sectors. [4] Some of examples are

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in agriculture, surveillance, as well as in communications. Moreover, as everyone-aware ad hoc networks are quite interesting for its architecture. Because it does not need any infrastructure [4], also, it allows its node to move freely/randomly to get its name as dynamic. Basically, UAVs are classified based on the following criteria as like size, wings type and communication capabilities such as autonomous nature or remote-controlled. Also, flying ad hoc network (FANET) is a network which suits to keep all UAVs active and dynamic. FANET supports multihop communication. Unmanned aerial vehicle, controller of the base station are the properties of unmanned aerial systems. Drones, which are very simple and easy to operate, are nowadays very famous for many applications and are being utilized in many sectors to automate the process [5]. This paper is organized from introduction to references. Related works discussed in Sect. 2. Methodology, simulations and results and finally conclusion takes the rest of Sects. 3, 4 and 5. Followed by references.

2 Related Works

In flying ad hoc network, the mobility of UAVs must be considered as a serious challenge. High speed may lead to datalink intervention, and it also disturbs the quality of coverage area. So on the whole, node mobility is one of serious issues under flying ad hoc network. Storage, security, routing and planning are some of the other major challenges could be addressed under flying ad hoc networks. Also, UAVs in the flying ad hoc network trigger their actions in an autonomous way as well. Routing protocol takes its most way to identify the shortest route among the UAVS in the network. Among different routing protocols, OLSR shows the best performance in any of the criteria's and conditions. It is not a huge requirement that all the UAVs in FANET need to communicate with the base station controller. One of the cluster head UAV communications is more than enough. Since these types of networks are infrastructure less, dynamic the power consumption must be taken or considered for the successful communications or transactions among the UAVs in FANET. Routing protocols as OLSR shows better performance in many applications and scenario which are based on the size of the networks, data rate and speed of UAVs. So energy behaviour of UAV is a crucial factor to be considered for FANET. Energy-efficient OLSR is accomplished by modifying a simple OLSR concept which can show better performance in the energy consumption. Also, energy consumption issue directly triggers few challenges such as UAV flight time, signal coverage and speed of the connection [6–12]

Table 1 Energy-based willingness selection

Energy	Low level	Medium level	High level
Short	W_LOW	W_LOW	W_LOW
Medium	W_LOW	W_LOW	W_DEFAULT
Long	W_HIGH	W_HIGH	W_HIGH

3 Methodology

The mechanism to optimize the energetic considerations in **multipoint relay** (MPR) selection is energy-aware willingness settings [13, 14]. In OLSR, the most important feature which is willingness represents availability of that particular node to act as MPR to their neighbouring nodes in ad hoc network. But to add to a value to this statement always every node is the ad hoc declares itself as "default willingness value". But in EE-OLSR, every **node** feels free to declare its own and appropriate willingness status after calculating its own energetic status [15, 16]. The battery lifetime and the willingness set-up have an indirect relationship [17–19]. In case if the predicted lifetime is short, a node will declare the willingness status as default. However for longer node lifetime, node declares as high. But if the battery charge is low, the willingness could be low, thus leading to better load balancing as shown in Table 1.

In this paper, the efficiency of routing protocols OLSR is tested in different network conditions as shown in Tables 2, 3 and 4

4 Simulation and Results

OPNET is used to simulate EE-OLSR. The network consists of 6, 12 and 18 nodes moving in a 1000X1000 m area. Every node feels free to move randomly with a speed of 50 m/s. The duration of each simulation is 1 h. OPNET simulator allows to extract from a simulation many interesting parameters, like throughput, load, delay and media access delay. To have detailed energy-related information over a simulation, OPNET is modified to obtain the amount of energy consumed over time.

4.1 Category 1:6 UAV1 Multilayer (Battery Life)

Based on the simulation shown (Fig. 1), delay records its lowest value in the short category; however, high category records its second position and the medium category shows its least performance among three. As per the simulation result (Fig. 2) of three categories, short category range shows better performance than medium and high categories, whereas medium category results are the least. From the result (Fig. 3), it is clear that medium, high and short find its position in the following as

Table 2 Network scenario with Willingness defaultTC interval (s) = 5.0

S. No.	Criteria name used during the modelling and simulation	Number of unmanned aerial vehicle	Architecture	Category
1	6 UAV1 backbone	One backbone UAV and 6 UAVs with one ground station (as shown in Fig. 1)	UAV Ad hoc network	Willingness default TC interval (s) = 5.0
2	12 UAV1 backbone	2 backbone UAVs and 12UAVs with one ground station (as shown in Fig. 2)		
3	18 UAV1backbone	2 backbone UAVs and 18 UAVs with one ground station (as shown in Fig. 3)		
4	6 UAV multigroup	One backbone UAV and 6 UAVs with one ground station (as shown in Fig. 4)	Multigroup UAV Ad hoc network	Willingness default TC interval (s) = 5.0
5	12 UAV multigroup	2backbone UAVs and 12UAVs with one ground station (as shown in Fig. 5)		
6	18 UAV multigroup	2backbone UAVs and 18 UAVs with one ground station (as shown in Fig. 6)		
7	6 UAV multilayer	One backbone UAV and 6 UAVs with one ground station (as shown in Fig. 7)	Multilayer UAV Ad hoc Network	Willingness default TC interval (s) = 5.0
8	12 UAV multilayer	2backbone UAVs and 12UAVs with one ground station (as shown in Fig. 8)		
9	18 UAV multilayer	2backbone UAVs and 18 UAVs with one ground station (as shown in Fig. 9)		

first, second and third. It is clearly understood from the simulation (Fig. 4) that short category range shows better performance than medium and high categories, whereas medium category results are the least.

Table 3 Network scenario with Willingness lowTC interval (s) = 5.0

S. No.	Criteria name used during the modelling and simulation	Number of unmanned aerial vehicle	Architecture	Category
1	6 UAV1 backbone willingness	One backbone UAV and 6 UAVs with one ground station (as shown in Fig. 1)	UAV Ad hoc network	Willingness low TC interval (s) = 5.0
2	12 UAV1 backbone willingness	2 backbone UAVs and 12UAVs with one ground station (as shown in Fig. 2)		
3	18 UAV1backbone willingness	2backbone UAVs and 18 UAVs with one ground station (as shown in Fig. 3)		
4	6 UAV multigroup willingness	One backbone UAV and 6 UAVs with one ground station (as shown in Fig. 4)	Multigroup UAV Ad hoc Network	Willingness low TC interval (s) = 5.0
5	12 UAV multigroup willingness	2backbone UAVs and 12UAVs with one ground station (as shown in Fig. 5)		
6	18 UAV multigroup willingness	2backbone UAVs and 18 UAVs with one ground station (as shown in Fig. 6)		
7	6 UAV multilayer willingness	One backbone UAV and 6 UAVs with one ground station (as shown in Fig. 7)	Multilayer UAV Ad hoc network	Willingness low TC interval (s) = 5.0
8	12 UAV multilayer willingness	2backbone UAVs and 12UAVs with one ground station (as shown in Fig. 8)		
9	18 UAV multilayer willingness	2backbone UAVs and 18 UAVs with one ground station (as shown in Fig. 9)		

4.2 *Category 2:12 UAV1 Multilayer (Battery Life)*

Based on the simulation shown (Fig. 5), delay records its lowest value in the category when all the coordinates are maintained as low; however, medium and high categories show almost the same performance. As per the simulation result (Fig. 6) of three

Table 4 Network scenario with Willingness lowTC interval (s) = 3.0

S. No.	Criteria name used during the modelling and simulation	Number of unmanned aerial vehicle	Architecture	Category
1	6 UAV1 backbone TC interval	One backbone UAV and 6 UAVs with one ground station (as shown in Fig. 1)	UAV Ad hoc Network	Willingness low TC interval (s) = 3.0
2	12 UAV1 backbone TC interval	2 backbone UAVs and 12UAVs with one ground station (as shown in Fig. 2)		
3	18 UAV1backbone TC interval	2backbone UAVs and 18 UAVs with one ground station (as shown in Fig. 3)		
4	6 UAV multigroup TC interval	One backbone UAV and 6 UAVs with one ground station (as shown in Fig. 4)	Multigroup UAV Ad hoc network	Willingness low TC interval (s) = 3.0
5	12 UAV multigroup TC interval	2backbone UAVs and 12UAVs with one ground station (as shown in Fig. 5)		
6	18 UAV multigroup TC interval	2backbone UAVs and 18 UAVs with one ground station (as shown in Fig. 6)		
7	6 UAV multilayer TC interval	One backbone UAV and 6 UAVs with one ground station (as shown in Fig. 7)	Multilayer UAV Ad hoc network	Willingness low TC interval (s) = 3.0
8	12 UAV multilayer TC interval	2backbone UAVs and 12UAVs with one ground station (as shown in Fig. 8)		
9	18 UAV multilayer TC interval	2backbone UAVs and 18 UAVs with one ground station (as shown in Fig. 9)		

categories, high holds first position, medium category takes the second place and short category is the least among **the** three. From the result (Fig. 7), it is clear that high and medium almost show equal media access delay for 1 h, whereas short category is the last among **the** three. It is clearly understood from the simulation (Fig. 8) that

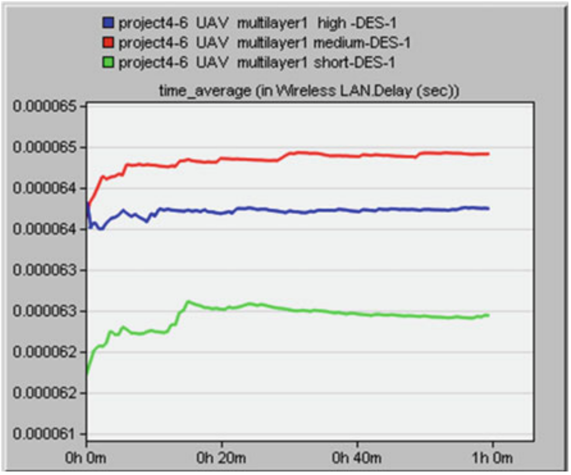

Fig. 1 Delay

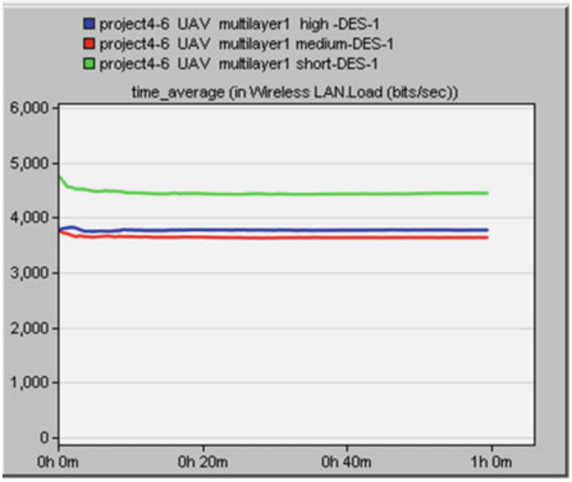

Fig. 2 Load

short category shows better result in throughput than other two categories such as medium and high.

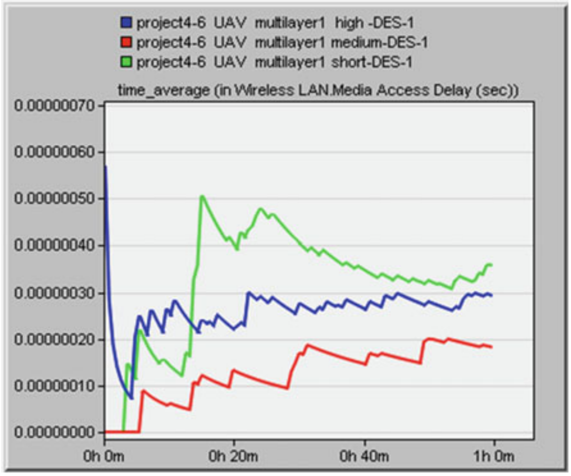

Fig. 3 Media access delay

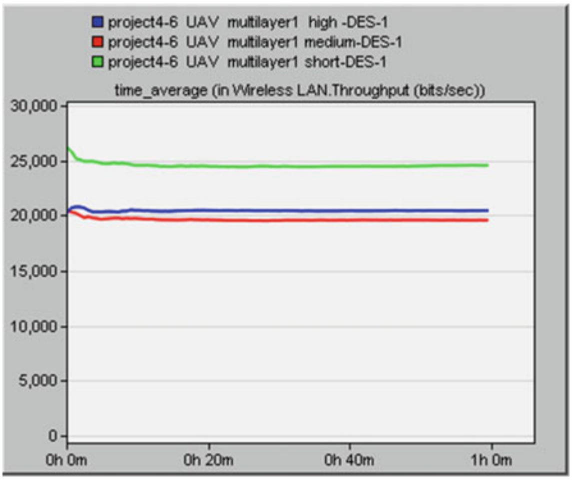

Fig. 4 Throughput

4.3 Category 3:18 UAV1 Multilayer (Battery Life)

Based on the simulation shown (Fig. 9), delay records its lowest value in the short category; however, high category records its second position and the medium category shows its least performance among three. As per the simulation result (Fig. 10) of three categories, short category range shows better performance than medium and high categories, whereas medium category results are the least. From the result (Fig. 11), it is clear that medium short and high finds its position in the following as

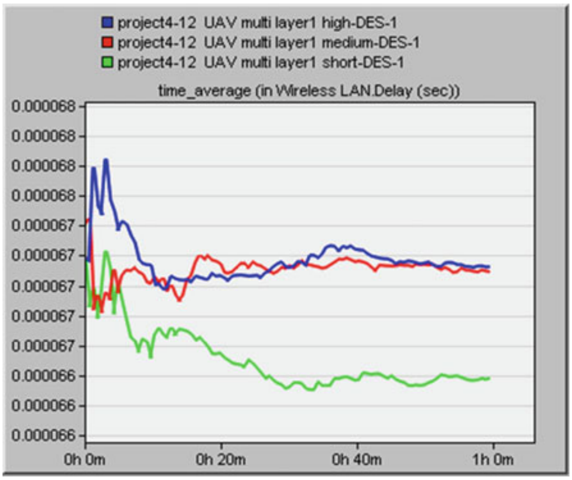

Fig. 5 Delay

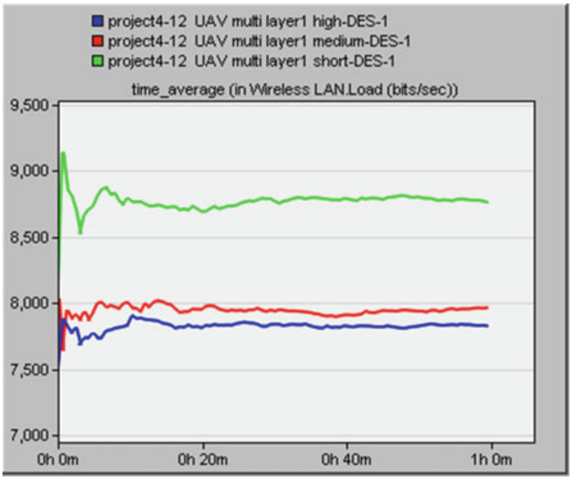

Fig. 6 Load

first, second and third. It is clearly understood from the simulation (Fig. 12) that short category range shows better performance than medium and high category, whereas medium category results are the least.

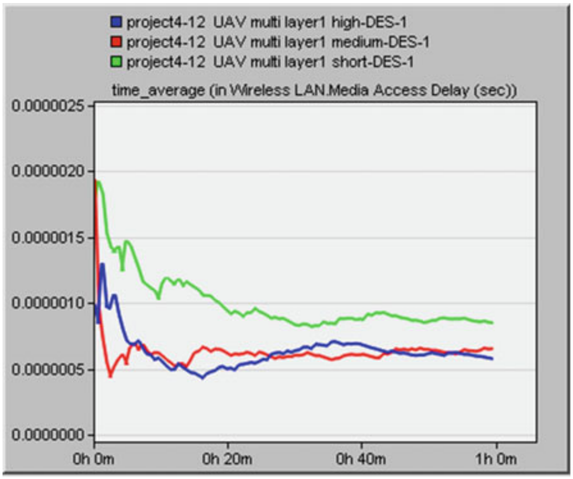

Fig. 7 Media access delay

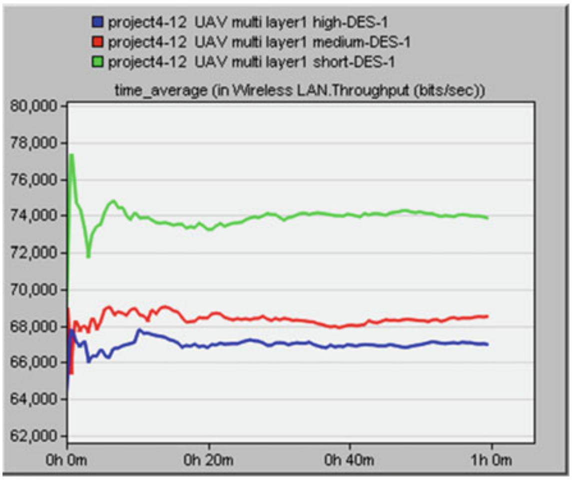

Fig. 8 Throughput

5 Conclusion

The best optimization of link state algorithm is achieved by the optimized link state routing protocol. Link state algorithm is better than distance vector algorithm in terms of less prone to the routing loops. On the other hand, link state algorithms need more CPU power and memory and lead to more cost. Multipoint relay (MPR) is the most efficient key factor **in OLSR**. During flooding mechanism, the selected multipoint relays forwards broadcast messages. But in the case of classical flooding

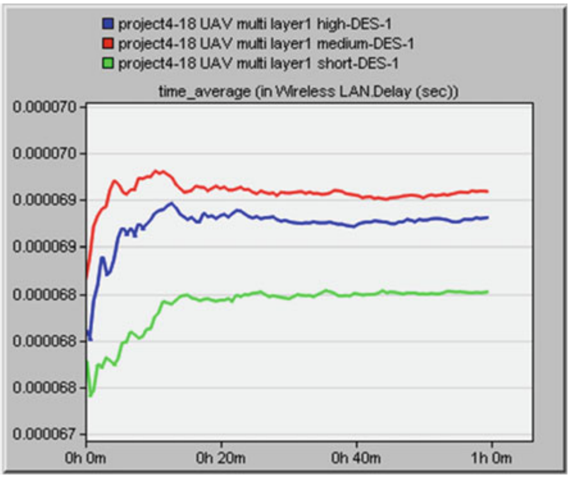

Fig. 9 Delay

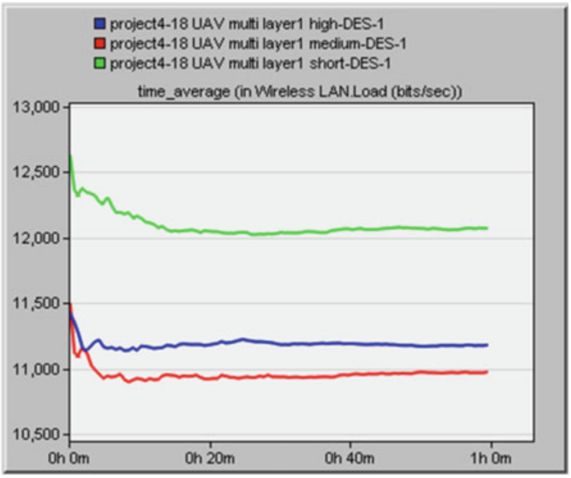

Fig. 10 Load

mechanism, every node takes the responsibility of retransmitting every message received, so indirectly it increases message overhead process. Whereas in OLSR, only selected MPRs will do this and it supports the **reduction** battery consumption. **So** this is very useful to find the optimal routes. Moreover, this protocol is very much suitable for large and dense networks. Minimum total transmission power routing **is** used to find the shortest path routing. It is the energy consumed to forward the information along the route. Power saving mechanisms are based only on the

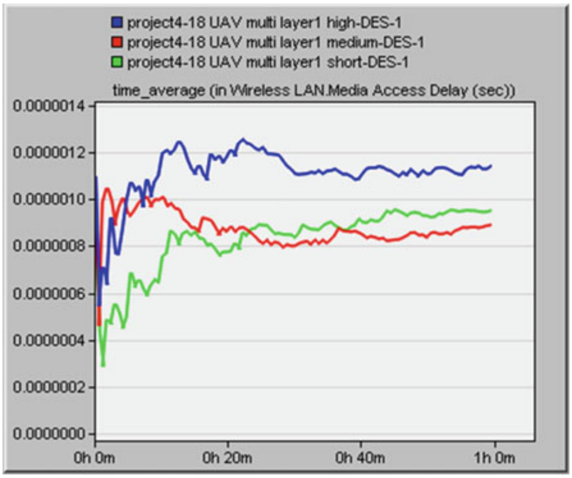

Fig. 11 Media access delay

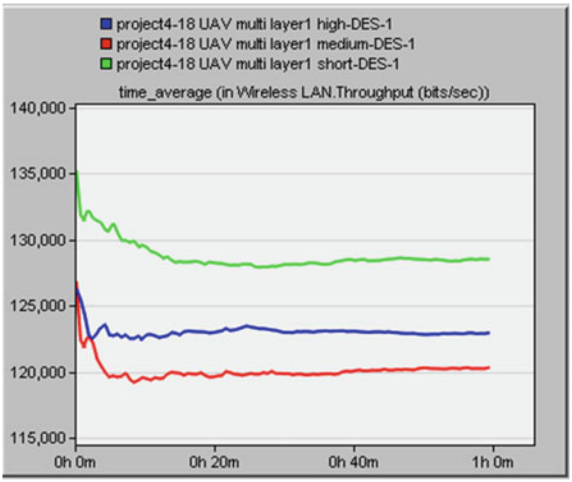

Fig. 12 Throughput

remaining power **and** cannot be used to establish the best route between source and destination nodes.

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Challenges in Malware Detection and Effecting Areas: Survey

Gaurav Mehta, Prasenjit Das, and Vikas Tripathi

Abstract Malware detection is big area in domain of computer science and is never ending chase between malware scholars and security analyzer. Data mining is one of the favorite model for researchers to detect and classify malware in different areas like windows, android, and IoT. As the malware attacking technique and its ability to hide with obfuscation technique is changing rapidly, same is for detection method to detect malware with high accuracy and less time. On top of different method and techniques, the focus of detection process is shifting from binary and executable files to grayscale image and colored image analysis for detection. This paper focuses on different detection techniques, classification techniques, framework, dataset, and tools used by many researchers.

Keywords Malware detection · Image processing · Neural network · Data mining · IoT · Cloud · Android

1 Introduction

Threat of malicious code or malware is increasing at high rate due to growth of Internet and open-source platform like android. Currently, scope of malware is not only restricted to machines (desktop or laptops or mobile phones) but its existence can also be seen in IoT and cloud. The growth of IoT devices and cloud architecture had given big platform to malware detector to proceed for security breach and get personal information without the knowledge of host [1]. Millions of apps are available

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on Google Play Store and with millions of download count of thousands of apps which shows the popularity of android platform all over the world. In comparison to iOS platform, android platform also allows the users to download apps from unsecured or unverified links which increases the chance of attack on user device. Huge amount of android devices allows the attackers to target this platform, and 97% of attackers has the target field, i.e., android [3]. Each type of attacking malicious code had 50 different variants that make it more difficult to be identified by malware detection community [4]. Different approaches for static and dynamic analyses are used by researched to address security concerns. Malware detection is never ending process; it is a never ending chase between malware detector and malware creator [5]. Malicious code is not an emerging or new trend; it is from ages, since the start of computer machine. Large number of malware gets introduced in one or other fields which increase the demand to detect malware in all the areas that are attacked by malware. There exists large number of attacks which affects the host machine or data or security settings in one or the other way. Table 1 discusses some of the attacks and their types.

1.1 Malware Detection Approach

Anomaly-based malware detection: It is used to detect malicious activity both in network and computer. It is a process to detect malicious activity by comparing description of code. The classification of malicious code in anomaly-based detection is as per heuristic or rules based rather than signature or pattern. Major disadvantage of this technique is that little deviation from normal traffic or pattern gives alarm to security administrator to check and validate accordingly.

Signature-based malware detection: Database of known malwares is updated by malware detector, whenever new malicious code is identified. The signature of malicious code is added in this database to refer for malware detection. The new identifier is established for known threats to be identified in future. Signature-based technique has two major disadvantages: firstly, malware detection product/tool need to look into big database to identify attack; secondly, newly developed malware can't be detect by this approach [7].

Machine learning-based malware detection: Is a data analytics tool to effectively perform specific task. ML practice to detect malware/malicious code is considered by many researchers. The power of machine learning tools helps to differentiate malware from benign by using different classification and clustering algorithm.

2 Literature Review

In this section, we had mentioned comprehensive state-of-art for malicious code recognition and classification technique on the literature from year 2018 to 2020. Three stage frameworks have been proposed [8]: Stage 1—behavior of sample files are extracted under scrutiny, and its interaction with OS is observed. In this stage, sample files are lope in sandbox environment—Virmon and Cuckoo. In stage 2—feature extraction is applied to analysis report, and label of sample is determined by virus total. In stage 3—dataset is divided into training set to get hold of testing and classification set to evaluate virus total—online multiple AV scan service. VirMon is used to extract Windows notification routines. Authors had used online machine learning framework—JUBATUS for malware classification based on behavior patterns. Lower feature space is achieved by using category-based modeling instead of API call-based modeling.

Mirza et al. [9] two main issues highlighted by authors are as follows: (1) Identifying malware accurately. (2) Enhance efficiency in term of energy for detection mechanism. CloudIntell uses ML technique to boost malware detection speed and support host methodology implementation based on cloud architecture. Weak classifiers performance is increased by decision trees, SVM, and then applying boosting on decision trees. Authors had developed automated feature extraction tool to extract features from 200,000 files. The tool also has the capability to remove obfuscated part of malicious file. Response and request queues configured using Amazons simple queue service (SQS) are monitored while forwarding the client request to detection engine.

Gu et al. [10] blockchain technologies are used to detect a mobile-based android malware for which framework CB-MMIDE (‘Consortium blockchain for malware detection and evidence extraction’) was proposed. Consortium chain by test members is compared with public chain by users in the consortium blockchain framework. Two features, i.e., permission information and signature are important features to be considered for malware detection; the consortium block chain framework is self-possessed of detecting consortium chain using test members public chain by users. In this work, feature modeling is performed to extract various features of malware families by statistical analysis method [11]. New malware gets introduced and that too in large number which makes the malware detection process to be more effective. Things get more critical when malware creators wrap the malware with techniques such as anti-emulation, packing, anti-virtualization, and obfuscation. Behavioral sequence chain is generated to collect malware followed by the process of clustering, preprocessing to create input sequence of MAS (‘sequence alignment algorithm’) which generate behavioral sequence chain of malware.

Chowdhury et al. [12] authors had used principal components analysis (PCA) to select features. The PCA has important feature of dimensionality reduction to enhance the computational speed. An ensembling of the API calls and n-gram features increases the effectiveness of malware detection. Integration of BAM and MLP neural network is proposed in which fast classification is achieved through BAM as it reduce dimensions of feature matrix [13]. Deep belief network (DBN) performs better as compared to support vector machines, decision trees, and k-nearest neighbor classifier algorithm. The machine language opcode describes the behavior of code/program. The opcode n-gram is used to describe the behavioral feature of malware as malware is represented as sequence of opcode. The model consists of PE parser, feature-extractor, and detection module for malware [14]. ‘Convolution neural networks' (CNNs) are used to detect malware based on image similarity. Binary code of malware is read as 8-bit unsigned integers to be organized in 2D array for visualization in grayscale image [0, 255] range. Images have large amount of dark spaces, and challenge is to find well-organized way to overcome weakness of NN that can be achieved by carefully analyzing binary file.

Wang et al. [15] authors had proposed network traffic analysis on multiple levels to identify features and combine it with machine learning algorithm. In this approach, HTTP and TCP network flow is monitored to determine the malicious activity. Data are collected under traffic collection module followed by feature extraction. The proposed framework includes foundation platform based on android virtual device, traffic generator to generate network traffic by installing and activating malware samples, traffic collector collect In/OUT bound network traffic and network proxy/firewall to analyze attack behavior.

Kim et al. [16] proposed model focuses on features like method opcode, string feature, API method, shared library function, permission and used component feature in detection process. Single feature vector is obtained by merging permissions, components, and environmental feature vector [17]. In proposed approach, multi-level fingerprint is extracted from application by n-gram analysis and feature hashing. These fingerprint features act as input to online classifier. The final decision on application to decide its benign or malware is based on confidence scores of classifier and device combination function. Feature of incremental learning of online classifiers helps to scale model for large number of applications to adapt it for new applications. Li et al. [18] proposed technique had used two features—permissions and API function calls which are used as input for the deep learning algorithm. The risky permissions and malicious API calls are combined to make feature set for weight-adjusted Droid-deep learning approach to distinguish benign from malware. Different features like APIs, permissions, IP address, and URL are packed in apk format to combine dangerous permission.

Kakisim et al. [19] features are extracted on the basis of descriptive and distinctive patterns of executables in isolated and virtual environment. Detection performance is increased by FS method at low dimension. Key observation of proposed work is that bi-gram increases as there is increase in samples.

AbRazak et al. [20] proposed bio-inspired algorithm approach to select permission features that are reliable and able to identify malicious code. Comparison of bio-inspired-algorithm PSO and to get finest features evolution, computation is done with information gain. ROC curve is used to visualize performance and gives reliable information of performance.

Ye et al. [21] proposed framework-heterogeneous deep learning is capable of detecting new malware. Framework is made of auto-encoder stacked up composed of multilayer restricted Boltzmann machines along with associative memory layer.

Detection process is divided in multiple steps as follows:

Step 1: Heterogeneous deep learning network is evaluated on labeled and unlabeled files with different parameters.

Step 2: Homogeneous deep network is compared with heterogeneous deep learning framework.

Step 3: Different shallow learning-based (ANN, SVM, NB, DT) classification methods are compared with proposed method.

Cai et al. [22] proposed dynamic app classification technique-DroidCat having dynamic feature set based on ICC intents and method calls. SOOT is used to transform apps (APK and SDK library) to Jimple code and run-time monitors to trace method call in Jimple code probes [23]. The most suitable option to detect android malware is SVM for binary files and KNN for manifest.xml files. Focused permissions for framework are users permissions, keywords from manifest.xml files, and strings from other files of applications. One combined feature vector is created by combining all the extracted features to achieve more accuracy. Karbab et al. [24] alDozer a supervised ubiquitous malware detection method that can be deployed both on server, IoT device and mobiles. Proposed works disassemble the class. DEX so as to produce VM assembly formalize to keep maximum raw information with minimum noise. Abdelsalam et al. [25] proposed malware detection method in cloud infrastructures using convolutional neural networks the 2D and 3D CNN approach. 2D CNN is employed by training on metadata of process in VM which is further enhanced by 3D CNN in which samples are collected during time intervals to reduce mislabeled samples during training [26]. MCSC proposed detection method as follows Step 1 opcode sequences are extracted from malware and then encode them with SimHash for equal length while preserving malware fingerprint. SimHash bits can be converted to images by taking each SimHash value as individual pixel. Step 2 CNN is adopted to train and identify the malware families. Converting malicious code to image and visualizing it to identify malware family is effective technique to detect malware. Malware classification using SimHash and CNN-MCSC approach is used to convert malware code to grayscale images using SimHash function to identify malware family by CNN.

Sharmeen et al. [27] proposed static, dynamic, and hybrid analysis methods based on features like suspicious permission list, API call list, and the system call list are identified. Features are extracted from apps (malware and benign) from different files like manifest, dex, byte code, and log files. To enhance the performance, accuracy, and detection rate, both static and dynamic features are used [28]. Three-level Hybrid model SAMDroid is proposed which combines the benefit of

(i) Static and Dynamic Analysis—improve analysis accuracy by combining benefits of both techniques.

(ii) Local and Remote Host—realistic inputs are taken from user during dynamic analysis.

(iii) Machine Learning Intelligence—remote host is used for detection operation to reduce memory overhead [29]. SIGPID has been proposed to extract significant permissions from side-to-side systematic pruning three-level approach by considering 22 permissions. (i) Permission ranking with negative rate (ii) Support-based permission ranking (iii) Permission mining with association rules is three major components for data pruning to reduce efforts required in analysis.

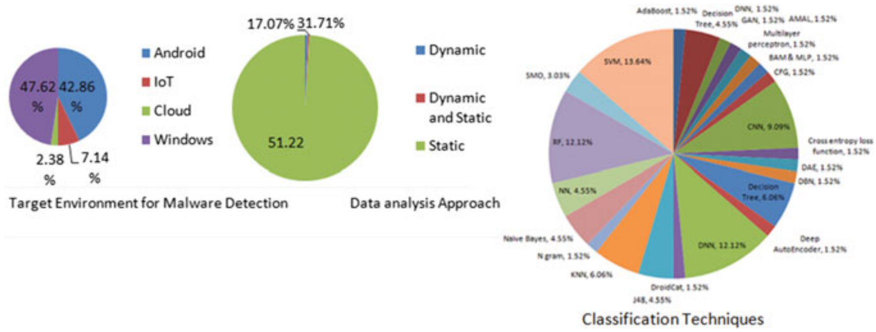

Fig. 1 Comparative malware target, analysis approach, and classification

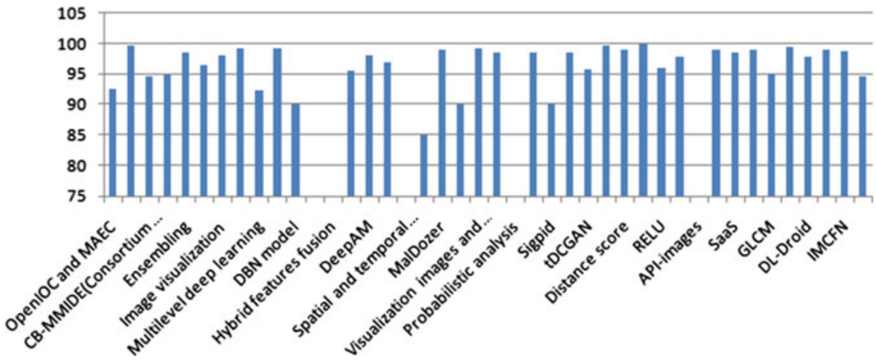

Fig. 2 Accuracy analysis of different methods

Venkatraman and Alazab [30] proposed work focus on feature and image-based visualization with similarity mining for identification and classification of malware. The technique is used to compare malware as per the behavior pattern and fast classification and detection of zero-day malware. Concept of visualization of the distance scores is used for malware detection. Classifiers (SVM and SMO) are used to compare results with four different kernels—normalized polynomial kernel, polynomial kernel, RBF, and PUK (Figs. 1, 2 and 3).

3 Conclusion

The paper presents literature review for different methods to detect malware in different fields like windows, android, IoT, and cloud. Papers were classified and investigated based on different approach like static or dynamic and on the basis of different classification technique as mentioned in Table 2. The detection of malware approach is reviewed on the basis of method used for malware detection, dataset

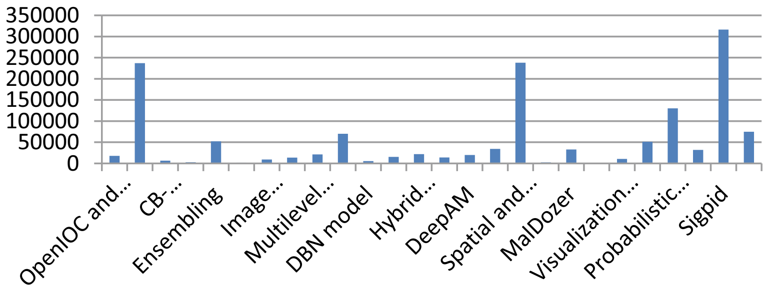

Fig. 3 Dataset analysis for different methods

used, total number of dataset values, accuracy, and case study of each method. The main idea of malware detection along with accuracy has been addressed for various methods used by researchers. Most of the article selected focus of malware detection accuracy by reducing detection time in different areas affected by malware like IoT, cloud, android, and windows. Figure 7 shows the different classification techniques used in different articles for malware detection, and Fig. 6 shows the accuracy for malware detection for various methods used in literature. OpenIOC and MAEC have 92.5%; CloudIntell has 99.69%; 'consortium blockchain for malware detection and evidence extraction' (CB-MMIDE) has 94.6%; API call sequence alignment and visualization have 94.89%; ensembling has 98.6%; opcode sequence has 96.5%; image visualization has 98%; traffic analysis has.99.3%; multilevel deep learning has 92.26%; feature hashing has 99.2%; DBN model has 90%; next-generation virus construction kit (NGVCK) has %; hybrid features fusion has 89.7%; bio-inspired algorithm has 95.6%; DeepAM has 98%; DroidCat has 97%; spatial and temporal perspectives have %, reverse engineered the android apps has 85%; MalDozer has 99%; IaaS cloud has 90%; ReLU has 96%; MALDAE has 97.89%; ScaleMalNet has 98.9%, SaaShas 98.5%; adaptive framework has 99.02%; GLCM has 95%; TrustSign has 99.5%; DL-Droid has 97.8%; IMCEC has 99%; IMCFN has 98.82%; KVMInspector has 94.7%. The review shows that malware detection is not only spotlight windows and android but also the upcoming field like IoT and cloud.

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Integrated Smart IoT Infrastructure Management Using Window Blockchain and Whale LSTM Approaches

K. Janani and S. Ramamoorthy

Abstract Internet of Things (IoT) is playing a vital role in the smart infrastructure environment. The IoT vendors are delivering their products in the market without any concern about the security of the devices, so it is an open number of security issues on the IoT devices and data. Security threats are growing high because existing techniques measures are inadequate; two of the most significant concerns in IoT are security and privacy. Due to the IoT devices limited CPU, storage, and energy resources, existing security architectures are unable to provide the key safety requirements, so deep learning and blockchain algorithms are used. These IoT devices give accurate results from heavy complex datasets. Furthermore, blockchain and deep learning model are very familiar to give secured devices to IoT. This proposed model is window blockchain (WBC). In proof-of-work, it leverages past $(n - 1)$ hash to construct the next hash with minimal change; because of this quick block analysis time, we can easily prevent IoT devices from the attackers. WBC's performance is evaluated using an actual data stream generated by one of the analyzed smart infrastructure devices. Another method using deep learning hybrid algorithms for LSTM networks with whale optimization algorithm is a new schema optimization technique that mimics humpback whales' intelligent bubble-net fishing activity. It is an easy, powerful, and predator probabilistic optimization algorithm that can avoid local optima and find global optimal answer. The findings indicate that the proposed window blockchain model improves security and reduces memory utilization this employing limited resources. In the Whale +LSTM (WLSTM), a large number of the dataset were gathered using a real-time scenario using OMNET++IoT plugins, and a Python API is created to insert various malicious activity through networks. The proposed WLSTM model output of 99% has been tested and related to other deep learning utilizing benchmark datasets such as CIDDC-001, UNSWN15, and

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KDD datasets, as well as actual datasets; the prediction of unknown threats is used to tackle the computation complexity in big networks.

Keywords IoT infrastructure · Security · Window blockchain · LSTM · Whale optimization

1 Introduction

Smart infrastructure is focusing to provide effective solutions. The term “smart city” refers to the use of innovation solutions for improving residents’ standard of living, improve government communication, and long term competitive advantage growth. IoT device has increasing count of heterogeneous devices interconnect with Internet [1]. The main challenges are to give safety and security to these devices, which work with lower energy, constraint data, communication protocol, and geographical devices. IoT devices are free to network access, very simple to pull hackers. The combination of these IoT devices with build and workable networks can easily intrude into the IoT network (Fig. 1).

In the blockchain each transactions are stored in blocks of data, which is encrypted by hashing part of the previous ($n - 1$) block. Blockchain is unchangeable; storage blocks can only be involved. A P2P (peer-peer) network communication for the blockchain of records is permitting requests to access the data carried in every record by communicating the entire model to all the nodes used a blockchain consensus algorithm (BCA) to give the solution to more secure IoT transfer devices. Other than that, it is more secure to apply consensus with hash encryption to give safety interconnected with blocks together [2].

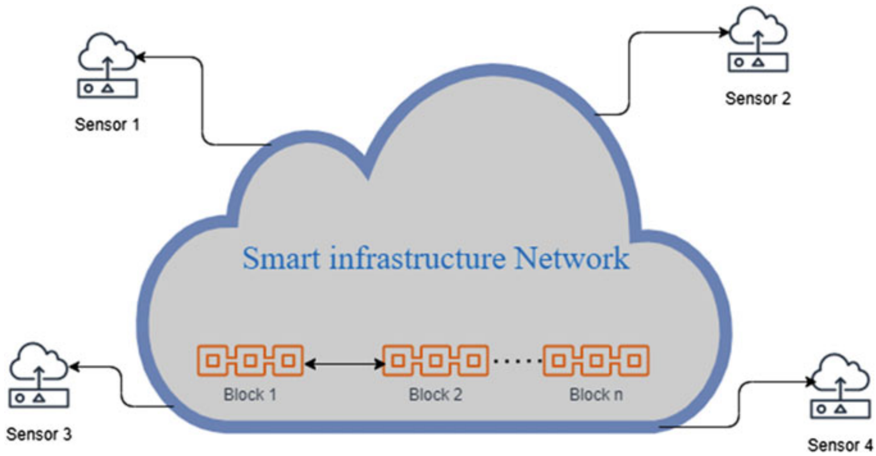

Fig. 1 IoT smart infrastructure network with blockchain security

Block structure in blockchain is a list of blocks that are added to each other in sequential order, almost like a chain. Each block is a data structure containing transactions and is connected to other blocks using an ordered linked list structure. Main data: Transaction data will be stored in blocks. This transaction data is determined by the blockchain's usage factor or the relevant services for which the blockchain is used. Business transaction data would be processed by financial institutions, such as banks. Timestamp: The blocks would also have a timestamp. The timestamp in this case includes the date and time when a specific block is created. Hash: Each block's hash is a unique number created by a cryptography hash algorithm such as SHA-256. The present block's hash as well as the preceding block's hash will be stored in the block. Merkle tree root hash is made up of all the hash for each transaction in a block, and it executes a computational hash calculation to generate a 64-character code. For fast performance and faster data verification, the hashing of the Merkle tree root of all block data is stored. Nonce once is a 4-byte number that is generated at random and can only be used once in an encrypted transaction process. In a proof-of-work algorithm, the nonce is often used as a counter that miners try to solve to generate a new block during the mining process [3] (Fig. 2).

Two of the most significant issues in IoT are security and privacy. Due to the IoT devices' limited CPU, storage, and energy supplies, current security frameworks are still unable to meet the essential security requirements. As a result, the security model for IoT must be distributed and adapted to resource constraints [4]. Blockchain is a decentralized encryption system that can be used for a wide range of purposes. Owing to the high computation time and poor scalability, in its current state, blockchain is unsuitable for IoT. We suggest a blockchain that uses a window block (WBC) that slides through the blockchain. The window starts with a single block and grows to

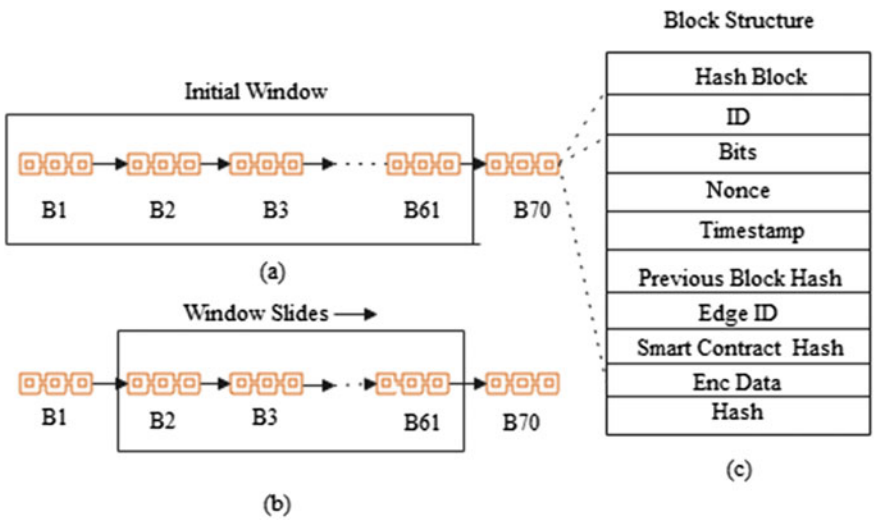

Fig. 2 WBC of window size 61 blocks. (**a**) Initial window. (**b**) WBC. (**c**) Block structure

multiple blocks depending on the hash block size. When making a new block, the blocks in the WBC are used in the architecture that has been proposed; by each hashing the BC inside the window size (WS), the block hash is created. The series of similar previous WBC used to execute and update hash functions is affected by the structure of the window. For a constant complexity of mining, the WBC has a communication complexity of O (n), where n is the count of WBC used in the hash update [5].

Resources like computational capability, energy sources, and memory are all limited in IoT devices. As a result, traditional security algorithms are unsuitable for IoT. A window blockchain that reduces memory overhead and limits communication complexity to meet the needs of a resource-constrained IoT system in the space overhead is reduced by storing only a portion of the blockchain in the IoT unit, as specified by the WS, and keeping the entire blockchain in the private cloud. Using a complexity level around 1 and 5 and omitting the Merkle tree reduces computational workload. The block hash is produced using the attributes of n blocks within the window, which increases protection. The preceding $(n - 1)$ blocks and the window size details are required for a fake miner to mine a block. The window represents a linked list sequence of data that are contiguous or adjacent to one another so the best way can imagine this is maybe an array of characters or an array of integer value and slap of window some subset of this array whatever question we have trying to optimize giving the solution in slid the window over which is find the best part of the solution [6, 7].

Deep learning is an ML process originating from artificial neural network. The network is adjusted to thinking about as variables connected via weighted path. Supervised (SL) or unsupervised (USL) learning group of association inside the network to reach the desired group of output [8]. The learning is carried forward by using labeled and unlabeled sources from supervised or unsupervised deep learning techniques followed by additional compromise of the weights among every pair of neurons. Several IoT-based devices produced a huge number of data DL methods that activate the deep linking of the IoT smart environment [9].

Which is a unified protocol that allows IoT-based application, and device will permit transfer from one to another casually without user intervention. Deep learning LSTM has many benefits; it has many disadvantages when dealing with large datasets. This necessitates the use of a large number of memory cells, which increases computational complexity. This type of problem can also lead to computational complexity. To reduce this issue, you'll need a computationally model for predicting the various types of visible and invisible IoT attacks. To meet the above requirements, a more developed, quick, reliable, and accurate model is needed. The current study aims to establish new hybrid algorithms for whale algorithm in LSTM networks [10].

The first layer of IoT network simulation is built on IP addresses. In both normal and malicious scenarios, a second layer data gathering unit has been added to collect packets. And in the third layer, various attributes were retrieved from the compressed data and utilized to train the proposed DL model to anticipate threats [11]. Finally, the whale-integrated LSTM networks were used to forecast attackers as one of five primary forms of common threats: MIM, DDoS, Dos, data leakage, and spoofing,

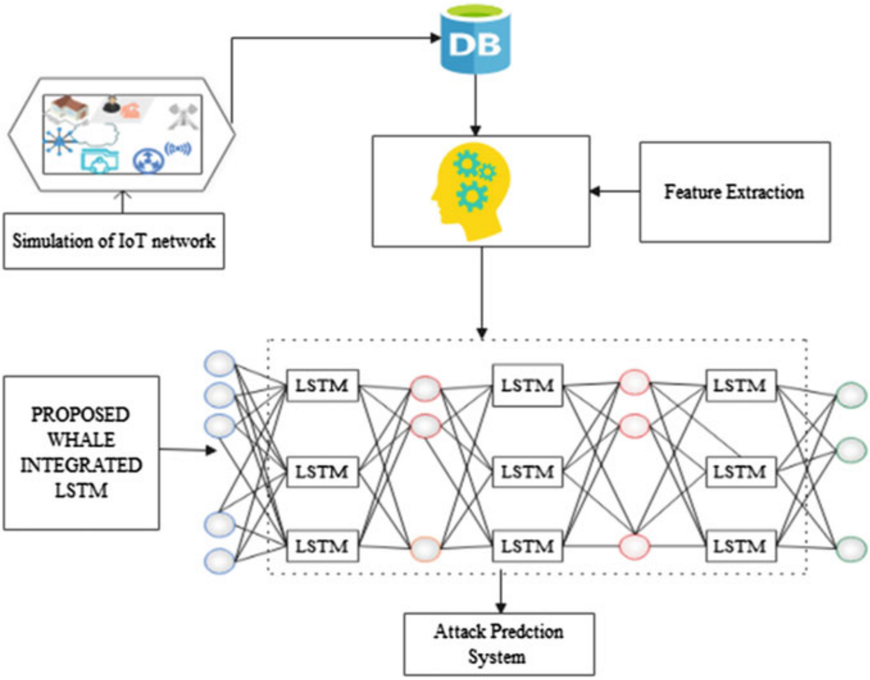

Fig. 3 Proposed model integrated WLSTM

and the system attack forecast as to whether the node is malicious or not, the sort of attack that happened, the Mac address of the devices under assault, and the measures that should be taken [12] Fig. 3.

Contribution of research work as follows:

- The WBC model for the Internet of things is designed to give privacy between the minimum of infrastructure devices.
- On the infrastructure-simulated devices, efficiency and security of the new WBC model were evaluated.
- When using large datasets, reducing the computational complexity needs a more efficient and highly accurate model, so developed the new hybrid algorithm by integrating the whale algorithms in the LSTM network.
- The prediction of unknown threats is used to tackle the computation complexity in large networks.

2 Literature Survey

See Table 1.

Table 1 Survey on smart infrastructure security

Author	Algorithm/protocol	IoT security problem	Implementation	Accuracy	Proposed method	Future work
Luca Barbierato et al.	NB-IoT	Devices that are not capable of actively monitoring and continuously reporting information are considered passive (dump devices)	BC95-B8 module, which operates at 900 MHz	Micro-control extended-309.4 days	Using narrow band IoT, dumb devices may provide real-time or periodic context awareness and data exchange (NB-IoT)	The identification and processing of vast heterogeneous data, data security assurance and user authentication, and data access control are all areas of future study
Petros Spachos et al.	BLE	Improve IoT indoor localization	Kalman filters boost localization, accuracy, and reliability without depending on the cloud	87.5	In a museum, BLE beacons are used to increase interaction. Aim of providing distance and localization facilities, iBeacons have been used	BLE beacons can boost museum interaction at a low cost without any interference with other wireless infrastructure and services in the region
Zhijun Li et al.	BLE2LoRa, CTC	Long distance, long delay, emergency alert	Our BLE2LoRa prototype was built using a USRP B210 (with LoRaWAN PHY) and popular BLE chips (CC1200)	80% Frame over 600 m, 20X	BLE2LoRa is a new CTC solution for direct contact between BLE and LoRa. selecting package bits from a valid BLE frame	Need to build with low cost

(continued)

Table 1 (continued)

Author	Algorithm/protocol	IoT security problem	Implementation	Accuracy	Proposed method	Future work
Zhihan Lv et al.	Zigbee	Humidity, temperature, and battery voltage in smart infrastructure, infrastructure monitor	A simulation validation experiment has been carried out with real-time traffic 20 streetlights counted from A to T as test objects	65RH, 23.5C	The streetlights serve as roads, and the taxis serve as nodes in a simple surveillance system	The different application can try with this network
Dinan Fakhri et al.	MQTT, bitcoin	IoT security problem	Worship, JSON format, Keccak-256, SHA-256	100%	The results of the tests show that an IoT system blockchain-based is more secure than an IoT device that does not use blockchain technology	Future work try with Ethereum
Nabila Islam et al.	Proof of concept	The cyberattack, physical tampering, denial of sleep, DoS for aircraft's data security	NASA's dataset, MATLAB	50 MB take 2500 ms of time	Proofs of concept have been developed to help people recognize how blockchain can function in real-world scenarios	We will improve the accuracy of our research by incorporating the concepts of machine learning and data mining, which will predict whether there will be problems with the planes and eventually reduce time

(continued)

Table 1 (continued)

Author	Algorithm/protocol	IoT security problem	Implementation	Accuracy	Proposed method	Future work
Ali Dorri et al.	Distributed throughput management	Reduces the processing mining delay and overhead	Simulation	51% of attack detected using simulation get high-level accuracy	Complexity, bandwidth and latency overheads, and scalability are all factors to consider. Proposed an LSB for IoT to solve these issues	To gain a better understanding of LSB's output in the real world, create a sample implementation
Safa Otoum et al.	RBC-IDS, ASCH-IDS	Boltzmann ML-based IDS, WSN-based critical infrastructure monitoring	The sensors are spread out over a 100 m × 100 m region in four clusters. The RBM model used for the simulations has one input data (V1) with training data, as well as three hidden layer layers (H1, H2, and H3) DR% = TP/(TP + FP)	RBC-99.12% H = 3–99.91%	When compared to an adaptive machine learning-based IDS solution, the clustered restricted Boltzmann machine-intrusion detection system (RBC-IDS) is an IDS known as the clustered restricted Boltzmann machine-intrusion detection system (RBC-IDS)	Extending the present IDS to wider networks with much more devices is on the future agenda

(continued)

Table 1 (continued)

Author	Algorithm/protocol	IoT security problem	Implementation	Accuracy	Proposed method	Future work
Gonzalo De La Torre Parra et al.	Distributed convolutional neural network cloud-based LSTM	Malicious, phishing, and Botnet attack, DDoS attacks	NB IoT dataset	Phishing attck-94.3%, LSTM-93.58%, Botnet-94.80%	A CNN model is used to detect URL-based attacks on a client's IoT computers. For identifying botnet attacks in IoT devices, the add-on operates in collaboration with an RNNLSTM model hosted on the back-end databases	Includes expanding the proposed technique to critical theory IoT device and machine attacks, such as those that use encrypted traffic to distort or escape detection
Bambang Susilo et al.	CNN, MLP	DoS	Python language, TensorFlow, seaborn	Epoch CNN-90.87%, MLP-54.10%	In an IoT network, different ML and DL algorithms were investigated. The analysis of RF, CNN, and MLP algorithms was included. In terms of effectiveness and AUC for classification tasks, decision trees and CNN got the best results	The NIDS is supposed to incorporate this algorithm

(continued)

Table 1 (continued)

Author	Algorithm/protocol	IoT security problem	Implementation	Accuracy	Proposed method	Future work
Feng Jiang et al.	LSTM-RNN, SVM	Multichannel intelligent attack	$DR = TP \vert (TP + FN)$, $FAR = FP \vert (TN + FP)$	GRNN—87.54%, PNN—96.66%, RBNN—93.05%, KNN—90.74%, SVM—90.4% Bayesian—88.46%, proposed—98.94%	LSTM-RNN is used in multi-channel storage to create classifiers that are used to distinguish the attack from normal traffic to maintain the attack feature of input traffic data	Other researchers would be inspired to build effective deep neural networks for intelligent attack detection somewhere along the direction using DL methods
Chi-Hsuan Huang et al.	SDN	IDS, adversarial attacks	Simulation	JSMA—35%	Studies on malicious examples for deep learning detection systems based on SDN	DDoS, U2L, and R2L are examples of adversarial attacks on SDN-based deep learning IDS systems
Wooyeon Jo et al.	CNN	IDS	NSL-KDD	90%	Three methods for CNN preprocessing	Adding one field to one pixel through preprocessing is highly beneficial for convolution learning, according to similar research that transformed data packets into binary

(continued)

Table 1 (continued)

Author	Algorithm/protocol	IoT security problem	Implementation	Accuracy	Proposed method	Future work
Manimurugan et al.	Deep belief network	IDS	CICIDS 2017	99.37%	We were using the CICIDS dataset for the detection of threats in the DL model DBN-IDS scheme	The based intrusion detection framework can be expanded to detect certain forms of attacks against IoT devices, as well as a variety of intrusion prevention datasets
Alaeddine Boukhalfa et al.	LSTM	NIDS	KDD Cup 99, NSL KDD, DARPA IDS	99.98%, 99.93%, FPR-0.068%, 0.023%	A new NIDS concept based on the Deep Learning system LSTM will identify attacks and hold a long-term memory of them together to order to prevent certain new attacks while also treating all types of attacks in a special way	We want to use our new proposed deep learning model LSTM to introduce a new smart NIDS in the modern world

3 Methodology

3.1 WBC Smart Infrastructure

In the framework of a smart infrastructure environment, an experimental IoT system is implemented with WBC. The smart infrastructure IoT system smart home testbed is depicted in Fig. 4. Cameras, electrical devices an Arduino, a Wi-Fi ESP8266 component, and a gateway computer hardware are all included in the design. An ambient street light sensor, hazardous proximity sensor, temperature sensor, fire sensor, pressure sensor, humidity sensor, and sound sensor, gas sensor, are used to sense the environmental parameters. A person entering and leaving a smart building is detected using directional microphones. The following are the functions of smart infrastructure.

1. Relay 1: Throughout the day, when there are persons inside the smart building and also the environmental street light will be less than the threshold value, the smart building is locked.
2. Relay 2: Whenever individuals are located within the building and also the temperature exceeds a threshold value, the door is locked.
3. Whenever a fire or gas leak is detected, the beep sounds an alarm.
4. When a sound reaches and no one is within the smart building, the light illuminates to identify burglary.
5. The sensor module (ACS712) detects the present and transforms it to a reference voltage that is relevant to the situation (0 and 5 V). The voltage sensor (ZMPT101B) detects voltages ranging from 0 to 1000 V air conditioning. The

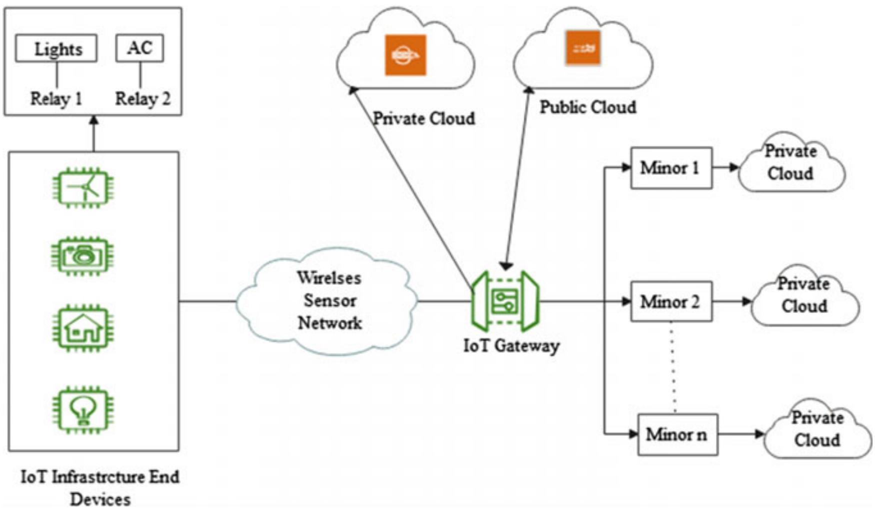

Fig. 4 Smart infrastructure WBC

smart infrastructure energy consumption is determined to use the voltage and current sensor values.

6. The smart building state is processed using UNIX time obtained from the remote system.
7. The TCP/IP protocol is used to transport sensor information from the network edge to the gateway via the ESP8266.
8. The detected key is protected to use the AES method with PBKDF2 and safely saved using WBC at the system level.

3.2 WBC Parameters

The hash function in a bitcoin system is set to 1 MB, and then a block is mined every 10 min [22]. WBC uses a configurable key length with a maximum of 1 megabyte. If another block size is greater than 1 MB, then data is split into many blocks. The data block is determined by the following formula:

$$\text{Size of the Block} = ((\text{Hash Encryption} + \text{Data})\text{Samples} + \text{Size overhead}) \quad (1)$$

When the hash is used encrypted inefficiency is the amount of time it takes to data encryption in bytes. The amount of data examples is represented by tests, while the number of blocks utilized to represent a block is represented by block overhead. The block capacity is restricted to <1 MB in this case. The complexity of determining a target value is determined by the following factors [24].

$$\text{Complexity} = \frac{\text{Complexity\_level\_Target}}{\text{Current\_target}} \quad (2)$$

The time it takes to create a block is determined by using the following formula.

$$\text{Avg Length of Time} = \frac{\left(\text{Complexity}2^{\text{Bits}}\right)}{\text{Hash Speed}} \quad (3)$$

The difficulty level of mining is represented by bits, while the hash rate is indeed the amount of hashes miners calculate every sec.

3.3 The Infrastructure Device Security is Model as Follows

At step S1, a traditional data cryptography algorithm E receives a security password P as input and produces a signature K public randomly. Using public-key cryptography K-Public and device data D, this encryption method produces a data stored encryption data D at phase S2. The smart contract stores its public key K-public using varied access permissions also for miners. Figure 4, as inputs, where n is the window frame size. Otherwise, the m miners start solving a POW puzzle by multiplying the nonce number by one for each repetition, unless the BlockID of the block header already exists inside any block within the ledger. If the riddle is resolved and also the miners validate it, e WBC algorithm 1 is successful.

Append-L is seen in algorithm1 (WBC), that also takes a current block's, previous block hash, BlockID, timestamp, edge ID Parts, nonce, MinerID, smart contract hash, and encrypt data, as well as block hash, Edge ID, timestamp, bits, nonce, previous block hash, Block ID, Miner ID, smart contract hash, and encrypt the data. Encrypted as input, data from the previous $(n-1)$ blocks, where n is the window's size. If the BlockID of the current layer already exists in any chain in the ledger, the process crashes; else, the m miners start solving a POW problem by adding the nonce amount using every additional iteration. Because an attacker does not specify the window size, computing hashes for all potential window block sizes is required to carry out the attack effectively. As a result, the computation time rises to

$$t_c = \mathrm{O}(n_t \times tn_t) = \mathrm{O}(n^2 2^b) \tag{4}$$

Let information be the combination of blacklist such as timestamp, Merkle tree, and encrypted data. The present block to be processed is represented by B_{curr}, with data is comprised of the concatenated of block attributes such as BlockID. Every nonce of the current block is represented by current, just as it is by N is then used to calculate the block hash of the current block H below Eq. (5).

$$H_{curr} = h\left(\sum_{i=1}^{n-1} B_{l-i} + [B_{curr} + N_{curr}]\right) \tag{5}$$

Algorithm 1: Append-L

Data: $h(a)$— Function that computes hash of input a

$N_{curr} = 1$
while *True* **do**
  $H_{curr} = h\left(\sum_{i=1}^{n-1} B_{l-i} + [B_{curr} + N_{curr}]\right)$
  if H_{curr} *achieves target* **then**
    break
  else
    $N_{curr} = N_{curr} + 1$

3.4 Deep Learning with IoT Security Model

The algorithm is used to simulate humpback whale hunting behavior, four devices using a spiral to simulate the attacking process and for correct search agent. Encircling the prey, using the bubble-net attacking (BNA) approach, and seeking the prey are the three phases of the mathematical model. LSTM has many benefits; it has many disadvantages when dealing with large datasets. This necessitates the use of a large number of memory cells, which increases computational complexity. This type of problem can also lead to computational complexity. To reduce this issue, you'll need a computationally model for predicting the various types of visible and invisible IoT attacks. To meet the above requirements, a more developed, quick, reliable, and accurate model is needed. The current study aims to establish new hybrid algorithms for LSTM networks [13–16]. The whale optimization algorithm is a new schema optimization technique that mimics humpback whale intelligence bubble-net fishing activity. It is an easy, powerful, and predator probabilistic optimization algorithm that can avoid local optima and find the global optimal answer. The whales begin by encircling their prey with spiral-shaped bubbles that extend down to 12 feet below the surface. And they swim back up to catch and capture their prey, which can be mathematically interpreted by updating old approaches rather than picking the best by random selection of new solutions. It differs from other optimization algorithms in that it only requires the adjustment of two parameters. This number of criteria allows for a seamless transition between the extraction and exploration processes [17] Fig. 5.

$$X(t+1) = \mathrm{Dl.ebl.}\cos(2\pi l) + X*(t) \tag{6}$$

D in the latest millennium is the gap between both the new role and the modified position b is constant which varies from the 0 to 1. $X(t+1)$ is the most advantageous position in the present circumstances. The weights of the LSTM network are optimized using metaheuristic algorithms, and the validity of the model is referred to as the fitness function. Input bias and weights are determined for each iteration. These amounts are then fed into the LSTM network that calculates fitness. If the fitness value is equivalent to the threshold, the iteration will either come to a halt or continue. Whale optimization has a slower convergence speed than most other metaheuristic algorithms, but it takes less time to optimize and increases time consumption [18–20].

4 Results and Discussions

4.1 WBC Experiment Results

The experiment was carried out on an Intel Core i7 personal computer with a Windows 10(8th generation) operating system, 16 GB of RAM, and an Arduino Uno with

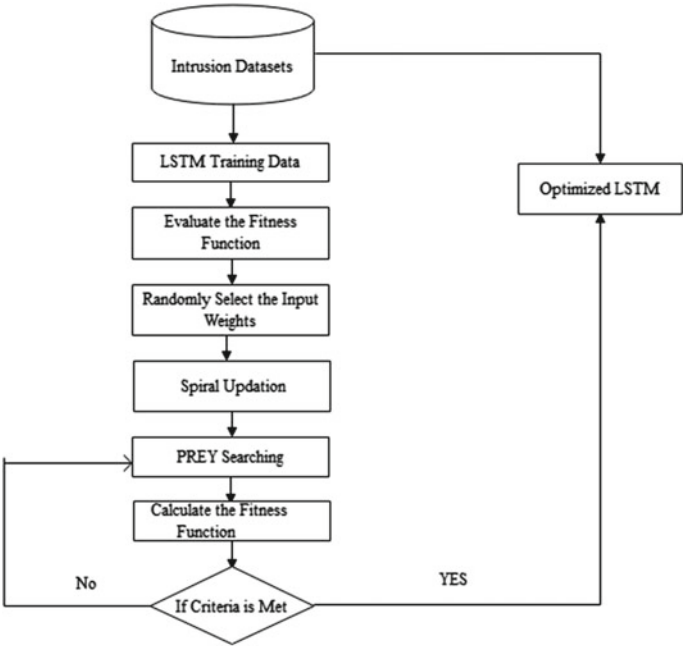

Fig. 5 Proposed WILS training and testing model

digital and analog pins to which cameras are connected serves as end devices. Sensors are connected to the 3.3 V ports of Arduino, whereas switches are connected to 5 V. The sensor connections are linked to the Arduino's input pin first, Vcc (3.3 V) second, then GND third. The Arduino Uno's Tx and Rx are wired to the ESP8266's Serial port. The AT instructions on the ESP8266 are used to connect with both the TCP/IP interface. The ESP8266 is attached to a shared entry point and connects with the computer through it. It requires about 14 s as an Arduino Board to charge up, confirm the ESP8266's availability, and establish a fresh TCP/IP communication with the router [21–23]. The above experiment is also conducted on Arduino Due [24] as edge device and Raspberry Pi as the blockchain miner.

Documents of various sizes are generated as a result of the impact of the threshold value. A 1 megabytes file represents a single block, while a ten-gigabyte file represents ten blocks. The time that it takes to generate a data file hash cost is computed. The rise in window size does have a sufficient level on the hash time complexity of a WBC, as shown in Fig. 6. As regards the window size, overall hash. Processing time is a continuously rising function. $F(x) = b + mx$ Where $f(x)$ is the time it takes to compute a hash, m is the window size, and $b = x$, the slope is the constant. Figure 6 shows this. The slopes are hash computation time (HCT) is $b = 0{:}01{,}641$ and $m = 0{:}0052$. As a result, the moment it takes to compute a hash can be stated as the Fig. 6 HCT = windowsize + 0.01641 × 0.0052. Therefore, WBC increases blockchain security with a negligible increase in computational complexity. WBC

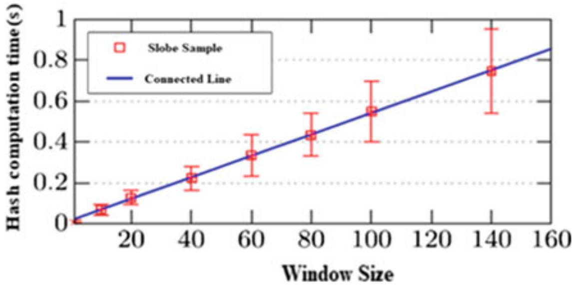

Fig. 6 Analysis of hash computation time versus WBC size

needs a mechanism to store the sequence of window sizes used for each block generation. Our analysis of WBC is carried out with fixed window size. The window size can be chosen based on: (1) our application; (2) requirement of time taken to mine a block; and (3) the required security level. WBC takes less amount of time to mine a block with small window size.

As a result, WBC improves blockchain security while increasing powerful cryptographic only a little. The size of a window might be constant or adjustable. The blockchain is now more secure and harder to compromise with changing window sizes. A dynamic window size calculates the hash of each incoming block in the blockchain using varying window sizes [25]. A changing WBC also requires a technique to keep track of the series of evaluation metrics utilized by each block generation. The WBC analysis has been done with set window size. The length of a window can be determined by our software, the time taken to mine a block, and the level of security needed. With a tiny sliding window, WBC takes less time to mining a block.

Changes in the network traffic, this number may change. The confirmation times for both the WBC with PC, WBC using bitcoin blockchain on Raspberry Pi, PC with a single miner are 92.27 s, 1098.80 s, and 9.16 s, respectively, with a 20-bits difficulty Fig. 7. For Arduino ATmega-based boards, the highest data capture frequency is around 10,000 times a second (nano, mini, and mega, UNO). Since a result, for fast real-time IoT applications, size of window 10–20 MB is preferred, because it has a hash computational cost of 0.066 and 0.126 s, accordingly.

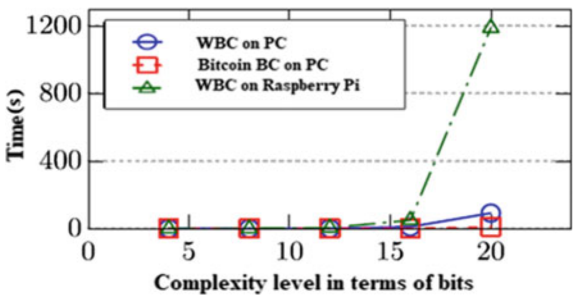

Fig. 7 Time taken for validation

4.2 WLSTM Simulation Results

The experiment was carried out on an Intel Core i7 personal computer with a Windows 10(8th generation) operating system, 16GB of RAM, and a graphics card. The OMNET++IoT API was used to construct a real-time scenario, and the threat model was generated using Python programming. TensorFlow version 1.3.5 was used to run the proposed deep learning system. Pandas is a data analysis and features extraction tool used the dataset NSLKDD-41, CIDDS-001, UNSWNB15 attributes with a single sticker. The proposed Fig. 9 accuracy is found to be 99% accurate and stable whenever the iterations are optimized to 50. Moreover, between training and testing verification, the root means square error is smaller than 0.0001. The suggested model's training and testing accuracy vary from 98.5% to 99%, with RAMSE errors ranging from 0.001 to 0.004. The suggested model's efficiency shows Fig. 8 comparable characteristics when tested using real-time metrics, demonstrating it can predict various.

UNSW-NB15-49 elements with one classification results, 56,000 examples of regular traffic, and 119,341 cases of attacked traffics were used for learning while the

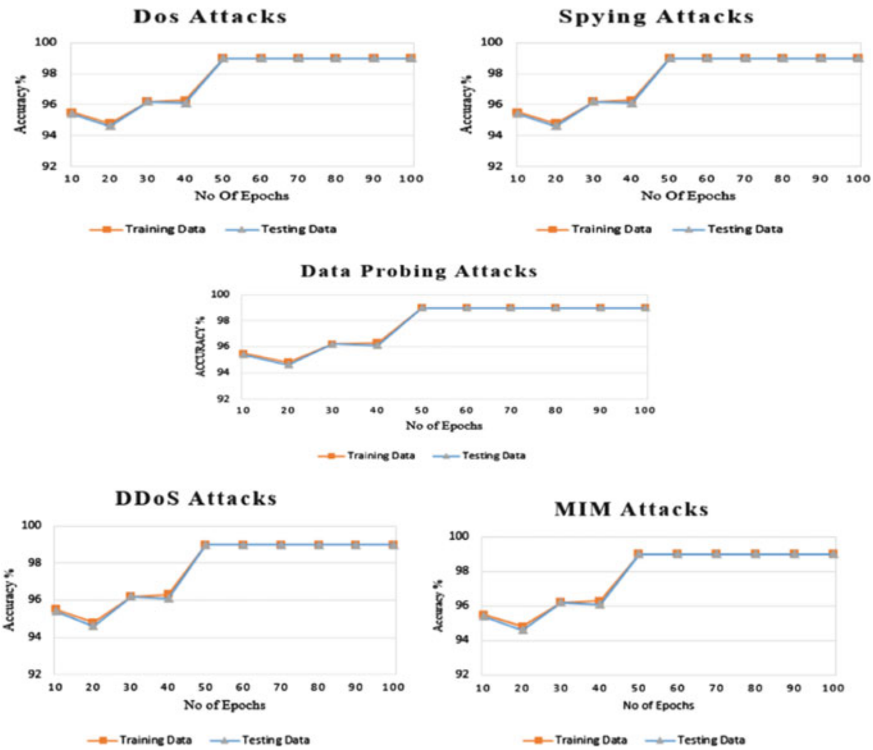

Fig. 8 Proposed model prediction attack analysis

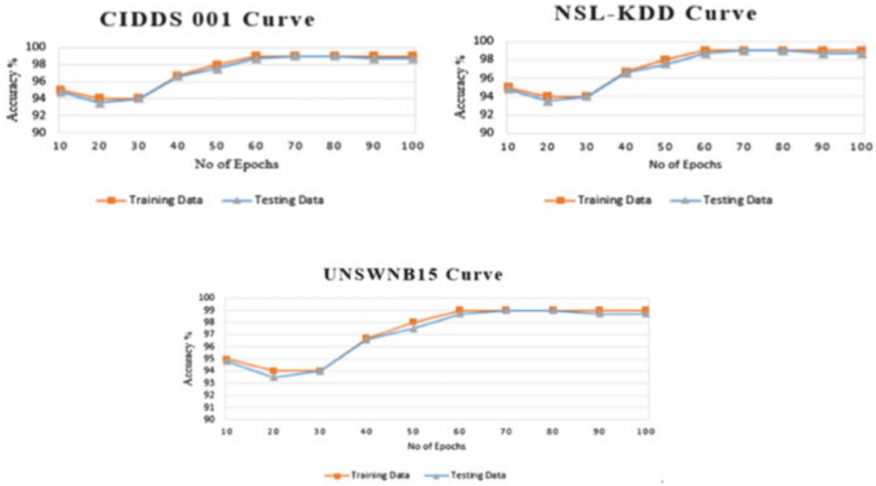

Fig. 9 Proposed model prediction and dataset analysis

testing process consisted of 37,000 instances of traffic flow and 45,332 occurrences of attack traffic, NSLKDD-41 elements with one label attributes Fig. 9.To back up previous studies, the setup was used to record and collect roughly three months of regular and assault data packets. Python API has been established to insert the many sorts of IoT network attacks generated to collect the malicious data from the configuration. In a nutshell, 45 days of regular data and 45 days of malicious activity were logged as separate occurrences and saved in log files. It is subsequently utilized to categories the data.

5 Conclusion

IoT device resources like computing requirements, sources of energy, and memory are all limited. Traditional security techniques are unsuitable for IoT. Developed a WBC that reduces memory cost and limits computation complexity to satisfy the requirements of a resource-constrained IoT network only a fraction of the blockchain is kept in the IoT device, as indicated by the window size, while the complete optimized blockchain is kept in the hybrid network. That uses a difficulty scale of 1–5 while omitting the Merkle tree to minimize processing time. The properties of n blocks in the windows are used to build a block size of the hash which improves security. A fraudulent miner will need the previous $(n - 1)$ blocks as well as the window size data to construct a block. Deep learning model was presented using WILS system. A large number of the dataset were gathered using a real-time scenario using OMNET++IoT plugins, and a Python API is created to insert various malicious activity through networks. The proposed model's output has been tested and related to other deep learning utilizing benchmark datasets such as CIDDC-001, UNSWN15, and KDD datasets, as well as actual datasets. In all of the tests, the proposed whale optimized in LSTM outperformed other algorithms by 99% in terms of effectiveness, precision, and recall when distinguishing malicious activity in an IoT system and detecting unknown attacks. Based on performance results. In future work, the influence of a varying WBC can be studied, to fit the IoT environment, new consensus methods can be devised. Moreover, the energy consumption of the blockchain can be investigated in order to acquire a deeper understanding of the energy supply required by an IoT device. Whale algorithm is a new form of swarm intelligence algorithm (SIA); the next step is to integrate LSTM in SIA refine the algorithm so that it can be used in more resolve issues in IoT devices with more constraints.

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Driving Analysis for Load and Fuel Consumption Using OBD-II Diagnostics

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Abstract As the number of vehicles are increasing, driving behavior analysis has become utmost important and compares the various parameters from the engine using mathematical model. The parameters for vehicle operations are monitored in this research paper, and the different physical parameters are read by the sensors and then analyzed and described. The OBD-II protocol is used to retrieve the vehicular data and used for monitoring vehicle operation in terms of the fuel consumption. In the given experimentation process, a trip is made of distance 5 km on different routes having uneven traffic conditions. The various parameters retrieved from the engine control unit (ECU) by the OBD II device are analyzed, compared, and discussed in detail with various charts and graphs. For the evaluation purpose, the observed values and the calculated values are compared for fuel consumption. The paper presents various methods to calculate the fuel consumption, and results are obtained to compare the fuel consumptions as seen in the vehicle against the calculated values and also analyze the load dependency with manifold absolute pressure and derive a polynomial nonlinear regression model out of the data derived from the vehicle. The proposed model retrieves its sample data from the ECU like lambda, air-to-fuel ratio (AFR), manifold absolute pressure (MAP), OBD and GPS speed. The values calculated are compared with the retrieved values by the conventional methods. This paper attempts to model fuel consumptions on different terrains for the vehicle and calculate the fuel consumptions based on OBD and GPS data and relate to the observed data.

Keywords On-board diagnostic-II (OBD-II) · Controller area network (CAN) · Data link connector (DLC) · pyOBD · Lambda · ECU · MAP · AFR

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1 Introduction

It has been a constant endeavor to improve the fuel efficiency and reduce emission of the vehicles in the last decade and monitor and analyze the driving which has attracted the attention of the government to set standards for fuel efficiency and emissions [1].We can monitor the vehicle operations continuously using various data derived from the on-board diagnostic (OBD)-II port of the vehicle. We get these real-time data from the various sensors connected to the vehicle to provide us smooth operations of the vehicle. To protect the environment and reduce carbon emissions, many car manufacturers were coming up with technologies for vehicles with low fuel consumptions and emissions. As a result of fuel combustions in the cylinder, it contributes to 27% of the total carbon dioxide emissions according to the report [2]. And to accomplish this task, the vehicles are fitted with dozens of sensors at various parts of the vehicles to gather instantaneous data using OBD system to interface through CANBus to the ECUs and take decision immediately and control and regulate other parts of the engine for better performance. The CANBus is a twisted pair of wires where all the ECUs are connected and terminated by 120 OHM resistor. The CANBus follows broadcast system of communication where all ECUs can send messages to every other nodes at any time. The two wires in CANBus work on differential voltages which determine high and low state of the system. The reason of considering differential voltage is that in car engine, and there are lots of noises due to electromechanical interferences. So to reduce the noise received by the CANBus, the differential voltage system is installed. The OBD system needs a scanner device for working which is plugged to the port to communicate with ECU. The scanner unit might be connected to the user by Bluetooth, WiFi, or even USB cable. The scanner device used is ELM 327 supporting OBD-II protocols, and the tool is the popular Torque Pro version. We can use pyOBD [3] library from python also for interfacing OBD data to retrieve and process our raw data in computer.

OBDSim is a simulator which is used to simulate an ELM327 device for OBD-II connection to one or more ECUs in CANBus. The interface is given in Fig. 1. In this research paper, the Torque Pro tool connected to out PC using Bluetooth and read the readings of the simulator in the dials of Torque Pro.

It supports various real-time simulated data from multiple engine control units (ECUs). This paper presents the literature survey and related works in Sect. 2. A detail description of the OBD-II system is given in Sect. 3. The experiment is presented in Sect. 4 which shows how the experiment is performed and OBD data is gathered in what conditions to discuss the load and fuel economy for the test vehicle. Section 5 shows the proposed method using various formulations, results, and graphs. Section 6 presents the conclusion.

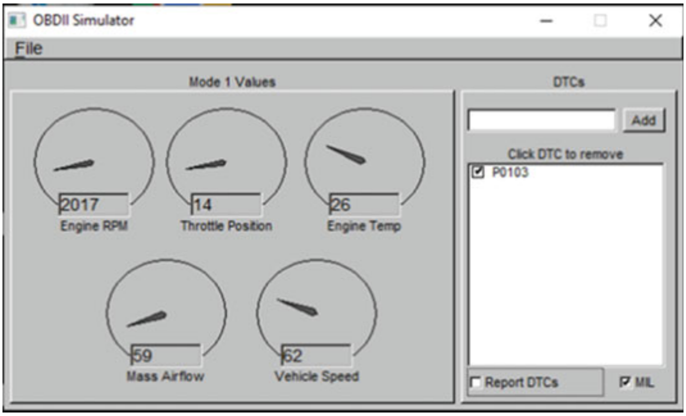

Fig. 1 OBDSim simulator

2 Related Work

The driver model from the observations of traffic for planning and decision making is discussed in the paper by T. Gindele et al. in his paper [4]. The paper models the decision making process of drivers by building a model which describes the driver's behavior and plans. Emad Badawy et al. proposed a system that can provide track child's life outside school using IoT [5]. IoT is comparatively newer technology. V. Kirthika and A. K. Veeraraghavan developed a system which connects ECU with Raspberry Pi, Arduino using WiFi [6]. The system connects to the bus using OBD-II and CAN interface and sends the engine data to the server using 3G/4G network. CAN stands for controller area network. It used massage-based protocol. It is supported under ISO 11898. Emir Husni et al. proposed a system to increase the efficiency and reduce the fuel consumptions and emissions of the vehicle using observed and supervise driving behavior [3]. H. Billhardt et al. employed efficient fleet management system to increase the efficiency of fleet at minimum cost and increase the quality of service [7]. The data read from OBD-II can be transmitted to the remote server for calculations involving speed, distance, fuel consumptions, MAF [8] for analysis and tacking purpose. MAF is the amount of air required in gm per second for ignition in the cylinder. OBD is a protocol system which is used to obtain diagnostic data from the ECU using various sensors connected in the vehicle for display and analysis purpose in smartphone [9]. It has been a great concern for automotive industry to reduce emissions which led the government agencies to set regulations and standards on emissions and fuel efficiency [1]. The driver and vehicle behavior was detected by the video data from the street traffic [10, 11]. The O_2 sensor response is the time to switch from lean to rich mixture or vice versa and controls engine at AFR [12].

Table 1 Pin configuration of OBD-II port

Pin#	Description	Pin#	Description
1	Vendor option	9	Vendor option
2	J1850 bus+	10	J1850 bus+
3	Vendor option	11	Vendor option
4	Chassis ground	12	Vendor option
5	Signal ground	13	Vendor option
6	CAN (J-2234) high	14	CAN (J-2234) low
7	ISO 9141-2 K line	15	ISO 9141-2 L line
8	Vendor option	16	Battery power

3 OBD-II Standard

OBD stands for on-board diagnostic which was developed by automotive makers for reading data from engine. It connects to with DLC in the vehicle. It is used for emission and checking errors in the engine. In the proposed system, we have used ELM 327 scanner for plugging in the port. The OBD-II port is located mainly at the driver side underneath the dashboard of the vehicle. The real-time data can be read by the scanner and transmitted to the computer or smart phone using Bluetooth, WiFi, or USB cable for analysis purpose [13].

The pin configuration of the OBD-II port is shown in Table 1. The port has 16 pins–8 pins in each row [14]. The scanner requests for a service by sending PID in hexadecimal form. It also received the reply in hexadecimal form from the ECU.

The OBD-II helps us to detect the diagnostic trouble code (DTC) [15] and repair the vehicle. Each trouble code consists of one letter followed by four digits, such as P1234.

4 Experiments

As a part of the experimentation, the real-time data was retrieved from ECU during vehicle movement. The Elm 327 Mini Bluetooth scanner was inserted at the OBD-II port the vehicle, and Torque Pro was used for reading the real-time vehicle data as show in the block diagram in Fig. 2. The OBD scanner collects the various parameters and communicates through Bluetooth with a smartphone device with Torque Pro tool. A trip of 5 km was made with 2.5 km of highway traffic and 2.5 km of traffic area at 9 am with ambient temperature of 25 °C and various data were collected in the log file.

As a part of the experiment, testing is done first of all on OBD-II simulator with various data using OBDSim tool. But for the research work, we retrieved real-time OBD data from various sensors. For the experiment purpose, we retrieved various data as shown in Table 2 like Lambda, Input Manifold pressure, engine load percentage,

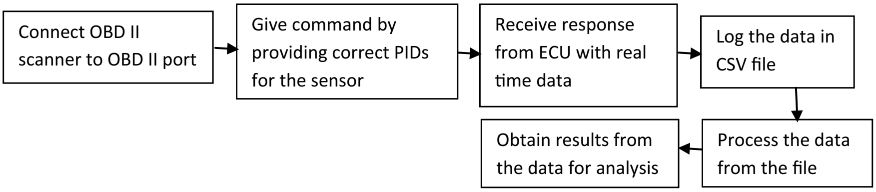

Fig. 2 Steps to gather data for analysis

Table 2 Sample OBD data

Time (s)	AFR	Lambda	KPL	Speed (GPS)(km/h)	Speed (OBD)(km/h)	Fuel flow rate (l/h)
148	14.7	1	16.1	38.62	40	2.42
149	14.7	1	17.4	38.56	40	2.3
150	14.7	1	27.16	38.41	40	1.47
151	14.6	0.99	35.25	33.29	33	0.96
152	14.7	1	36.61	32.35	33	0.9

speed in OBD and GPS, fuel data and was analyzed and compared. The average speed of the car was maintained at 25 km/h in the entire journey. The engine load is varied from 12.16% at idle to 98.82% for high power which is referred to the condition when the car is at high RPM at uphill movement in flyover, and maximum torque is required. The average lambda value was 1. More fuel was consumed at lower speeds.

5 Modeling for Fuel Consumption and Load

For modeling fuel consumptions and load on engine, we are using various OBD data and formulations. The analysis on the various data as observed and calculated is discussed below.

Lean mixture is when there is more air than gasoline/fuel going in to the combustion chamber of a cylinder or for a car, cylinders. Rich mixture is when more gas is being injected without enough air to combust properly. As depicted in Fig. 3, a lambda value of 1.1 means lean mixture followed by rich mixture at higher fuel consumption. The prominent fuel consumptions can be seen at other higher lambda values also. The fuel consumptions were compared among the observed data with calculated data for OBD speed and GPS speed using the following formulas. Fuel consumption is calculated as in Eq. 1.

$$\text{Fuel Consumption}\left(\frac{\text{lit}}{\text{km}}\right) = \frac{\text{Fuel Flow}\left(\frac{\text{lit}}{\text{hr}}\right)}{\text{Speed}\left(\frac{\text{km}}{\text{hr}}\right)} \tag{1}$$

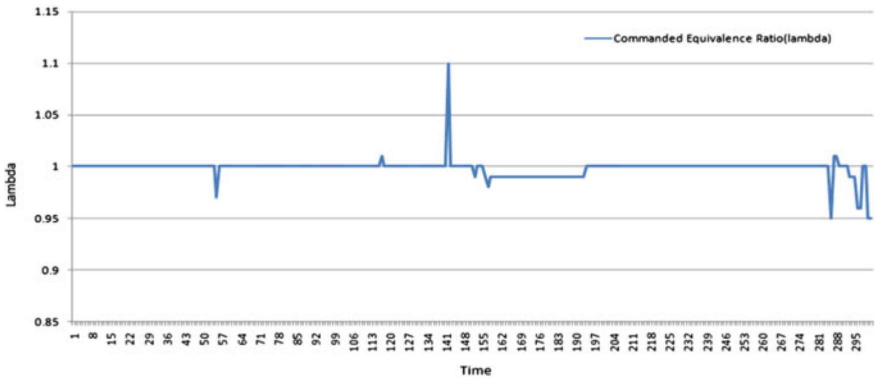

Fig. 3 Lambda

And the fuel flow depends on mass air flow rate, lambda value, and air-to-fuel ratio. Rimpasa et al. [16] from Eq. 2.

$$\text{Fuel Flow} = \frac{\text{MAF}}{\lambda * \text{AFR} * \rho} \tag{2}$$

where λ is the lambda value from OBD-II, AFR is the stoichiometric ratio has value of 14.7, MAF is mass of air in gm/s read by MAF sensor, ρ is the density of petrol which is 770 gm/l standard value. It can also be calculated using Eq. 3.

$$\text{Fuel Consumtion} = \frac{\text{Speed}}{\text{Mass Air Flow}} \tag{3}$$

The various results obtained for fuel consumptions are as follows:

As observed fuel consumption = 16.55 kpl, as calculated on OBD data = 16.59 kpl, and calculated on GPS data = 16.11 kpl.

But the company mileage of the gasoline version of Honda Brio ranges between 16.50 and 18.50 kpl.

For the perfect combustion to happen always, it requires an $\text{AFR}_{\text{stoichiometric}}$ value of 14.7:1 (by weight) where 14.7 gm of air mass is mixed with 1 gm of the fuel under normal condition. Thus, a lean mixture with AFR ration 15:1 (say) would have a lambda value of 1.020 and a lambda of 0.95 would indicate an AFR value of 13.97:1.

Lambda value does not alter by combustion. Even if there is a lack of combustion or complete combustion, it has no effect on λ values. This implies that samples of exhaust gas can be taken at any time in the exhaust section without concerning about the effects of the catalytic converter.

Although there is not much difference between the observed OBD and calculated values for fuel consumptions as shown in Fig. 4, we can see the variation in the curve

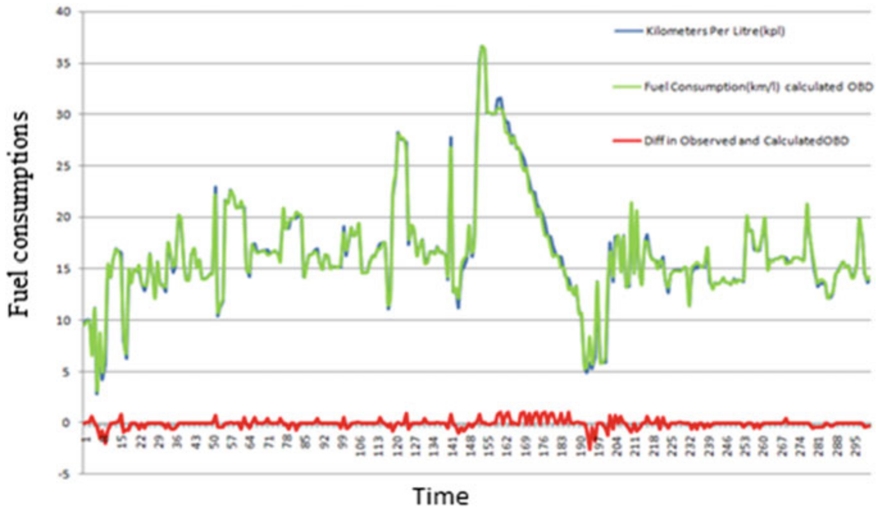

Fig. 4 Fuel consumptions (calculated) OBD, KPL and difference

denoted by red color. The differences more significantly can be seen when there is change in the fuel consumptions. The difference can be shown on the graph with absolute values to avoid the negative range.

As depicted in Fig. 5, fuel consumptions gradually decrease with the decrease in the speed and the fuel flow is also showing the minimum constant value during this time and the increases with speed are depicted in the graph. The graph also shows that consumption is more at higher speeds as in time 48 on time axis and as it decelerates,

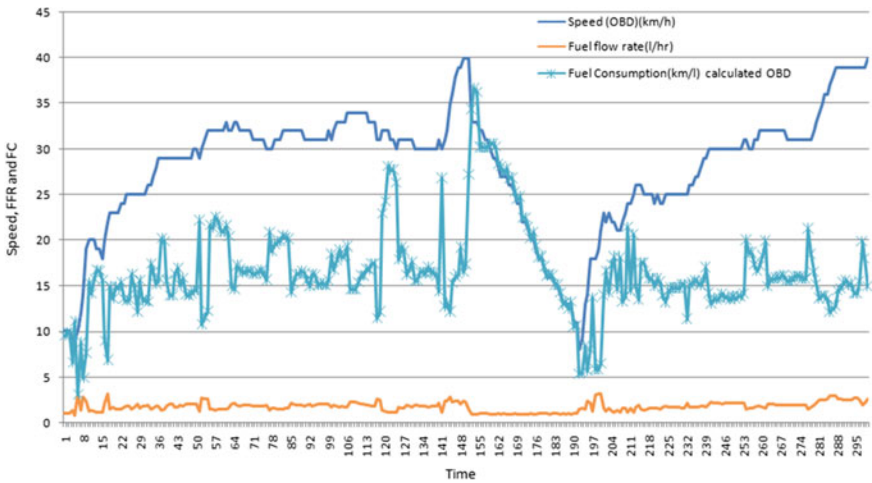

Fig. 5 Fuel consumptions (calculated) OBD, speed fuel flow

consumption also decreases almost linearly with speed. At some point in time, due to sudden decrease, fuel consumption still persists even after speed abruptly going down which shows bad driving condition.

As depicted in Fig. 6, the GPS speeds derived from the satellite is keeping smaller as compared to the speed read by the OBD scanner. So there may be a lit bit of changes in the accuracy level, when result is derived on these two data sets.

As seen in Fig. 7, the pressure at the input manifold increases along with the increase in the load of the engine to increase power and consume more fuel.

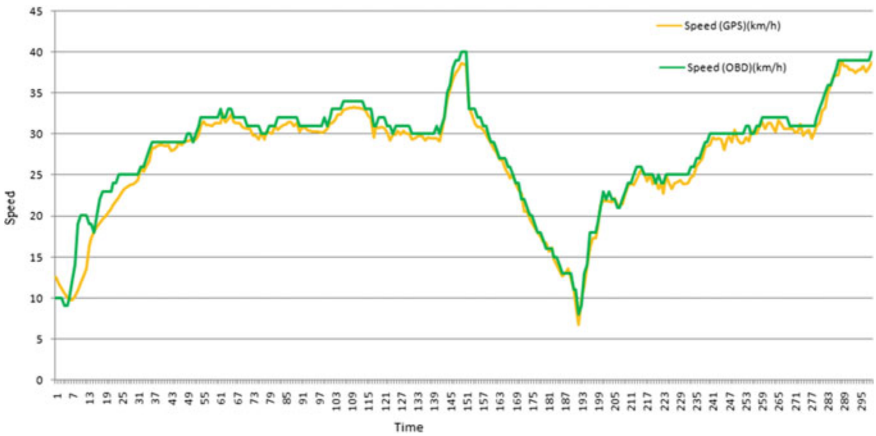

Fig. 6 Speed (calculated) OBD versus GPS

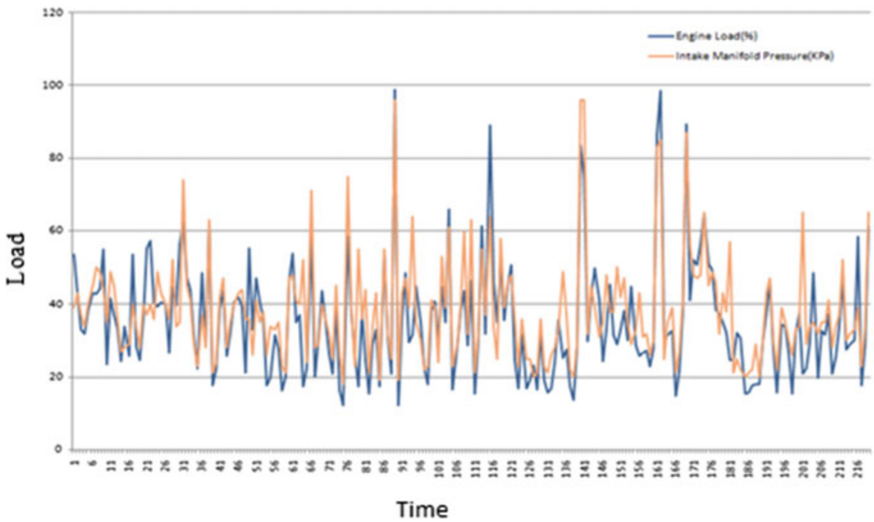

Fig. 7 Engine load and MAP

Engine load depends on input manifold pressure retrieved from MAP sensor which is connected at the input manifold section before the cylinder.

Engine load as given in Eq. 4 also depends on the following parameters.

$$\text{Engine Load} = \frac{\text{Current Air Flow}}{\text{Max Air Flow(rpm)}.\frac{\text{Barometric ressure}}{29.92}.\sqrt{\frac{298}{\text{Tamb}+273}}} \tag{4}$$

Another definition [17] of engine load is given by Eq. 5,

$$\text{Engine Load} = \frac{\text{Current Torque}}{\text{Max Torque(rpm)}.\frac{\text{Barometric Pressure}}{29.92}.\sqrt{\frac{298}{\text{Tamb}+273}}} \tag{5}$$

We can fit a polynomial regression curve of degree 6 using the expression in Eq. 6 to fit this intake manifold pressure with the equations as in Fig. 8. Using MATLAB, we can generate the coefficient matrix which yields the 1 by 7 matrix with different values of beta as the coefficients.

$$y = \beta_0 + \beta_1 x^1 + \beta_2 x^2 + \beta_3 x^3 + \beta_4 x^4 + \beta_5 x^5 + \beta_6 x^6 \tag{6}$$

where $\beta_0 = -34.92$, $\beta_1 = -1.428$, $\beta_2 = 1.123$, $\beta_3 = -0.084$, $\beta_4 = 0.002x^4$, $\beta_5 = -4\text{E–}0, 5$, $\beta_6 = 2\text{E–}07$, $R^2 = 0.81$.

where y is the dependent variable to determine intake manifold pressure. The polynomial has a degree 6. We can see the nature of intake manifold pressure variation with load for different load conditions.

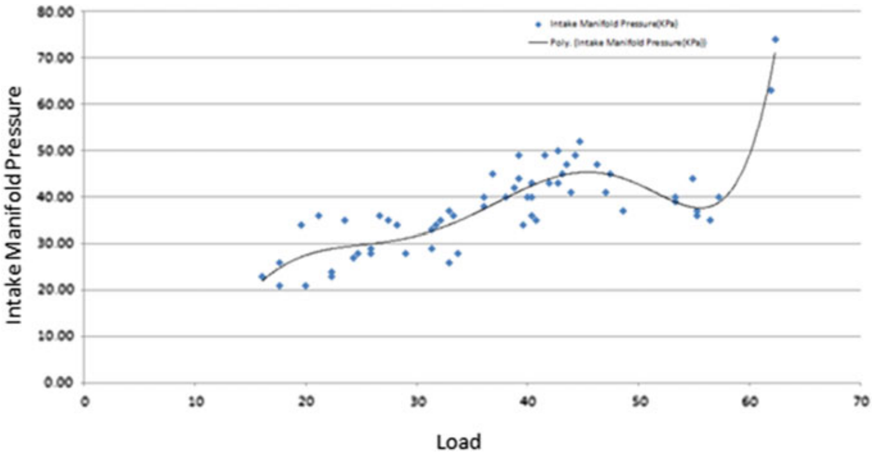

Fig. 8 Polynomial curve for engine load versus MAP

6 Conclusion

In this research paper, several parameters are retrieved and calculated, compared and analyzed with the observed values. The results are consistent with the OBD-II data and the hardware, sensors and software also worked properly. Several OBD-II parameters had been collected, and they have been calculated, graphed for the load and the fuel consumption. Fuel consumption calculations aligned with the OBD values. It has been seen that driving behavior affects the fuel consumption. The fuel consumption may be better if operated at prescribed speed while moving. Bad driving behavior causes inconsistent changes in the engine load which in turn increases fuel consumption.

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2D and 3D Human Pose Estimation and Analysis Using Deep Learning

Anju Yadav, Rahul Saxena, Anubhav Bhattacharya, Vipin Pal, and Nitish Pathak

Abstract 3D human pose estimate has recently been made, a novel pipeline and architecture for 3D human posture estimation in in-the-wild pictures is a challenge. The major goal of this paper is to reduce keypoint re-projection loss, allowing the proposed model to be trained using in-the-wild pictures with only 2D ground truth annotations. In proposed model, several networks are employed at various phases of the process. COCO, a publicly available dataset, was utilized to train and validate results. Proposed pipeline model consists of yolo v3 to recognize and segment a person from an image, scale the picture without distorting the aspect ratio and inferring 17 essential points of a human body using PoseNet. Further, to measure the performance difficulties are highlighted with a subset of pictures where 2D keypoint recognition isn't doing well, and proposed model is showing better performance that HMR and PoseNet.

Keywords Regression network · Machine learning · Pipeline · Human mesh reconstruction (HMR) · Single shot detection (SSD) · You Only Look Once (YOLO)

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1 Introduction

Pose estimation is a phrase used to describe computer vision algorithms that recognize human figures in pictures and videos, such as determining where someone's ankle appears in an image. It is crucial to remember that posture estimation just guesses the location of major bodily joints, not who is in the picture or video [4]. The orientation of a human is represented graphically by a human pose skeleton. It is, in essence, a series of coordinates that may be linked to describe a person's posture. A part is the name for each coordinate in the skeleton (or a joint, or a key point). Pose of a human skeleton is a graphical representation of a person's orientation. In essence, it is a set of coordinates that may be linked to describe a person's posture. Each skeletal coordinate is referred to as a component (or a joint, or a key point). A pair is a legitimate link between two components (or a limb) [5].

From visuals such as pictures and movies, 2D human posture estimation is used to estimate the 2D position or spatial location of human body key points. Different hand-crafted feature extraction approaches for the individual body components are used in traditional 2D human posture estimates methods. To get global posture structures, early computer vision research portrayed the human body as a stick figure. Modern deep learning-based methods, on the other hand, have made considerable improvements in single-person and multi-person pose estimation performance [3].

The position of body joints in 3D space is predicted using 3D human pose estimation. Some approaches, in addition to recovering 3D human mesh from pictures or videos, also recover 3D human mesh. Since it is utilized to give rich 3D structural information linked to the human body, this subject has sparked a lot of attention in recent years. It may be used in a variety of settings, including 3D animation, virtual or augmented reality and 3D action prediction. On monocular pictures or videos, 3D human posture estimate may be done.

This deep learning task is designed to track human poses and movement, and it can be used in activities such as activity recognition, animation, gaming, augmented reality and real-time applications such as video surveillance, assisted living and advanced driver assistance systems (ADAS), among others. Knowing a person's orientation offers up possibilities for a variety of real-world applications, including activity recognition, motion capture and augmented reality, training robots, motion tracking for consoles and so on. For example, the popular deep learning software HomeCourt analyses basketball player motions using pose estimation. Strong articulations, small and barely visible joints, which make it difficult to infer key points of the human anatomy like nose, eyes and so on, clothes, and lighting variations make this a tough challenge, especially when dealing with photographs taken in the wild, make this a difficult problem. Occlusions are another important issue in pose estimates, as well as a difficult challenge to cope with.

1.1 Contribution of the Paper

The challenge faced in pose estimation was for some subset of images in which there is a considerable distance between the ankle and knee key points. On these subsets of images, the PoseNet fails to detect the key points properly or confuses between the key points. So to resolve this challenge a pipeline model is proposed. The addition to the pipeline is a regression network which takes the output joints, 17 key points, as input and predicts the correct positions of the key points for pose estimation using co-relation between joint points which in turn resulted in a poor accuracy and incorrigible 3D projections. The following are the major contributions of this work:

- A new pipeline: A novel pipeline is proposed that comprises picture segmentation, inference of 2D joint key points and 3D projection.
- We also include a regression network, which is unique in that it fine-tunes the ankle joint points and adjusts them to their proper locations, resulting in a 2D belief map, and further, results are compared with HMR, PoseNet and also in 3D overlay.

In this paper, Sect. 2 describes the literature review in detail. In Sect. 3, dataset description and proposed methodology are given. Further, results are analysed in Sect. 5 and conclusion was drawn in Sect. 5.

2 Literature Review

In this section, related work is discussed for 2D and 3D pose estimation of a single person. The skinned multi-person linear (SMPL) model is used to estimate the placement and orientation of 3D joints from a monocular video. A deep regression neural network is used to generate initial predictions of body posture, shape and camera parameters using the SPIN method [5]. Based on the IMUs, they offer a geometric technique for reinforcing the visual characteristics of each pair of joints. This significantly increases the accuracy of 2D posture estimation, especially when one joint is obstructive. Orientation regularized network is the name given to this technique (ORN). Then, using an orientation regularized pictorial structure model (ORPSM), they lift the multi-view 2D poses into 3D space, minimizing both the projection error between the 3D and 2D poses and the difference between the 3D pose and IMU orientations. On a public dataset, the simple two-step technique decreases the error of the state of the art by a considerable margin [6].

To lift a series of 2D joint positions to a 3D pose, they present an enhanced transformer-based architecture dubbed Strided Transformer for 3D human pose estimation in movies. On two difficult benchmark datasets, Human3.6M and HumanEva-I, the suggested architecture delivers state-of-the-art results [7]. PARE: Part attention regressor for 3D human body estimation they present the part attention regressor

(PARE), a soft attention mechanism that learns to predict body-part-guided attention masks. State-of-the-art techniques rely on global feature representations, rendering them susceptible to even minor occlusions, according to our findings. PARE's part-guided attention mechanism, on the other hand, solves these difficulties by utilizing information from nearby body parts to forecast occluded portions while using information about the visibility of particular body parts. On both occlusion-specific and standard benchmarks, they show qualitatively that PARE learns reasonable attention masks, and quantitative assessment shows that PARE produces more accurate and resilient reconstruction outcomes than previous methods [8].

TesseTrack is a unique top-down method that uses a single end-to-end learnable framework to reason about many people' 3D body joint reconstructions and connections in space and time. On common benchmarks, quantitative examination of 3D posture reconstruction accuracy reveals considerable gains above the state of the art. The advantage of TesseTrack over strong baselines is demonstrated in our unique assessment methodology for multi-person articulated 3D pose tracking [9]. An extension of faster CNN was proposed for finding the pose and key point of 2D using mask RCNN, and mask is developed by segmentation [10]. Further, variant of mask RCNN was introduced in which joints are considered as region instead of whole person [10]. Some work is also done on 3D pose estimation of single person. 3D pose estimation work is divided into two major categories based on directly regress 3D joints or 2D to 3D pose conversion using pipeline approach [12–14]. These pipeline approaches reported a significant improvement in the performances and by also considering more diverse 2D pose dataset.

3 Proposed Methodology

In this section, proposed methodology is discussed in detail: dataset description, proposed model (pipeline approach) and its block diagram (see Fig. 1).

3.1 Dataset

The MS COCO [1] dataset (Microsoft Common Objects in Context) is a large-scale dataset for object recognition, segmentation, keypoint detection and captioning. There are 328K pictures in the collection.

Splits: In 2014, the MS COCO dataset was released in its initial edition. It has 164 K pictures divided into three sets: training (83 K), validation (41 K) and test (41 K). A fresh test set of 81 K photographs was published in 2015, which included all of the previous test images as well as 40 K new images. The training/validation split was adjusted from 83 K/41 K to 118 K/5 K in 2017 as a result of community input. The same pictures and annotations are used in the new split. The 2017 test set is a subset of the 2015 test set's 41 K pictures.

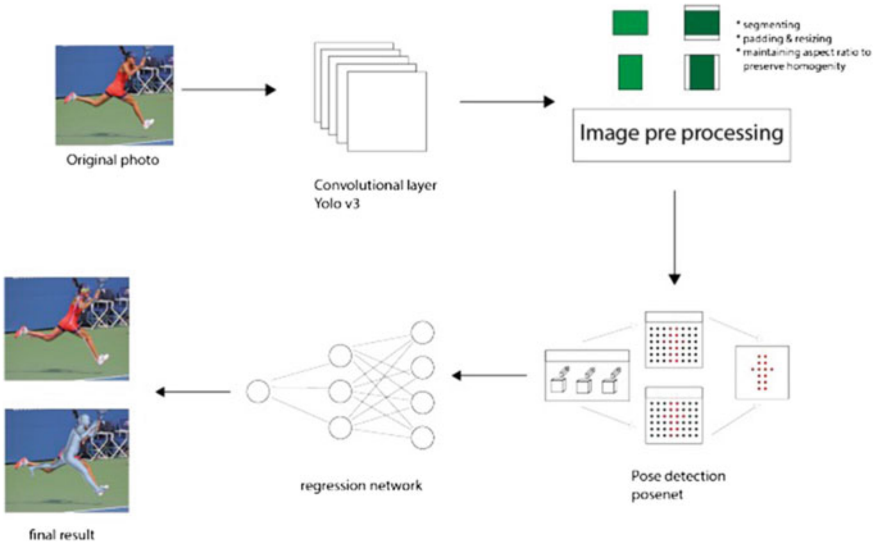

Fig. 1 Block diagram of proposed work

The dataset includes annotations for keypoint detection, which includes more than 200,000 images and 250,000 person instances labelled with key points (17 possible key points, such as left eye, nose, right hip, right ankle), as well as dense pose detection, which includes more than 39,000 images and 56,000 person instances labelled with DensePose annotations—each labelled person is annotated with an instance id and a mapping. Only the annotations for training and validation, pictures are provided to the public.

The number of key points is provided in sets of three (x, y, v), with x and y indicating picture pixel locations. v denotes visibility: v=0 suggests no labelling (in which case x=y=0), v=1 implies labelling but not visibility, and v=2 indicates labelling and visibility. Key points represent distinct bodily components in the instance of a person. The skeleton shows how points are connected. The pictures linked to sports category, with a subcategory related to tennis, is one of the 91 categories we utilize.

3.2 Deep Learning Pipeline Approach

3.2.1 Image Segmentation

In real-world photographs, the first step in proposed model pipeline is to separate the human from the image.

The You Only Look Once (YOLO) [2] method is a convolutional neural network modification that detects and classifies the items in a picture. Since we only need to forward propagate through the neural network once to detect the objects, this technique is dubbed "only look once." The image is divided into grids, and the bounding boxes and related probability scores are calculated for each grid. Since the model predicts numerous bounding boxes, non-max suppression is employed to filter out those with low confidence scores. In comparison with other object detection algorithms, it is a quick algorithm.

As several pictures have noise in the background, segmentation is critical in estimating 2D joint key points. For this, yolov3 model is utilized that has been pre-trained on the ImageNet dataset for 80 classes. To produce $7 \times 7 \times 2$ border box predictions, YOLO uses a linear regression with two fully linked layers. To create a final forecast, ones with the highest box confidence ratings (higher than 0.25) was kept. Output bounding box coordinates are noted, crop the image and pad the image to make it $n \times n$ in size while keeping the aspect ratio in mind.

3.2.2 Keypoint Detection: 2D Belief Mapping

In order to infer the 2D key points from the segmented image, PoseNet is used. The PoseNet model inputs a processed camera picture and outputs keypoint information. A part ID is used to index the key points found, with a confidence score ranging from 0.0 to 1.0. The chance that a key point exists at that position is indicated by the confidence score. The PoseNet model is invariant in picture size which allows for a positioning of the picture to be predicted at the same scale as the image. This indicates that you set the model's accuracy to be higher at the price of performance. The PoseNet estimate takes place in two steps at a high level:

(1) A convolutional neural network is fed an RGB image as input.
(2) The algorithm used to decrypt poses, provide trust, key point and trust scores from the model results is either a single-pose or multitasking algorithm.

The following is an explanation of the major points mentioned above:

- PoseNet's output is (x,y,c), where x,y are keypoint coordinates and c represents their confidence.
- Pose confidence score—this indicates how confident you are in your pose assessment. It has a range of 0.0–1.0. It can be utilized to conceal poses that aren't considered powerful enough.
- Key point—an estimated part of a person's stance, such as the nose, right ear, left knee, right foot and so on. It has a position as well as a keypoint confidence score. At the moment, PoseNet detects 17 key points.
- Keypoint Confidence Score—this metric reflects how certain you are that a keypoint location estimate is correct. Between 0.0 and 1.0 is the range. It can be used to cover up weak key points.
- Keypoint Position—in the original input picture, 2D x- and y-coordinates where a key point was identified.

3.2.3 3D-Net Regression Network

In order to deal with the problem with PoseNet keypoint detection, the novel approach was proposed which uses regression between key points to predict the joint points.

- Regression of ankle key points is used in order to improve the result of keypoint detection and to curtail the missing.
- For feature extraction, a correlation matrix of key points is used to find the linearly dependent features.
- The problem of multi-collinearity is also accounted between the features and provided a more efficient and accountable neural network to counter.
- Model was trained on 700 images and tested on 100 images from COCO dataset so as to get an appreciable result during 3D mapping.

4 Result Analysis

In this section for result analysis, we have used Python 3.9 as the programming language. The model was developed on a Jupyter Notebook. The libraries and versions used are HMR, PoseNet v1.0, TensorFlow.js, Pandas v1.3.1, YOLO v3.0. Following are the key points that have been used in formulation for joint correction:

$$\text{Right Ankle}\, x = A_0 * \text{Right Knee}\, x + C \tag{1}$$

$$\text{Right Ankle}\, y = A_0 * \text{Right Knee}\, y + A_1 * \text{Right Hip}\, y + C \tag{2}$$

$$\text{Left Ankle}\, x = A_0 * \text{Left Knee}\, x + C \tag{3}$$

$$\text{Left Ankle}\, y = A_0 * \text{Left Knee}\, y + A_1 * \text{Left Hip}\, y + C \tag{4}$$

Here C, A_0 and A_1 are weights associated with their corresponding features and right ankle x refers to the x coordinate of pixel corresponding to the same and similarly for the rest other joint points as well. For regression, a feedforward network is used having three dense layers with 500, 200, 1 hidden units, respectively, with ReLU used as activation function. Mean-squared error is used to calculate loss function which takes loss between the predicted point and the annotated ground truth. From Fig. 2, it is clearly seen that from our proposed model the train and test loss is very less.

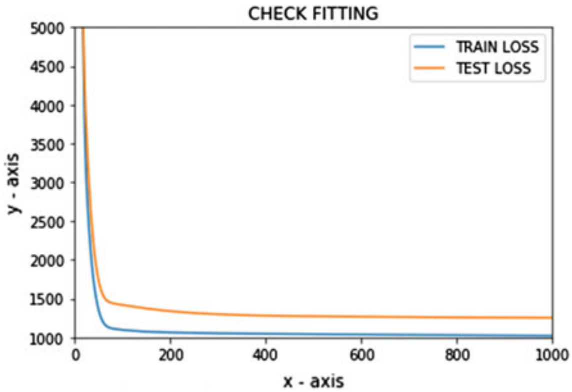

Fig. 2 Train–test graph

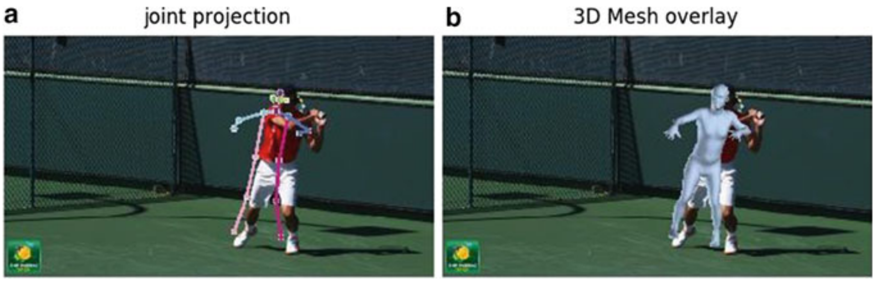

Fig. 3 **a** Joint projection and **b** 3D mesh rendering on an image without segmentation

4.1 Performance Comparison of Proposed Model with PoseNet and HMR

In this section, the performance of the proposed model is compared with PoseNet and HMR. As we have proposed a pipeline approach in which segmentation is performed to segment the person from an image. To show its effect in result, we have measured the performance of result with two cases one with segmentation and another without segmentation for both joint projection (2D) and 3D mesh overlay. From Fig. 3, it is clearly seen that for both the images (a) and (b) the hand key points are missed in calculation. But after performing segmentation, it is observed that the same hand key points are considered in pose estimation for both 2D and 3D. Finally, two-sample 3D mesh overlay is created using our proposed model, and from Fig. 7, it is clearly visible that model is calculating accurate key points (Fig. 4).Fig. 5a 2D results from PoseNet b Ankle correction by proposed model

Further, performance analysis of proposed model PoseNet and HMR is considered for comparison. From Fig. 5a, it has been observed that PoseNet 2D results with loss of ankle correction key point and whereas from Fig. 5b that key point of ankle is

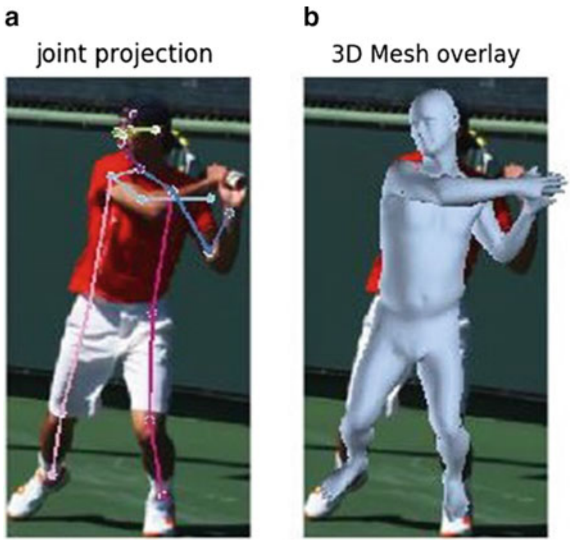

Fig. 4 **a** Joint projection and **b** 3D mesh rendering on an image with segmentation

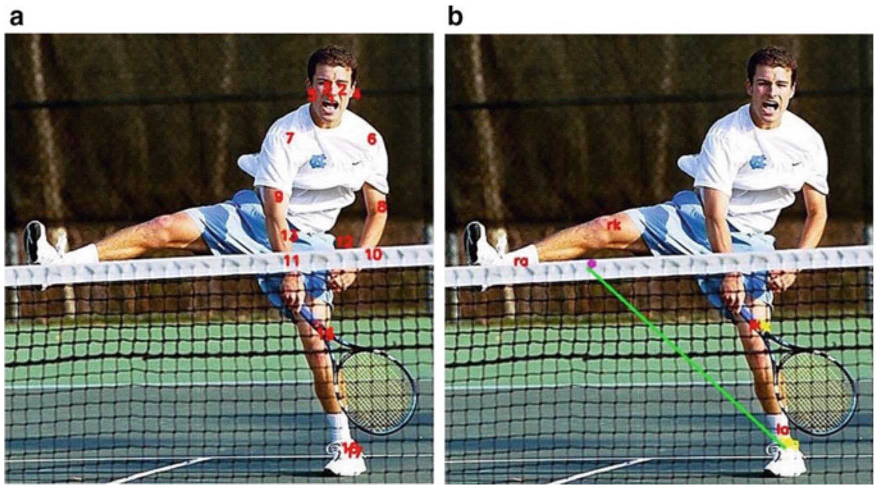

Fig. 5 **a** 2D results from PoseNet **b** Ankle correction by proposed model

corrected by applying our proposed model. 2D results of key points of an image are obtained, and it has been observed that some key points are wrongly identified (see Fig. 6a), whereas from Fig. 6b it is clearly seen that those key points are corrected after applying our proposed model. Hence, from both examples it has been observed that our proposed approach performance is better than PoseNet and HMR (Fig. 7).

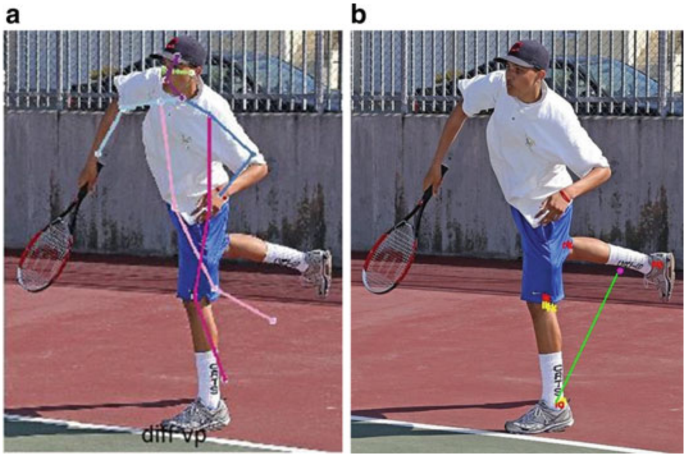

Fig. 6 a 2D results from HMR **b** Ankle correction by proposed model

Fig. 7 Final 3D result for two images by proposed model

5 Conclusions and Future Work

This paper proposes a novel approach to improve the 2D belief map of the key points, which involves a regression network and equation formed based on co-relation matrix of joint points. To accomplish this high co-relation between some joint points is observed which is used in network to predict the correct 2D joint points. In proposed approach, 2D key points are predicted better than the PoseNet and HMR, for the images in which there is a certain distance between the ankle points. An illustrated example in the figures which shows the 2D annotations by HMR, and it is clear that the left knee and ankle are misplaced/wrongly predicted which will ultimately result in a bad 3D model, similarly in the image showing the result from PoseNet, the left ankle is correctly predicted but now the right ankle is misplaced. The figures show the correction of the right ankle by my 3D Net regression network than both PoseNet and HMR and as future work, extend this work with videos, which is also a very challenging task.

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The Comprehensive Art of Atmospheric Turbulence Mitigation Methodologies for Visible and Infrared Sequences

Janki M. Patel, Dippal Israni, and Chintan Bhatt

Abstract Heat scintillation also known as atmospheric turbulence distorts the image. This distortion is due to the propagation of light that passed through the volatile surroundings. The distortion created by the atmospheric turbulence is proportional to the distance between camera and object. This paper gives an overview of state-of-the-art techniques, working principles, and challenges in the field of the atmospheric turbulence. The techniques include first register then average and subtract (FRTAAS), independent component analysis (ICA), Lucas–Kanade, and control grid interpolation (CGI). These techniques use image registration for mitigation atmospheric turbulence. Different standard datasets mostly used in this field are represented in the paper. Finally, all state-of-the-art algorithms are evaluated based on standard evaluation performance parameter.

Keywords Long-range video surveillance · Heat scintillation · Registration · MSE · PSNR

1 Introduction

Long-range image processing atmospheric turbulence results in distortion of video as well as image frames. Atmospheric turbulence is a natural phenomenon induced from random fluctuations of the air along the path through the video sensor [1]. This introduces geometric distortions in a local scene and results in blur images. Fog, hot air, and haze are the main reason behind geometric distortion. It also results

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in space and time-varying blur [2]. Atmospheric turbulence mainly consists of blur and distortion which makes the viewing object difficult to view by human eyes [3]. The turbulence caused by the various factor of the atmosphere can be modeled mathematically as follows:

$$F_k(x) = G_k(B_k(I(x))) + n_k(x) \tag{1}$$

Here, $k = 1 \ldots N$ represents frame number. As mention in Eq. 1, $F(x)$ is the observed frame, and G, B are the geometric distortion and blur kernel, respectively [1]. $I(x)$ is the blunder-free image, and $n(x)$ is an additive noise. The atmospheric unstable blur kernel in the optical transfer function (OTF) can be written as [4]:

$$H(x, y) = e^{-\gamma (x^2+y^2)^{\frac{5}{6}}} \tag{2}$$

In Eq. 2, variables x and y represent the discrete frequency through which the severity of blur is controlled. There are two challenges for mitigation of turbulence-degraded sequences. The first is to get a single mitigation sequence image of high quality from a distorted video sequence [5]. Second, there are less efficient approaches that can preserve the motion of moving object [6].

Atmospheric turbulence mitigation techniques are primarily used in remote sensing [7]. Remote sensing is a technique for acquisition of information about an object without making physical contact. In computer vision [6], mitigation is apprehensive with the automatic extraction, analysis, and understanding of useful information from a single image or a video (sequence of images). In astronomical imaging [8], the atmospheric effect can severely hinder the resolution of a telescope. Hence, by removing the blurring effect and correcting the effect, a good resolution can be obtained. Patel et al. proposed a novel approach that can handle several challenges such as moving object disorders as well as scene changing sequences [3].

2 Related Work

There are various methods to remove turbulence in video sequence. (1) Image registration based and (2) Non-image registration based. Image registration techniques are severely utilized for reconstruction of the frame that is turbulent affected. Hence, this paper focuses on image registration techniques to remove atmospheric turbulence.

Halder et al. proposed FRTAAS technique [9]. This technique removes atmospheric turbulence using non-rigid image registration approach. Here, each captured frame is registered to an associated frame, and shift map is determined. FRTAAS method is used for removal of geometric distortion. ICA was proposed by Kopriva et al. [10]. Here, the data are separated into their fundamental informational components, and it belongs to a class of blind source separation techniques.

Lucas–Kanade [11] proposed an image registration technique that uses the local constraints to construct an optical ow of the atmospheric turbulence. The swiftness is estimated that minimizes the restriction errors. The least-squares (LS) estimator minimizes the squared errors. CGI was proposed by Sullivan et al. [12].

3 State-of-the-Art Techniques Mitigation Atmospheric Turbulence

3.1 Lucas–Kanade

Lukas–Kanade method is accepted as an additional constraint in which the optical ow is separated smoothly along the near object points that possess the same speed [11]. The process of Lucas–Kanade is represented in Fig. 1. In Fig. 1, input video represents the image sequences that are degraded by atmospheric turbulence. The image contents between two nearby frames are small and approximately constant within an area of the point *p* under consideration.

The movement of a pixel from frame to frame can be estimated as represented in Eq. 3.

$$f(a, b, c) = f(a + \delta a, b + \delta b, n + \delta n) \tag{3}$$

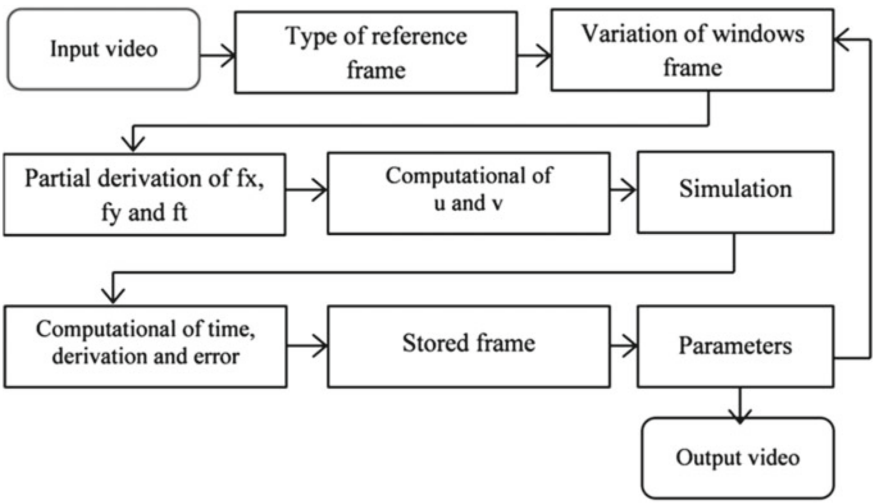

Fig. 1 Block diagram of Lucas–Kanade algorithm

Here, *f (a, b, n)* represents the pixel intensity; *a* and *b* represent the pixel coordinates, and *n* represent the frame number. The images of optical ow are computed by partial derivatives between pixels in the *a, b,* and *n* directions [13].

3.2 Independent Component Analysis (ICA)

ICA is used to extract the source of turbulence from the video sequences. The turbulent image frames can be represented as in Eq. 4.

$$I_i = AI_0 + v \tag{4}$$

Here, I_i is a $N\,x\,T$ matrix of the turbulent frames. I_0 represents the original frame. A is the unknown mixing matrix which distorts the original frames to form the turbulent frames, and v represents additive noise [14]. As presented by Liao et al., the ICA method constructed in the fourth order cumulates Joint Approximate Diagonalization of the Eigen-Matrices (JADE) [15]. Statistical independence in JADE is demonstrated by cubes minimization on fourth-order cross-cumulants as represented in Eq. 5.

$$X = \text{arglow} \sum_a \sum_b \sum_c \sum_d \text{off}\left(X^T \hat{C}\left(I_{i_d} I_{i_c} I_{i_b} I_{i_a}\right) X\right) \tag{5}$$

Here, $\hat{C}\left(I_{i_d} I_{i_c} I_{i_b} I_{i_a}\right)$ are the fourth-order cross-cumulant [15]. The unmixing matrix X is the transpose of the mixing matrix.

3.3 First Register then Average and Subtract (FRTAAS)

The FRTAAS technique is an upgradation of first average then register (FART) algorithm by Fraser, Thorpe, and Lambert [16]. In FART, any frame is taken as a reference frame. In contrast, FRTASS uses averaging method to generate the reference frame [9]. The time-changing nature of the atmospheric turbulence results in different degradation level of all frames [9]. In sequence, a sharpness metric is used to select the most distorted frame. Sharpest frame can be achieved with sharpest metric S_h as represented in Eq. 6 [9].

$$S_h = -g(a, b)\,\text{In}\,[g(a, b)]dadb \tag{6}$$

Here, *g(a, b)* denotes the image, and *a, b* denote pixel coordinates.

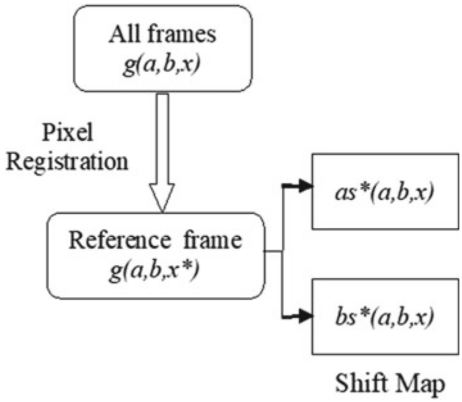

Fig. 2 Registration with respect to reference frame [19]

Here, all frames are mentioned in *g(x)* and reference frame g(x)*; the pixel registration generates shift maps $as^*(a, b, x)$ and $bs^*(a, b, x)$. This scenario is explained in Fig. 2.

After selecting the reference frame, all frames are registered with respect to the reference frame. To compute the shift maps as to compute the shift maps $as^*(a, b, x)$ and $bs^*(a, b, x)$, image registration technique is used [9].

3.4 Control Grid Interpolation (CGI)

Control grid interpolation is a technique proposed by Sullivan et al. [12] for motion compensation. For the computation of the optical ow, motion field is used. The estimated control point's works as anchors in which intermediate vectors are computed using bilinear interpolation [17].

In Fig. 3, input video contains the video sequences distorted by atmospheric turbulence. Image preprocessing is important since the quality of an input video can vary significantly. This is followed by bilinear interpolation to estimate shift of control points [18]. Average of displacement metrics is used to warp original input target frame to remove scintillation. The post-processing step involves improving quality that is said to be disturbed by the algorithm used. Post-processing also includes accuracy assessment, validation of results, and contrast adjustment [19].

4 Evaluation Metrics

The standard parameters utilized for measurement are peak signal-to-noise ratio (PSNR), mean square error (MSE). The parameters used for comparing the accuracy of the algorithm are as follows:

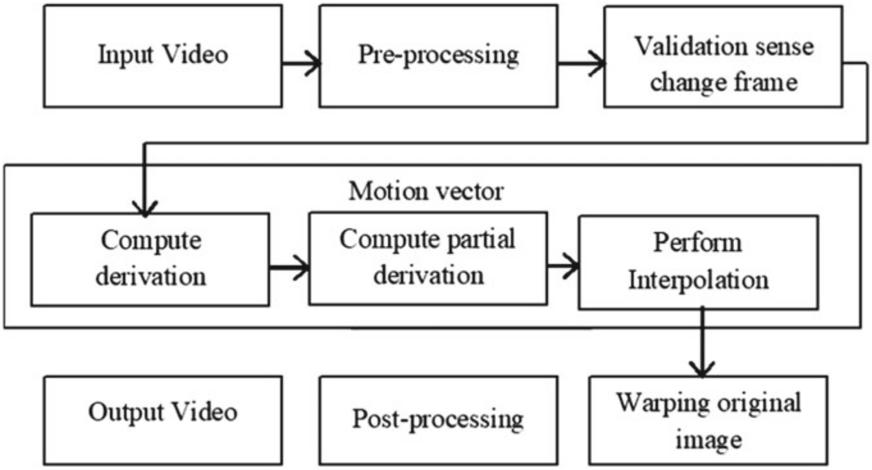

Fig. 3 Block diagram of CGI

(1) MSE: This parameter results with the measure of the average of the square of the errors. MSE value should be the minimal that depicts that utilized algorithm has low error (Eq. 7).

$$\text{val} = \text{MSE}(A, B) \tag{7}$$

where A is reference image and B is target image. It is mathematically formulated as in Eq. 8 [20]:

$$\text{MSE} = \frac{1}{mn}\sum_{x=0}^{m-1}\sum_{y=0}^{n-1}[I(x, y) - N(x.y)]^2 \tag{8}$$

Here, I denotes image intensity, and N denotes the noise present in the image frame.

(2) PSNR: This parameter is utilized to measure the dominance of image re-enactment. A higher value of PSNR denotes the efficient feature of image reconstruction. This is stated as in Eq. 9 [20]:

$$20.\log_{10}\text{MAX}_i - 10.\log_{10}\text{MSE} \tag{9}$$

As in equation, MAX_i represents the maximum possible pixel information in the image.

5 Simulation Results

Simulations are carried out in a MATLAB environment on Intel Core i5-4570 T with 2.90 GHz processor having 8 GB RAM. Lucas–Kande and CGI algorithms were evaluated on the dataset. The generated output is as shown in Figs. 4 and 5. The algorithm is evaluated on standard OTIS dataset [21].

Figures 4 and 5 showcase output taken of Lucas–Kanade and CGI on two different datasets of OTIS. Figures 4a and 5a showcase the turbulent input frame of the door and pattern 13 sequences. Figures 4b and 5b represent the output simulated using Lukas–Kanade algorithm. Finally, Figs. 4c and 5c represent the output simulated using CGI algorithm. The standard parameters for checking the simulation results are MSE and PSNR.

Table 1 and Table 2 showcase results of performance evaluation parameter on Lucas–Kanade and CGI algorithms.

[a] [b] [c]

Fig. 4 **a** Input frame door. **b** Result of Lucas–Kanade. **c** Result of CGI

[a] [b] [c]

Fig. 5 **a** Input frame pattern 13. **b** Result of Lucas–Kanade. **c** Result of CGI

Table 1 Parameter result for door

	MSE	PSNR
Input video sequence	0.0018	75.5565
Lucas–Kanade	0.0010	77.0864
CGI	0.0013	80.4038

Table 2 Parameter result for pattern 13

	MSE	PSNR
Input video sequence	0.0087	68.7301
Lucas–Kanade	0.0051	71.0239
CGI	0.0029	73.4329

6 Conclusion

In past few decades, lots of improvements are derived in the field of atmospheric turbulence. This paper gives a broad insight to existing atmospheric turbulence application and methods. This paper provides an overview to different techniques for registration of image sequences. The represented techniques are effective to remove atmospheric turbulence effects like heat scintillation, heat shimmer, and atmospheric blur. We present results of existing algorithms, namely CGI and Lucas–Kanade. This paper also highlights to performance evaluation parameters to measure the induced turbulence and its removal. The results clearly depicts that CGI algorithm efficiently removes turbulence than latter. In future, this can be improved for mitigation in scene having moving object (Real-time motion). This can also be further enhanced to mitigate turbulence in sequence having moving camera. This work can also be extended by implementing the same in real-time environment using FPGA hardware.

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Graphical Interpretation and Multi-dimensional Data Visualization on Heart Disease Dataset

Sreeja Rashmitha Duvvada

Abstract Heart disease is the most leading cause of death in most developed countries among young adults and aged peoples. Sometimes, even after spending enormous amount of money for treatment, the patient cannot be saved due to their medical condition. Doctors and hospitals in the verge of finding new techniques and methodologies in treating patients following applicable procedures. With the emerging latest medical devices, in recent days, the diagnosis is mostly data-oriented. The historical readings of patient are recorded, and suitable diagnoses are administered to increase the chance survivability. Such a well-defined heart disease-based readings are provided in the UCI heart disease datasets. In this article, we are motivated to perform exploratory data analysis to uncover interesting patterns in the datasets. The patterns are illustrated as a graphs and charts throughout this article.

Keywords Exploratory data analysis · Data visualization · Heart disease dataset

1 Introduction

Healthcare industry provided enormous amount of data, which give us a great insight on understanding the disease and the impacts on the variable acted upon the disease. Huge amount of data is very useful to perform mining task and to exploratory data analysis to uncover interesting patterns. Exploratory data analysis is considered as a primary step to understand about the data before moving to data mining-based tasks. Exploratory data analysis is an emerging method to uncover the hidden structures among the data and provides us greater insights about the given dataset. It is also used to find the anomalies in the dataset. Exploratory data analysis can be differentiated into two types, i.e., graphical and non-graphical-based methods. The graphical methods make use of graphs, charts, and other visual representations, whereas non-graphical methods use statistical measures to analyze the dataset. Data analysis can be done in two types: they are univariate analysis and multivariate analysis.

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Univariate analysis considers a single parameter in the dataset to do the analysis, whereas multivariate considers set of attributes in the dataset.

The generalized heart disease is defined as where the heart is not capable of pumping the blood throughout the body, or the blood vessels are blocked due to the fat deposits. Cardiovascular disease is responsible for 17.9 million deaths per year. Predicting heart disease and diagnosing it are challenging tasks for a medical professional. The most influencing symptoms are blood pressure, obesity, family disease, blood pressure, food habits, and smoking. Heart diseases are majorly categorized into three types: heart attack, heart failure, and arrhythmia. Heart attack is the condition where the heart cannot be able to pump the blood to the vital organs in the body. Heart attack symptoms includes neck pain, chest pain, nausea, vomiting, and shortness of breath. Arrhythmia means palpitations in the chest. In specific, coronary artery disease is the most common type of heart disease among the people. This is a medical condition where the coronary artery is blocked with cholesterol which can partially or totally block the blood flow. In the early stage to diagnose the blockage in blood vessel, a special dye is injected into a patient's body to identify the blockage. A stunt is applied to blast the cholesterol deposit inside the blood vessels. This process is called as an angiogram. Apart from this, the patients' ECG or EKG, electrocardiogram, chest x-rays, and cardiac characterization are administered. Based on the coordinated readings produced by all the medical devices, the procedure is identified by the medical professions. If the disease is untreated at the right time, the fat deposits in the artery will increase, and it restricts the oxygen and essential minerals needed for the proper functioning of the heart. In such cases, there is an expensive solution to counter this problem is called us coronary artery bypass graft surgery. The artery in the heart is completely replaced from the artery removed from the thigh muscle or similar muscles. Now, the blood flow in the alternate path that helps the full functioning of the heart.

2 Literature Survey

Data visualization is an essential part of any data mining activity. Data visualization helps the users and the scientist understand the nature of the data. The very widely used data visualization libraries are matplotlib [1], pyplot, and seaborn [2]. The seaborn visualization library has native support to the pandas data frames; hence, it is very easy to integrate the Python native Python programs for visualization. Data frames provided by the pandas library are the basic data structure used by machine learning and statistical algorithms. The seaborn library also has automatic color mapping different kinds of variables like categorical and numerical to preserve consistency in the project workflows. Seaborn offers many inbuilt graph and chart types, and the user has the flexibility to dynamically reconfigure the visualization. The matplotlib is a portable Python package for graphing proposed by University of Chicago in the year 2005. It is an open-source software and designed to provide interoperability among various text editor including latex. Matplotlib can produce high-resolution graphic image with less configuration and greater customization. Scikit learn [3] is an image processing library majorly used to process image-based data inputs. Scikit learn has inbuilt function to perform all the basic tasks like (filters, histogram, and edge identification) in an image. This library includes the state-of-the-art algorithms to do the image manipulation, but, however, its functionality to plot a graph is very limited. In [4], the author stated in Tessa visual understanding of the data and summarized various type of graphs used to represent the data. He also concluded that the limitations of graphical data analysis, the graphical representation of the data gives greatest insights, but it is essential to consult a statistician's perspective. The combination of graphical representation and statistical analytics is always recommended. Data visualization is very widely used in medical industry to visualize the cost and effect of a disease and used in visualizing the epidemic spread in a prime area. Visualization can be applied in wide array of domains. In [5], the visualization is applied in infection prevention. The collected data is correlated with location-based maps to analyze the spread of the disease. Later, the same model can be applied for predicting the COVID pandemic spread in various location. The key challenges addressed in this article [6] are the selection of attribute for visualization and data preprocessing. Eliminating the outliers is particularly essential when visualizing large amount of data under single context. In [7], the author mapped the interaction between the individuals, and the psychometric attributes are visually represented in spider graph. Visualization is greatly helping in showing differences between individuals in their competency levels. In [8], the author addressed data projection using graphical libraries, and for post-hoc, analysis is performed using k-means clustering. They used knee point detection method [9] to decide the number of clusters in the k-means algorithm.

3 Dataset Description and Visualization

The University of California, Irvine (UCI), has hosted a public repository which has a collection of reliable datasets to work and benchmark with various machine learning and data mining algorithms. From the UCI repository, we have considered the famous heart disease dataset in our article. The Cleveland database is considered, and it is pre-processed for our work. The dataset is multivariate characteristics with 303 instances, and the attributes are categorized into categorical, integer, and real valued numbers. The total number of attributes in the dataset is 75 with some missing values. Principal component analysis is done on the dataset; out of the 75 attributes, 14 attributes are considered in our study. The 14 attributes are well studied, and the definitions are presented below (Fig. 1).

1. Age—is a numerical value represented in the numeric value.
2. Sex—is a Boolean variable. 1 represents male and 0 represents female.
3. Chest Pain (CP)—is represented in the scale of 0 to 3. Where 0 represents low, 1 represents medium. 2 represents average, 3 represents high.

Dataset statistics	
Number of variables	14
Number of observations	303
Missing cells	0
Missing cells (%)	0.0%
Duplicate rows	1
Duplicate rows (%)	0.3%
Total size in memory	33.3 KiB
Average record size in memory	112.4 B

Variable types	
NUM	6
BOOL	4
CAT	4

Fig. 1 Dataset statistics

4. Resting Blood Pressure (trestbps)—when a person is at rest without any physical activity, the blood pressure is measured (mm/hg); the readings are produced in this column. It is a numeric value
5. Cholesterol (chol)—the serum cholesterol is measured from the blood sample. It is a numeric value.
6. Fasting Blood Sugar (fps)—fasting blood sugar is observed from the patient in empty stomach. It is a Boolean kind of variable. If it exceeds the 120 mg/dl, the value in the column is 1, else 0.
7. Resting Electrocardiogram (restecg)—Resting electrocardiogram is the measure of electrical impulse generated by the heart. The value is scaled from 0 to 2 where 0 represents left ventricular issue, 1 represents normal, and 2 represents abnormality.
8. Maximum heart rate achieved (thalach)—This is a measure of heart rate under the physical activity. Also, this attribute value changes based on the age of the person. The value is represented in the numeric value.
9. Exercise Induced Angina (exang)—Under the physical activity, the blood vessels become narrow. The blood flow is regulated over a period. If this condition cause of heart pain, then it is Yes, else No. This is a Boolean variable.
10. ST depression (oldeak)—The distance between the two highest peak in the ECG reading is measured in this parameter. It is a numerical value.
11. Slope—In the ECG measurement, if the reading is reduced over a time, it is called as a down slope. If the reading is increased over time, then it is called as upslope. 0 represents downslope, 1 represents flat, and 2 represents upslope.
12. Number of major blood vessel (ca)—This represents number of blood vessels actively pumping blood through the veins to the heart. It is a numerical value.
13. Thalassemia (thal)—It is a disorder in the blood condition where the blood has less hemoglobin compared to the normal one. 1 represents normal, 2 represents fixed defect, and 3 represents reversible defect. It is a categorical variable.
14. Target—The results whether a person has heart disease or not is represented in this field. It is a Boolean variable.

The programmatic screenshot off the above-explained attributes is given below (see Fig. 2). The attributes with three sample values are displayed.

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	target
0	63	1	3	145	233	1	0	150	0	2.3	0	0	1	1
1	37	1	2	130	250	0	1	187	0	3.5	0	0	2	1
2	41	0	1	130	204	0	0	172	0	1.4	2	0	2	1

Fig. 2 Attributes considered in the dataset

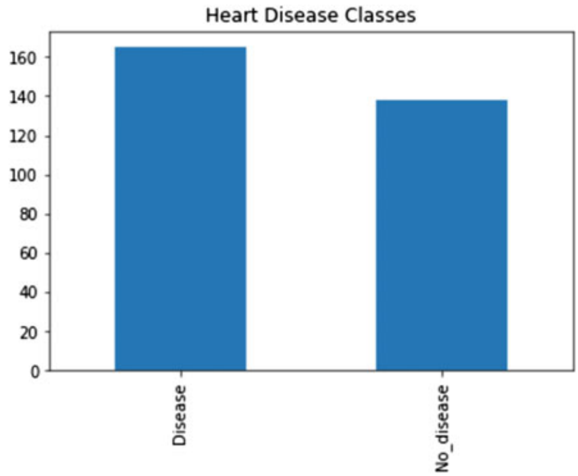

Fig. 3 The disease class

The dataset is preprocessed, and the values are filled using a median and average in the respective attribute. The null values are eliminated in the entire dataset. Figure 3 represents that out of 303 records in the heart disease dataset, 165 members are affected with heart disease and 138 persons are not affected with the heart disease. In this dataset, 114 are male candidates and the remaining are the female. 93 males and 72 females are affected with heart disease. Figure 4 represents the distribution of age in the dataset.

Figures 3 and 4 together represent the diversity in the dataset. The youngest in the dataset is of 29 years old, and the eldest in the dataset is 77 years old. The average age of a person is around 54.

The distributions of various attributes are once again depicted in Fig. 5 that includes target, chest pain distribution, vessel distribution, angina distribution, ECG distribution, and slope. Under each parameter, it is once again separated to represent affected and not-affected count. Surprisingly, none of the people has any irregularity in ECG slope.

The illustration in Fig. 6 represents the continuous variable and class the target variable. So, the increase in the graph shows the corresponding target values. The blue color represents the affected individual, and the orange color represents unaffected individual. The conclusion withdrawn from this dataset is that there are a greater number of unaffected individuals. The attribute old peak represents the distance

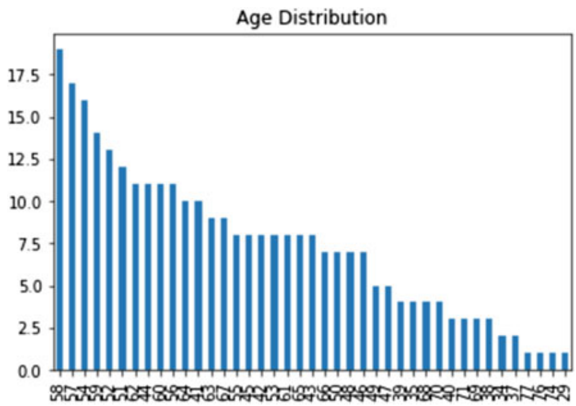

Fig. 4 Age distribution in dataset

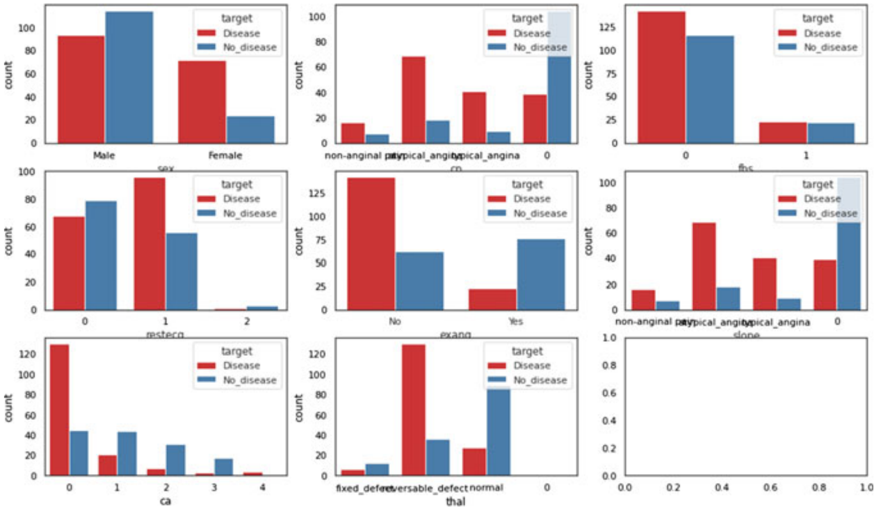

Fig. 5 The distribution of attributes in connection with target class

between two upper peaks in the ECG reading. It is a key parameter in deciding the affected individual. An irregular rhythm in the heartbeat leads to a significant heart disease. Resting blood pressure is the least significant parameter considered in this dataset. The individual with high blood pressure and cholesterol is most likely to get heart disease. Diabetes is also a cause for heart disease.

The Pearson's correlation matrix is very useful in considering whether a parameter is positively contributing or negatively contributing to a given objective. If the correlation between any two parameter is negative, then both are mutually excluded, i.e., if one increases and the other one decreases. If a parameter is positively correlated, it denotes that an increasing in parameter A also increase the parameter B (Fig. 7).

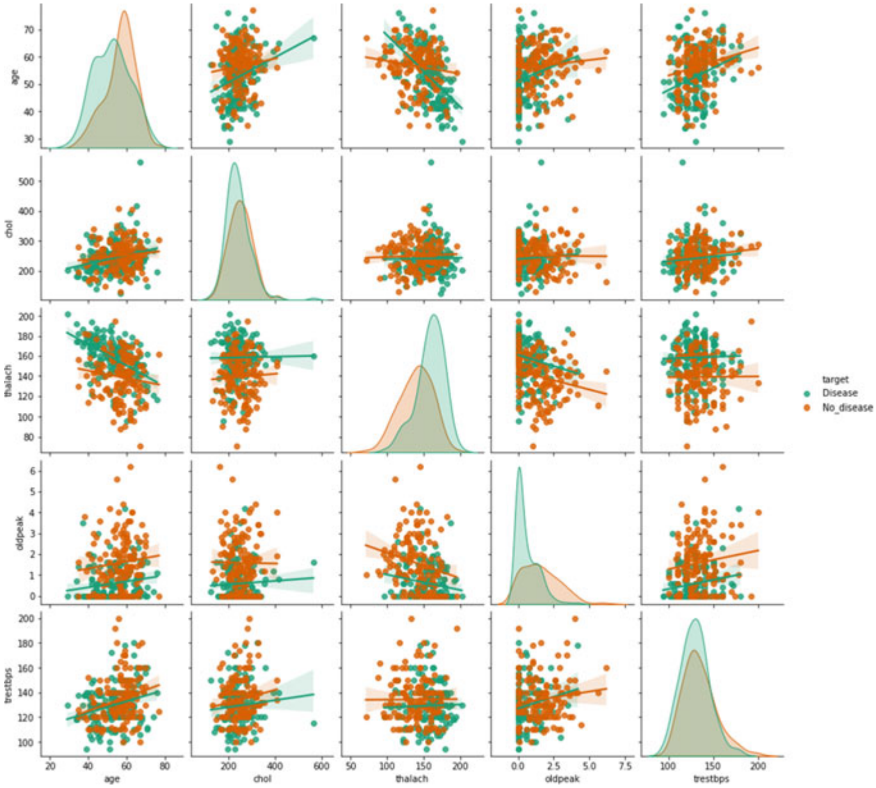

Fig. 6 Distribution of continuous variable across target variable

Outliers [10] are unexpected deviations of data points in dataset. Outliers usually deviate the final output data mining algorithm. Before performing any mining algorithm or machine learning algorithm, outliers must be removed or normalized. In most of the cases, the outliers are simply ignored. In the heart disease dataset, the resting heartbeat per second and old peak (distance between two consecutive ECG peaks) have more outlier values. Figure 8 gives us a visual representation of the outliers present in the dataset attributes, it is seen that before we proceed to any data mining or machine learning algorithms, these outliers must be administered properly.

4 Conclusion

This article provides a great insight on the UCI heart disease dataset, and the data points are explored using various visualization techniques called exploratory data analysis. In this article, we have used Google Colabs, a cloud-based ide, and the libraries like pandas, matplotlib are used to produce the charts and the graphs. The

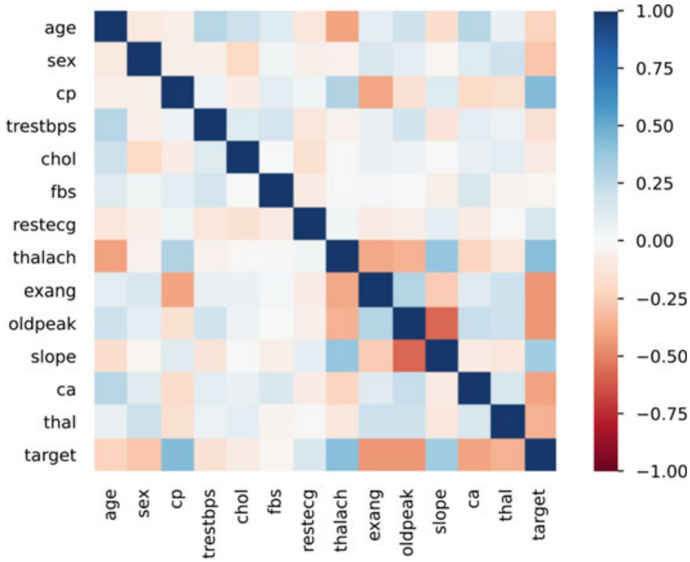

Fig. 7 Pearson's correlation among the data points

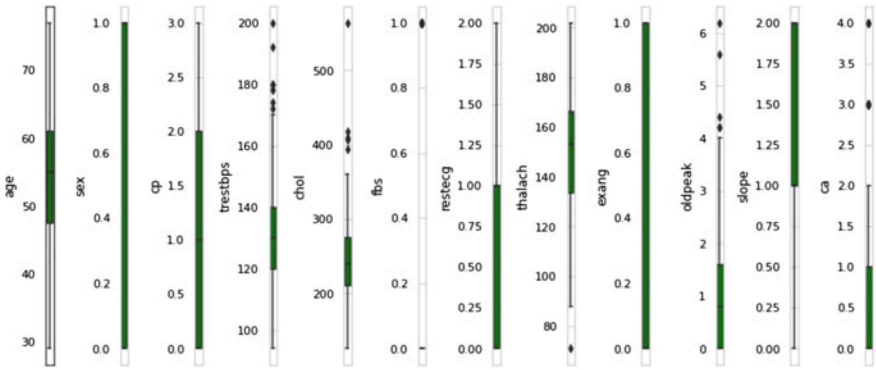

Fig. 8 Outliers in the dataset

correlation matrix, distributions of attributes with the target class are well studied in this article. However, this article projects only the existing data but not addressed any prediction of the disease. In our future work, we like to extend our work to use machine learning algorithms and data mining techniques to predict the heart disease.

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Violence Detection in Videos Using Deep Learning: A Survey

Gurmeet Kaur and Sarbjeet Singh

Abstract There is a significant need of intelligent surveillance systems to monitor people and recognize their violent behavior at public environments (like banks, hospitals, market centers, and railway stations, and so on). Therefore, violent activity recognition becomes an emerging topic among the researchers in the field of computer vision. Effective and successful approaches for identification of violence in videos are extremely needed for safety concerns. Over the past few years, several techniques based on handcrafted and deep learning features have been introduced for detection of these activities. This paper commences with common framework for violence recognition followed by review on different deep learning techniques and methods based on convolution neural network (CNN) and long short-term memory networks (LSTM) used for violence detection. Besides that, popular datasets and challenges of this topic are also discussed in this review. The findings of the research have been also discussed which may help to find future work in this domain.

Keywords Surveillance system · Violence detection · Deep learning · Computer vision

1 Introduction

Research on human activity recognition (HAR) with in computer vision has achieved crucial progress over recent decade. The most important and useful applications of HAR include surveillance [1], smart home, video analytics, healthcare systems, autopilots, and human–computer interaction. Nowadays, violence detection becomes an emerging and challenging research topic within great field of human activity recognition. This research topic switches between detection of violence and abnormal activity detection [2, 3], activities or actions such as fighting, beating, pushing,

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punching, kicking, stealing, snatching, and thieving are analyzed under violence detection.

Especially, violence detection receives significant heed in monitoring or surveillance systems for security of people in public places such as shopping malls, parks, market, hospitals and banks to monitor behavior of people [4, 5]. Traditional surveillance systems were completely human dependent. But due to rapid growth of global population and increasing amount of camera installation, those systems were not that much effective as large number of manpower and competent human attention required, keeping surveillance continuously [6]. This shortcoming of existed systems became necessity to develop automatic video surveillance system for intelligent supervision to minimize the human dependency [7]. In automatic surveillance systems, a network of computers process the input video continuously and efficiently scan the frames to identify any uncommon or abnormal activity [8], which they can describe to the controller for their attentiveness and to take appropriate action at time. Already, there are lot of researches have been conducted on automatic violence detection system for video surveillance. Still, detection of violence in videos is an exacting task [6], as recognition of human actions has great impact of changes in weather conditions, camera motion, occlusion and dynamic background, the person's body appearance, camera viewpoint, and style of dressing.

A significant number of works have been described in the literature related to this area. To detect the abnormal and suspicious actions in videos, various techniques and methods have been developed by researchers and scientists [9]. In these techniques, several approaches are presented to work with various input parameters. Some basic parameters or attributes of the video like acceleration, flow, time, motion [2, 10], appearance etc., are used by researchers with techniques based on machine learning and deep learning to achieve efficient accuracy and enhanced performance in violence detection. The primary goal of the paper is to explore deep learning techniques used for violence detection in videos.

The title role of automated surveillance system is to spot unusual activity and inform to supervision. Several researchers and scientist have proposed different approaches to detect violence in videos, but a common framework of violence detection (Fig. 1) follows some common steps which include: (1) collect the videos, (2) segment that video in clips or frames as requirement, (3) preprocess the database for missing and noisy values, (4) object detection in frames, (5) feature extraction using approach is done to find behavior of object, and (6) detect the violent and non-violent activity. Previous survey identified on this topic from year 2016 to 2020 is shown in Table 1 which provides the contribution from other research papers of review on violence detection. A survey on violence detection in surveillance videos was conducted to present various approaches used for violence recognition in surveillance video and to put insights on the important challenges to solve in this emerging field [6].

In 2017 [11], a review of applications of deep learning network approaches was presented which explain various convolution neural networks used for violence video classification. In 2017, survey on state-of-the-art was introduced to demonstrate suspicious and abnormal activity recognition from surveillance videos [3]. One year

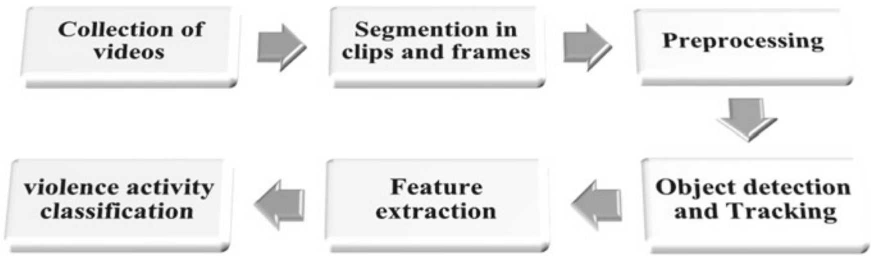

Fig. 1 Framework for violence detection

Table 1 Related literature survey summary

First author	Year	Title
Anuja Jana Naik	2016	"Violence Detection in Surveillance Video-A survey" [6]
Rajesh Kumar Tripathi	2017	"Suspicious Human Activity Recognition: A Review" [3]
Ashikin Ali	2017	"A Review on Violence Video Classification Using Convolution Neural Networks" [11]
Mrs. Savitha C	2018	"Motion Detection In Video Surveillance: A systematic Survey" [10]
Amira Ben Mabrouk	2018	"Abnormal behavior recognition for intelligent video surveillance systems: A review" [8]
Muhammad Ramzan	2019	"A Review on State-of-the-Art Violence Detection Techniques" [2]
Kamal Kant Verma	2019	"A review of supervised and unsupervised machine learning techniques for suspicious behavior in intelligent surveillance system" [5]
Aayush jain	2020	"State-of-the-arts using ConvoNets" [4]

later [10], a survey is presented to discuss about the several methods to identifying objects, motion patterns, and behavior evaluation for anomaly detection. Feature extraction and description for behavior representation techniques were studied in same year for detection of unusual behavior [8]. In 2019, reviews on various progressive and modern techniques of violence detection were discussed. Author subdivided the detection methods into three groups based on traditional machine learning, support vector machine (SVM), and deep learning [3]. In the same year, authors evaluate existing research to discuss machine-learning-based supervised and unsupervised techniques which used SVM, HMM, and ANN classifiers for doubtful and abnormal behavior detection in intelligent surveillance system [5]. Last year review on various CNN-based advanced techniques for violence detection was published [4], in which authors discussed variants of CNN, their uses, and datasets which play a key role in the detection process.

As explained on above, each study explained different approaches used for violence detection. But introduction of various new deep-learning-based frameworks has recently added some new hypothesis and procedures which are important for researchers who are interested to conduct new research in this area. This study summarizes previous research, methods of feature engineering, models to detect violence activity, and draw conclusion of violence/anomaly detection research.

- A comprehensive review of violence activity detection in videos
- Explain various deep learning approaches implemented for violence detection.
- Discuss the publically available datasets that are extensively used.
- Discuss challenges, gaps, and future directions for violence detection.

2 Violence Detection Techniques

As activity recognition becomes hot topic with in computer vision. Violence detection is also a part of activity recognition. Thus, violence detection is also proved as emerging computer vision problem by number of researches in this field [12]. Presently, several methods and techniques have been proposed to recognize different human activity including violence detection and abnormal activities in order to provide intelligent surveillance systems to reduce the crime rates for public safety [2]. On the basis of feature extraction and classification, violence detection technique can be divided into two ways: tradition techniques and deep learning techniques.

Traditional violence detection methods utilize handcrafted features, i.e., features are obtained manually, and a leaning model learns pattern for violent and abnormal behavior recognition. Some spatiotemporal features such as STIPs [12] and MoSIFT [13], have got great popularity. Similarly, there are other descriptors to describe violent scenes like MoWLD [14] which are based on appearance and motion information, violent flow (ViF) [15], is based on variations of optical flow magnitudes between subsequent video frames. Further, SVM is adopted to classify the violent scenes.

However, in deep learning techniques, features extraction and classification are done automatically by end-to-end deep learning methods. In this paper, various deep learning techniques are explained in following section.

2.1 Deep-Learning-Based Violence Detection Techniques

After 2014, researchers started to implement deep learning approaches in human activity recognition. In this section, several previously proposed frameworks are discussed that used deep learning algorithms for violence detection. Table 2 displays the summary of methods which used CNN, LSTM base classification-based feature extraction and classification. Deep learning is based on neural networks. Now, the deep learning methods of violence detection are explained in detail individually.

In order to develop technique for automatic analysis of surveillance videos, researchers used combination of CNN and LSTM [16–19]. In [16], model used an

Table 2 Summary of deep learning techniques for violence detection

Method	Feature extractor	Classifier	Dataset	Accuracy (%)	Year
Using convolutional long short-term memory [16]	CNN ConvLSTM	FCN	Hockey fight	97.1	2017
			Movies	100	
			Violent flow	94.57	
Spatial–temporal cues using deep learning [17]	P3D LSTM	LSTM	Hockey fight	95.97	2018
			Violent flow	97.2	
Using CNN and LSTM [19]	VGG-16 LSTM	CNN LSTM	Hockey fight	100	2019
			Movies	96.33	
			Violent flow	85.71	
Using bidirectional LSTM [20]	HOG	BiLSTM	Violent interaction	94.5	2019
Localization-guided fight action detection [7]	C3D	C3D	Hockey fight	99.8	2019
			Movies	98.6	
			UCF101	96.2	
			FADS	93.3	
Using ScatterNet in drone surveillance [24]	FPN SHDL	CNN	AVI	87.5	2019
BiLSTM with attention layer [18]	Fight CNN LSTM	Attention Layer	Hockey fight	97.7	2019
			Peliculas	100	
			Self-collected	71.1	
Violence detection using deep learning [21]	CNN LSTM	FCN	Hockey fight	92	2020
			RLVS	94.5	
Using pre-trained modules with different deep learning approaches [23]	VGG16 VGG19 ResNet50	CNN LSTM	Self-collected	97.6	2020
Multi-frame feature-fusion-based model [22]	VGG 16 LSTM	CNN LSTM	Hockey fight	98.8	2020
			Movies	99.1	
			BEHAVE	97.1	
Campus violence detection based on artificial intelligent interpretation [25]	C3D	C3D	Campus violence	92.5	2021
Violent activity detection using mask RCNN deep learning model [26]	Mask RCNN LSTM	LSTM	Weizmann	73.1	2021
			KTH	93.4	
			Self	86.5	

AlexNet pre-trained CNN for feature extraction at frame level along with convLSTM to feature accumulation in the temporal domain. Then, a fully connected layers series applied for classification. In [17], a deep learning approach using multi-feature fusion is proposed for violent video recognition. It used Pseudo-3d (P3D) convolution network to extract the static features from frame followed by temporal features extracted by LSTM. Then, late fusion method is owned to merge the static and temporal features to acquire video classification labels. In 2019, Abdali et al. in their work [18] presented a framework consists of VGG- 16 pre-trained CNN for spatial feature extraction LSTM as temporal relation learning method. They trained their model on hockey fight dataset and then applied on combination of three datasets with speed of 131 frames/s model. In the same year, the authors of [19] proposed a model in which the attention layer combined with LSTM. In this model, fight CNN for feature extraction and bidirectional LSTM combined with self-attention layer is applied for classification of fight scenes.

In [20], authors introduced a system that can detect the actions in real-time and alert the security administration to overcome the violence incidents. HOG function is used as a feature extractor from the video frames which are used to train bidirectional LSTM network on violent interaction dataset (VID), to recognize violent scenes from the videos. A novel localization-guided framework [7] has been proposed to regulate active regions, and to combine adjacent humans into groups, and a two-stream 3D convolution network is used with a novel motion acceleration representation on the temporal stream to detect fight scenes. Moaaz et al. [21] have given a pure deep neural network to detect the violent scenes in the surveillance camera videos. First of all, selection of frames from video clip is performed. In second step, extraction of spatial features is conducted through conventional build convolution neural and LSTM network are used for extraction of temporal features. Then, these features are passed to a fully connected (FC) neural network for classification the video as violent or non-violent action video clip.

In [22], VGG-16 CNN is used for multi-level features extraction from two consecutive frames and combined them using feature fusion method. Then, wide-dense residual block is employed to get spatial features from the two input frames collectively and passed to LSTM units for collecting temporal information. Sumon et al. [23] contributed to this field by proposing a noble technique to identify the features from pre-trained models to detect violence in videos. Three variants of ImageNet model named VGG16, VGG19, and ResNet50 were used to draw out features from the videos frames.

The real-time drone surveillance system (DSS) framework has been proposed [24], which can spot one or more individuals involved in aggressive activities from aerial images. This framework used feature pyramid network (FPN) to detect humans. Then ScatterNet Hybrid (SHDL) network is employed for pose estimation of the humans for recognition of violent activity. In [25], to contribute in this area, use of image features and acoustic features have been introduced to detect campus violence. The C3D (Convolutional 3D) neural network is used for extraction of features and classification for recognition of violence. Another deep neural network model by Naik et al. [26] have been designed to find single person's violent activities, for instance punching, kicking. Mask region-based CNN has been used to get human key-joints and mask and LSTM to record the information related temporal domain of the data and classification of activities.

Based on the literature review carried out in the direction of violence detection, it is clear that most of the researchers used hockey fight, movies, and violent flow datasets. Technique proposed by Abdali et al. performed 100% on hockey fight dataset among others; however, it is less effective for violent flow dataset due to crowd in scenes, whereas ConvLSTM model given by Xu et al. achieved highest accuracy for movies dataset. P3D-LSTM multi-feature approach helped in achieving highest accuracy for violent flow dataset with late fusion. The mask RCNN approach achieved good result on three datasets for single person violence activity detection which is not applicable for multi-person. SHDL network model for drone surveillance systems helped to produce significant results for drone videos. CNN LSTM model based on multi-frame feature fusion achieved comparable result among other state-of-the-art methods. A two-stream 3D CNN approach based on localized active regions provided excellent results for fight action among other approaches in this area.

3 Research Challenges and Future Directions

In recent years, there has been much work done on the automatic violence activity recognition, but it is still a difficult task to understand and recognize human behavior automatically. A few difficulties identified in this field during this survey are as follow:

- Changes illumination and lightning
- Problems occur due to camera movement, camera resolution real-world dynamics and multiple camera view
- Dealing with occlusion and overlapping of objects
- Very less models to specific device like unmanned aerial vehicle
- Some other issues are normal and violent behavior patterns, lack of labeled data, complex human behavior, noise, and variation in same activity.

To the best of my knowledge, there is no existing method which can solve all these issues. Existing techniques provide solutions to these problems separately. There is need to develop such method which can handle all above these issue in efficient and effective way.

4 Conclusion

An automated detection of human activities and behavior analysis has become emerging research area in computer vision. Due to increasing growth of surveillance cameras, it lead to the demand of automatic and intelligent systems that can detect any violent or suspicious activity. To address this problem, many researchers have proposed various techniques for detection of violence in videos for the safety and security purpose. In this paper, we have presented a survey of different deep-learning-based techniques used to detect violent scenes in videos.

As we know, many studies have been proposed for this task, but still, there is requirement of more robust and efficient detection method that can achieve more accurate performance by handling occlusion, illumination variation, camera movement, multi-camera view, and also can deal with pose variation of human body and noisy data. For this purpose, researcher can use advance deep learning models with large amount real-world data to perform automatic feature engineering and improve current results.

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Comparative Study on the NOMA Based Optimum Power Allocation Using DLS Algorithm with DNN

M. Ravi and Yaka Bulo

Abstract High throughput, successive interference cancelation, higher cell edge spectrum efficiency, and low latency are the main requirements for future generation technology. Non-orthogonal multiple access (NOMA) technology offers a scale of the multiple numbers of users (multiplexing), extremely high spectral efficiency, greater improvements in user pairing and more than one user shares single resource block; hence, it is a superior technology than orthogonal multiple access schemes (OMA). NOMA-based optimum power allocation, first by using direct techniques and then using (depth limited search) DLS algorithm with (deep neural network) DNN is studied in this research paper. These techniques are first applied to two users and then extended to multi-user communications. Distributing optimum power to the weaker user (who are not getting proper signal strength) is a challenging task and to add to it successive interference cancelation (SIC) also brings difficulty in the proper distribution of source power from a base station. In this work, we try to solve this problem with the help of DLS algorithm with DNN, where optimum power is allocated to the weaker user and minimum power is allocated to the stronger user. Here, the DLS algorithm-based DNN-NOMA technology assists to decode the user without interference, with more accuracy in real-time. DLS algorithm provides greater potential in DNN-NOMA technology by the successful application of successive interference cancelation (SIC). A DLS predicts the position of user equipment and provides the optimum power allocation. In our proposed work, performance is improved compared to the previous existing conventional multi-user case. In the case of multi-user communication, optimum power allocation capacity to the weaker user is very less compared to the two-user case optimum power allocation NOMA. Through the application of the DLS algorithm and DNN, optimum power allocation capacity for the weaker user is improved.

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Keywords NOMA · DLS algorithm · DNN · Successive interference cancelation (SIC) · Optimum power allocations

1 Introduction

In recent trends, non-orthogonal multiple access (NOMA) has become an efficient technique than orthogonal multiple access. It pairs multiple users simultaneously without inter-user interference, and optimum power allocation also has reached to desired level [1, 2]. The Internet for everything demands high data rate and is necessary for virtual quality [3]. In the fourth generation, orthogonal multiple access and orthogonal frequency division multiple access (OFDM) were widely used. However, with the rapidly increasing demand and huge usage, the spectrum efficiency is not sufficient and frame synchronization required for orthogonal multiple access leads to the need of NOMA [4]. By the non-orthogonal multiple access technique, multiple users share the same time–frequency resources, and it becomes a potential technique for achieving higher spectral efficiency in fifth generation and technology beyond [5]. NOMA prioritizes more attention to power allocation from the transmitter to relative receivers, then checks the probability of interference during superimposing at the transmitter, and finally, successive interference cancelation occurs at the receivers [6]. Hence, an optimum power allocation is required between transmitter and receiver [7]. However, SIC may not work perfectly because of the less power in the cell-edge user; hence, the weak user might decode the wrong signal, and the separation of the users' signal may not be perfect [8]. Machine learning is used in various applications in telecommunications, such as physical layer security, network management, self-organization, and self-healing. The author in [9] proposed ideas that support the radio in decision-making and adaptive network, so that diverse requirements of a next-generation wireless network can be satisfied. Deep learning is applied to machine learning applications because deep learning scales well with the amount of data and model complexity [10, 11]. Few questions pertaining to the implementation of machine learning into the wireless communication have been framed as follows: Why a deep neural network is an indispensable tool for the operation and design of wireless communication techniques? How artificial neural network architecture integrates with future wireless communication networks? Nowadays, the deep neural network has become an indispensable tool for providing features like ultra-reliable low latency (latency in terms of 1 ms), 99.9% reliability, one million connections per square kilometer area, more than 50 MBPS data rate, and vehicle communication with more accuracy [12]. The main aim of artificial neural networks for machine learning functionalities is to integrate with the architecture of wireless communications [13].

In this paper, we try to implement machine learning, particularly DLS algorithm for optimum power allocation in the NOMA technology for increasing the performance of system. We implement optimum power allocation to a weak user by using direct optimization and DLS algorithm optimization by considering the two-user and multi-user scenario. And then, comparison is done for both the optimization techniques.

In multi-user, each user receives the same superimposed signal from the base station, but their signal strength is different. Weaker users are strengthened by applying maximum power before applying successive interference cancelation. In the case of multi-user, we get more than one weaker user because of which successive interference cancelation technique fails. Also, power allocation to the weaker user requires more SNR. Therefore, we apply a DLS algorithm with DNN to the multi-user case to achieve the maximum capacity.

The remaining section of the paper is organized as follows: Section 2 discusses the conventional NOMA system for optimum power allocation using SIC, then with the assistance of a deep neural network. Section 3 describes the optimum power allocation in DNN-NOMA system using DLS Algorithm. Section 4 discusses the simulation results. Section 5 concludes this study with ideas for future work.

2 Optimum Power Allocation in Conventional NOMA System

In the case of two-user NOMA system, one user is near to the base station and the other one farther from the base station (cell-edge user). Both the users receive the superimposed signal from the base station; however, their signal strengths are different. Before applying successive interference cancelation, we need to apply more power to the weaker signal user, so that both the users decode signal successfully. In the case of multi-user NOMA, same approach is followed as that of the two user cases. In multi-user, each user receives the same superimposed signal from the base station, but their signal strength is different. Weaker users are strengthened by applying maximum power before applying successive interference cancelation. In the case of multi-user, we get more than one weaker user because of which successive interference cancelation technique fails. Also, power allocation to the weaker user requires more SNR. Therefore, we apply a DLS algorithm with DNN to the multi-user case, and the same will be presented in Sect. 3.

In optimum power allocation conventional NOMA system, we consider downlink NOMA system having ‘i’ users, one base station, which contains ‘i’ antennas (group of antennas); each antenna contains data regarding individual users. In this assumption, user ‘i’ is close to the base station, user ‘$i - 1$’ next closest to the base station, such that user1 is farthest from the base station. Figure 1 depicts such an arrangement, while Fig. 4 depicts deep learning in case of two user, $i = 2$.

At transmitter side, the base station creates superposed signals, which contain data of individual users. This superposed signal is transmitted to all users. All the receivers receive the same signals, but the signal strength is different for individual users based on distance from the base station. SIC is first performed by the closer

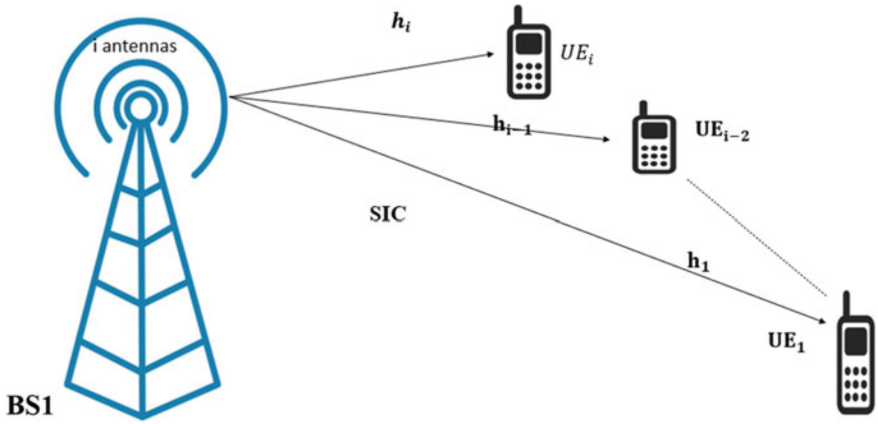

Fig. 1 Multi-user network for conventional NOMA optimum power allocation

user; it decodes the farther signal, then iterates 'i' times, finally decodes its own signal which others consider as noise.

User 'i' is close to a base station, and user 1 far from a base station and accordingly, Base station superposed signal is given as

$$X_s = \sum_{l=1}^{i} \sqrt{a_l \rho_s}.x_l \tag{1}$$

Here, x_l is the data of individual users, ρ_s is the signal-to-noise ratio of all users, and a_l is the power allocation coefficient of individual users. In NOMA, signal-to-noise ratio is $\rho_s = \frac{p_t}{\sigma^2}$, $p_t$is the total transmitted power, and σ^2 is the random variance of adaptive white Gaussian noise channel.

The received signal at the ith user is

$$y_i = h_i \cdot X_s + n_i \tag{2}$$

$$y_i = h_i \cdot \sum_{l=1}^{i} \sqrt{a_l \rho_s x_l} + n_i \tag{3}$$

Here, h_i is the relay fading channel coefficient for the ith user, and n_i is the noise power signals $(0, \sigma^2)$.

The total power allocation coefficient should be one

$$a_1 + a_2 + a_3 + \cdots a_n = 1 \tag{4}$$

The achievable data rate for user 1 is (From Shannon Harley law data rate)

$$R_1 = w \cdot \log_2\left(1 + \frac{a_1 \rho_s \beta_1}{\sum_{l=1}^{i} a_l \rho_s \beta_1 + 1}\right) \tag{5}$$

Here, w is the bandwidth of the entire signal. The ith user decodes its signal; hence, there is no other noise signal for interference cancelations.

Then, the data rate for the ith user is

$$R_i = w \cdot \log_2(1 + a_i \rho_s \beta_1) \tag{6}$$

Then, sum-rate of NOMA is

$$r_{x_1}^{u_1} + \cdots + r_{x_i}^{u_i} \tag{7}$$

$$r_{x_1}^{u_1} + \cdots + r_{x_i}^{u_i} \log_2(1 + a_i \rho_s \beta_i) + \cdots + \log_2\left(1 + \frac{a_1 \rho_s \beta_1}{\sum_{l=1}^{i} a_i \rho_s \beta_1 + 1}\right) \tag{8}$$

Calculation of a_1 minimum is difficult when number of users increase. Therefore, for simplicity, we take a_1 minimum as in Eq. (10). For optimum power allocation, any power allocation coefficient has to be maximized (maximum power allocated to the weaker user) which is considered as

$$a_{1\,\max} \geq \frac{R_1(1 + \rho_s \beta_1) - 1}{\rho_s \beta_1} \tag{9}$$

$$a_{1\,\min} < \frac{R_i}{\rho_s \beta_i} \tag{10}$$

With this value of power allocation coefficient, optimum power is allocated to the weaker user and detects the signal without interference.

Results in Figs. 2 and 3 show the plot between capacity and signal–noise ratio for random power allocation NOMA technology and optimum power allocation using NOMA technology. Figure 2 is plotted for two user case, and it can be observed that the capacity of the weak user increases as the optimum power is allocated to it. Figure 3 is for multiple user case, and it is evident from Fig. 3 that when number of users increases, then the data rate is declined, and power allocation to the weaker user requires more signal-to-noise (SNR); hence, consumption of power increases rapidly. In Fig. 2, capacity is very high in compared to Fig. 3 because user utilization is very less (number of users is two) in Fig. 2.

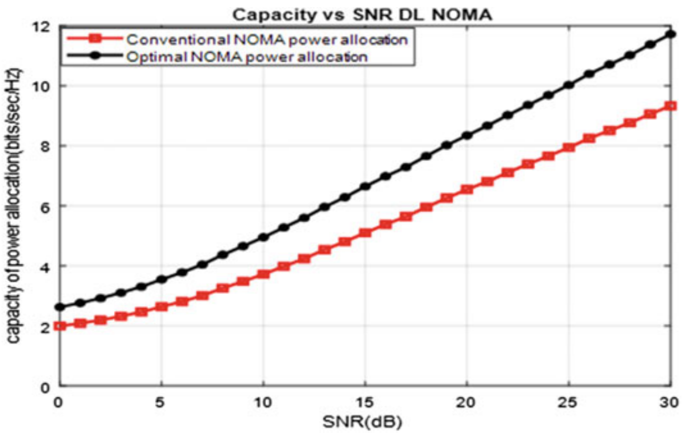

Fig. 2 Capacity versus SNR (dB) in two user cases. SNR range from 0 to 30 (dB)

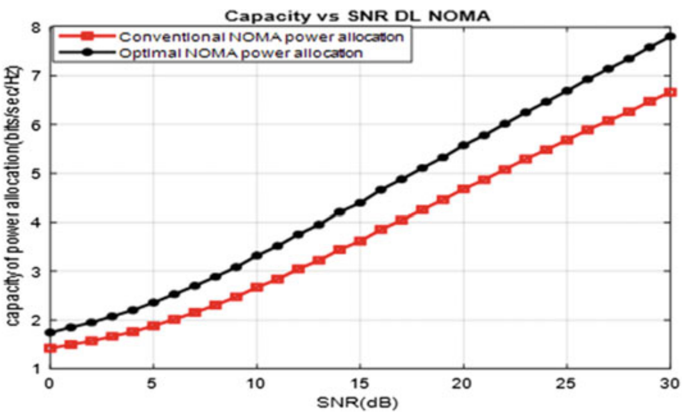

Fig. 3 Capacity versus SNR (dB) in multiple user cases. SNR range from 0 to 30 dB

3 Optimum Power Allocation Using DLS Algorithm with DNN

In this section, we will be discussing optimum power allocation to the cell-edge user (weak user) in DNN-NOMA technology using DLS algorithm in multiple user scenario. At transmitter side, the base station creates superposed signals, which contain data of individual users. This superposed signal is transmitted to all users. All the receivers receive the same signals, but the signal strength is different for individual users based on distance from the base station. SIC is first performed by the closer user; it decodes the farther signal, then iterates '*i*' times, and finally, decodes its own signal which others consider as noise.

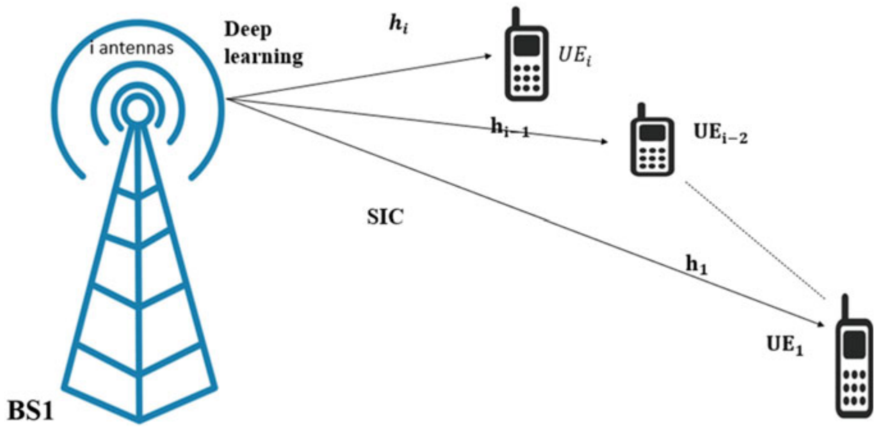

Fig. 4 Multi-user DNN-NOMA network for optimum power allocation with DLS algorithm

In case of multi-user scenario, we get more than one weaker user because of which successive interference cancelation technique fails. Also, power allocation to the weaker user requires more SNR. Therefore, we apply a DLS algorithm with DNN to the multi-user case. At the base station, we consider the 'i' number of antennas; these are input layers to a deep neural network. In the same way at the output, we consider 'i' users; these 'i' users become the output layer of the deep neural network. The base station transmits a superimposed signal to the deep neural network layer, through the hidden layer; the superimposed signal reaches multiple users. Each user receives the same superimposed signal and also might have the same signal strength. So, power allocation to the weaker users becomes simpler. Successive interference cancelation can decode the users successfully and without interference (Fig. 4).

In this section, we will be discussing optimum power allocation using machine learning. As per authors in [9, 10, 12], an easy solution for telecommunication problems is machine learning. It can help with quick operation, give accurate results, and lower error rate.

Figure 5 depicts the information (source) passing through multiple -users to the nearest BS, the BS to the channel, the channel to the destination closest BS, and at the closest BS. Deep learning neural networks are being used to transfer information to multiple users.

Here, we look at long-term mean power (p_{avg}), which is used to control power, maintain a constant minimum average value and, also, total sum power rate.

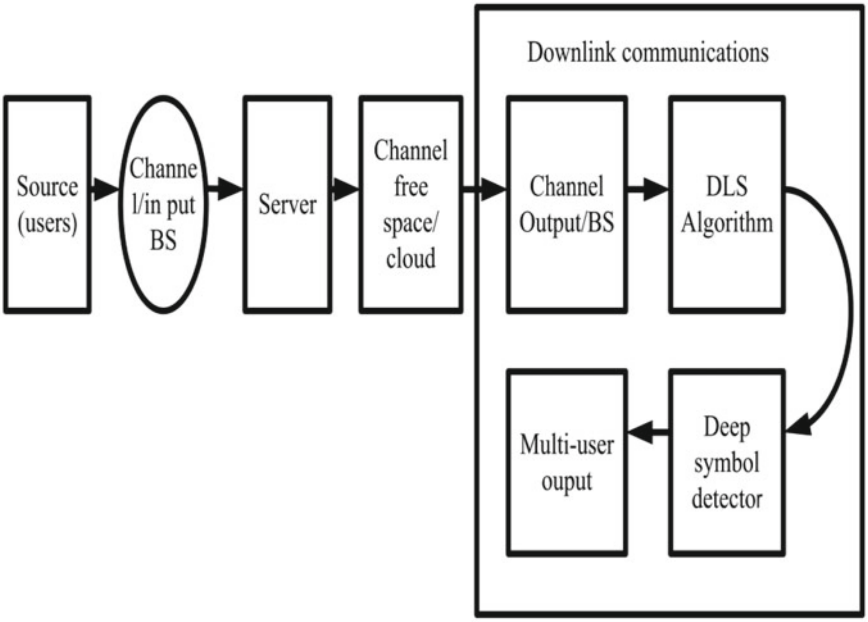

Fig. 5 End to end communications

We can derive this from Eq. (8), which is written as

$$\log_2(1 + a_i\rho_s\beta_i) + \cdots + \log_2\left(1 + \frac{a_1\rho_s\beta_1}{\sum_{l=1}^{i} a_i\rho_s\beta_1 + 1}\right)\_R_{\text{avg}} \tag{11}$$

According to (Sun et al. 2019) [13] sum of the power is greater than the mean power

$$p_i(t)\max \geq \left(\frac{\text{noise power}}{\text{signal power}}\right) + \frac{1}{i}\sum_{l=1}^{i} a_l\rho_s\beta_l \tag{12}$$

$$p_i(t)\max > \tfrac{1}{i}\sum_{l=1}^{i-1} a_l\rho_s\beta_l \tag{13}$$

Here, $p_i(t)$ max represents the maximum power transfer to the ith user, such that the signal is decoded with the least average power to user1 without interference. This technique was implemented using the DLS algorithm.

Developing a DLS algorithm for deep learning operations in NOMA optimal power allocation [14]. The operation of the DLS algorithm, as depicted in Fig. 6.

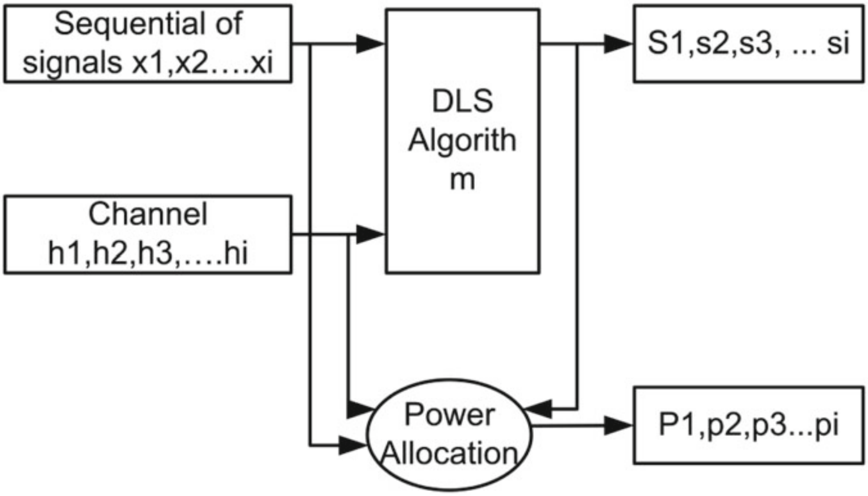

Fig. 6 DLS algorithm for optimum power allocation

DLS algorithm for deep learning optimum power allocation

Inputs
Batch size, $p_{avg,[X_1,X_2,X_3,......X_i]}$, epoch, bandwidth(w), $p_i(t)\max$, learning rate
// optimum power allocate to the weaker user
output: power allocations
$[p_1, p_2, p_{3,..........}p_i]$
1. Assign batch size b, to train both input and output
2. Structure of deep neural network
3 DLS algorithm
4. Optimum power allocation procedure
5. Assign 'l' from 1 to 'i' and perform the iteration
6. Generate the action: generate outputs $\hat{X}_1, \hat{X}_2, , ... \hat{X}_i$
return $X_1, X_2, X_3, ...X_i$ input
6. Power allocate to all the resource
7. Return $[p_1, p_2, p_{3,..........}p_i]$// optimum power allocation
End

Advantage of DLS algorithm:

From the DLS algorithm, the optimum algorithm is Adam's algorithm to the following benefits.

1. Direct way to implement
2. Less amount of memory requirement
3. Computationally efficient

4. Fixed diagonals re-scale of the gradient
5. Approximately non-stationary object
6. Hyper-parameters have intuitive iteration and very little tuning is required.

In the dataset (http://data.ieeemlc.org/dst/02/multi_cell.zip), they employed multi-user data transmission and reception. There are four input data transmission matrixes, each with a size of 40 × 33,000, 105,600,000 bytes, and double class. There are also 25 output data transmission matrixes, each with a size of 5 × 330,000, 13,200,000 bytes, and a class of doubles. Finally, they mentioned the maximum power matrix, which is 1 × 1, 8 bytes in size, and has a double class.

Operation of Deep Neural Network

From Fig. 7, input values are assigned from the base station transmitter; the batch size is decided on the number of input samples, neurons in each hidden layer, dense of the hidden layer as the input [14]. Our main motive is to transfer the 'i' users (multiple users) through the hidden layer to the output layer. Let us consider 'i' users as a function of $f_i(x_i)$, which compose input, multiple hidden layers, and output layers. Hence, the operation is given by [15, 16].

$$f_i(x_i) = e_{i,n_i}(w_{i,n_i} \ldots e_{i,1})(w_{i,1}x_i + b_{i,1}) \ldots (b_{i,n_i}) \tag{14}$$

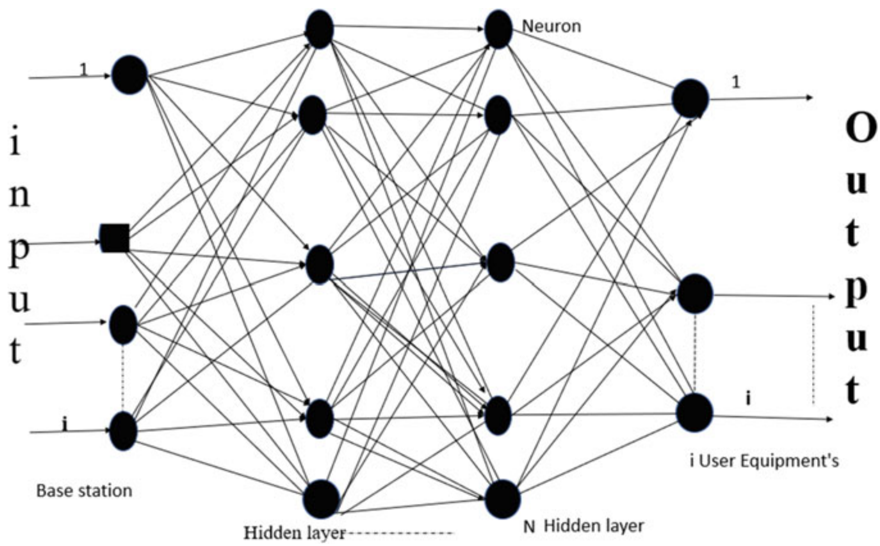

Fig. 7 Deep neural network with DLS algorithm for optimum power allocation. Batch size = 50, epochs = 50, learning rates lr = 0.01, 0.001, 0.001, 0.0001, and 0.00001. No. of layer = 7, one input, one output, and five hidden layers. Multi-cell dataset adapted from the GITHUB (http://data.ieeemlc.org/dst/02/multi_cell.zip)

Here, n_i defines the number of layers, e_{i,n_i}, w_{i,n_i}, b_{i,n_i} denotes activation function, weight matrix, biases vector in mth layers, respectively, where $m = 1\ldots$ 'i,' it is an input of the ith user of signal x_i. To find the loss from layer to layer, we need lose function. When the number of layers increases, then the probability of signal to interference noise ratio is minimized. Hence, optimum power is transferred to the weaker user.

The loss function of a deep neural network is the difference between predicted valve to actual value [15, 17].

$$L(\theta, v_i) = \sum_{i=1}^{I} \frac{1}{X_I} \sum_{x_i = x_I} ((X_s - R_i\{X_s\}, \theta, v_i)^2) \tag{15}$$

Here, θ, v_i are the weights and biases function of the precoder, X_s is the number of input samples, decoding signal at the ith user is $(R_i\{X_s\}, \theta, v_i)$. To minimize loss function by gradient descent method, that is a change in θ, v_i to $\theta - \beta\delta L_\theta\{\theta, v_i\}$, $v_I - \beta\delta L_{v_i}\{\theta, v_i\}$, respectively. Here, $\beta > 0$ for all value 'i,' the gradient of the θ, v_i are $\delta L_\theta\{\theta, v_i\}$, $\delta L_{v_i}\{\theta, v_i\}$, respectively. The source was taken from Kim (2016) [18, Chap. 6.5].

4 Result Analysis

In this training procedure, we chose number of cell indexes as [1–4], assigned sample size as given in Table 1. For iteration of the process, considered several epochs = 50, and also assigned a batch size = 50, Adam power allocations beeta_1 = 0.01 and beeta_2 = 0.999. Input to the learning rate changes from layer to layer, so learning rates = 0.01, 0.001, 0.0001, and 0.00001, respectively. For a change in weights and biases considered, the minimum, that is, delta_min = 0, and for validation split, considered the same for each learning rate validation_split = 0.03125, all activation functions are ReLU. We modified the GITHUBs's multi-cell dataset and fed it into the DNN using DLS algorithm.

Table 1 Input and output samples, params variation

Layer (type)	Output shape	Param#
Layer1 (Dense)	(None, 512)	20,992
Layer2 (Dense)	(None, 256)	131,328
Layer3 (Dense)	(None, 256)	65,792
Layer4 (Dense)	(None, 256)	65,792
Layer5 (Dense)	(None, 5)	1285
Layer7 (Dense)	(None, 5)	30

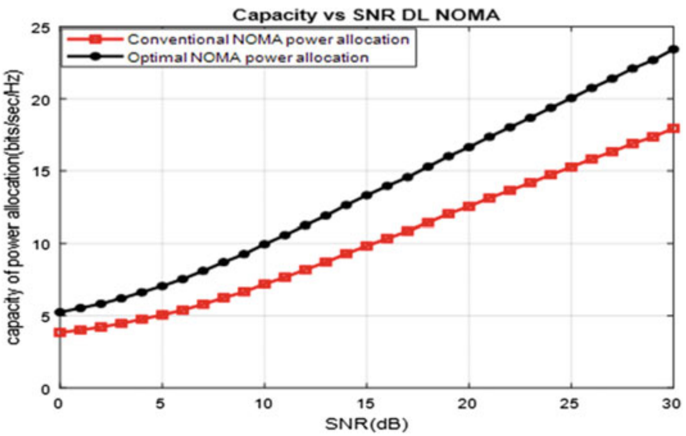

Fig. 8 Capacity versus SNR (dB), in multi-user case SNR range from 0 to 30 dB

Size input vector (40, 330,000) Size output vector (5, 330,000)

Model: "sequential_3" Total params: 285,219

Trainable params: 285,189 Non-trainable params: 30

In Figs. 3 and 8, comparison of power allocation capacity in terms of the SNR (dB) is done. From figures, we can confirm that power allocation capacity improves when DLS algorithm is used. In Fig. 3, power allocation capacity is less than in Fig. 8; hence, the variation of power allocation is observed clearly. In all the cases, SNR ranges from 0 to 30 dB.

5 Conclusion

In this paper, we achieved the optimum power allocation with the help of a DNN-NOMA using DLS algorithm, and also, we compared two users' optimum power allocation NOMA and multi-user optimum power allocation NOMA in the case of relay fading channel. From the two users and multi-user optimum power allocation NOMA, we observed how the optimum power reduced when increasing the number of users. In a multi-user case, optimum power allocation capacity is very less compared to the two-user case optimum power allocation NOMA. Through the overall comparison between the two user NOMA, multi-user NOMA, and DLS algorithm optimum power allocation DNN-NOMA, maximum power allocation is possible using DLS algorithm in DNN-NOMA. More investment in this article to completely eliminate the SIC problem by using Deep-NOMA with LSTM/GRU layer and varying algorithms.

Appendix

For 'i' user's data rate is

$$\log_2(1 + a_i\rho_s\beta_i) + \cdots + \log_2\left(1 + \frac{a_1\rho_s\beta_1}{\sum_{l=1}^{i} a_i\rho_s\beta_1 + 1}\right) \tag{16}$$

If assume $i = 2$

$$\log_2(1 + a_i\rho_s\beta_i) + \cdots + \log_2\left(1 + \frac{a_1\rho_s\beta_1}{\sum_{l=1}^{i} a_i\rho_s\beta_1 + 1}\right) = \text{sum} \tag{17}$$

To find, function dependent values from the above function

$$\log_2\left(1 + \frac{a_1\rho_s\beta_1}{a_2\rho_s\beta_1 + 1}\right) \cdot (a_2\rho_s\beta_1 + 1) \tag{18}$$

The Sum of the power coefficient is one

$$a_2 = -a_1 + 1 \tag{19}$$

Substitute a_2 in Eq. (18)

$$\log_2\left(1 + \frac{a_1\rho_s\beta_1}{(-a_1 + 1)\rho_s\beta_1 + 1}\right) \cdot ((-a_1 + 1)\rho_s\beta_2 + 1) \tag{20}$$

$$\log_2(1 + \rho_s\beta_1).\frac{((-a_1 + 1)\rho_s\beta_2 + 1)}{((-a_1 + 1)\rho_s\beta_1 + 1)} \tag{21}$$

$1 + \rho_s\beta_1$ is constant

$$\frac{\frac{1}{a_1} + \frac{\rho_s\beta_2}{a_1} - \frac{\rho_s\beta_2}{1}}{\frac{1}{a_1} + \frac{\rho_s\beta_1}{a_1} - \frac{\rho_s\beta_1}{1}} \tag{22}$$

From Eq. (22), if, $a_1 = 0$ then function becomes invalid, so apply L—'Hospital's rule, to make function valid.

Apply partial derivation above and below.

$$\frac{\frac{1}{a_1^2} - \frac{\rho_s\beta_2}{a_1^2} - 0}{\frac{1}{a_1^2} - \frac{\rho_s\beta_1}{a_1^2} - 0} \tag{23}$$

$$\frac{1 - \rho_s\beta_2}{1 - \rho_s\beta_1} \tag{24}$$

To make the function maximum, consider β2 minimum and β1maximum.

To find, $a_1$max from the data rate function. Assume data rate is greater than or equal to R_1

$$\log_2(1 + r_{x_1}^{u_1}) \geq R_1 \tag{25}$$

$$1 + r_{x_1}^{u_1} \cong 2^{R_1} = \hat{R}_1 \tag{26}$$

From Eq. (17)

$$a_1\rho_s\beta_1 + \hat{R}_1 a_1\rho_s\beta_1 = \hat{R}_1(1 + a_1\rho_s\beta_1) \tag{27}$$

$$a_{1\,\max} \geq \frac{\hat{R}_1(1 + a_1\rho_s\beta_1)}{\beta_1\rho_s(1 + \hat{R}_1)} \tag{28}$$

Similarly, from the 'i' users

$$\log_2\left(1 + \frac{a_1\rho_s\beta_1}{\sum_{l=1}^{i-1} a_i\rho_s\beta_1 + 1}\right) \tag{29}$$

$$1 + r_{x_1}^{u_1} \cong 2^{R_1} = \hat{R}_1 \tag{30}$$

$$\frac{a_1\rho_s\beta_1}{\sum_{l=1}^{i-1} a_i\rho_s\beta_1 + 1} = R_1 - 1 = \hat{R}_1 \tag{31}$$

The Sum of the power coefficient is one, so

$$\sum_{l=2}^{i} a_l \cong 1 \tag{32}$$

$$\frac{a_1\rho_s\beta_1}{\rho_s\beta_1 + 1} = R_1 - 1 = \hat{R}_1 \tag{33}$$

1. From the Eq. (28) $a_{1\max}$ is

$$a_{1\,\max} \geq \frac{\hat{R}_1(\rho_s\beta_1 + 1) - 1}{\beta_1\rho_s} \tag{34}$$

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Part-of-Speech (POS) Tagging for the Nyishi Language

Joyir Siram, Koj Sambyo, and Achyuth Sarkar

Abstract Part of speech is the building block of any language, and to operate efficiently in any language, it is beneficial to know about the part of speech of that particular language. The prime purpose of this paper is to create resources to carry out part-of-speech tagging of the Nyishi language, which in turn, will create a proper structured data for the Nyishi language. Nyishi part-of-speech (POS) tagging is more difficult than its English equivalent because it needs to be solved together with the problem of word identification. For the Nyishi part of speech tagging, we have built a 36 item tag sets, and from Nyishi-to-English dictionary, we have collected more than 25,000 entries both manually and automatically. In this paper, we will explain how the dictionary creation and part of speech of Nyishi language is done. Therefore, we have designed a tag set first based on training the data which will then be used in the construction of an automatic POS tagger for Nyishi language. And there are many challenges like ambiguity, foreign words, orthography, etc., to overcome.

Keywords Parts of Speech · Nyishi language · POS tagger · Dictionary · Ambiguity · Orthography

1 Introduction

As every language follows its sequence of words in accordance to syntactic functions, and as learning of any language, we maintained the usage of part of speech in that particular fashion. POS tagging is the very first step in the development of any NLP application. Part-of-speech tagging is the procedure of marking up words and punctuation characters in a text with suited POS labels, and in this task, we assign the POS labels to work furnished in the text. Sequencing labeling of words is very important. Each word's tag is identified within a context using the previous word or tag combination. The problems faced in POS tagging of the words are many. Many words that occur in natural language texts are not listed in any catalog or dictionary. A

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large percentage of words also show ambiguity regarding lexical part. The challenge of our work on part of speech is to mark the proper tag set, as there are very little proper computational linguistic exist for the language.

The Nyishi [1] people are one of the major tribes inhabiting a large tract stretching from the eastern half of the Kameng to the Subansiri in the east of Arunachal Pradesh. The Nyishi language is a Sino-Tibetan language of the Tani branch spoken in eight districts of Arunachal Pradesh, and as per 2011 census of India, there are approximately three lakhs native speakers making them one of the predominant tribes of the state.

Although POS tag set of many languages are usable, a POS tagged data for Nyishi language was very few till we started creating one for the work introduced in this paper. As main part of our work, we have developed a tag set consisting 36 tags; using this tag set, we have manually and electronically tagged a corpus of about 25,000. Dictionary plays an important resource for any language. Interpreting with dictionary and exploiting it, we can create the tag set of the language. In this paper, in the next section, we discuss a previous work, Sect. 3 provides a brief relevant linguistic background, then in Sect. 4, we build tag set and dictionary, and last section is about the future work and conclusion to this work.

2 Previous Works

It is first of its own type, but there have been numerous related works on part of speech, and such data are used for executing many natural language processing (NLP) tasks. For English speakers, there is a wide variety of POS taggers usable, such as Brill tagger, Tree tagger, and CLAWS tagger. For many languages, the part of speech has been implemented, but there have been Indian languages also gradually started many new taggers such as Hindi, Manipuri, Mizo, and Assamese.

In a paper by Joshi et al. [2], they have implemented words tagging, training and testing of Hindi words, in which creation of tag sets is the primary element.

In 2015, in a paper by Govilkar and Bakal [3], they accessed Marathi language and work with rule base and created a Marathi tagger.

Singh and Bandyopadhyay [4] composed paper for Manipuri language, where they exploited all parts of speech of Manipuri language, and they produced a well working POS tagger.

In 2009, Rahman et al. [5] worked on part of speech for Assamese language, where they have used context-free grammar for the sentences, and using machine learning techniques, such taggers are developed based on rules.

3 The Nyishi Language

The Nyishi language [1, 6] at first may appear difficult to understand to the speaker because some sounds and concepts of grammar are different. In Nyishi language, the particles have an important function in the structuring of this language. Often, a number of them form a chain as show in Table 1.

The Nyishi language's phonological systems have adopted and accepted to use the roman script, but to protect the original pronounce of the Nyishi language, the sound value of each alphabet and cluster have monotone or single-value sound type. It is very difficult to spell the words exactly as all the phoneme of this language are in Roman script, and this is where the orthographic challenges arise. In Nyishi language [7], there are 28 alphabets—18 consonants, 7 vowels, 2 clusters, and 1 glottal—in the total orthography as shown in Table 2.

The central vowels of Nyishi language are '***E***' and '***I***'; these vowels are pronounced with the lips in position and the tongue drawn slightly back. The '***Ng***' cluster occurs both finally and initially. The '***Ny***' cluster is palatal '***n***' which is realized by pressing the front tongue lightly against the palate when articulating the '***n***' sound.

The Nyishi language does not have a proper grammatical structure. While the third person nouns are differentiated for gender, not all the third person pronouns are distinguished for gender in Nyishi. Both masculine and feminine genders are marked with some marker to distinguish them, but it should be noted that most of the nouns are disyllabic and most of the verbs in Nyishi are monosyllabic. And it also has its own cardinal numbers.

Table 1 Some chain forms of Nyishi language

Nyishi word	Meaning
Ka-to	Look (command)
Ka-nam	Look
Ka-tam-to	Show (command)
Ka-tam-num	Show
Ka-pa-pa	Find/found
Ka-pa-ma	Did not find
Ka-la-ju	Let us see

Table 2 The alphabets of the Nyishi language

	Alphabets
Consonants	B, C, D, F, G, H, J, K, L, M, N, P, R, S, T, X, Y, Z
Vowels	A, E, I, O, U, V, W
Cluster	Ng, Ny
Glottal	Q

Table 3 Dictionary format for Nyishi POS

English Nyishipos		
Compensate	Kwlyjinam	NN VB
Flight	ura jaajjaanam	NN (FW) VB
Globe	Gvdangamkaan nan	NN VB MD
Academic	Poorylexynambvrwq	NN NN ADJ
Account	Twngkxikanam	NN NN
Hunter	Nyorawkybo	NN VB
Parcel	Puucwtvljilwqnam	NN IN VB
This is cobra snake	si taagintvbb go	JJ NN NN MD
This cobra snake is very big	soqtaagintvbb si sotv pa	JJ NN NN MD JJ MD
This is tiara	si dumpin hv	JJ NN MD
This tiara is worn by the women	soqdum is nyemgvnam hv	JJ NN MD NN VV MD
This is a house	si naam hv	JJ NN MD
This house is long	soq naam si naamsoo pa	JJ NN MD JJ MD

We have found that many new words were included in the Nyishi dictionaries which were not practiced in olden days. Finding the part of speech for such type of word is also challenge. Few examples are shown in Table 3.

4 Tag Set

The most important thing to start up POS tagging is the tag set. A tag set contains the list of all tags that are used to represent the grammatical information about a particular language. For POS of a given sentence, we have expended the tag set for Nyishi language. For example, CMN can used to represent common Noun, ADV for adverb, CJN for conjunction, and so on. Each language has different pattern of having the tag sets. Table 4 shown can be utilized for the part of speech (POS) of Nyishi language.

5 Building Dictionary for the Nyishi Language

We used many Nyishi dictionaries that are obtainable both in printed and electronic form. We created a Nyishi-to-English dictionary using basic rules as required. We are building the dictionary because it is prerequisite for machine learning system for the Nyishi–English language pair. The dictionary was created including the following data in column wise (i) English word, (ii) meaning of that word in Nyishi language, and (iii) POS tag for each translated Nyishi words.

Table 4 Nyishi language tag set and description about the detailed part of speech

Sl. No.	Type	Subtype	Tags	Examples
(1)	Noun	Noun	N	name (vmin), place (gvda), thing (dvrab),
(2)		Common noun	CMN	bird (patv), animal (svdin)
(3)		Proper noun	PPN	kamle pobu (Kamle River), abotani (ancestor name), namlo (praying hall)
(4)	Pronoun	Personal pronoun	PRP	i (ngo),you (no), (mv) (he/she)
(5)		Possessive pronoun	PSP	our (ngul),your (nul)
(6)		Objective pronoun	OP	me (ngog),him (mwam)
(7)		Demonstrative pronoun	DMP	hoqtulu (these)
(8)		Interrogative pronoun	ITP	who (hiyv), whom (hiyam)
(9)		Indefinite pronoun	IDP	some (meeg), few (michago)
(10)		Reflexive pronoun	RFP	myself (ngoqgv), themselves (bulv)
(11)		Distributive pronoun	DSP	each (ak), everyone (nyivxiv)
(12)	Verb	Verb	V	love (aby), family (imiqdvpar)
(13)		Action verb	AV	cry (khabnam), laugh (nyirnam)
(14)		Linking verb/helping verb	LV	do (nyit), must (hoggubnyijaqkam), could (hvbnyiyin dvi)
(15)	Adverb	Adverb	ADV	very (vi), then (hvbnyilokam;)
(16)		Adverb of time	ADT	Afterward (kokso) tomorrow (aro)
(17)		Adverb of frequency	ADF	always (lwxiam), sometime (mood golo)
(18)		Adverb of manner	ADM	slowly (nyinyiaqb), quickly(nyebiab), frankly (mwwsmwwpeq)
(19)		Adverb of place	ADP	above (odum), far (aado)

(continued)

Table 4 (continued)

Sl. No.	Type	Subtype	Tags	Examples
(20)	Adjective	Adjective	ADJ	safe (boshaaidoomanam.), enough (jotnam)
(21)		Adjectives of quality	ADQ	brave (haakamnam) beautiful (kangam)
(22)		Adjective of quantity	ADQ1	any (ak) little (anyoko)
(23)		Demonstrative adjective	DAJ	this (si), that (tv)
(24)		Interrogative adjective	IAJ	which (hogloqhv) whose (hiyvgwj)
(25)	Conjunction	Natural conjunction	CJN	but (hvbmabde) and (hoo, la)
(26)	Person	First person singular common gender	1PS	i (ngo), mine (ngog)
(27)		First person plural common gender	1PP	we (ngul)
(28)		Second person singular gender	2PS	you (no)
(29)		Second person plural gender	2PP	you (nul)
(30)		Third person singular gender	3PP	she/he (mwv)
(31)		Third person plural common gender	3PS	they (bulv)
(32)	Preposition		PRE	under (ura), before (otuqb)
(33)	Cardinal number		CN	1 (akin)
(34)	Foreign words (Assamese/Hindi/English)		FW	zip (cen), airplane (urajaaj)
(35)	Article		AR	si (the)
(36)	Ordinal number		ON	otub (first)

The dictionary was compiled by combining both automatic and manually entered data. It consists of 20,000 entries of words noted from the dictionaries and 5000 entries of sentences entered manually. The format of dictionary created can be seen at Table 3.

6 Nyishi Grammatical Part of Speech

The main purpose of this section is to discuss about the grammatical part of speech of Nyishi language and also depicted in Table 5. In Nyishi language, to represent demonstrative relations, deictic particles have been used. Further, the nouns are basically classified on the basis of certain properties like size, shape, length, and so on. The deictic words or an anaphoric word occurs in a noun phrase following the head noun they act similar to the role of articles in English. Some examples of proper nouns: kamle pobu (Kamle River), abotani (ancestor name), and namlo (praying hall).

Plurality is not strictly a grammatical feature of the Nyishi language. When specifically intended, the particle *mvlv* or *tulu* meaning 'Many' is suffixed.

Man ::	nyi	Men	::nyitulu
Machete ::	orioq	Machetes	::oriog mvlv

Pronouns are those forms that refer to the speaker. In Nyishi language, we have all three person pronouns, but it does not distinguish gender in the third person pronouns. Personal pronouns have different forms and meanings for is, he, she, it, this, and that according to the position of the man or the object spoken about.

This	si
He/it	mwv
He/that [up the hill]	tv
He/that [down the hill]	bv

The deictic word '*nge*' occurs with the noun phrase to indicate that the referent is not in the vicinity of the addresser and addressee. 'ho' is used as anaphoric word.

These are boys'	si hvmitulu nge
Keep them away	bulum ado apto

Table 5 Cardinal numbers of Nyishi

Definite	Meaning	Example
Dor	Animal	Svdorkin (one cow), dvbdornyi (two mithuns)
Takin	Flat object	Svtatakina (one plank), pota takin (one paper)
Bor	Leaves	ok borkin (one leaf)
Bu	Bamboo	Vvbukin (one bamboo), vvbunyi (two bamboo)
So	Pen	Kolom sokin (one pen)
Pi	Round objects	Pvppikin (one egg)

Interrogative pronouns are formed by the addition of appropriate case markers with the interrogative particle ho/hv/hi; e.g., who (hiyv) and whom (hiyam). There are four genders: masculine, feminine, neuter, and common gender in Nyishi language. Masculine nouns end with ‘bu,’ ‘o,’ ‘pu,’ and ‘ga,’ and ‘ne’ and ‘me’ are for feminine nouns.

Example	**Masculine**	**Feminine**
Parents	Abo	ane
Chicken	rokpu	rockne
Goat	bingpu	bingne

A numbers of verb particles are used in Nyishi language that are added to the verb to modify the inherent semantic composition of the verb. The particle is fused together with the verb to appear like a single lexical item. Nishi verbs do not distinguish number and person. The same form serves the entire three person and both the numbers. In the present indefinite, the same form of the verb is used for all degrees of person (singular) as am/are/is as hv/nge. For the present tense, dwn/do/twn suffixes are used. For past tense pan/twn/an/en, suffixes are used. And for future tense, wn/an/ywn are used.

Present tense	I read	ngo poorydwn
Past tense	I read	ngo poorypan
Future tense	I will read	ngo poorytaywn

Nyishi language has their cardinal numbers with respect to different things. The classificatory terms definiteness is given below.

But numerals can use for human beings without any definitive. Foreign words from Assamese, Hindi, and English are very influential to define the name of a new thing and it continued. In many new dictionaries, still senior or researchers could not replace it with a new terminology.

The basic word order in a Nyishi sentence is ***subject-object-verb.*** Other orders can also be found in the language, but most of the time, the verb occurs as the last constituent of the sentences. Like most of natural languages, Nyishi language also has the ambiguity issues as the single word has different forms of tags. To overcome the consequences of ambiguity and assign a “correct” tag in linguistic contexts, disambiguation rules are required. Disambiguation is based on contextual information of word/tag sequences and example as shown:

You must **refrain** from action

*No nyilkaakinamhoge**aado**doto*

I stay **far** place.

*Ngo **aado** ho dodo*

In the first sentence, the refrain is expressed by word ‘aado’; it indicates stay away, and its POS is verb. Whereas, in the second sentence, far is expressed with word 'aado'; it indicates far, and its POS is adjective. So, in this way, the ambiguity of part of speech can be reduced.

7 Conclusion and Future Work

In this paper, we present the grammatical pattern of part of speech, declaring tag sets and construction of dictionary in Nyishi language which can be a foundation for future computational working on Nyishi and on which very less work has been done till now. Hence, this work will be implemental in preserving, developing, and disseminating of the Nyishi POS. Here, we found that the ambiguity can be corrected if proper labeling of the tag set is done to the corresponding word. The formed large corpus will be used in future work for various type of machine learning, especially to find the proper POS of any Nyishi word.

In future work, we are going to add more data to our dictionary, and finally, we will create a Nyishi part-of-speech tagger for tagging the Nyishi language which will enable us to evaluate the performance accuracy of the part-of-speech tagger of Nyishi language.

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A Multi-model-Based Pre-clinical Prediction System for Heart Diseases Using RFE-BPNN

S. P. Abiram and G. Kousalya

Abstract Cardiovascular disease is one of the major concerns in day-to-day life. The disease leads to an increase of various complications in many people around the globe. In specific, heart failure occurs when the heart muscle is incapable of pumping sufficient blood which is generally caused by diabetes, high blood pressure, or diseases. The occurrence of such heart failures could arise due to several other factors like age, anemia, serum creatinine, ejection fraction, smoking, serum sodium. The main motivation of this research work is to identify the major features contributing to the identification of heart failures which in turn support early diagnostic patterns. In this research work, the detection of heart failure is carried out using learning algorithms such as random forest, gradient boost, and artificial neural networks. The diagnostic system is trained on selecting optimized features that contribute toward the prediction using the recursive feature elimination algorithm. The comparisons of the implemented models are made in terms of accuracy, specificity, and sensitivity network to classify the presence of autism. The paper ensures better and faster convergence of the positive class label of autism with maximized accuracy, specificity, performance, and minimized error. The novelty of the paper lies in the fact of extracting important features for modeling so as to make a prior analysis by any parents at home before approaching clinicians which supports the early intervention of autism.

Keywords Cardiovascular · Gradient boost · Random forest · Neural network · Feature selection · Early intervention

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1 Introduction

The main aim of the researchers and clinicians is to predict the diseases at an earlier stage which reduces the risk of failing life. It is observed that almost 32% of all deaths recorded around the world is due to cardiac problems [1]. Such early detection and treatment of many heart diseases are complex. On account of this issue in the medical field, recently, computer technology and machine learning are being used to make software that helps in the early identification of such complex diseases [2, 3]. Early identification may reduce the risk of deaths with proper clinician guidelines. Also, the estimation of risk of a person's life owing to coronary heart disease is important to be identified in many aspects such as health promotion and clinical medication. [4]. Such types of prediction models may vary in their Qos parameters but are primarily through various multi-models built using learning methodologies [5, 6]. The project aims to apply the learning models over the dataset to analyze the important features contributing to heart disease. On identification of such features, more improvised models are adopted to learn the pattern of feature influence and its contribution [7]. The research focuses on incorporating a gradient boost classifier, random forest, and applied feature selection technique. The research also compares its result with modeling back propagation neural network (BPNN), in order to check which algorithm gives the highest accuracy of all and for predicting the heart disease at an earlier stage as possible.

2 Literature Survey

Many theories have been proposed related to heart failure detection using machine learning techniques [8]. This literature review focuses and covers a wide variety of such related topics. Guruprasad et al. (2021) proposed a system called heart failure prediction using machine learning techniques. They have used a dataset with 13 attributes and have implemented various algorithms such as SVM, Naive Bayes, logistic regression, decision tree, and KNN [9]. Out of these algorithms, SVM showed a good accuracy of 79.2%. Many algorithms were implemented for heart disease prediction system that predicts the threat of heart disease using Naive Bayes, KNN, and decision tree algorithms [10, 11]. They have used 15 medical attributes and is observed that the Naive Bayes model finds the physical characteristics and features of patient suffering from heart disease. Out of those algorithms, Naive Bayes have good accuracy. The limitation of this research is the highest accuracy value 53.3% which is relatively very low. Khan et al. (2019) proposed a paper for heart disease prediction using machine learning. In this research, decision tree algorithms have been proposed for predicting heart disease. They used their own feature creation and selection. They compared precision, recall, F-measure, and accuracy with existing systems and found their model has better accuracy than those [12]. Punith et al. (2020) proposed a comparative analysis of machine learning algorithms in the study of heart disease prediction [13]. In this research, the main aim is to find the hidden features necessary to find and predict heart disease by data mining techniques. They have used a dataset with nine fields. They have used five machine learning algorithms with an accuracy as Naive Bayes—81.25%, support vector machines—77.97%, decision tree—81.97%, random forest—83.08%, KNN—67.21%, linear regression—85.25%. Harshit Jindal et al. (2021) proposed a heart disease prediction system using machine learning algorithms [14]. In this paper, they have used different machine learning algorithms such as logistic regression and KNN to predict and classify the occurrence of a patient with heart disease. It is implemented on the .pynb format. The highest accuracy of their model is KNN which has 87.5%. The limitation is observed to be the high complexity in execution.

3 Proposed Methodology

The proposed works aim in identifying (i) a new classifier model that takes optimized features out of chi square and information gain through optimization algorithm and (ii) back propagation-based analysis on gradient descent optimization technique. The main objective of the research work is to predict heart failure using varied machine learning and deep learning algorithms [15, 16]. This research work incorporates the Keras software library to implement the same on the application of neural networks. The work is initiated by employing classification algorithms like random forest and gradient descent boosting algorithms. The RFE wrapper method [17] is implemented so as to filter the most important features for training the model this in turn will reduce the complexity in training and executing the model. Back propagation neural network is employed so as to improve the performance of the classified by distributing the error rate over the designed neural network framework. Figure 1 depicts the flow of the system model adopted for predicting heart disease.

3.1 Dataset Description

The dataset for the cardiac disease was obtaining from Kaggle dataset which constituted about 300 records. The training and testing were carried out as a proposition of 80/20 records in which the former contributes to training and the later to testing. Though the classifier could be modeled on the dataset, a k-fold method was incorporated in a view of minimizing the data in the training phase. The fivefold cross-validation process was incorporated such that out of the sliced blocks of data, one slice was used for testing the data under each classifier model. Similarly, the training data were used to test in either of the epochs. This cross-validation method acts as a trail method to maximize the training dataset that results in increased accuracy.

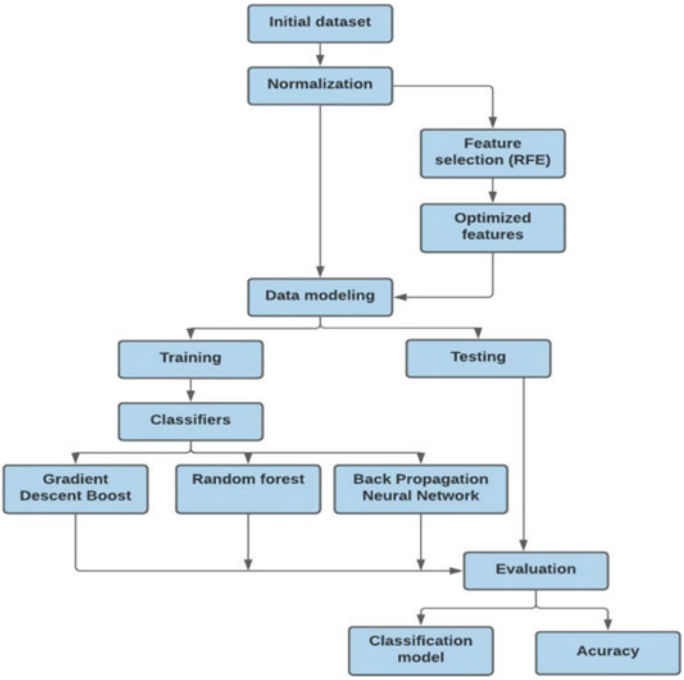

Fig. 1 Flow diagram of the implemented technique over heart disease dataset

3.2 Random Forest Classifier

The random forest classification algorithm is implemented for supervised learning of heart disease analysis which is of labeled data. It creates decision trees on random data samples and results in producing various predictions from each branch of the formed tree. Voting method is employed to obtain the optimum solution. For implementing the random forest algorithm, sklearn.assemble.Randomforestclassifier has been called for [18]. The pseudo-code for the random forest adopted for heart disease is stated as in Table 1.

3.3 Gradient Boost Classifier

Gradient boosting classifiers implemented are an ensemble classification algorithm that classifies heart disease failure. In this, strong predictive models are created by combining many weak learning models. The weak learning models mainly used are decision trees that compute the loss of the function. The process is repeated by learning features and updating the loss function. The final stage of classifier is

Table 1 Pseudo-code for RFE algorithm adopted for heart disease prediction

PSEUDO CODE FOR RANDOM FOREST ALGORITHM ADOPTED
To generate classifiers
To produce Di, randomly sample the training dataset (D) with replacement
Now to store Di, create a root node
Call a function to build a tree of this node.(Build tree)
Repeat this process from step1 to step3 until c classifiers.
Build tree function:
Y% of feasible splitting features in N is selected randomly.
The highest information gained feature f is selected.
The selected feature (F) has x possible values (F_1,…,F_x), so create x child nodes of N, N1,… N_x.
Set Di = Ni , if N matches Fi
Repeat the process STEP4 until x.
Recursive function is called until instances of only one class contained by N.

Table 2 Pseudo-code for random forest algorithm adopted

PSEUDO CODE FOR GRADIENT DESCENT BOOSTING TECHNIQUE
Step 1: Initialize the function with some constant.
Step 2: Calculate the loss function
Step 3: Now we construct the decision tree to predict the residuals.
Step 4: Predict the output using all of the trees.
Step 5: Compute the new loss.
Step 6: Steps 3 to 5 is repeated until there is no improvements in the performance.
Step 7: Use all the trees to predict the output as to the value of the target.

activated through softmax activation function. The basic algorithm for the gradient descent boosting classifier is as specified in Table 2.

3.4 Wrapped Feature Selection

Feature selection is used to find the best optimized features contributing to the classification at a faster rate. The project is implemented with recursive feature elimination (RFE) from wrapper method which contributes to the efficient supervised methods. The pseudo-code for the RFE is as specified in Table 3.

On application of RFE algorithm, there are five major features which are identified as ejection fraction, serum_creatinine, serum_sodium, creatinine_phosphokinase, and time. On obtaining the optimized features, the estimators used for classification are random forest, gradient boost, and linear regression. The contribution of the features toward the class label of heart disease prediction is depicted in Fig. 2.

Table 3 Pseudo-code for RFE feature selection method

PSEUDOCODE FOR RECURSIVE FEATURE ELIMINATION
Step 1: Create a subset of features.
Step2: Train the model using training data using every subset.
Step 3: Calculate the performance of the model.
Step 4: If accuracy of the model is greater than the required accuracy add it to the feature set or else neglect it.
Step 5: Finally calculate the rankings for features.

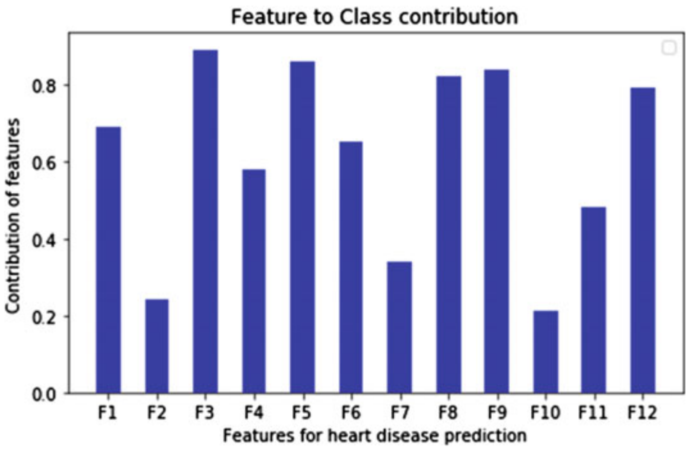

Fig. 2 Contributions of features in predicting the model

3.5 Back Propogation Neural Network

The feed forward neural network, integrated with back propagation, holds appropriate prediction by exemplifying the output with minimized error rate. The minimization is due to the concept of weight updating over the network. The simple feed forward neural network that operates with two input parameters x_1 and x_2 with weights w_1, w_2, and w_3 varied over the layers of the neural network and b_i be the bias for the function. The output of every layered function computes as in Eqs. (1), (2), and (3), iteratively.

$$y_1 = f_1(x) = (w_0 \times x_1 + w_0 \times x_2) + b_0 \quad (1)$$

$$y_2 = f_2(x) = (w_0 \times x_1 + w_0 \times x_2) + b_1 \quad (2)$$

$$y_4 = f_4(x) = w_1 \times f_1 + w_1 \times f_2 + w_1 \times f_3 \quad (3)$$

Table 4 Pseudo-code for back propagation neural network

PESUDOCODE FOR NEURAL NETWORK
Step 1: Initialize the weights
Step 2: Create a model.
Step 3: Train the model using weights.
Step 4: Find the loss function.
Step 5: Back propagate the errors using a back propagation algorithm.
Step 6: Alter the weights using the errors that are back propagated.
Step 7: Repeat from Step 3 to 6 until the number of iterations declared.

Similarly, y_5 and y_6 are computed based on the previous layered output related to the current operating neuron. The final output from the output neuron is computed and is compared with the actual value of the network. The error rate of the BPNN is identified using the differential equation in which δ is the computed error, and δ_1 is the rate of error distributed backward for one neuron. Similarly, the computed error is distributed over the entire network, and the weights are recalculated. The research has encompassed the Keras classifier model for prediction using optimized features. The tanh activation function is used in the hidden layers and a sigmoid activation function in the output layer of the neural network so as to influence the features to the classifier. The basic pseudo-code of the defined back propagation neural network is as in Table 4.

4 Experimental Results and Analysis

The heart disease prediction was made an attempt to identify the maximum features contributing to various cardiovascular problems. The research was carried out using varied techniques, and the results were compared in terms of accuracy precision and recall. Table 5 shows the comparison of the implemented RFE-BPNN. The results stand to be over fitting over n iterations which could be improved by increasing the number of data values. The training of more real-time data value leads to better training of the neural network model with maximum accuracy and correctness along with over fitting elimination.

Table 5 Comparison of parametric value over implemented classifiers

Parameters	Without feature optimization (existing system)			With feature optimization (proposed system)		
	SVM	Random Forest	Gradient boost	Random forest	Gradient boost	Back propagation neural network
Accuracy	79.83	83.3	80.7	93.7	90.6	97.7
Precision	81.46	84.4	75.3	94.2	85.1	96.4
Recall	76.91	70.9	70.9	80.8	80.2	84.6

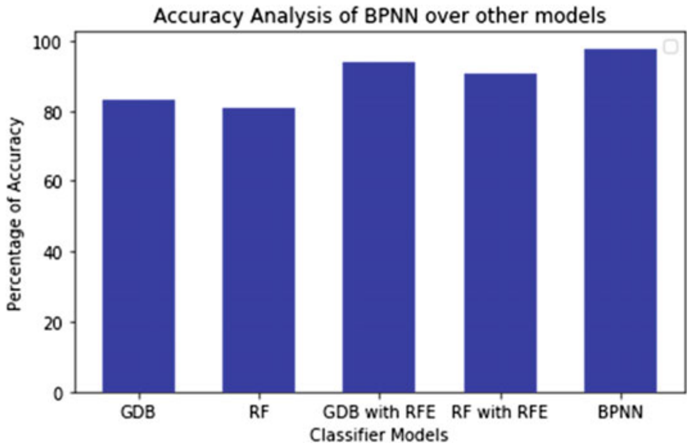

Fig. 3 Comparison of accuracy over proposed models

The pictorial representation of the accuracy comparison is shown in Fig. 3. From this graph, it is inferred that BPNN and random forest have more accuracy compared to other models.

5 Conclusion

Heart attack, this prediction is much helpful in the medical field. The proposed system implements using Keras implements gradient descent boosting, random forest, and back propagation neural network. The classifier models are then integrated with RFE feature section method which is incorporated in an intention of attaining the prediction at a faster rate. This RFE-based selected features are then feed as input to the classifier models to check for its accuracy and correctness. This minimizes the complexity in training the models with minimized features. The selected features are feed as neural inputs to BPNN that indicates the early convergence of prediction with maximum accuracy of 97.9%. Thus, the system stands a trustable pre-clinical prediction of heart disease prediction. Further, to improve the prediction, the system could inculcate the real-time data values along with the cardio images observed during a regular checkup of every individual.

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Human Computer Interaction Proclivity Formed from the Analysis and Interpretation of Survey

Axita Shah and Jyoti Pareek

Abstract Human Computer Interaction—HCI is an interactive technique to perform computing and communication on what user says and what computer cognizes. In current era, development of an intelligent system grows rapidly where providing interactive interface pertaining to the users also plays an important role. Major classes of HCI styles are Command Line Interface (CLI), Graphical User Interface (GUI), Natural Language Interface (NLI), and Perceptual User Interface (PUI). The authors have hypothesized that amalgamated HCI approach of GUI with NLI and PUI is recommended and convenient option for intelligent system interaction. To manifest and clearly evince the hypothesis, the authors have conducted a survey to the experienced researchers of information technology domain. Analysis and interpretation of the survey suggests amalgamated interface for HCI. Combined interaction between human and computer are as per the prospective user's preferences.

Keywords Human computer interaction (HCI) · Command line interface (CLI) · Graphical user interface (GUI) · Natural language interface (NLI) · Perceptual user interface (PUI) · HCI for intelligent system

1 Introduction

> An interaction technique is the fusion of input and output, consisting of all software and hardware elements that provides a way for the user to accomplish a task. [1]

A Man–Machine interface is a user interface that provides an interaction between a computer, machine, system, or device. An interaction technique is a way to perform computing task on what user says. Moreover, from the machine's perspective, it interprets the user's input, practice it in progression and output as a visualization to the user, which is, crossed check against user's feedback. Manaris states that [2] "One of

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the goals of Human Computer Interaction (HCI) is the development of systems which match (and possible augment) the physical, perceptual, and cognitive capabilities of users." Man uses diverse means of interactive i/o techniques to communicate with machine. With all, let us change attention to "what is said" on the semantics of interaction from "How things are said to computers". Researchers in [3] inspects varied recent and existing trends and challenges for further research. HCI has its roots in principles and practices of theory and practice of people.

Human acts as per the utilized perceptual senses towards the machine. In the beginning IT was the one-character command to the machine to perform the action, then word-based command to the software of the computer application via keyboard, then pointing device mouse is used to point the graphics of the display unit, and then audio-based speech-based interface, so on and so forth. Varied applications have diverse demand of interaction practices for its prospective users. Gradually, computer application development is happened towards on data management system, enterprise resource planning, decision support system, management information system, and an expert system in artificial system. Artificial intelligent system is booming and in the excessive mandate in current era. Hence, interaction for an intelligent system is also a vital and imperative feature and functionality to look for.

Here, based on these two formerly defined mind and visionary senses, Human Computer Interaction styles include but are not limited to, Command line Interface (CLI), Graphical User Interface (GUI), Direct Manipulation Interface (DMI), Guided Interface, Form filling dialogues, Linear Keyword Language (LKL), Restricted/Controlled Natural Language (RNL), natural language interface (NLI), Perceptual User Interface (PUI) and Iconic interface etc.… [4, 5]. HCI evolution in interaction approaches are CLI, GUI, NLI and PUI subsequently. These HCI styles are explained in detail in ***Section-Elucidation of HCI Styles Classes—Literature review***.

Each user interface has been utilized by industry and academia as a part of an application development. Highlighted strength and challenges of the interface depends on the identified factors and based on the application usage. The authors have hypothesized that amalgamated HCI approach of GUI with NLI and PUI is recommended and convenient option for intelligent system interaction. To evince the hypothesis, the authors have prepared a survey and conducted a survey to the experienced researchers of information technology domain. Detail of the survey with its analysis and interpretation is depicted in ***Section-Survey of HCI Application***.

Based on the literature review and survey, the authors have interpreted and utilized interface for intelligent system. Conducted survey suggest that the combination of user interface utilize the convenience for diverse types of users. Moreover, input and output as an interaction to the computer varies based on the categories of the intelligent system. Following sections entail various HCI styles, factors affecting HCI reviewed from literatures, accessing HCI aspects from researchers' perspective, interpretation of statistical analysis of HCI styles based on conducted survey, and concluding remarks on HCI styles.

2 Elucidation of HCI Styles Classes—Literature Review

The choice of the "best" interaction style is and will remain a complex function of the task. People need more intelligent, concise and efficient human–computer interaction. It is of great significance to optimize the components of human–computer interaction. Applications and new research directions in HCI such as unimodal, multimodal configurations of HCI applications, its factors, system design trends, historical evolution, problems and solutions for HCI are overviewed [6–10].

Three major principles used for system design are [5]: (1) Iterative design, (2) Empirical Measurement and (3) focus on users and tasks. HCI requires to be adaptive due to the interaction happens with human and it should be intelligent as the new generation of intelligent system booms. Both requires more adaptive HCI environment [11, 12]. Measurement of performance and reaction of user on simulated environment are necessary for HCI selection. Catalogue-I (see Fig. 1) list down the possible factors to consider while opting for HCI [4, 5].

The authors shall discourse factors of major two restricted and two non-restricted categories of interactive styles. Literature and industry implementation suggest four major human computer interaction styles; as, (1) Command line Interface (CLI), (2) Graphical User Interface (GUI), (3) Natural language interface (NLI) and (4) Perceptual User Interface (PUI) [4, 5]. Here, we have reviewed these four categorical styled from research literatures and existing prominent Business Intelligence applications and provided Elucidation of Human Computer Interaction Types as below:

Catalogue-1 : Factors to select Human Computer Interaction for developing the computer software

- Who is accessing the system?
  - The Users who are to carry out this task: Technical Expert, Domain Expert, Common End User, Disable people
- In which Environment user interact with the system?
  - The Environment within which they will work: Commercial, Technical, Linguistic, Scientific, Common
- Is Accessibility of the system convenient or suitable for general user? Is Human able to communicate to the machine?
- Does the interface require prior knowledge to communicate?
- Ease of Learning : How long does it take to learn interaction with computer?
- Performance Speed : How long does it take to carry out standard task?
- Rate of Errors : How many and what kinds of error do people make in carrying out the specified task?
- Retention over time : How well do users maintain their knowledge after a time?
- Subjective Satisfaction : How much did users like using various aspects of the system?

Fig. 1 Catalogue for the factors to select human computer interaction for developing the computer software

2.1 Command Line Interface

Command Line Interface allows the user to provide formally defined command instructions to perform the task. CLI is commonly implemented with command prompts that is a software, which accepts text as command input and converts command into certain functions. Typed command languages are created within limited domain and with fixed lexical, syntactic and semantic structure. CLIs are used by technical expert such as system administrator, programmer and even it is popular among visual disables. CLI compared to GUI requires fewer system resources to implement. Learning time is required for novice user to become familiar with CLI. Examples of CLI are DOS Command Prompt, Tally Application, etc.

2.2 Graphical User Interface

Form Design Interface (FDI) in Graphical User Interface (GUI) allows the user to issue commands by filling in and modifying fields to a form, and supports the activity through extensive error detection and correction [5]. Desktop-based Government Application Form is an example of FDI.

Instead of text-based command navigation, **Graphical User Interface** allows users to interact with machine through graphical indicators. Many machines such as desktop, laptop, mobile devices and many handheld devices use GUI. GUI's learning curve is faster than CLI.

In **Direct Manipulation Interface** (**DMI**) of GUI user interact with the system by manipulating task through a language of button pushes and movements of a pointing device such as a mouse, graphic representation of the underlying data [5]. GUI uses combination of input tools and techniques to perform defined task.

Windows, icons, menu, pointer (WIMP) computing of GUI improves ease of use by non-technical user interaction. Design, structure, implementation factors, pros and cons of Icon-based interfaces are discussed [13]. WIMP style GUI is impediment to visually disabled. Applicability of menu-based interface is easy but less expressive [14]. Post-WIMP allows the user to interact graphically by defining and modifying diagrams, sketches, two-dimensional and three-dimensional images and pictures. Web-based application with WIMP is an example of ERP system.

In addition, ZUI, CBI are also kinds of Graphical User Interface. In **Zooming/Zoomable User Interface** (**ZUI**), user can zoom more or less into objects of interest. Photoshop with image zoom feature is an example of ZUI. **Crossing-based interfaces (CBI)** use crossing gestures instead of, or in complement to menus and pointing. Intelligent system for HCI using Hand Gesture recognition is developed [15]. Mobile Gaming Interface is an example of CBI.

Now a days many users use GUI and WIMP instead of using CLI. However, many advanced technical users use CLI for efficient task of configuring their machine that are not available through GUI.

2.3 Natural Language Interface

Natural Language Interface allows the user to interact via natural language such as English, Gujarati. "Natural Language Processing (NLP) could be defined as the discipline that studies the linguistic aspects of human–human and human–machine communication, develops models of linguistic competence and performance [2]."

In [16], Suh and Jenkins had conducted laboratory experiment between two different language interfaces, i.e. **Linear Keyword Language (LKL)** and **Restricted Natural Language (RNL)**. A Linear Keyword Language (LKL) has a restricted syntax involving the use of a limited set of keywords in a predetermined sequence. It is one of the most popular DBQL interfaces available for novice end-users. SQL is a typical example of an LKL, and Clout is used as RNL query system. Training of these two different languages was given to the novice user at different level. Result indicates that the RNL performed significantly better than LKL, measured by query correctness and query writing time. Keyword-based search in Information Retrieval is an example of LKL. "**Restricted/Controlled natural languages** (RNLs) Proposes restriction in user interface by recommending language constructs. RNLs are subsets of natural languages that are obtained by restricting the grammar and vocabulary in order to reduce or eliminate ambiguity and complexity" [17–19]. Restricted QA in Business Intelligence Application is an example of RNL. It benefits human user to communicate in natural language hiding complexity of creating, maintaining and understanding natural language.

It is possible to build **Free-Form Natural Language Interface [FFNLI]** communicator [20, 21] but requires implementing natural language processing approaches such as language syntactic and semantic analysis and it also involve creating and maintaining domain-based knowledge representation. Free-Form NL Search Engine like Google is an example of FFNLI. FFNLI requires rich domain-based knowledge, underlying structure of data, etc.

Guided user interface (GI) takes more time to communicate because computer is in learning phase to understand user's language and assure the communication. Chatbot, Guided QA System are an example of GI.

Research survey of comparison and evaluation between NLI and Graphical User Interface (GUI) on impression-based retrieval system in [22] suggests that to NLI is slightly convenient than GUI. To increase user's evaluations of NLI convenience, it is important not only to improve retrieval accuracy but also makes the systems more robust. To make the NLI system better, it should be easy to operate with higher and faster retrieval accuracy and should help to the user in verbalizing. For hard natural language processing, DMIs are added to describe object and temporal relation [23].

2.4 Perceptual User Interface (PUI)

There are intuitive human computer interaction styles that mimic human communication through the five human senses, which is essential for **Perceptual User Interface (PUI)**. Perceptual User Interface [24] works on speech, vision, hearing, etc. Current Internet of Things—IOT practice is based on PUI. However, visual and auditory senses are most used and supported with the use of language for communication. Representative techniques, systems and applications of HCI to address user affect are discussed [25]. Authors in [26] have reviewed and stated interaction approaches for intelligent robots based on human senses such as listening, speaking, reading, visual sense, tactile and other senses, etc. They have highlighted various technologies and applications in the field of intelligence that are utilized based on senses and challenges for the future development.

2.5 Human Computer Interaction for Intelligent System as Business Intelligence Application

Business Intelligent applications are moving towards providing smart interaction approaches. The authors have reviewed several Business Intelligence applications' Human–Computer Interaction aspects.

As per the Gartner's Magic Quadrant Report published in last 3 years. Niche players, visionaries, challengers and leaders in Analytics and Business Intelligence platforms are Tableau, Microsoft, Qlik, Oracle, SAS, SAP, etc. These BI tools have utilized purely GUI approach and some of the applications have considered NLI and PUI approach (Speech utilized Interface) in BI and Analytics Platform. Two developed interaction technologies, i.e. old with information visualization and new with optimal one on Business Intelligence and Analytics platforms are evaluated based on the user experience, usability and aesthetics factors [27].

Recommendations are represented regarding HCI engineering processes [28]. Collective intelligence has been contoured to facilitate HCI and also provided call to action future direction and challenges for human interaction [29]. Researchers in [30] proposed eighteen design guidelines for human-artificial intelligence interaction. This research highlights the future direction of interaction as well as further guidelines development. Researchers in [31] summarizes a human machine interaction research agenda based on the functional, relational and metaphysical dimensions that constitutes human, machine and communication.

Several researchers have developed designed guidelines for interacting with the system. Even literature in the research community categorizes diverse HCI and showcased usage for the same for different purposes but no one has conducted any survey that requires to cognize user's point of view for using Human Computer Interaction for intelligent system. Here, we have contributed by delineating the survey for deciding factors for intelligent system development and this sampling survey will be helpful for the academic and industry for further research development. And ***The Authors have hypothesized that amalgamated HCI approach of GUI with NLI and PUI is recommended and convenient option for Intelligent System Interaction***. To prove the hypothesis, our survey to the Computer Science Researcher described in the copyright filed as "Human Computer Interaction Proclivity Survey Sheet for Intelligent System", summarized in Table 1 and detailed complete sheet in [32], prepared using catalogue-1 and literature review; regarding factors of HCI indicate the usage of an interface. Survey constitute with its analysis and interpretation is detailed in the following sections.

3 Survey of HCI Application

3.1 Survey Creation and Data Collection

Objective of the survey [32] is to know user's point of view for using Human Computer Interaction as a part of Man–Machine Interaction for intelligent system. Nine HCI factors are selected for Human Computer Interaction survey. Stubs of survey represent factors for the selection of Human Computer Interaction for intelligent system and captions represent classified category of Human Computer Interaction. This survey provides figurative facts of user's interaction tendency for the factors such as knowledge and manual requirement, consideration for time of learning and knowledge retention over time for various HCI. It also provides facts about user's recommendation, conveniences, satisfaction and technical interface success ratio towards HCI with significant and imperative remarks. Table 1 summarizes survey in the copyright filed as "Human Computer Interaction Proclivity Survey Sheet for Intelligent System", detailed in [32] regarding factors of HCI indicate the usage of an interface. This structured questionnaire consists of closed-ended questions, for which finite discrete multiple choice answers to choose from are provided. Questions of questionnaire are classified and represented in tabular qualitative form.

Our Pilot survey helped in assessing the suitability of questions, the cost and time involved in actual survey; drafting precise and clear questions, avoiding ambiguity by multiple choice questions, arranging questions in order from general to specific one to enable the respondents to answer quickly, correctly and clearly. The authors have conducted an actual survey by asking questions from questionnaire. Collection of primary data has been carried out by getting surveys filled up in person and via email the questionnaire with phone a respondent.

Following assumptions are considered and mentioned to the researcher-participant for valuation survey study:

- User will provide unbiased opinion in survey. Through the survey cum interview method, users' uncertainty regarding questions would get cleared.
- The authors kept survey sample size as 30 academic researchers. Instead of going to the above defined types of users, here our participant is majorly Ph.D. in

Table 1 Survey of Factors to select Human Computer Interaction (Summarized from Copyright Filed Ref. [32])

Survey for the selection of human computer interaction for intelligent system	
Objective: To know user's point of view for using Human Computer Interaction as a part of Man–Machine Interaction for intelligent system	
Stubs: Factors for the selection of human computer interaction for intelligent system\captions: classified category of human computer interaction	Columns for various human computer interfaces
(1) Does the interface require prior knowledge to communicate?	Yes/No
(2) Is the user's manual required to work with?	Yes/No
(3) Time of Learning: How long does it take to learn interaction with computer?	Little/a little/more/most
(4) Tendency of Acquired Knowledge Retention over time: Is the acquired knowledge of communication via interface retained with the user?	Fully retained/partially retained/not retained
(5) Rate of Errors: What does the probability of mistakes common end user make in carrying out the specified task?	Range of percentage: 0/1–20/21–40/41–60/61–80/81–100%
(6.1–6.5) Is it recommended and convenient to access specified UI for the users that are Technical Expert, Technical Operator, Domain Expert [Such as Business Developer, Finance Manager], Common End User, Disabled People [Such as Physical Disability, Vision Disability]?	Not Recommended/Recommended/ Strongly Recommended
(7) Performance Speed: How long does the machine take to carry out standard task?	Little/a little/more/most
(8) User Satisfaction: Give the rank of the above said approaches that has brought satisfaction for the user? [Rank:1–4 (High…Low) to general categories and x.1, x.2, as subcategories in GUI and NLI]	
(9) What is the ratio for the success of the response of the technical implementation of user's interface as far as your opinion is concerned?	Range of percentage: 0/1–20/21–40/41–60/61–80/81–100%
Remark	
Surveyor Profile Information	
Research Survey Disclaimer: We will not pass any data to the other third party academic or organization. The data is ONLY used for research purposes, and we guarantee to work confidentially with the data	

computer science and having experience of application development in varied kind of Human Computer Interaction.

- User manual also considers tooltip defined on application.
- The authors have considered physical and vision disability of disabled people and even they do not know braille. Hence, disabled people are able to provide voice input only.

The authors have selected representative non-random sample based on the purpose, quota, convenience and judgement. By human efforts, the authors have resolved sampling and non-sampling errors such as data entering, processing and transformation error. Characteristic of selected respondents are showcased in Fig. 2.

A box plot in b and columnar chart in a of Fig. 2 displays descriptive statistical distribution of respondent's work experience in no. of years with 20 mean, 16.5 median and 87% variance with positively skewed and leptokurtic distribution. Selected respondents are diversified with varied professionals specified in d of Fig. 2 and respondents from around 14 varied institutes such as universities or IT industrialist are shown in c of Fig. 2 after analysis of 30 survey respondents. Academic qualification of respondents is majorly Ph.D. in computer science and/or experienced academician from diverse universities or IT industrialist.

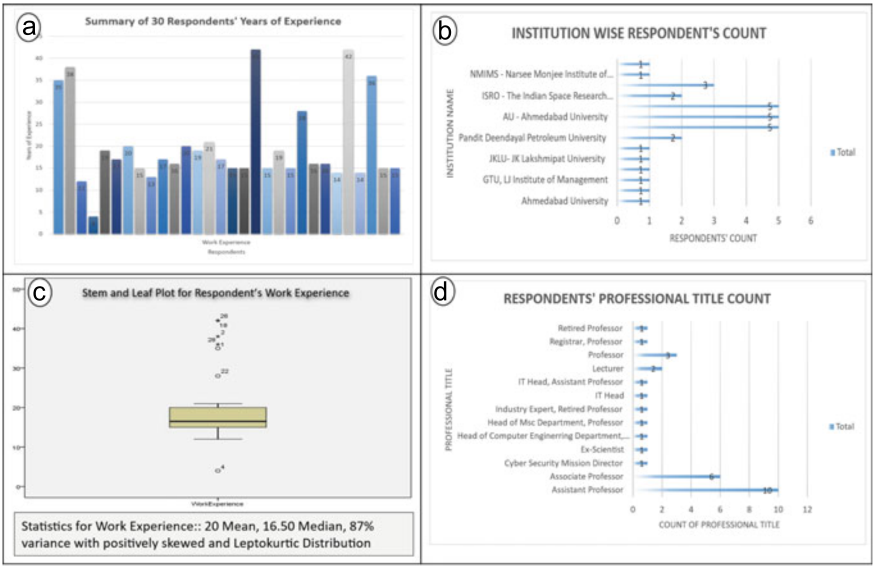

Fig. 2 Descriptive statistics of respondent's work experience, professional title, and industry

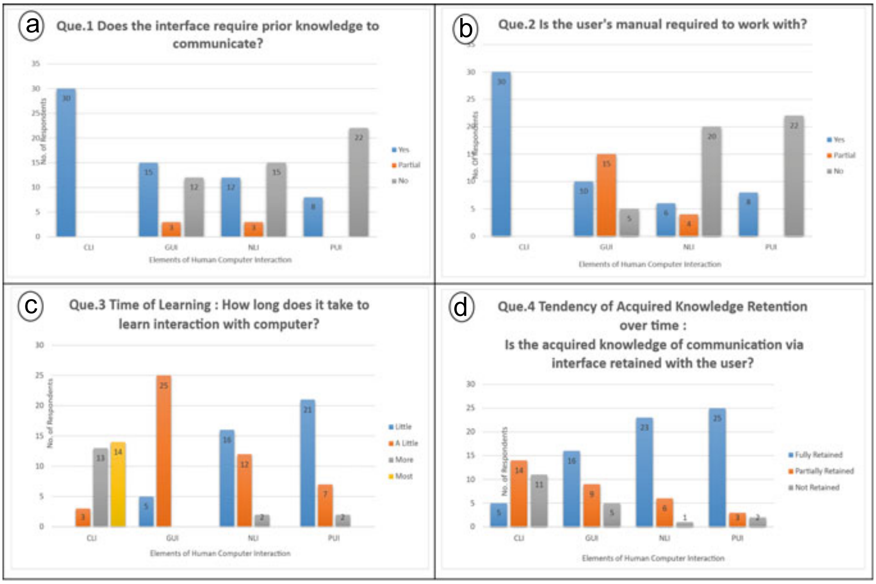

Fig. 3 Interpretation of human computer interaction survey of user's prior knowledge and manual requirement, learning time and acquired knowledge retention

3.2 Analysis and Interpretation of HCI Survey

The authors have interpreted and analysed the result of survey to know user's point of view for using Human Computer Interaction for intelligent system. Figures 3, 4 and 5 demonstrates analysed and interpreted factors of HCI survey using statistical pivot chart and other statistical comparison techniques.

Que-1 and Que-2 of survey talks about prior knowledge and user's manual requirement for intelligent system to communicate with computer interface, depicted in Fig. 3. 100% participants agree with the prior knowledge and manual requirement of CLI; 30% of PUI user requires prior knowledge and manual to access the system; 50% NLI users require both while other 50% do not and 60% GUI users require prior knowledge and higher around 83% require user manual to access GUI. This result shows prior knowledge of interface access and user's manual requirement is low to high consecutively as for GUI, NLI, PUI and CLI.

CLI requires time of learning to access interface the most while NLI and PUI requires little time to learn how to access the interface depicted in c of Fig. 3 for Que-3. Knowledge retention vary person to person. But based on the mentioned general tendency depicted in d of Fig. 3 for Que-4, NLI and PUI have tendency to retain the gained knowledge more compared to CLI.

Que-5 resulted as depicted in Fig. 4 provides recommendation and convenience to access specified UI for varied types of users. Here are the examples for types of

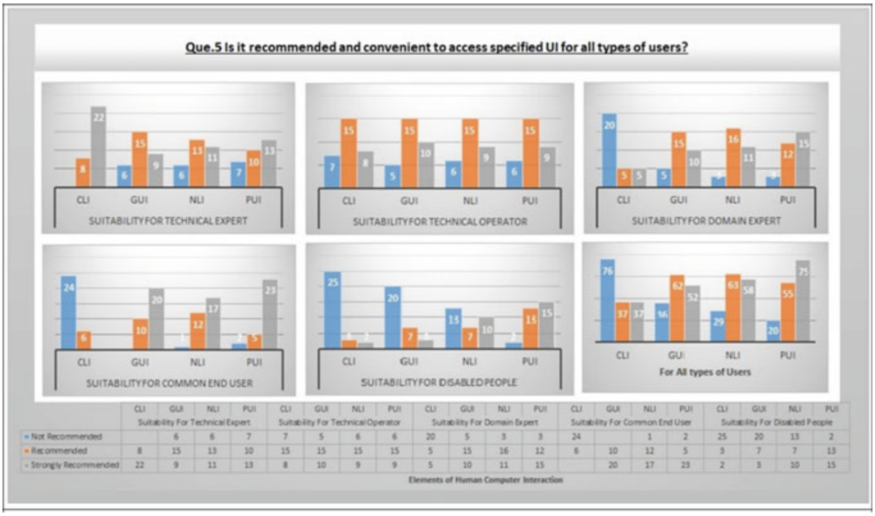

Fig. 4 Interpretation of HCI Survey of user's recommendation and convenience factor

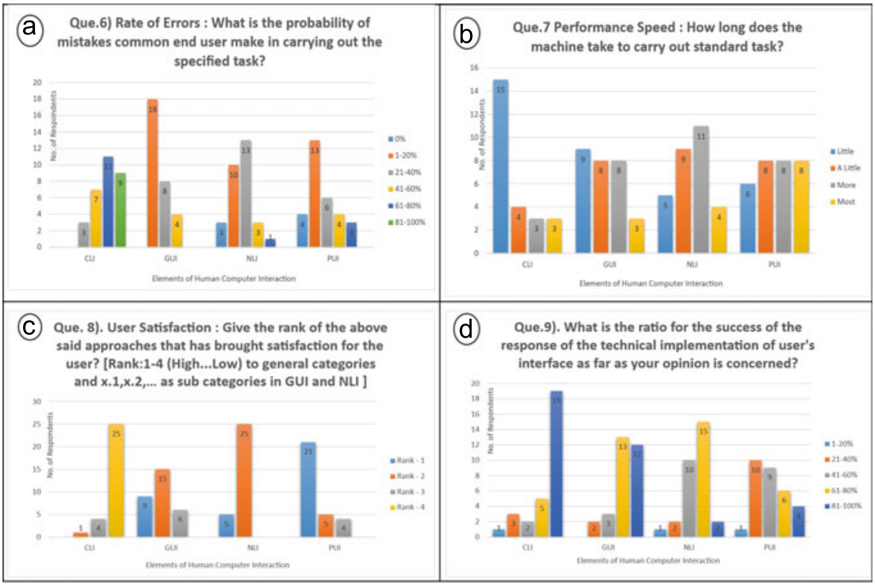

Fig. 5 Interpretation of human computer interaction survey of rate of errors, performance speed, user satisfaction and implementation success ratio

users. Administrator is an example of Technical Expert. One who operates application is technical operator. Business developer or finance manager, etc. is considered as Domain Expert. Common end user is a business user who has only knowledge of how to access an application. Disabled people with physical and vision disability are considered as disabled people user. As per the result depicted in Fig. 4 recommendation and convenience to access the interface are different for different types of users.

The authors have applied non-parametric Kruskal–wallis test extended by Bonferroni Mann–Whitney U test—Post Hoc statistical test by rank to compare 5 independent Que-5.1 to 5.5 data. Survey result of 30 respondents is processed and transformed to question as row, respondent as column and result of Que., i.e. ranking as Data Format. This processed data is passed to Kruskal–wallis test using SPSS tool.[1] Following is the formula to apply the test:

$$H = \frac{12}{N(N+1)} \sum_{i=1}^{k} \frac{Ri^2}{n_i} - 3(N+1) \tag{1}$$

where N = Total no. of respondents,

R_i = the sum of ranks from the ith group.

This statistic is asymptotically chi-square distributed with $k - 1$ degrees of freedom. And for multiple comparisons treatments i and j to be significantly different in effect by applying Post Hoc statistical test using Bonferroni Mann–Whitney U test as follows:

$$\left|\overline{R_i} - \overline{R_j}\right| > z^* \sqrt{\frac{N(N+1)}{12}} \left(\frac{1}{n_i} + \frac{1}{n_j}\right) \tag{2}$$

where

$$Z^* = z[\alpha/k(k-1)] \tag{3}$$

And n_i = Number of observations in ith group,

N = Total no. of observations in all groups

α = Level of significance.

Equations 1–3 of non-parametric test is applied on the result of Question-5 to compare between users of group for convenience.

Comparative analytical result in Table 2 is exhibited as follows. Table 2 indicates comparative analytical result among 5 sub questions of Que-5 which point out null hypothesis rejection or acceptance at 5% significance level for specified 5 varied types of users. Comparison defined in CLI of Table 2 with recommendation result

[1] https://statistics.laerd.com/spss-tutorials/kruskal-wallis-h-test-using-spss-statistics.php.

Table 2 Comparative analytical result of the Kruskal–Wallis test by ranks – extends the Bonferroni Mann–Whitney U test—Post Hoc tests for Que-5.1 to Que-5.5

Que-5.1 to 5.5 test result	CLI		GUI		NLI		PUI	
	p-value	Result	p-value	Result	p-value	Result	p-value	Result
Que. (5.1)–(5.2)	0.000103	Reject	0.722250	Don't reject	0.706875	Don't reject	0.557204	Don't reject
Que. (5.1)–(5.3)	0.000000	Reject	0.722250	Don't reject	0.650464	Don't reject	0.363413	Don't reject
Que. (5.1)–(5.4)	0.000000	Reject	0.001436	Reject	0.052701	Don't Reject	0.007967	Don't reject
Que. (5.1)–(5.5)	0.000000	Reject	0.000231	Reject	0.221198	Don't reject	0.294081	Don't reject
Que. (5.2)–(5.3)	0.004822	Reject	1.000000	Don't reject	0.369756	Don't reject	0.096956	Don't reject
Que. (5.2)–(5.4)	0.000005	Reject	0.003974	Reject	0.016069	Don't Reject	0.000575	Reject
Que. (5.2)–(5.5)	0.000013	Reject	0.000072	Reject	0.338398	Don't reject	0.065855	Don't reject
Que. (5.3)–(5.4)	0.154715	Don't reject	0.003974	Reject	0.099328	Don't reject	0.045524	Don't reject
Que. (5.3)–(5.5)	0.133056	Don't reject	0.000072	Reject	0.089112	Don't reject	0.908017	Don't reject
Que. (5.4)–(5.5)	0.851731	Don't reject	0.000000	Reject	0.004427	Reject	0.051864	Don't reject

given in Fig. 4 of CLI for technical expert and operator cannot be merged with other types of users. CLI is convenient and preferable option for technical expert and operator. Appropriate choice of users for NLI and PUI is same for every specified type of users. For Business Developer, common end user and Disabled people GUI is not replaceable recommendation with other types of users. The result specifies unalike HCI requirement for the diverse types of users.

The interpretation of HCI analysis on technicality and user satisfaction for Que-6 to Que-9 is specified in a–d of Fig. 5.

Researchers agreed that around 66% Rate of errors of Que-6 are included in set of 61–100% in CLI, 60% in set of 1–20% in GUI, 36% in set of 1–20% and 36% in set of 21–40%, i.e. 76% in set of 1–40% in NLI and PUI as depicted in a of Fig. 5. Hence, common end user makes more mistakes in CLI compared to others and less mistakes in GUI compared to NLI and PUI.

As per the researcher's point of view to carry out the standard task machine takes little to most time consecutively for CLI-NLI-GU-PUI as depicted in b of Fig. 5.

User satisfaction is from highest to low for PUI-NLI-GUI-CLI while ratio for the success of the response of the technical implementation is from highest to low for CLI-GUI-NLI-PUI as depicted in detail in c and d of Fig. 5.

The authors have also conducted survey on factors for 4 types of natural language interfaces such as LKL, RNL, DI and FFNLI and 4 types of graphical user interface such as Form Design Interface [FDI], Direct Manipulation Interface [DMI] using windows, icons, menu, pointer (WIMP) , Zooming/Zoomable User Interface [ZUI], and Crossing-based interfaces [CBI]. Conducted Analysis suggest the following interpretation. Prior knowledge and user's manual is required to communicate for restricted natural language interface. Each Natural Language interface is fast to learn, and knowledge is retained for the same. FFNLI and DI is recommended and convenient with higher performance speed and more technical errors to access compared to other two NLI interfaces. Result of GUI—All Inclusive is similar compared to other individual GUI type and it is remarked that it is better to include every single style together as interface interaction style.

By applying manual analysis given in the remarks of survey, Promising State of affairs is that Graphical and Natural Language User interfaces with minimal PUI should be integrated for their characteristic advantage. Hence, for intelligent system it is convenient and recommended to provide amalgamated HCI approaches for diverse types of users.

4 Conclusion

The authors have reviewed literature, application and conducted survey to analyse and interpret varied styles of Human Computer Interaction to know user's point of view based on several defined factors. Our interpretation suggests the usability of all four types of interfaces for varied types of users with plus and minuses of defined factors. Time of learning, prior knowledge and user's manual requirement is more in CLI compared to other interfaces for intelligent systems. NLI and PUI are recommended and convenient for non-technical users while CLI and GUI are preferable for technical users. Time of learning, knowledge retention, performance speed and user's satisfaction are almost similar in NLI and PUI although ratio for the success of the response of the technical implementation is higher in Natural Language Interface compared to Perceptual User Interface. Our amalgam HCI approach of GUI with NLI and minimal PUI reasons to support lucid and preferable interface for prospective user. The results verify the relevance of the factors over an interaction scenario and highlighting opportunities for further research. Based on the evaluations, we believe that the set of HCI factors can serve as a resource to practitioners working on the design of applications for intelligent system, and to researchers interested in the further development of factors of HCI. Many real systems, however incorporate elements from several styles in a single interface, and how to do this intelligently is again a question. A challenge is the development of integrated computer interactive technique.

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Mesh Variants for Massively Parallel Systems Using MATLAB

Faizan Nasir, Mohammad Ubaidullah Bokhari, and Abdus Samad

Abstract The article presents the comparative study of topological properties for various Mesh-based networks. The objective of the study is to find best performing Mesh variant in terms of topological parameters and to find a suitable network which can be more feasible to use in data centers. For our analysis, variants of Mesh networks such as Mesh, D-Mesh, X-Mesh, and Z-Mesh are considered. The various topological parameters like Diameter, Average Distance, Message Density, and Cost are evaluated for considered topologies using MATLAB tools. The performance analysis is carried out on the basis of complexity, cost-effectiveness, fault tolerance, and reliability. The effect of waiting time and total execution time has also been considered to analyze the performance of the considered system. A comparative study is carried out, and graphs are depicted to understand their performances in detail. Best results are obtained for different parameters. The present study concludes with the overall performance track for the family of Mesh networks.

Keywords Mesh networks · Performance analysis · HPC · Topological properties · Interconnection network

1 Introduction

High-Performance Computing (HPC) shoves the design and limitations of computing techniques. HPC has abilities to deliver unique scientific discoveries and always helped in driving the market forward. Computing sector gets many major break-

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throughs due to advancements in HPC [1]. Nowadays co-design approach is providing the best-suited system for a specific kind of scientific application [2].

In co-design techniques, computer vendors and application scientists do collaborate to develop a specific exascale system that targets a series of applications rather than just concentrate on the computational limits [3]. This requires an extensive understanding of the system's performance over various topological parameters. Hence, exascale systems are benchmarked by their performance evaluation through various specific applications and parameters.

In the past few years, many researchers have been proposed to identify best among already proposed HPC interconnect [4]. Mesh topology and its variants are one of the most widely used topological designs. In this article, noble networks such as Mesh, D-Mesh, X-Mesh, and Z-Mesh are discussed in detail and made simulations through MATLAB tools to evaluate parameters like Diameter, Average distance, Message Density Cost, and Bisection Width. For each above network, the values of their topological properties are calculated and compared using bar graphs.

This paper consists of 4 sections. Where Sect. 1 explains the introduction. Whereas Sect. 2 explores the related work proposed by other researchers. Section 3 gives a complete evaluation of the comparative study where graphs depict each topological property, and Sect. 4 discusses the conclusion and future work.

2 Related Work

Many application programs are prerequisites for High-Performance Computing (HPC) to complete their tasks. Several advanced systems like Cosmic Cube, Blue Gene/Q SGI origin 2000, Intel iPSC, and Connection Machine CM-2 have implemented various interconnection networks. Typical infrastructures and designs have been proposed in the last few years in the development of interconnection networks. One of the most widely used topologies is Mesh which provides point-to-point links [5]. As it is point-to-point, nodes can communicate through any site connected. Load balancing is straightforward to manage and access the fastest path to deliver information or data. The most promising ability of the Mesh network is high fault tolerance and availability [6]. Though disadvantage is, it has bulk communication links, which makes it costlier and complex to implement.

In order to improve the Mesh network, various new variants of Mesh interconnection networks like Z-Mesh, D-Mesh, and X-Mesh are introduced by adding new links in the old Mesh setup. D-Mesh was built by adding diagonal links to Mesh, which can improve its scalability as few more routers can be connected to neighboring routers [7]. D-Mesh also decreases the necessity of having virtual channels and buffer capacity to store more flits as it was required in the Mesh network. However, X-Mesh is an improved version of T-Mesh. The drawback of T-Mesh was it has a larger Diameter and large Average Distance [8]. At the same time, X-mesh has diagonally crossed links instead of vertical links like in T-Mesh. X-mesh has a shorter Diameter and Average Distance in comparison with T-Mesh. It holds the advantage of being highly suitable for VLSI implementation. Many systems prefer Mesh and C-Mesh interconnect because of their coveted properties such as low radix routers, short-range links, and regularity. To enhance the performance, the number of virtual channels and buffer size was increase traditionally. This results in an increase in the overall cost and power consumption of the network. To improve this problem, a new topology Z-Mesh is proposed, which incorporated new diagonal links and high radix routers [9].

With the advancement in networks, various parameters have also been proposed in order to define interconnection network performances. In a network, Diameter is one of the noble topological parameters, which is defined as the maximum distance between two nodes while considering the shortest path [10]. Diameter is the measurement by which complexity and communication delay can be predicted [11]. Whereas Average Distance and Message Density also predict a network's communication delay and congestion in the network due to flits. More would be the Diameter, Average Distance, and Message Density more complexity and latency a network will experience.

While cost directly depends on Degree and Diameter and explains how difficult for building a large system in terms of resources requirement. Bisection Width explains how a network will behave if a node is dead or stopped working. It also explains the reliability and fault tolerance of a system [12].

3 Comparative Study

On the basis of MATLAB programs, results for the topological parameters such as the Diameter of the network, Average Distance of nodes, Message Density in the network, Cost of the network, and Bisection Width have been evaluated, and comparison graphs for each parameter is made.

The evaluation of parameters by writing MATLAB program is done through the following mathematical definitions. The process model quantified through these procedures.

$$\text{Average Distance} = \frac{1}{n(n-1)} \times \text{sum of all node distances} \tag{1}$$

$$\text{Message Density} = \frac{n \times \text{ Average Distance}}{\text{number of edges}} \tag{2}$$

$$\text{Cost} = \text{Degree } \times \text{Diameter} \tag{3}$$

$$\text{Diameter} = \text{Max (Maximum Distance from a source to every node)} \tag{4}$$

where 'n' is total number of nodes in any network.

Table 1 MATLAB results of topological parameters for Mesh variants

Networks	Diameter	Average distance	Message density	Cost	Bisection width
Mesh	6	2.6667	1.7778	24	4
D-Mesh	3	1.9	0.7238	24	10
X-Mesh	4	2.0667	1.1022	16	6
Z-Mesh	5	2.1917	1.0626	30	7

For each network variant topological parameters are calculated by using a separate code for each network and depicted in the tabular form in Table 1. Each topology is designed using the MATLAB graph module. To understand each network performance more clearly separate graphs for each parameter is made by using the Table 1 dataset.

3.1 Diameter

The trend of Diameter is shown in Fig. 1. With the increment in the Diameter, the distance between nodes also increases, and hence the system becomes more complex with the increase in Diameter. The results show that Mesh has the highest value of Diameter in the graph. Whereas D-Mesh is having the smallest value of Diameter, therefore the performance of ordinary Mesh in terms of Diameter is poorer as compared to other modified mashes. Among other variants of Mesh, the Z-Mesh and X-Mesh also do not have a significant impact on Diameter as such. However, X-Mesh is comparatively performing better than the Z-Mesh network.

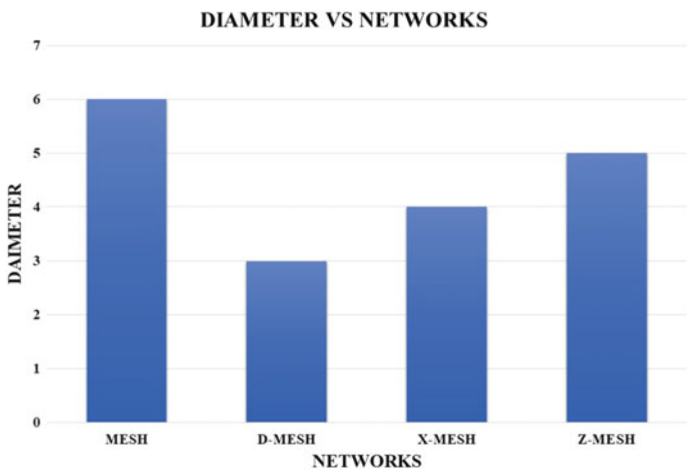

Fig. 1 Diameter of 4 × 4 mesh network variants

3.2 Average Distance

Average Distance is also an important parameter to judge the performance of massively parallel interconnection networks. One of the major factors for latency in the network is the measure of Average Distance. With the increment in Average Distance the performance of the network degraded. The highest value trend of Average Distance is shown by the Mesh network in the experimental result. Thus ordinary Mesh is also a poor performer in terms of Average Distance. At the same time, D-Mesh has the smallest value among all the networks and performed best for the Average Distance. However, X-Mesh and Z-Mesh performed average in terms of Average Distance parameters.

3.3 Message Density

Message Density is directly associated with the waiting time. High Message Density may result in a deadlock in the network. Higher Message Density also features higher communication delay and possibly a deadlock due to high congestion on the nodes of the network. Figure 2 shows trends of Message Density for the Mesh variants. The output of the graph demonstrate that Mesh network is having the highest congestion among its nodes, therefore as it performed worst in terms of Diameter and Average Distance, the ordinary Mesh network also performed worst while considering Message Density characteristics. Similarly, by having the lowest value for Message Density, D-Mesh performed the best. Whereas X-Mesh and Z-Mesh performed average for the Message Density.

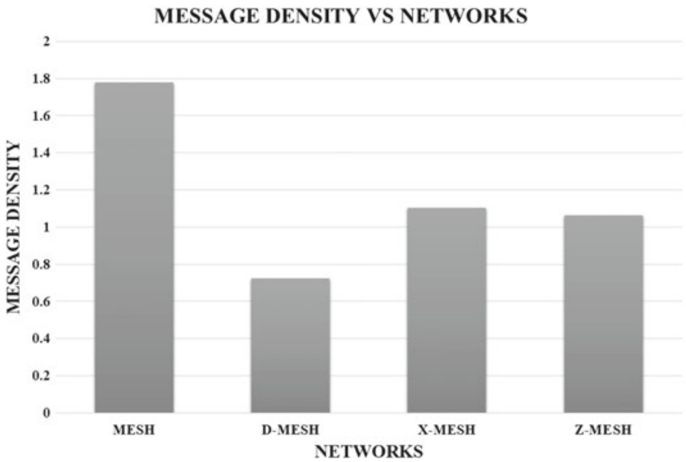

Fig. 2 Message Density of 4 × 4 mesh network variants

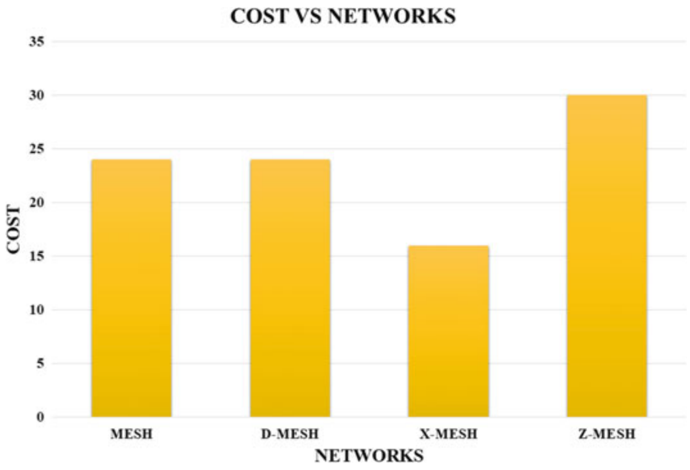

Fig. 3 Cost of 4 × 4 mesh network variants

3.4 Cost

While designing any system cost is one of the major concern which is evaluated before any prototype is developed. Cost of an interconnection network is a product of the Diameter and Degree of the network. The effect of increase in size and number of connections at each node, the overall cost of a network also increases. Figure 3 depicts the cost for different types of Mesh networks and the cost parameter for D-Mesh does not follow the same trend and comes out to be a much costlier network because D-Mesh is having higher value of the degree. According to the graph, X-Mesh is the cheapest network in terms of designing cost among various Mesh networks, whereas Z-mesh is the most expensive topological design.

3.5 Bisection Width

Bisection Width is associated with the tolerance and reliability of a system. Bisection Width is the minimum number of links that must be removed to break a network into two equal halves. Hence, the network is more fault-tolerant as long as it needed more links to break the network into two equal networks. Figure 4 demonstrates the Bisection Width, and it is noted that ordinary Mesh again performed poorest among all its modified designs of networks by having the lowest Bisection Width and tolerance. On the other hand, D-Mesh is considered as most fault-tolerant between all considered Mesh Variants by having the highest value for Bisection Width. However, Z-Mesh is comparatively more tolerant and reliable than X-Mesh.

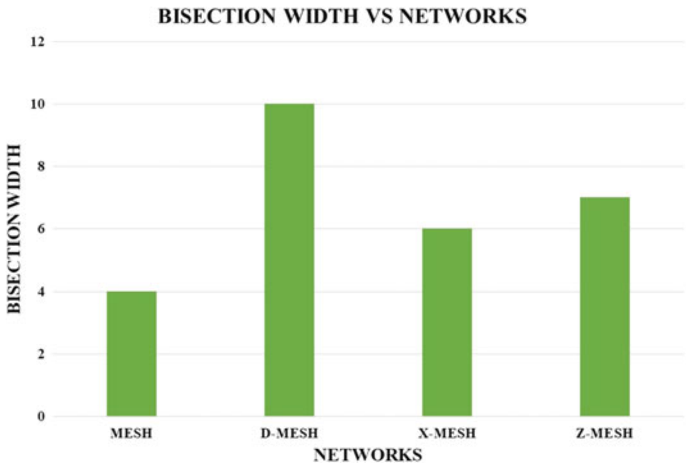

Fig. 4 Bisection Width of 4 × 4 mesh network variants

4 Conclusion and Future Work

The paper presents an analysis for Mesh-based networks on the basis of topological parameters. The various parameters like Diameter, Average Distance, Bisection Width, Cost, and Message Density are considered for performance evaluation. Graphs are drawn to show the variations among different networks for various parameters. In the comparative study of Mesh, D-Mesh, X-Mesh, and Z-Mesh, it is concluded that D-Mesh comes out to be the best network in terms of Diameter, Average Distance, Message Density and Bisection Width and ordinary Mesh network comparatively performed poorer for the same characteristics than the modified versions of Mesh networks. On the other hand, D-Mesh is come out to be an expensive network, in contrast, X-Mesh is better in terms of cost. In the future, the performance of these Mesh networks can be evaluated by injecting different types of traffics. A similar approach can be implemented for other networks such as Torus, X-Torus, and Tesh networks with more network characteristics. Study can help the designers of data centers to choose suitable network for their massively parallel applications and can achieve enhanced performance by implementing best Mesh network topology.

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Blockchain-Based Secure File Storage with Hybrid Cryptography and Machine Learning for Malware Detection

Ahmed Mohammed Ali, Vijay Ghorpade, Nitish Pathak, and Neelam Sharma

Abstract Storing your data on hosted servers is made possible through cloud storage. With each organization using the cloud to save their data, there is a significant risk of data misuse. For added security, there is an urgent need to safeguard user data. We are here to store information on the cloud, and our main goal is to make sure data confidentiality, integrity and availability are maintained. Instead of keeping data on our local server, we have developed a model that saves data on cloud-based servers. Encrypted data will be protected. Additionally, it will check for malware attack policy while exchanging data. Finally, it will feature two layers of protection. The first is an implementation of hybrid cryptography, and the second is to avoid malware-based attacks. Incorporating machine learning will find all of the various possible malware attack methods and look for ways to prevent similar attacks in the future.

Keywords Decryption · Encryption · Machine learning · Malware · Security

1 Introduction

In regard to information on the Internet, there are pretty important security issues. To prevent sensitive data from being lost in the event of a file system crash, we have developed a solution. An encryption algorithm is a reliable method for safeguarding sensitive data. It is a way of storing and transferring data that only the intended parties can read. Many users storing their data in cloud data triggers cloud computing's

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secondary challenge, which is security, like protecting the integrity and correctness of a user's data in the cloud. The components of traditional storage devices, such as flash drives, hard discs and other physical storage devices, are rapidly becoming obsolete [1]. Companies need to share data so that employees in different locations can work together. Security is an essential service for wired networks and wireless networks to make the cloud's offer even better. Information and knowledge, while stored on clouds, do not eliminate the problem [2]. The defining feature of this process is that the key has to be recovered. The project's objective is to design a safe and encrypted file storage system for distributing files between users who are located at remote locations [3]. To use this system, you must first successfully encrypt an input using any encryption techniques and store it anywhere. To read the data stored in the uploaded file, the user must use the decryption algorithm and the information about the uploaded file provided by the owner to decrypt the file [4]. Increasing cloud use in multiple industries offers new software at a low cost. Concerning the low price and accessibility of data, cloud computing is advantageous. Cloud computing provides a wide range of benefits at a low cost, along with increased accessibility to data via the internet. To ensure the security of cloud computing, data that is not under the control of the data owner is the goal [5].

Blockchain technology has changed the way businesses process transactions and applications by introducing decentralized applications and verification, which have been dependent on centralized architectures or trusted third parties. The blockchain offers transparency, durability, suitability and security by design [6]. Even with the exciting possibilities blockchain technology offers for building the future Internet system, it faces many technical challenges. First, the problem is scalability. Bitcoin's block size maxes out at one megabyte, and blocks are created every ten minutes. The system then caps the network's transaction processing speed at seven transactions per second, preventing it from handling high-frequency trading [24]. It is established that each transaction is validated by the consensus of the majority of members in the system. Meaning that, since data has been entered, it is impossible to remove. Every transaction is recorded in the blockchain's permanent ledger. It is easier to steal from a cookie jar in a secluded location rather than one in a heavily trafficked area, where you are more likely to be caught [7] (Fig. 1).

2 Literature Survey

The importance of security has never been greater than it is today. A large part of this domain's research focuses on preventing security breaches and leaks.

Shahade et al. (n.d.) discovered using the RSA and AES algorithms together, they developed a new type of encryption known as hybrid encryption. Using their system, the user generates an RSA private key, stores it and produces an RSA public key. In the cloud, the server encrypts and holds the file using RSA and AES [8].

In their research, Mata et al. [9] elaborated that the combination of AES and Blowfish algorithms is used to encrypt and decrypt data. For both encryption and

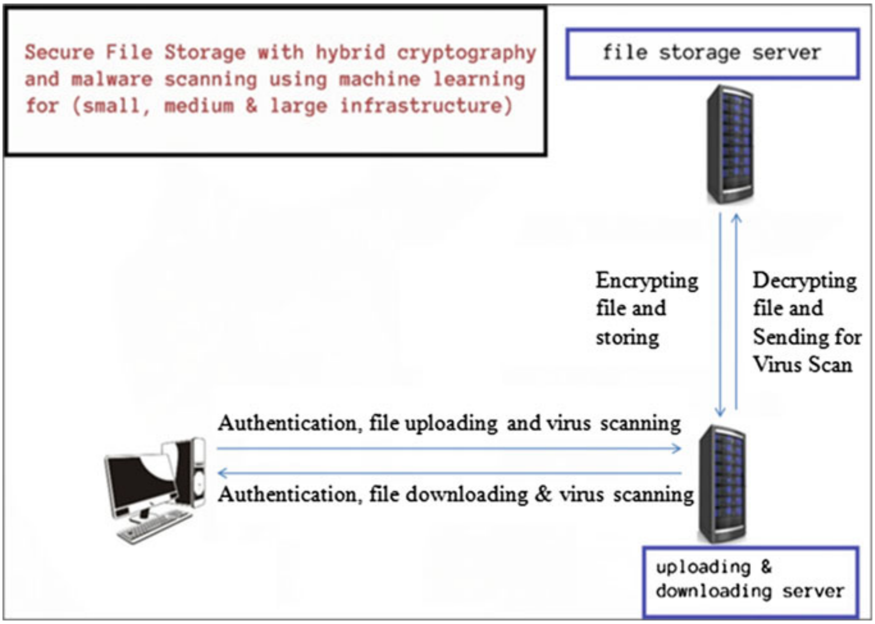

Fig. 1 Malware scanning process while uploading and downloading the data

decryption, the run time increases, resulting in a longer total processing time. Their planned research compares the performance attributes like throughput, encryption time, ciphertext size and delay. We propose the three encryption algorithms, AES, Blowfish and the combination of these algorithms, which use optimization metrics such as throughput, encryption time, ciphertext size and delay [10].

Shah [11] identified that, to balance the asymmetry in asymmetric cryptography, their system added layer of security that combines algorithms including AES, DES, RC6, ECB, CBC and Triple DES. A process for dealing with file security issues in storage systems has been developed. Similarly, cloud computing employs new techniques and methods for implementation. The proposed system users can store the data, and they will access it using the cloud computing service [12].

3 Existing Algorithms in Cryptography

In the IT industry, security can no longer be ignored. You can purchase many technologies to secure your data, but understanding encryption is a security aspect that everyone should be aware of. A message or file is encrypted so that only those allowed to read it can do so. Message senders use complex algorithms to decrypt scrambled data using the keys they send. Information is kept private and confidential, whether it is stored or in transit, thanks to encryption [13]. Access to data without permission will see a chaotic mix of data bytes.

(a) Triple Data Encryption Standard: Triple DES, otherwise considered entirely secure due to its long key length, has a third form that is regarded as even more secure. A Triple-DES key is three times as long as a single DES key at 192 bits. Of each key, only 56 bits, i.e. k1, K2 and k3, are considered, rather than 64. Because of the values of these three keys, eight bits of every key are ignored as key bits, with the remaining bits being used as parity bits [14].

(b) Advanced Encryption Standard: Advanced Encryption Standard is an abbreviation for Advanced Encryption Standard, a cryptography standard defined in the Federal Information Processing Standard (FIPS) 192. AES is the newest of the four cryptographic algorithms currently used by the federal government in the USA. AES is a 128-bit block encryption algorithm that straightforwardly performs its duties. AES is symmetric because encryption and decryption are performed using the same key [15]. AES is one of the NIST block cipher-encryption algorithms published in 2000. DES algorithm's shortcomings prompted this algorithm's development to replace it. NIST invited experts working in data security and encryption around the world to introduce a robust new block cipher algorithm used to encrypt and decrypt data [16]

(c) RSA Security: A public-key cryptography system has two keys: one secret and one public. Though dissimilar, the two key pair parts are mathematically connected. Both keys can encrypt and decrypt the plaintext and ciphertext, respectively. Neither key is capable of performing both tasks alone. It is safe to publish the public key, but you must keep the private key secure and secret. The asymmetric key algorithms, such as RSA, are used for public-key cryptography. It is easy for the recipient to create the public and private keys, but it is challenging to figure out the private key from the public key alone. However, it is computationally demanding for the sender to encrypt the message using the public key [17].

(d) Blowfish: Blowfish is a simple block cipher with 64-bit block size. This algorithm follows the Feistel network and has two main steps: key expansion and data encryption.

(e) We will use sub-key arrays to break a key of up to 448 bits into 4168 bytes. The network will be iterated 16 times in the process of encrypting data. The key- and data-dependent substitution is part of each round, along with the key-dependent permutation. The processing in the algorithms includes XORs and 32-bit word additions. We also need to create four lookup tables indexed by the round number for this process [5].

(f) Twofish: An algorithm with 128-bit blocks and a key length that varies from 0 to 256 bits. It is more secure and easier to use. Large processors and 8-bit smart card processors both work well with it. It has a total of 16 rounds, which in each game predict at least 32 bits of non-trivial data [18].

4 The Aim of the Study

It is the goal of the research to design a cloud-based document management and resource sharing system to address issues that influence cloud computing performance, security and reliability. The purpose of this study is to determine what factors influence customer behaviour:

- To propose a comprehensive solution for securing users' private information, privacy and trust in cloud computing.
- To establish a standard against which users can measure their available capacity in the cloud service for scaling and load balancing.
- To provide a shield against malware attacks.

5 Hybrid Cryptosystem Technique

A hybrid cryptosystem is used to ensure data security in the cloud. In this instance, we assume that the remote server is trusted, so files are encrypted by the server and encrypted at the small end. Encryption and malware scanning are utilized in this solution. In a physical or network environment, the protection of data is essential for proper communication. Because of advances in information technology, sending and receiving data over the internet is simple, fast and affordable. The protection of confidential communications is essential when transferring data in the network [5]. It introduced a new hybrid cryptography technique, based on message digest and symmetric algorithms, used for asymmetric algorithms. This research study suggests that a hybrid cryptographic scheme in a digital envelope combines the message digest and symmetric key cryptography algorithms. Message digest is a digest of messages or information [19].

5.1 Encryption Using ML

Machine learning (ML) and cryptography differ in many ways, but they also share many similarities, such as large data sets and complex search spaces. ML applications in cryptography are not new; however, given that over 3 quintillion bytes of data are generated each day, ML techniques are more relevant now than they were in the past. A machine learning algorithm generally automates the building of analytical models to learn and adapt as more and more data are fed into it [20]. A mathematical model can be used to identify the relationship between input and output data created by cryptosystems. ML techniques such as boosting and mutual learning can create the private cryptographic key over the public and insecure channel.

5.2 Malware Scanning

The term "scoping out the target environment" is the term that describes port scanning, which is a way for attackers to understand their target environment by sending packets to specific ports on a host and monitoring the responses. It means that due to the many legitimate uses of port scanning, it is critical that the system can accurately distinguish between the two: benign and malicious scanning. Empirical approaches analyse patterns, such as the number of times an IP address has scanned each port. Malicious activity can sometimes be indicated by the high amount of scans carried out on multiple ports by an IP address. Using statistical models, it is possible to discern whether scanning behaviour deviates from the expected norm on the network. IDS and firewalls are generally configured to detect scans. Still, scanners can alter the frequency and order of scans and avoid detection by changing the port sequence or mask their source address [21].

5.3 Malware Scanning

The method of distributing malware depends on the specific goals of developer.

- Computers running malicious software, commonly called computer viruses, are programmed to reproduce and spread from one computer to another. They may occasionally replicate and spread to computers on a network [22].
- Malicious programmes appear to be practical applications but once activated, they cause damage to the computer on which they reside.
- A Trojan horse is distinct from a virus, which replicates itself. Instead, a specific piece of malware will attempt to obtain personal data or passwords.
- A computer worm spreads throughout a network by replicating itself. A computer worm will spread across computers instead of viruses that usually spread from file to file on a single computer.
- Programme logic bombs are hidden within the software and can be set off by the user or activated at a predetermined time. They can destroy a system or render a hard drive unusable [2].

6 Developed Model

The waterfall model is a linear, sequential flow. As a software development strategy, progress appears to flow steadily downward, like a waterfall. Phases of development do not begin until all preceding steps are complete. There is no defined process for handling changes in requirements. Using the waterfall methodology early on was the earliest strategy employed in software development (Fig. 2).

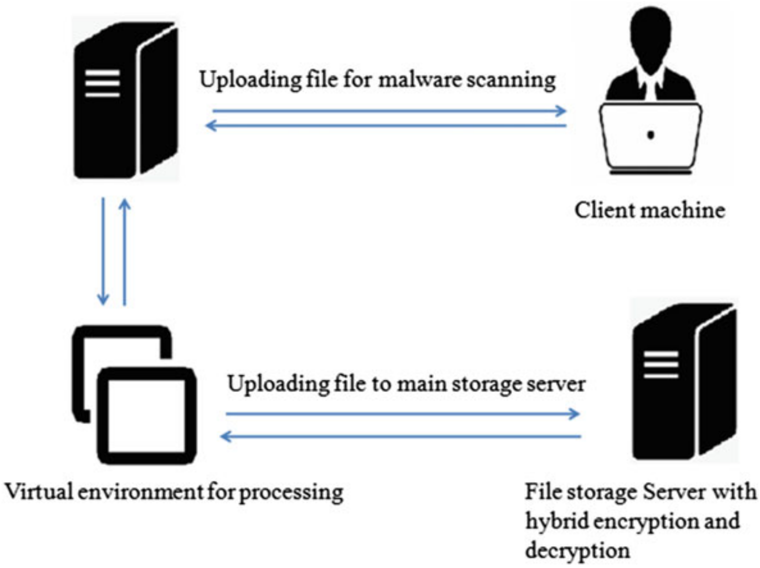

Fig. 2 Working on hybrid encryption and decryption of the system

The following steps need to be performed during the execution of this project;

Step 1: The client will upload the file to the cloud.
Step 2: Before sending the file to the cloud, it will check for the malware scanning model. If it qualifies the step, files will get encrypted.
Step 3: Once the cloud server receives files, it will scan for the malware. Then files will get decrypted.
Step 4: Decrypted files will get stored on the server.
Step 5: Once the client receives a request to access the files, it will scan the malware again.
Step 6: Files will be sent to the client encrypted.
Step 7: Files will get decrypted, and again, it will check for malware scanning.

7 Result Analysis and Discussion

The developed model allows for malware scanning while storing data on a blockchain-based server. Blockchain technology is currently being used to store data, but there is a possibility of storing data with malware. By using the developed model, files will be scanned before they are sent to the server. The virtual environment created will assist in the scanning process. Once the files are downloaded, they will be checked again for malware. All files will be scanned for malware before encryption and decryption. In this way, malware threats become impossible.

8 Conclusion

Nowadays, protecting sensitive or confidential data is critical for any organization or individual. Security was maintained only for governments and militaries, but anyone can now employ it to keep their data safe. For the time being, encryption is seen as the best way to ensure data security and keep it secure. This paper contains the results of comprehensive research on cloud data storage security. The data will have to qualify the malware scanning in both cases. It will check for malware while sending and receiving the files. When we say malware scanning, it will contain all the related malware kinds of attack. Ultimately, data will be securely stored in the cloud storage. Traditional cryptography only encrypt/decrypt data, but this system also provides the malware scanning facility with the existing advantage of cryptography.

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False Data Injection and Detection in Smart Grid Cyber-Physical Systems by Iterative Load Flow Analysis

Swati Sharda, Kapil Sharma, and Mukhtiar Singh

Abstract In a cyber-physical system, there is an exponential rise in cyber-attacks targeting power grid monitoring systems. False data injection attacks (FDIAs) are potential threats to the security of the smart grid as they can bypass the bad data detection (BDD) attack by manipulation of the power system state estimation (SE). Most works on false data injection (FDI) attack detection comprise computationally expensive and memory-intensive models to detect and analyze the attack. This paper introduces a cost-effective iterative procedure that conducts the load flow analysis using the efficient and improved Newton–Raphson (N-R) method. The aim is to detect the attacked node by comparing bus states' comparison analysis before and after the attack. It is implemented by creating instances of false data injection. Further, we discuss a defense mechanism to avoid such attacks in the future. Case studies on the IEEE-9, 14, 30, 57, and 118- bus systems demonstrate that the proposed method can inject and detect the FDI attack on different voltage magnitudes.

Keywords Bad data detection (BDD) · False data injection (FDI) · Newton–Raphson method (N-R) · Energy management system (EMS) · Fast decoupled load flow (FLDF)

1 Introduction

Smart grid envisions modernization of the delivery systems of electricity which plays an imperative role in the safety of power generation and its transmission and distribution.

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The primary threat is posed to the stability and security of society due to the vulnerability and susceptibility of critical infrastructure of the smart grid [7]. Above all, smart grids, which integrate classic components of a power system with information and communication technology (ICT) to build a cyber-physical system, are considered to be particularly insecure and vulnerable due to (among many reasons) targeted attacks [23]. Ongoing research on the operation of power systems is developing ways to deal with power system disturbances and physical defects such as outages, random and off-nominal frequency waves [18], and voltage and angle imbalances [6, 16]. However, developing methods to minimize and manage the impact of cyber-attacks on power systems and smart grids is a relatively new field, and classical security practices, mainly derived from ICT, are currently viewed as insufficient and inadequate against this growing risk.

Load flow analysis is a critical aspect in effective planning of economic power generating scheduling and calculation of power loss, bus voltage, and angle. Thus, globally, several forms of load flow analysis, namely, Newton–Raphson, Gauss–Seidel, and Fast decoupled Load Flow methods, are employed. The Newton–Raphson method [15] allows for simple convergence as well as a wide range of sensitivity studies, system optimization calculations, and outage evaluations.

After conducting the load flow analysis and obtaining the results on grid functioning, we proceed with false data injection in the smart grid. Recently, a lot of attention has been attracted by false data attacks and their countermeasures. The authors in [4] suggested that if the hackers and attackers have prior knowledge of power grid topology, they can successfully manage a data attack that can dodge detection by bad data detection (BDD) system on a global scale in the state estimator. Hereafter, plenty of efforts have been made to design efficient attack algorithms as well as the corresponding countermeasures, such as [13, 20, 22]. In our paper, we have introduced a cost-effective method that injects a random value in each range in the bus voltages of the nodes that represent the IEEE bus systems in the smart grid. Various false data detection methods relying on spatial-temporal correlation, real-time correlation, and statistical correlation of meter measurements have been proposed. Previously unobservable attacks have been detected by the method proposed in [25]. However, it comes with a limitation that it cannot detect the attacks where the measurement devices are temporarily compromised, called sparse attacks.

Furthermore, other solutions to this problem require either reliable and authentic load forecasts [17] or explore the ways of machine learning and reinforcement learning [11]. The shortcoming with the machine learning approaches is that they need an extensive data set of historic grid states for training which is also required to contain attacked states to train the model. Obtaining such datasets is very difficult. In [2, 14], hardware and protocol-specific solutions are suggested which employ the signals originating from hardware components and from the process level, respectively, which add to its limitations.

This article will focus on smart grid load flow analysis through the Newton-Raphson algorithm and executes false data on the bus voltage of the nodes randomly. We have implemented this mechanism on various bus systems such as IEEE-9, 14, 30, 57, and 118 to depict the adaptability and flexibility of the proposed model. If a change is detected in the "change matrix," the concerning authorities will be alerted.

The remainder of the paper is organized as follows. In Sect. 2, we introduce the graph representation of the Power System. The load flow analysis using the Newton–Raphson algorithm is explained in Sect. 3. The concept of injection of false data in the bus is presented in Sect. 4. In Sect. 5, the detection mechanism is explained, and in Sect. 6, results of the case studies on IEEE-9 and 14 bus systems are examined in detail with comparisons to previously published papers in this domain.

2 Graph Representation of Power System

A suitable construction of an abstract representation of a system as a network topology with statistical measurements is enabled with the application of graph theory to this problem. Hence, a review of topology changes on the system's robustness when exposed to different types of attacks is conducted. Representation through scale-free graphs resembling electric power systems enables the depiction of most of the assets that define the power grid. If substations are presented as nodes and electric lines, we can drastically simplify the complex network system. Mathematically, a graph can be represented by an adjacency matrix consisting of node and edges pair.

$$G = (D, E) \tag{1}$$

where $D(G)$ is the set of nodes and $E(G)$ the set of edges.

The pairs of nodes are connected by edges in form of $E_(i, j)$ where (i, j) denotes the link. Analysis of the adjacency matrix properties can be done by studying the properties of a graph. The nodal degree ($\deg_i$) is the set of the converging edges (E_i) to a specific node (D_i):

$$\deg_i = |D_i| \tag{2}$$

where, $D_i = j \in D|i, j \in E$

Since randomly disrupted node may relate to one of the low connectivity degrees, this representation proves to be very useful in assessing the random error-related risks. Figure 1a, b represents the graphical representation of an IEEE-5 Bus system.

3 Analysis Using Newton–Raphson Method

The Newton–Raphson method is a powerful technique that uses bus admittance matrix in either first- or second-order expansion of the Taylor series. It is based on the idea of linear approximation. Due to good accuracy and insensitivity to slack bus selection factors, regulating transformers, Newton–Raphson proves to be a good fit for performing load flow analysis. It also requires fewer iterations comparatively to

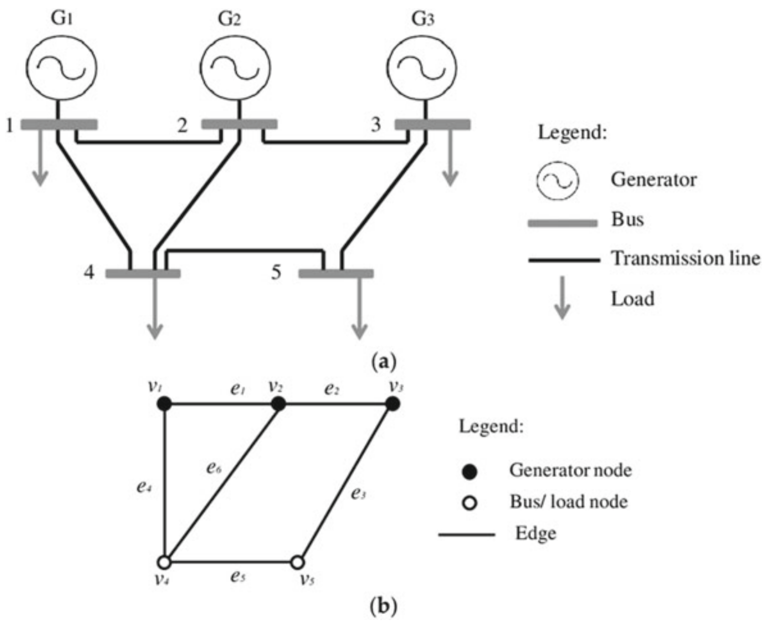


Fig. 1 **a** Represents IEEE-5 bus system, whereas **b** is the graphical representation of (**a**)

reach convergence while simultaneously taking less computation time and cost. In addition, the system size rarely affects the number of iterations required which is suitable for our work as it deals with multiple IEEE bus systems.

Algorithm:

1. The magnitude and phase angle of the bus voltages for the load buses P and Q are initialized for all buses present in the system, except for the slack bus with a value (where V and δ are specified). Generally, the assumed bus voltage magnitude and phase angle are kept equal to the slack bus quantities.
2. The real and reactive components of power is calculated by substituting these assumed bus voltages (both real and imaginary). P_i and Q_i, for all the buses i = 2, 3, 4, …, n except the slack bus, i.e., bus:1.
3. Since the magnitude of P_i and Q_i for any bus i is given, hence specified error in the power would be:

$$\Delta P = P_{specified} - P \tag{3}$$

$$\Delta Q = Q_{specified} - Q \tag{4}$$

4. Further, The latest bus voltages and calculated power are used to derive the elements of the Jacobian matrix (J_1, J_2, J_3, and J_4).

5. Then, the iterative technique or the Gaussian elimination method is used to solve the linear set of equations to accurately determine the voltage correction, i.e., Δe_i and Δf_i at any bus i.
6. Moreover, new estimates of the bus voltages are calculated with the help of this value of voltage correction determined in the above step.
7. Using this new estimate of the bus voltage, the power error is determined. Thus, the entire algorithm starting from step 3 repeats itself.

In this procedure, the elements of Jacobian are computed as these depend upon the latest voltage estimate and calculated power in each iteration. This procedure is continued until the power error determined becomes minute.

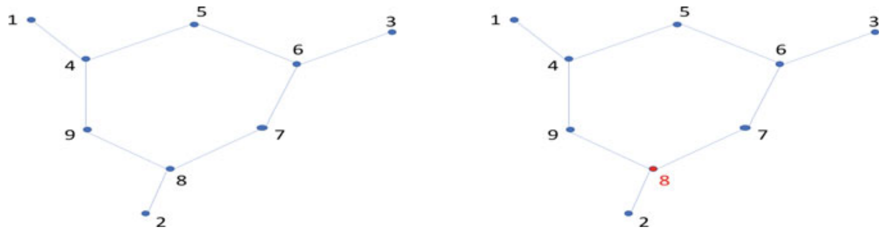
$$\Delta P < \epsilon \ and \ \Delta Q < \epsilon \tag{5}$$

The drawback of this method is that it is a bit complex with more calculations involved in each iteration.

4 False Data Injection in the Smart Grid

False data injection (FDI) is a cyber-attack on the state estimation process in smart grids. The state of a power system comprises phase angles and bus voltage magnitudes. The FDI attack targets data integrity. Hence, it is different from the classical cyber-attacks that target data availability or confidentiality, such as eavesdropping attacks, flooding, denial-of-service, jamming, etc. Moreover, these attacks can be initiated multiple times without being traced. Injection attacks are often colluded with physical attacks to cause line outages. In other types of attacks on injection measurements, the attack vector is unstructured and amorphous and is thus, probable to be detected by BDD. On the other hand, FDI attacks are capable of evading BDD so that injection measurements remain undetected. It is why we need an efficient detection mechanism that does not let the false data injected go undetected. Furthermore, a cost-effective and efficient defense mechanism is needed to protect the smart grid from such patterns of attacks in the future.

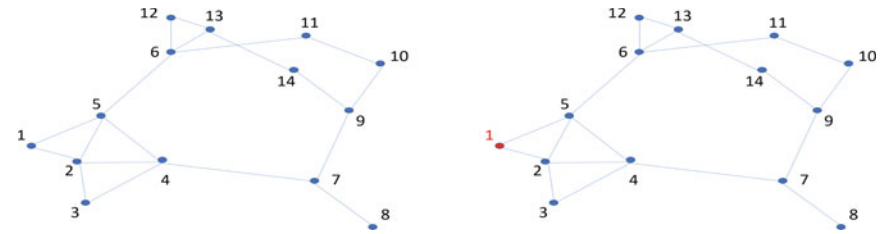
In our model, false data is injected in the bus voltage of the nodes representing the bus voltages randomly. To elaborate, a function is written to add a random error in a given range to the bus voltages on the graphical nodes representing the various buses. The bus is chosen randomly in which the random value is injected. The advantage of randomly changing the voltage is to hide the identity of a node being affected so that there is uncertainty in the security system which node has been attacked. In the time taken to detect this error, the injected bad data already introduces faults in the other node's bus voltages and phase angles, therefore, corrupting the entire grid in a matter of time. Figures 2 and 3 represents the IEEE-9 and 14 bus system under FDI attack.



(a) Graphical representation IEEE-9 bus system.

(b) Node 8 is attacked

Fig. 2 Graphical representation IEEE-9 bus system and attacked node



(a) Graphical representation IEEE-14 bus system.

(b) Node 1 is attacked

Fig. 3 Graphical representation IEEE-14 bus system and attacked node

5 Detection of an FDI Attack

This section presents an efficient approach for the detection of FDI attacks in smart grid systems. The current approaches for detecting bad data in the smart grid are highly dependent on the state estimation of the power system. Since FDI attacks produce anomalous state estimations, BDD methods can be deployed directly for smart grid systems. This approach has been studied in numerous research domains such as image processing, sensor networks, and cyber intrusion [1, 5, 19].

Our approach for detection aims at a computationally inexpensive method to detect the FDI attacks by conducting the load flow periodically. In regular intervals, the conducted load flow analysis gives us the state estimation. The state estimation results are compared with the initially set database for the respective bus system. The change matrix can then be output with a consequent graphical representation. If an error is introduced in the bus voltages in any nodes, the change matrix determines the node attacked and the value injected in the node. If the change matrix is not a Zero matrix, it means an FDI attack has compromised one of the nodes and the concerned authorities are alerted.

The detection approach has been implemented on multiple IEEE bus system namely IEEE-9, 14, 30, 57 and 118. Other than adaptability, our proposed model is also computationally cheap and does not require any prehistoric data to learn patterns. In addition, the method is economical and can be easily updated to adapt to the needs of the ever-evolving smart grid system. With a great accuracy score, this model also presents efficacy and utility.

6 Results

6.1 *Comparison of Results*

In this section, the proposed model is compared to some previously published papers and a parallel is drawn to bring out the advantages and limitations of our model respectively. This is discussed in Table 1.

6.2 *Case Study*

IEEE Bus-9 For performing the load flow analysis, the Newton–Raphson method is employed on the IEEE bus system-9 with originally documented values. The analysis is conducted twice, before and after performing injection of false data in the grid system. The line flow and losses calculated before the injection are illustrated in Table 2. It shows the calculations of readings of a properly functioning IEEE-9 bus system. Further, Table 3 illustrates the irregularity that is introduced in all the grid calculations after a minor error of (-1.0800) is introduced in the 7th node of the grid system.

We observe that the injection of false data on this node leads to introduction of error in the bus voltages of all the nodes thereby corrupting the entire bus system as seen in Table 3. The difference in the line flow and losses before injection and after injection of false data is used to detect the injection attack.

IEEE Bus-14 Similarly in the case of IEEE-14, the Newton–Raphson load flow analysis was performed with the originally documented values. The analysis is conducted twice, before and after performing injection of Bad data in the grid system to illustrate the difference in Line flow and loss calculations after an FDI attack. The Line flow and losses calculated before the injection attack are illustrated in Table 4. Table 4 illustrates the calculations of a properly functioning IEEE-14 bus system. Moreover, Table 5 illustrates the irregularity that is introduced in all the grid calculations after a minor error of (-0.0300) is introduced in the 3rd node of the grid system.

It is observed that the FDI attack on this node leads to introduction of error in the bus voltages of all the nodes thereby corrupting the entire bus system as seen in Table 5. The difference in the Line flow and losses before injection and after injection of false data is used to detect the injection attack.

Table 1 Comparison table

Comparison of results		
References no.	Features of the mentioned paper	Comparison with our paper
[9]	– Behavioral features of the FDI attacks extracted using the historical measurement of data – The database used for model training will become outdated. On updation, the entire model will have to be trained again which renders the model inefficient in terms of computation time taken and memory consumed – The ever-evolving smart grids have a disadvantage in the deep learning model due to in-adaptable and rigid model definition – The deep learning-based proposed mechanism effectively eases the presumptions on potential attack scenarios	– Graph representation of the IEEE bus systems makes it easier to implant new buses or loads and study the paths between the nodal representation of the buses, generators and loads – The proposed model is tested out for 100% accuracy on 7 Bus systems giving it an advantage in accuracy, adaptability as well a variance on different a bus systems
[2]	– The model lacks to find the estimate of injected bad data after detection. Core of the estimation and detection problems in the smart grids lies in assuring good estimation performance	– Our model after detection presents a matrix showcasing the approximate value injected at the node. We also compare how the voltage magnitude, angle, real power and reactive power are affected
[3]	– Throughout the simulations performed, the FDI attacks were represented by 100 attack instances, each of which consisted of 6–12 attack vectors. However, in every 915 of 1000 Attack Vectors, 850/1000 are detected with 72 false positives and 137 false negatives – The RNN model is time consuming and costly in terms of computation power and time. It also becomes outdated with time since the data on which it has been trained becomes outdated in a few years	– Our model provides 100% accuracy as opposed to 99.901% accuracy rate of the RNN model – Our model produces instantaneous results without delays and outputs a properly defined matrix specifying in which bus the false data is injected – Our model supersedes the RNN model by consuming less computation power, time and memory. It's also adaptable to new data due to easy graphical representation
[21]	– In [21], all the three detectors yield over 80% accuracy for direct FDI attacks and over 85% accuracy for stealth FDI attacks – The model also falls short on the run-time performance and cost analysis since they are too high	– Our model produces 100% accurate results for FDI attacks with knowledge of the grid topology – The matrix showcasing the false data injected node along with the value – Our model is much faster and cost-effective that can easily be implemented in the real-world

Table 2 Line flow and losses calculated before the false data is injected in the smart grid system in IEEE bus system-9

From bus	To bus	P (MW)	Q (M Var)	From bus	To bus	P (MW)	Q (M Var)	Line loss (MW) (MVar)	
1	4	71.56	21.32	4	1	−71.56	−18.35	0.00	2.97
2	7	163.00	7.93	7	2	−163.00	7.61	0.00	15.54
3	9	85.00	−9.54	9	3	−85.00	13.45	−0.00	4.00
4	5	50.25	29.29	5	4	−31.87	−27.26	18.38	2.03
5	7	−68.97	1.42	7	5	102.97	10.00	33.99	11.42
6	9	−40.97	2.63	9	6	80.28	3.19	39.31	5.82
7	8	84.40	6.76	8	7	−68.12	−2.80	16.28	3.96
8	9	−13.06	−13.38	9	8	35.47	14.11	22.41	0.73
Total loss								130.37	46.47

Table 3 Line flow and Losses calculated after the false data is injected in the smart grid system in IEEE bus system-9

From bus	To bus	P (MW)	Q (M Var)	From bus	To bus	P (MW)	Q (M Var)	Line loss (MW) (M Var)	
1	4	71.64	27.05	4	1	−71.64	−23.92	0.00	3.12
2	7	163.00	6.65	7	2	−163.00	9.18	0.00	15.83
3	9	85.00	−10.86	9	3	−85.00	14.96	−0.00	4.10
4	5	50.20	32.15	5	4	−31.96	−29.96	18.24	2.19
5	7	−69.15	3.85	7	5	102.72	7.72	33.57	11.57
6	9	−41.11	4.90	9	6	79.89	1.00	38.79	5.90
7	8	84.22	7.04	8	7	−68.22	−3.02	16.00	4.03
8	9	−13.31	−13.51	9	8	35.22	14.26	22.01	0.75
Total loss								128.60	47.48

The “change matrix” for bus system IEEE-9 and 14 has been shown in Fig. 4a, b respectively. It shows the anomaly that was introduced to corrupt the grid system. The nonzero “change matrix” depicts that an anomaly has been injected in the bus voltages randomly. One can determine the node in which the error is injected from the “change matrix.”

The false data injection and detection has been performed on other IEEE bus systems as well, i.e., on 30, 57, and 118. Due to long tables and big graphs, we have not shown the results here.

Table 4 Line flow and losses calculated before the false data is injected in the smart grid system in IEEE bus system 14

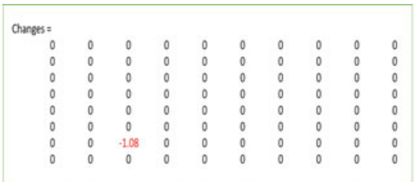
From bus	To bus	P (MW)	Q (M Var)	From bus	To bus	P (MW)	Q (M Var)	Line loss (MW) (M Var)	
1	2	160.05	−17.48	2	1	−149.89	30.46	10.16	13.15
1	5	78.28	7.98	5	1	−70.20	3.46	8.08	11.45
2	3	75.79	5.94	3	2	−68.83	3.89	6.96	9.83
2	4	57.80	2.94	4	2	−52.53	2.13	5.27	5.07
2	5	43.62	4.74	5	2	−39.02	−1.93	4.60	2.81
3	4	−22.48	7.75	4	3	24.19	−6.75	1.70	1.00
4	5	−59.58	11.57	5	4	00.60.06	−10.06	0.48	1.51
4	7	28.30	−16.10	7	4	−27.67	5.69	0.62	−10.41
4	9	16.47	−2.81	9	4	−15.96	−2.25	0.51	−5.06
5	6	52.83	−24.00	6	5	−49.24	−7.00	3.59	−31.00
6	11	8.29	8.90	11	6	−8.16	−8.64	0.12	0.26
6	12	8.06	3.18	12	6	−7.98	−3.01	0.08	0.17
6	13	18.34	9.98	13	6	−18.09	−9.49	0.25	0.50
7	8	−0.00	−20.36	8	7	0.00	21.03	−0.00	0.67
7	9	27.07	14.80	9	7	−27.07	−13.84	0.00	0.96
9	10	4.39	−0.90	10	9	−4.39	0.92	0.01	0.02
9	14	8.64	0.3214	14	9	−8.55	−0.13	0.09	0.19
10	11	−4.61	−6.72	11	10	4.66	6.84	0.05	0.12
12	13	1.88	1.41	13	12	−1.87	−1.40	0.01	0.01
13	14	6.46	5.08	14	13	−6.35	−4.87	0.11	0.21
Total loss								42.688	1.448

7 Conclusion

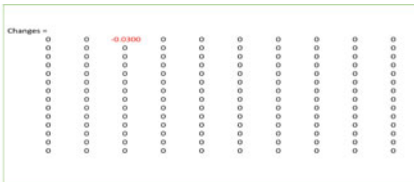
This paper presents complete research on cost-effective and computationally inexpensive methodology to save a smart grid system from FDI attacks. The FDI attacks are menacing as it attacks power system state rather than data integrity. First, FDD has been injected in the bus voltages by random value change. Then, an efficient and computational inexpensive Newton–Raphson method has been employed for load flow analysis to detect the attack. This study is conducted on various IEEE bus systems such as 9, 14, 30, 57, and 118. It is observed how an anomaly introduced in one node can corrupt an entire bus system and how protecting a subset of the initial grid values proves to help defend the system from such future attacks. A comparison has been drawn with the previously proposed successful models, and the strengths and limitations have been put forward. We plan on proposing a cost-effective and efficient algorithm for our defense mechanism for future work. Furthermore, our current

Table 5 Line flow and Losses calculated after the false data is injected in the smart grid system in IEEE bus system 14

From bus	To bus	P (MW)	Q (M Var)	From bus	To bus	P (MW)	Q (M Var)	Line loss (MW) (MVar)	
1	2	159.81	37.02	2	1	−149.56	−24.11	10.25	12.91
1	5	78.67	19.39	5	1	−70.39	−7.91	8.28	11.48
2	3	75.51	5.96	3	2	−68.57	3.79	6.94	9.76
2	4	57.77	0.26	4	2	−52.49	4.79	5.28	5.05
2	5	43.60	0.86	5	2	−38.99	1.91	4.61	2.77
3	4	−22.74	5.07	4	3	24.43	−4.11	1.69	0.96
4	5	−60.23	7.04	5	4	60.70	−5.55	0.47	1.49
4	7	28.56	−17.01	7	4	−27.94	6.51	0.63	−10.51
4	9	16.60	−2.85	9	4	−16.09	−2.26	0.51	−5.11
5	6	52.34	−20.93	6	5	−48.78	−10.28	3.56	−31.22
6	11	8.06	7.92	11	6	−7.95	−7.70	0.11	0.22
6	12	8.01	3.05	12	6	−7.93	−2.89	0.08	0.16
6	13	18.20	9.47	13	6	−17.96	−9.00	0.24	0.48
7	8	−0.00	−22.71	8	7	0.00	23.53	0.00	0.82
7	9	27.32	16.34	9	7	−27.32	−15.33	0.00	1.01
9	10	4.60	0.01	10	9	−4.59	0.00	0.01	0.02
9	14	8.81	0.91	14	9	−8.72	−0.71	0.09	0.20
10	11	−4.41	−5.80	11	10	4.45	5.90	0.04	0.10
12	13	1.83	1.29	13	12	−1.82	−1.28	0.01	0.01
13	14	6.27	4.48	14	13	−6.18	−4.29	0.09	0.19
Total loss								42.894	0.786



(a) The change matrix for IEEE bus 9 after injection of false data.



(b) The change matrix for IEEE bus 14 after injection of false data.

Fig. 4 The change matrix for IEEE bus 9 and 14 after injection of false data

model works on the DC power model, and we plan to put forward an approach for an AC non-linearized model.

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Empirical Study on Energy-Efficient IoT-Based WSN Routing Protocols for Smart Agriculture System

Ashutosh Kumar Rao, Kapil Kumar Nagwanshi, and Sunil Pathak

Abstract In agriculture, Internet of Thing (IoT) system can be used to provide information to the farmers which will very helpful to increase the farming efficiency. Modern agriculture requires the use of new technology to increase manufacturing process, supply, and consistency. Indeed, recent developments in computational modelling, segments and subsystems, software, and smart sensors have allowed the development of compact and inexpensive detectors. The smart systems are allowing the implementation process in varying circumstances considerably simpler. In this paper, various smart agriculture existing techniques are reviewed. The basic architecture of the wireless IoT-based agriculture system is represented with its nodes. There are various techniques used in wireless IoT-based agriculture system that are also mentioned in the paper. In wireless sensor networks, routing protocols play a very essential role. The routing protocols that are helpful in wireless IoT-based agriculture system are discussed in the paper. The existing techniques are compared with different parameters.

Keywords IoT · Smart agriculture · Routing protocols · WSN

1 Introduction

made up of a collection of integrated different nodes known as receptors that communicate through wireless networks. The collection of parameters connected to the ambient atmosphere, such as weather, pressure, or the existence of objects, is its major component. In the agriculture field, newer technologies and approaches are often used to provide the efficient substitute for maintaining data whereas increasing net profitability. Simultaneously, the troubling consequences of climate change and the growing water shortage necessitate the establishment of innovative and enhanced techniques for smart agriculture fields [19]. In IoT system information is shared with

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Table 1 Use of IoT system in different fields.

S. no.	Fields	Uses of IoT
1.	Smart IoT-based agriculture system [6]	Soil fertility evaluation, Climate checking, Need of water, Insects detection
2.	Smart homes	Temperature management, Security checking
3.	Medical	Diagnosis patient's disease, Medicine recommendation

the help of sensors. Sensors perceive the information from the environment and transmit it to other devices. IoT systems allow the communication between electronic devices. There are different fields in which the IoT system is used; some of them are mentioned in Table 1.

Wireless sensor system consist multiple sensors and allow wireless data packet transmission. This type of systems is used in various fields. Agricultural production must also include use of new technologies, especially the IoT and wireless sensing system, which have a wide range of applications for increasing productivity of agriculture. IoT is currently become a main model in which the various internet devices and things combine together and generate a smart system. The Internet of Things (IoT) is today's open emerging paradigm. Things in Internet of Things include all sensing devices that collected the data from the environment. There are different protocols used in smart system that enhanced the efficiency of the system [13]. The several data transmission protocols used in the smart systems are:

1. Z-WAVE,
2. Bluetooth,
3. LTE advance, and
4. IEEE 802.

The paper is divided into different subsections. In the above section, wireless sensor system and IoT systems are discussed. The smart agriculture and benefits of smart system are discussed in Sect. 2. Section 4 discussed the survey of existing techniques. Different techniques used in IoT-based agriculture system are explained in Sect. 5. Routing protocols are explained in Sect. 6. Performance parameters are depicted in Sect. 7. The conclusion of the paper is discussed in Sect. 8.

2 Smart Agriculture

There are various challenges in traditional way of farming, such as sudden rainfall and temperature variation. To reduce the effects on farming, smart approach of farming is generated that automatically predicts the weather by perceiving the data from the environment. IoT-based smart system of agriculture provided several interconnected devices and communication between the devices. Wireless sensing devices are also less expensive for farming techniques, and easy to program. The sensing devices can be used with open platform sensing frameworks. The bottom details for smart farming predictive analytics farming maintenance are stored in the cloud database. It is giving producers more flexibility in maintaining them agricultural processes through tablets and smartphones [6]. The advantages of the smart agriculture are given below:

- Maintain the pH level of the soil, by checking the moisture level of the soil.
- Growth of crop can easily monitor through drones.
- Increase the productivity of farming.
- Sensors can detect the insects on plants or crops.
- Sensors can recognize the disease or infection of crops.

2.1 Benefits of IoT in Agriculture Field

In Ref. [17] IoT or wireless sensor system belongs to programmable device interactions, which is really an essential aspect of the modern economy's growth. Different issues have been used to explain the Internet of Things, including such as:

- Weather condition checking,
- Data Analytics,
- Precision Farming,
- Agricultural Drones,
- Smart Greenhouses, and
- Dynamic environment.

3 IoT-Based WSN Framework for Smart Agriculture

Numerous experiments have used wireless sensor network technology to perceive atmospheric data from a variety of contexts. WSN also has engaged mostly in evaluation and controlling of agricultural production in form of crops, environment, and water use, among other things. Due to the constraints rechargeable batteries of sensing, the farm production often faces a number of challenges, which including energy conservation, data routing, and protection [5]. As shown in Fig. 1, there seem to be three sensor nodes in a wireless sensor network: sensor node, sink node, and router node.

Definition 1 *(Sensor node)*. The sensor nodes get the ability to self-configure [11]. The sensor node detects perceptual data and sends it in a multicast pattern to adjacent routers or router nodes utilizing cutting-edge wireless communications like BLE, ZigBee, and Wi-Fi.

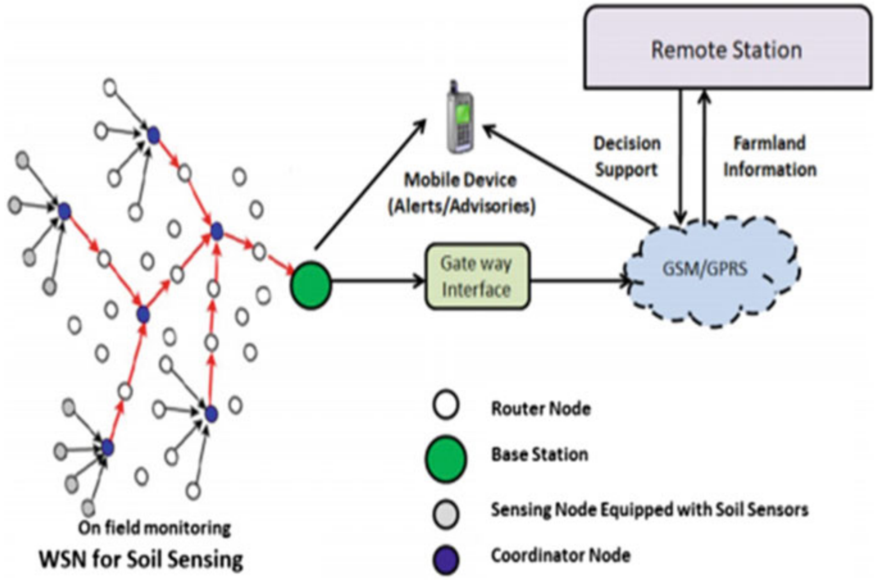

Fig. 1 Smart wireless agriculture system[5]

Definition 2 *(Route node)*. The data is transferred or routed by the route nodes to other nodes that are nearer to just the sink node or ground station. This ground station gathers all of the test set from either the sensor node and sends it to a monitoring location, at which information is stored on a storage server for further analysis and analysis [10].

4 Related Work

As the technology enhanced rapidly, it spread significant effects on every field. The smart agriculture system is one of the fields where advanced techniques provided high impact. The wireless sensor network such as IoT improved the productivity of the crops that is very helpful for the farmers. There are various existing techniques of smart agriculture systems based on the wireless network (IoT). This section provides a survey on several existing methods of smart farming.

Haseeb et al. (2020)[5] designed a IoT-based application for smart agriculture which was based on WSN platform with multiple design steps. In the initial step, farming detectors gather feedback and use a multi-criteria decision boundary to decide a collection of sensor nodes. In order to attain coherent and effective transmission of data, the frequency of the inputs on the data transmission had often been calculated using the signal to noise ratio (SNR). In the second step, by using repetition of the linear congruential transformer, protection was given for transmitting data from agriculture indicators to baseline stations (BS). The results of performance had achieved 13.5% of throughput on the network, improved the packets drop ratio with enhancement in communication.

Wang et al. (2021) [22] had used the MLP (multilayer perceptron) and IoT to made agriculture smart. The authors focused on sugarcane field production. The development of sugar was influenced by a wide range of variables. Analytical prediction was challenging and unlikely in smart farming due to the wide range of specifications and the extensive procedure. The results of the proposed system were examined by various parameters and achieved efficient results. The precision rate of the system was 95%, recall rate was 96% and accuracy was 99%.

An IoT-based collaborative system for the farming production was proposed by Pachayappan et al. (2020) [14] that gave focus on the sugar cane field. The proposed integration framework would enable to create a real-time channel of communication for decision makers such as producers, industries, and authorities. The system would be sufficient for better regulate and various advantages of the system were: (1) track the sugar cane balanced development, (2) produce a better and sustainable sugar cane production, (3) increase crop yields, (4) regulate fertilizer concentrations in the field, soil moisture, moisture levels, and monitor plantation inefficiencies.

Bu et al. [3] used the edge-based cloud computing to design a smart agriculture system. The deep learning-based models were used to made system smarter. A deep reinforcement learning-based improved agricultural IoT framework was designed with four layers: agriculture collecting data layer, edge of the network layer, farming transmitting data layer, and cloud services layer. The advanced automation model is integrated within cloud computing and deep reinforcement learning, to make instantaneous intelligent choices. The choices including deciding the volume of water that needs to be cultivated and to improve crop production process.

Dhall et al. [4] proposed an efficient framework to generate a smart agriculture. The framework was based on DC termed as Duty Cycling algorithm. Duty cycling clustering algorithm was used to increase the ground channel's energy consumption. An effective path selection method based on remaining energy specifications was used to improve efficiency of the network and lifespan. The NS2 (Network Simulator 2) simulator was used to run simulations and to assess the performance metrics. The NS2 was an event-driven method that was commonly used in research. No Duty Cycling (NDC), Duty Cycling (DD) and Duty Cycling (DC) algorithms were used to compare with proposed algorithm.

Podder et al. [15] designed a smart system with agrotech and IoT. The system was used to verify the agriculture parameters that determine whether cultivation would start or halt based on the agricultural soil status. The system was also provided tracking service and navigation system to the landowner. The system's dependability was determined by calculating the percentage error among real and integrated learning at various points in same time. The reliability of the system was verified with percentage of error. Table 2 shows the Comparison of state-of-the-art Methods.

Table 2 Comparison of state-of-the-art Methods.

Author	Year	Proposed work	Comparison techniques	Simulation tool	Performance metrics	Remarks
Haseeb et al. [5]	2020	IoT-based smart agriculture system	EECRP and PSO-ECHS	NS2	PDR, Throughput, Network Latency (NL), Energy Consumption	Low energy consumption
Wang et al.[22]	2021	MLP with IoT-based agriculture system	–	–	Precision rate, Recall rate, Accuracy, MAE, RMSE	Provide perfect prediction of the field
Pachayappan et al.[14]	2020	Real-time-based IoT system	–	RFID	–	Physical harm, precipitation regulatory compliance, and resource waste are all minimized by the system
Bu et al. [3]	2019	Deep learning, cloud computing with IoT	–	–	Q function	More efficient
Dhall et al.[4]	2018	Duty cycling algorithm with IoT	No Duty Cycling (NDC), Duty Cycling (DD) and Duty Cycling (DC)	NS2	Throughput, energy consumption, processing time	High energy efficiency
Podder et al.[15]	2021	Agrotech with IOT system	–	–	Error rate	Provide benefits to crop production

Abbreviations used in Table 2

MLP Multilayer perceptron
IoT Internet of Things
EECRP Energy-efficient centroid-based routing protocol
PSO-ECHS Particle swarm optimization energy-efficient-based cluster head selection
NS2 Network Simulator 2
RFID Radio-frequency identification
MAE Mean absolute error
RMSE Root Mean Square Error
PDR Packets drop ratio

5 Energy-Efficient WSN Techniques for Smart Agriculture System

WSN-based smart agriculture IoT systems are an efficient technique for challenges such as efficiency improvement, predictive modelling, and farm surveillance in agriculture. The techniques provide factual info regarding development in the field and soil fertility, allowing for greater harvesting by smart farming [9]. The various energy-efficient WSN techniques for agriculture are shown in Fig. 2.

5.1 Power Reduction Techniques

Wireless sensor networks (IoTs) are made up of a number of sensor nodes that measure environmental processes in actual time and send data back to the main server via a wireless connection. Sensor nodes are available in a multitude of implementations in extreme conditions due to the lack of interconnect. Wireless networks are used in a multitude of scenarios, including power reduction techniques. Each component in a sensor node (sensor devices, standard instruments, and microcontroller unit) may occurs at different energy states, so the overall power consumption of a sensor node

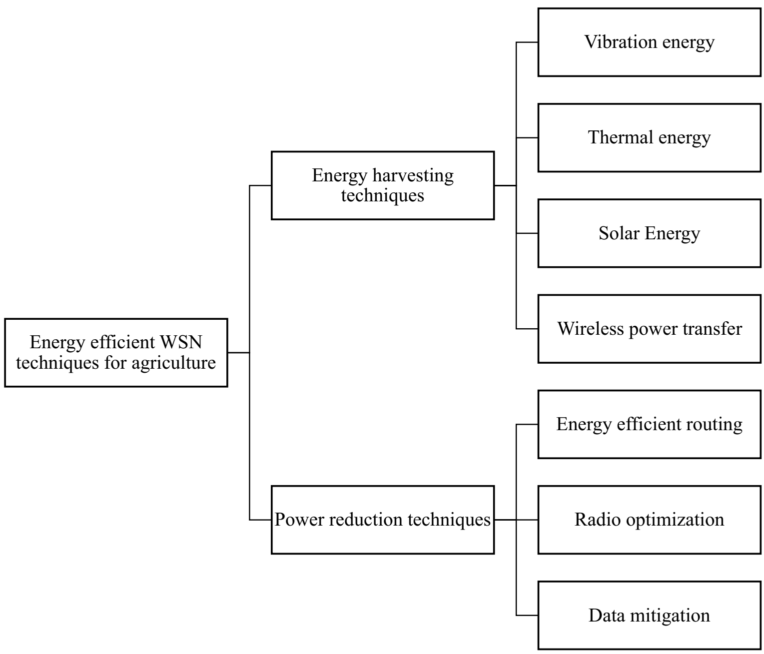

Fig. 2 Energy-efficient WSN techniques for smart agriculture system [9]

is the addition of every component in the network (sensor, microcontroller unit, and radio module). As a result, a sensor node's lifetime is described as the amount of time it takes to deplete its resources while operating within a safe operating range [7]. The different types of power reduction techniques are depicted in Fig. 2.

Definition 3 *(Energy-efficient routing).* In a wireless sensor network, network energy efficiency is a major concern. When networks grow in size, the amount of data collected also increases, and all of which consumes a significant amount of energy, resulting in a node's failure [8].

Definition 4 *(Radio optimization).* Radio optimization is the traditional approach to reduce the power consumption of the wireless sensor network.

Definition 5 *(Data mitigation).* Data mitigation is used to reduce the failure of the wireless system in data transmission.

5.2 Energy Harvesting Techniques

The main disadvantage of the wireless sensing nodes is the capacity of battery. Due to short battery storage, the lifespan of the network is limited. The energy harvesting techniques are used to reduce this problem. There are a number of techniques used in energy harvesting such as thermal energy, solar energy, vibration energy and wireless power transfer. These techniques enhanced the lifespan of the wireless network system and improve the efficiency of the system [21]. The energy harvesting techniques are used the natural ways to perceive the energy from the environment.

Definition 6 *(Vibration energy).* Vibration energy is based on the principle of resonance in which mass kinetic energy is converted to electrical energy [20].

Definition 7 *(Thermal energy and solar energy).* These types of energies are very helpful in wireless sensor systems and provided very efficient results. The sun energy is directly converted to usable energy form. These are natural ways to perceive energy from the environment [2].

Definition 8 *(Wireless power transfer).* Wireless power transfer is the energy harvesting technique that is used to transmit the data packets to one end to another end of sensor nodes.

6 IoT WSN Protocols for Agriculture System

Routing protocols of IoT wireless agriculture system specifies that how to or more nodes communicate to each other and transmit data from one node to another. Wireless sensor routing protocols can be classified in a variety of ways [14]. Figure 3 depicts the basic grouping of routing protocols.

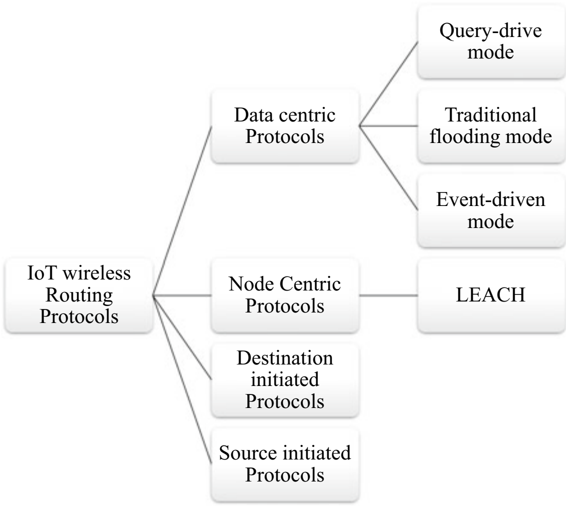

Fig. 3 Routing protocols in IoT wireless sensor system [18]

6.1 Data Centric Protocols

The collected information or knowledge seems to be more interesting than the actual node in many of these IoT wireless systems. As a result, the central emphasis of data-orientated routing strategies is on transmitting information identified by certain attributes rather than collecting data from specific nodes [1]. This type of protocols is further divided into several types, some of them are event-driven mode, and traditional flooding and quire-drive mode-based protocols.

6.2 Node Centric Protocols

The destination node in node centric protocols is identified through statistical identities, which are not an intended method of communication in wireless sensor IoT system. LEACH is the type of node centric protocol that termed as low-energy adaptive clustering hierarchy [23]. LEACH protocol is used to equal distribution of energy in sensor nodes of network.

6.3 Destination Initiated Protocols

When the route layout generation comes from the destination node, the protocol is called a destination initiated protocols.

6.4 Source Initiated Protocols

The complexity of pathway design is still the most difficult aspect of implementing network architecture. A base station must modify its network traffic periodically related to connection failures and saturation in entire network, which would be apparently time consuming process. Therefore source initiated protocols are used to resolve these problems [12].

7 Performance Analysis

The efficiency of the IoT-based smart agriculture system is determined by different parameters, some of the efficiency measurement parameters are defined as follows.

Definition 9 *(Throughput of network)*. The throughput of the network is defined as the number of data packets received by base station of the network. It measures that how many data packets successfully reached their destination through gateway nodes [19].

Definition 10 *(Energy consumption)*. In wireless sensor system, energy is used to transmit the packets from source to destination. It plays a vital role in smart systems. It is used to measure the energy resources of the network used by sensor nodes to transmit and receive the data packets. The consumption of energy in the network is always calculated with data transmission rounds.

Definition 11 *(Network Latency)*. The delay of the packets, when transmit from one node to another node is known as network latency. It measured the round trip delay time of the packets.

The comparison of existing techniques is depicted in Table 3, and graphical representation of throughput, energy consumption, and latency of network is presented in Fig. 4.

Table 3 Comparison of existing techniques based on throughput and energy consumption

References	Year	Throughput	Energy consumption (200 rounds)	Network latency [1000 rounds (s)]
[16]	2020	90	0.45	0.03
[5]	2018	100	0.35	–
[11]	2020	98	0.4	–

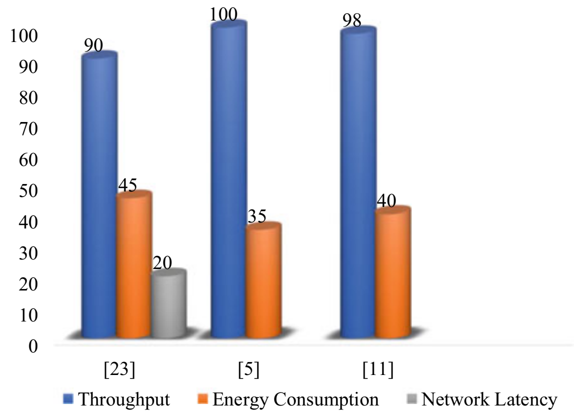

Fig. 4 Routing protocols in IoT wireless sensor system [18]

8 Conclusion and Future Scope

The Internet of Things (IoT) is intended to help in advance farming and agriculture sectors through adding new facets. Smart farming provided high productivity as well as reduced the farmers' efforts. The IoT-based smart agriculture framework is depicted in this paper. There are many researchers who used smart farming system to increase the productivity of crops. The existing techniques of various researchers are also explained in the paper. There are different techniques used in IoT-based smart system that are also described in paper. Routing protocols play a vital role in wireless system because they have the capability to reduce the failure in data transmission and also reduce the faults in the network. Smart agriculture-based routing protocols are also mentioned in this paper. The comparison of existing techniques of IoT-based agricultures system is also presented in the paper. In future, IoT-based smart farming techniques will be compared with respect to several parameters.

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Security Amplification of IoT: Blockchain

Upendra Kumar, Akancha, Nancy, and Nitish Pathak

Abstract In today's world, the IoT is based on federal system which has immense security distress. The federal network systems are effortless to be hacked and get access to the resources, which are major concern for the security with IOT that has hindered its large-scale deployment. Drawback of present centralized IoT network can be prevail over through the most secure distributed model of the blockchain technology. This chapter discusses about the security challenges in IoT and how it could be dealt using distributed ledger technique (DLT) of blockchain. With increasing interest in IoT and blockchain, the opportunity to create more trustworthy IoT devices has increased. The distributed concept of blockchain can leverage the IoT system by providing security threats such as cyber-threats, distributed denial of service (DDoS) attack, device spoofing, and reliable data sharing. Blockchain being a distributed database is robust against any tamper as it allows storage of data at every node which are transparent and immutable; this property of blockchain can be implemented in IoT network to make it stronger against any kind of threat as it can provide a more secure online environment.

Keywords Blockchain · Security threat · IOT · DLT · DDoS

1 Introduction

Blockchain and IoT, the two revolutionary inventions creating hype these days, are the most buzzed and discussed topic in research field these days and have become

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very popular. These revolutionary inventions combinations can be put together to get something more fruitful. The exponential growth of blockchain and IoT in today's world is gaining much attention within the research community and industry and have a huge scope as peoples are using more and more devices connected over Internet. In IoT, interactive devices with wireless networks and sensors having the network perform analysis and is very complex due to ever increasing number of devices getting increased day by day [1–3]. Gartner reports that by 2020 about 25 billion newer objects can comprehend in being part of the community of connected IoT devices [4]. Billions of devices of IoT are connected by Internet throughout the globe which collects and share data there by adds intelligence to the device and are controlled and connected smartly in IoT. These networks of sensors and interconnected things which are increasing more than the world's population can provide services at a higher rate. The rapid advancement and wider acceptance of the IoT device call for focusing attention toward the seriousness of the security risk associated with it before its absolute implementation. However, first generation suffers privacy risk. Security and privacy aspects of IoT are receiving a lot of attention within the industry and research community to get a smart work place. IoT and blockchain could lead to a smart new ecosystem. Internet being the core of IoT, all the threats of Internet propagate to IoT irrespective of other conventional network are committed in position without manual surveillance the poor efficiency limits the security causing trouble for the IoT security. The unreliable network interconnection of IoT and limitation of IoT such as central authentication through servers which is centralized due to which IoT faces several challenges such as false authentications, insecure data flow, device spoofing, and trustworthiness issue over the Internet of sensitive information. Elimination of central server by implementing distributed ledger technique-based (DLT) technique blockchain can help to solve these issues. The concept of blockchain came from the success of cryptocurrency (Bitcoin) having several features of blockchain-like ledger-based technique tamper proof, i.e., immutable technology has wider application. The continuous updation of the information leads to better and more authenticated database.

1.1 Motivation

In recent times, blockchain and cryptocurrencies have become very popular; however, a question also arises that how much trustworthy blockchain is. In spite of being eight years old, its concept is still evolving. Blockchain the technology behind Bitcoin is much more than foundation of cryptocurrencies. It is considered revolutionary invention of the modern digital world as it offers a secure transactions and lowers trade cost by reducing third-party intervention. Online industrial expansions are inhibited by cyber-crimes and frauds; blockchain will help to overcome these challenges as it possesses rapid and valuable chains with faster innovations of production, closer client relationship, and wider assimilation of IoT and cloud technology [5]. It has the potential to lead a fundamental change in the existing economic and political system and can bring revolution in the field of management law and governance and in the financial sector [6]. Many researchers and professionals hypothesize that blockchain technology can transform a lot of online application as it is still in its premature stage, we cannot express it decisively before its maturity [7]. The research curiosity in blockchain technology has vehemently been studied after its inception by S. Nakamoto whose mysterious paper emerged shortly after the 2008 financial crisis. In his paper, he gave a P2P e-cash system called Bitcoin [8]. Blockchain key attribute anonymity, openness, reliability, data integrity, faster transactions, immutability makes the reason for its acceptance by the researchers, thus creates a fascinating area for research to overcome challenges and the technical limitations. Bitcoin before 2014 was in most search queries, but blockchain is getting more and more attention recently; research in blockchain is still sparse [9].

2 Related Literature

Being a new field, studies are based on the research available on white papers. To fully explore the concept, authors follow a qualitative and systematic research approach. Authors collected information by analyzing articles and papers on blockchain, i.e., through the secondary sources. Authors, by following a systematic approach during the literature review, searched online for the keywords and phrases, "IOT," "IOT + threats," "IOT + vulnerability," "blockchain," "blockchain" + "security," "blockchain" + "attacks," "Bitcoin" + "blockchain," and move on by refining the search to reach the analysis. Authors construct a comparative chart by finding paper related to the topic mainly from Google Scholar, IEEE Explore, ACM Digital Library, Springer, and Elsevier and keep their focus on paper from 2008 onward, but the research is done in a fast rate after 2016; authors researched on the paper and concluded how much secure and trustable blockchain has proved to be and what are the breaches which blockchain are vulnerable to. To present, the development of blockchain technology authors has synthesized a comparative table from the paper collected [10].

Authors covered a systematic review of various peer paper and collected research paper related to this topic. Authors analyze the subject, its challenges and how to implement blockchain in IoT such that the IoT network become more trustworthy and secure from technical point of view. Authors downloaded 42 papers from the Internet and Google Scholar and focused on the trend of the development over time and hence find the research gap which is yet to be covered in order to reach the challenges and limitations of present scenario (Fig. 1; Table 1).

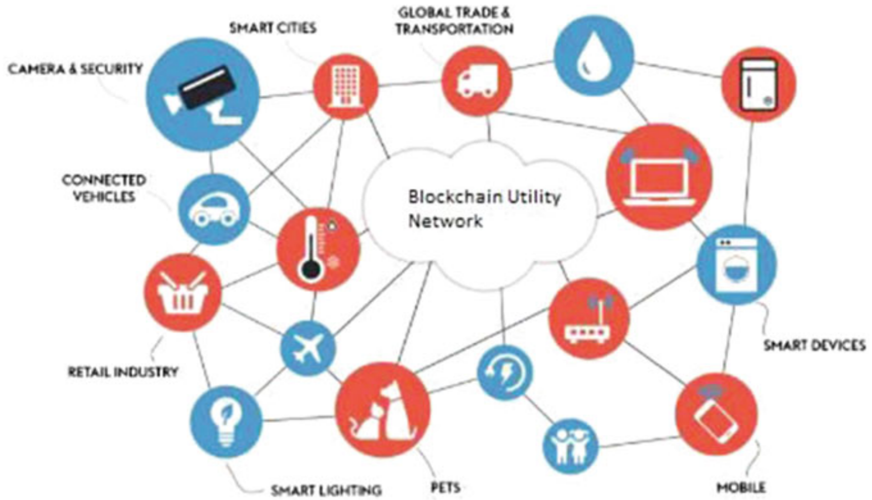


Fig. 1 Mapping blockchain with Internet of Things (IoT) utilities

3 Components of IoT

The Internet of Things (IoT) is an amalgamation of connected computing devices comprising machines, objects, animals, and people who can send and receive data through a network enabled by unique identifiers hence minimizing the intra-human or human-to-computer interaction.

4 The Internet of Things Structure Revisited

The basic building block of an IoT system is formed by sensors, processors, gateways, and applications. They are generally transparent, visible, and non-invasive in character, and every node retain its own attributes which ultimately produces an effective IoT system. The inter-layer communication is shown in Fig. 2 in which these building takes part in the communication and thus produces meaningful result.

Sensors—in general, sensors are the part of IoT devices which give input from there surrounding environment to the actuators. It should necessarily be unique, recognizable in nature with a particular IP address. As they have to be traceable over a large network, i.e., the sensors work by gaining information of the surrounding like temperature or humidity and then simply converting them into electrical data.

Processors—processors process the gathered information or inputs and gives meaningful output.

Table 1 Summary of related work in blockchain security

S. No.	Year/month	Author	Development
1	2016 (Springer)	J. Leon Zhao, Shaokun Fan, and Jiaqi yan	This paper presents an analysis on exploration and progress in the field of blockchain as well as presents review in this major issue
2	2016 (Springer)	Jennifer J. Xu	The paper deals with frauds, malicious activities detected by blockchain technology, and identifies areas vulnerable to blockchain
3	2016 (Springer) [11]	Ning Shi	The paper deals with the proof-of-work procedure to enhance decentralization and lowering the risk of a 51% threat without increasing the chance of a Sybil attack
4	2016 [12]	Jesse Yli-Huumo, Deokyoon Ko, Sujin Choi, Sooyong Park, Kari Smolander	The paper deals with the current research subject and concerns for future challenges of blockchain
5	2016 (ACM) [7]	Ghassan O. Karame	It illustrates the reported threats in the security provisions of blockchain and its connection to bitcoin
6	2017 (Springer) [13]	Stefan Seebacher and Ronny Schüritz	A structured literature review of peer-reviewed articles is conducted to enable trust and decentralization of a service system
7	2018 (arXiv) [14]	Xiaoqi Li, Peng Jiang, Ting Chen, Xiapu Luo, Qiaoyan Wen	A review on security threats blockchain and real attacks in such systems
8	2021 (Springer) [15]	Alex Shafarenko	This paper proposes an architecture and a protocol suite for a permissioned blockchain for a local IoT network. The architecture is based on a sealed Sequencer and a Fog server running (post-quantum) Guy Fawkes protocols
9	2020 (Springer) [16]	Geetanjali Rathee, M. Balasaraswathi, K. Prabhu Chandran, Sharmi Dev Gupta, C. S. Boopathi	In this paper, in order to preserve transparency and secure each and every activity of smart sensors, it proposed a secure wireless mechanism using blockchain technology that stores extorted proceedings of each record into number of blocks

(continued)

Table 1 (continued)

S. No.	Year/month	Author	Development
10	2021 (IEEE) [17]	Nidhi Pathak, Anandarup Mukherjee, and Sudip Misra	It proposed the unique paradigm of AerialBlocks for blockchain-enabled UAV virtualization to provide virtual UAV-as-a-service for industrial applications. AerialBlocks also aim at providing secure and persistent UAV services to the end users along with a partially decentralized blockchain model to ensure security, privacy, service quality, and transparency

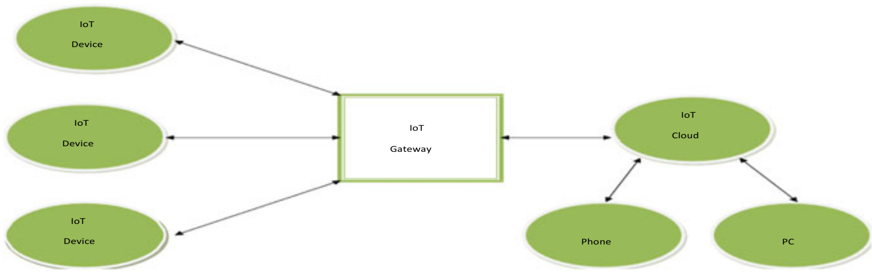


Fig. 2 Component diagram of an IoT network

The processed information becomes the smart data. Processors are generally real time. Processors are controlled by the application and provide the cryptographically encrypted form of data, and it also performs their decryption.

Gateways—gateways allow routing of data in discrete direction such that it can be utilized efficiently in the process of communication of data and also provides connectivity to the data which are essential for the IoT devices to communicate.

Applications—application is required for proper utilization of the assembled data and are the release end of specific function. The IoT applications deliver meaningful data and are responsible for delivering purposefully gathered data, which are managed by users (Fig. 3).

5 The IoT Architecture

Traditionally, there are three layers of the IoT structure, namely they are as follows:

1. Perception layer

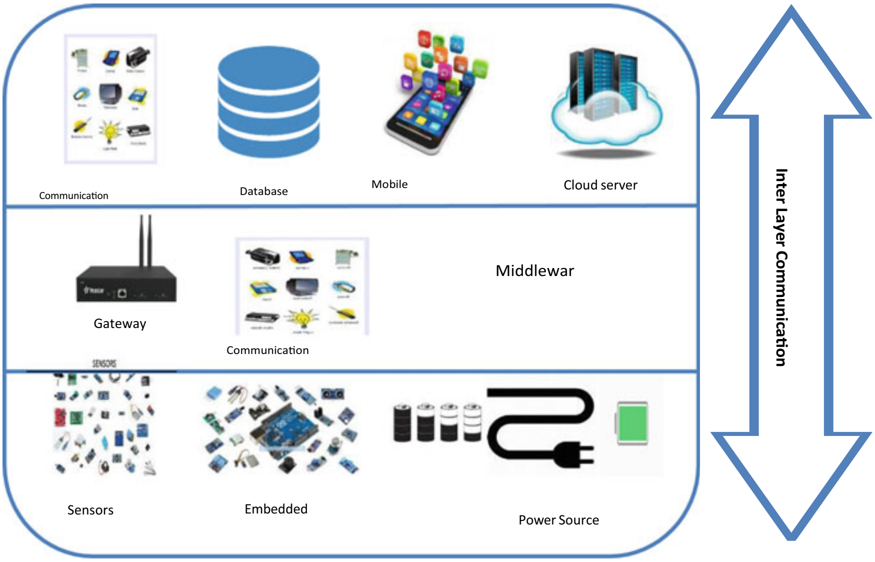


Fig. 3 Inter-layer communication architecture in IoT

2. Network layer
3. Application layer.

Recently, there has been Introduction of another layer known as support layer or middleware layer [18]. It is therefore sandwiched between the network layer and the application layer. As illustrated in Fig. 4.

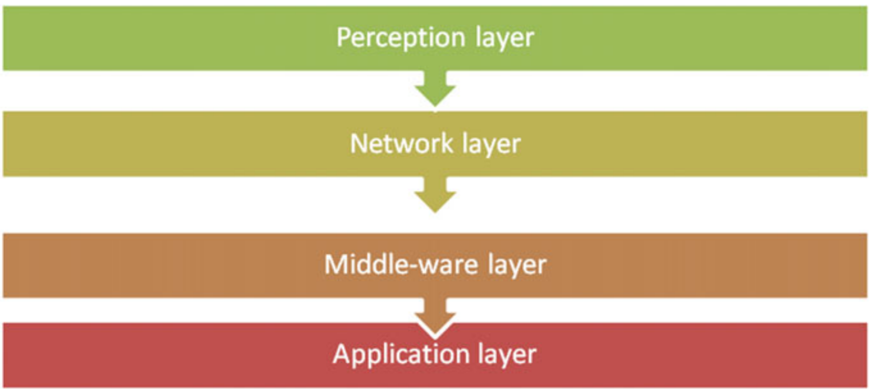


Fig. 4 Architectural tiered view of IoT

6 Overview of the Blockchain

6.1 *Defining Blockchain*

The blockchain is a distributed ledger technology database having decentralized virtual ledger which securely connects information from the very first transaction to the last transaction thus creating a chain of blocks called blockchain. Each transaction is distributed among and allowed over a peer-to-peer network. It is made up of a chain of blocks, each of which contains a time stamp and the message of a transaction that is protected by public-key cryptography and confirmed and validated by each and every individual on the network. Each of the network's members gets the updated copy of the ledger such that they can validate new transaction. Once a transaction is committed and saved, it is then added serially in a chronological order to the chain, and it cannot be altered and rolled back, thus converting a blockchain into an immutable historical record by creating a clear history of each transaction.

Blockchain uses the concept of cryptography, digital signature, and distributed consensus mechanism which make it decentralized and trustable. The most popular

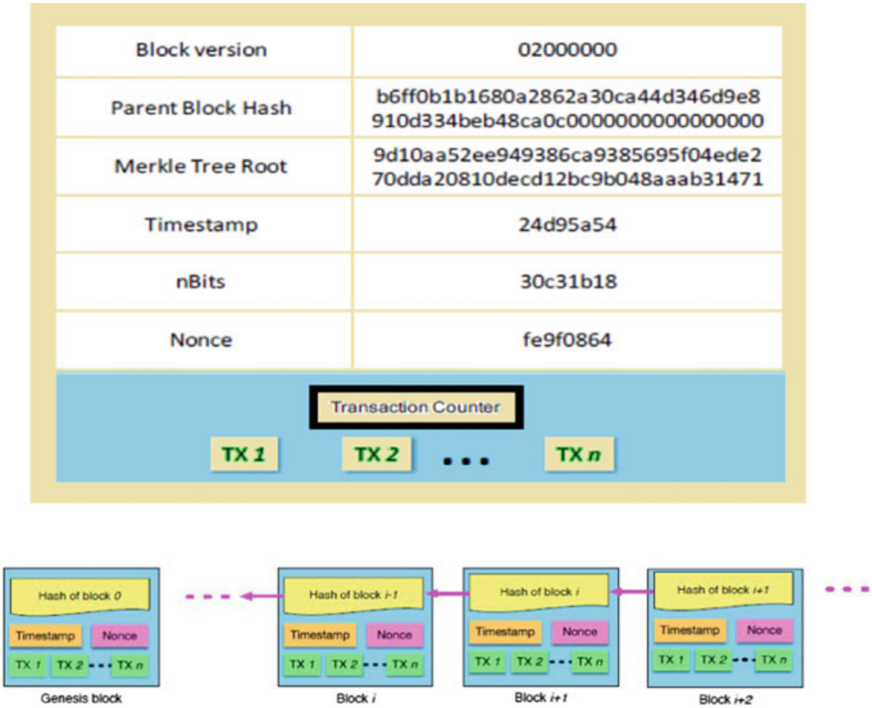


Fig. 5 Transactional view of blockchains

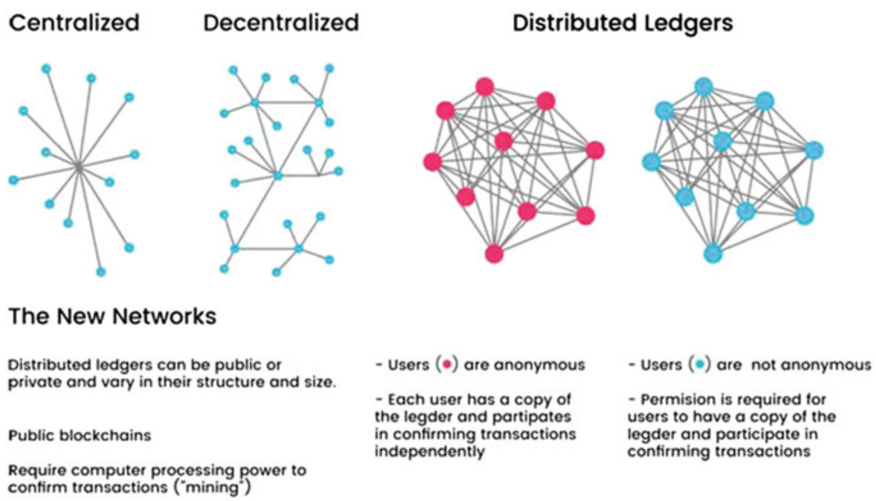


Fig. 6 Types of blockchain network implementation

application of blockchain, Bitcoin are also used in many other applications. Figure 5 shows the single block of blockchain transaction and the continuous chain (Fig. 6).

6.2 Features of the Blockchain Technology

The blockchain technology employs the combination of cryptography, distributed ledger, a consensus algorithm, and thus maintains decentralized and trustworthy environment. In this part, we will discuss the key features of blockchain technologies.

Cryptographic Digital Signature: The public-key cryptography is employed in the blockchain to achieve unique signatures for such transactions. The user's transactions are carried out by creating a digital signature using their private keys. Beneficiaries in the blockchain network authenticate the transaction by applying the public key of the sender to ensure that the transaction is signed by the sender. The source devices sign the transactions when they process a transaction.

Distributed Ledger: Blockchains use a distributed storage scheme to record the transactions. All the sub-node of the network keeps the record of transactions or subsets of the transactions. The nodes after consensus come to conclusion to keep the true transaction in the ledger. These characteristics form blockchain completely immutable.

Consensus algorithm: Blockchain verifies and validate the transactions after agreeing upon by all the nodes of the network as it is truly based on decentralized technique. And thus, it uses a peer-to-peer network; the judgments within the network are carried out by the participating nodes through a consensus protocol and procedure.

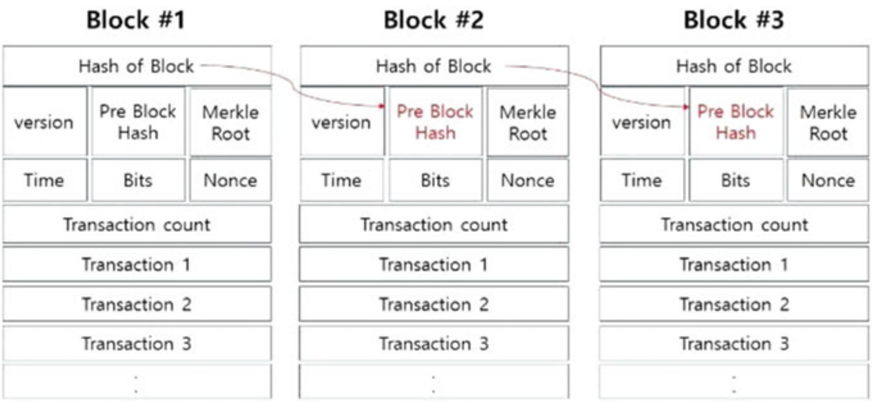


Fig. 7 Types of blockchain network implementation

6.3 The Blockchain Architecture

It is evident in Fig. 7 that every new hash contains the hash of the previous block in blockchain architecture.

6.4 Blockchain IoT Interaction

The centralized architecture poses challenges to secure IoT deployments. Handling and managing the enormous volume of existing devices are very complicated to unlimited complex of growing number of data. The centralized security model of today struggles to meet the demands of the Internet of Things, or IoT.

The blockchain is a potential solution for the security and privacy issues of the present IoT. Through the concept of decentralization, blockchain ensures the authentic data flow over the network. Blockchain applies the concept of distributed tamper-proof technology based on ledgers that recognizes different use cases in extensive field of applications.

7 Contributions of Distributed Nature of Blockchain

The distributed concept of blockchain can help to solve security and trust limitations and challenges:

- Blockchain can be applied to record the sensor data and avoid replication of malicious data.

- Distributed ledger concept of blockchain helps in ensuring and establishing secure transactions, and thus, IoTs sensors can exchange data through a blockchain more securely.
- Single-node failure is eliminated in blockchain that helps in IoT data from unauthorized access and reduces the risk of tamper.
- Blockchain enables the autonomous simulation of devices by concept of smart contract, thus ensuring individual identity. By reducing technical bottlenecks and inefficiencies, data integrity is maintained, and peer-to-peer communication is enabled.
- Because blockchain eliminates third-party dependencies, IoT deployment and application expenses can be reduced.
- IoT devices may be promptly addressed using blockchain, which keeps track of all connected devices for troubleshooting.

8 Implementation Techniques of Blockchains

The two most revolutionary technologies which have already created a buzz in the field of IT; their combination can form a better, more useful, and secure technology that will give promising results, and a new height to the security standards of devices used every day. Blockchain will give a base to IoT which will provide a trustworthy platform for sharing of services, which can be traced and relied upon. There would be an easier identification with no loss of data over time. The above features will increase the security at last in various cases where the information in IoT would have to be shared among many participants. Figures 8 and 9 show the implementation of blockchain in IoT and thus eliminating and reducing the load of central server. The blockchain can be implemented through three different ways:

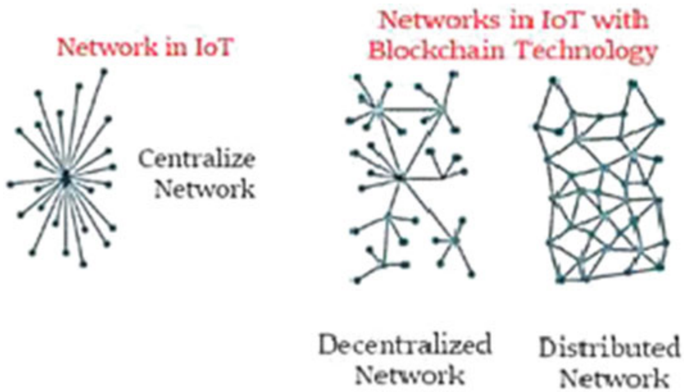


Fig. 8 Amalgamating IoT networks with blockchain techniques

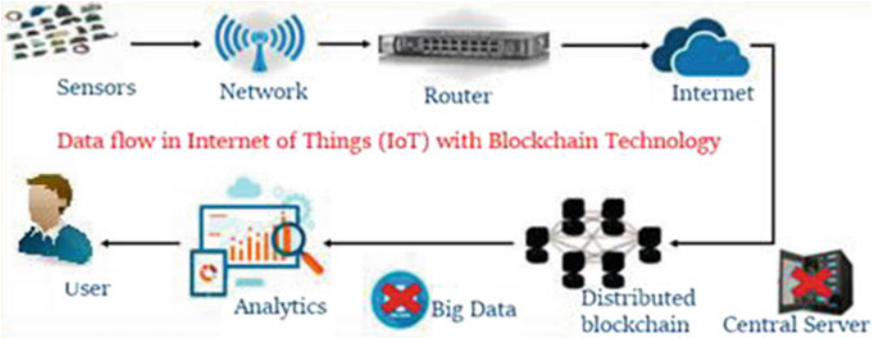
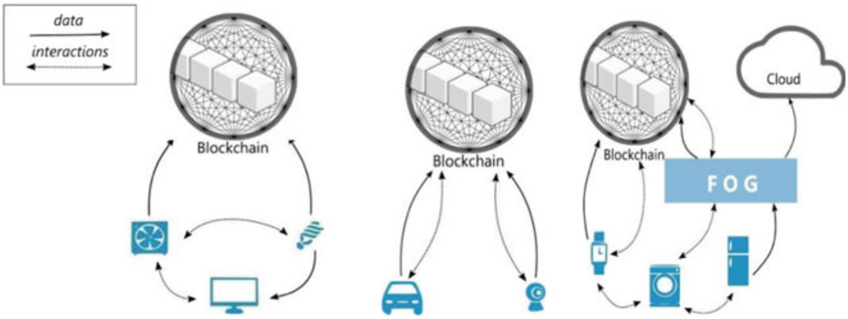


Fig. 9 Representation of dataflow in IoT with blockchain systems

- IoT–IoT: This approach won't need an Internet access, but the devices should be able to communicate among themselves, but the interaction between the IoT devices will need discovery and routing mechanisms. We know that blockchain stores only a part of the data of IoT, while the interactions in IoT take place without blockchain. This concept would only be useful where we have a reliable data and the IoT interactions would take place at low latency. This approach is the fastest and most secure in terms of latency.
- IoT–Blockchain: This approach uses blockchain for all transactions and interaction purposes. As the transactions are carried out through blockchain, there is security and a base where all the data are recorded. This will enables us to trace every transaction is as blockchain keeps data of every transaction. It also raises the quality of results of IoT devices given by making them more autonomous. But, the shortcomings are there because storing high amount of data can potentially hamper the speed of transactions as bandwidth and data vary increased exponentially, which is also a well-known challenge in blockchain technology.
- Hybrid approach: This approach is a mix of both above listed approaches. In this, only, a part of interaction is carried out through blockchain, while remaining is directly carried out among the IoT devices. The major challenge of this approach is to select in real time that which interactions should go through the blockchain. A precise composition of this method can be best mutated to integrate both technologies of blockchains clubbed with the advantages IoT interactions in real time. This method can be put to action by implementing Fog computing and supplemented by cloud computing, to achieve the solution to the blockchain's and IoT's limitations.

This is crucial in recognizing IoT sovereignty, which occurs in the face of more intricate hardware and higher computing costs. However, the benefits of using blockchain in this way are limited. In order to make the integration of both blockchain and IoT fully functional, there would be a demand of very high computational cost both in hardware as well as software. Gateways in this solution are also plausible, and there is also a direct need of understanding that the use of this technology should



The IoT–IoT interaction vs. IoT–Block chain vs.. Hybrid approach.

Fig. 10 Data interactions in the different implementation scenarios

be determined by the need of its application, i.e., in order to get higher performance level, but just blockchain is not enough, but then, hybrid approach can be of great use (Fig. 10).

8.1 Advantages of Blockchain

Blockchain technologies have the following advantages for large-scale IoT systems that make it more trustworthy, secure, and acceptable; they are as follows:

- Immutability: Blockchain being a database its significance is that it is permanent and tamper proof was transactions are agreed and recorded it can't be added the originality of transactions and maintain as one can only record and the transactions to the state, but the riddle transactions remain as in variable was it built interest in the transaction and records storing data.
- Decentralized: The ledger copy is accessed and copied by every node on the network; thus, it creates decentralization.
- Reliability: Blockchain technology is highly reliable as data does not need to be supervised by any intermediaries.
- Fast transactions: Blockchain processes faster as there is no third party for validations; also, the delay of checking details and credentials is eradicated by blockchain.
- Openness: Shared and public interaction property makes it transparent.
- Reduced Transaction Cost: Blockchain being decentralized eradicates the third-party dependencies; as a result, blockchain can greatly save the cost of transactions and improve efficiency

8.2 Current Challenges

Since blockchain is in its current state of maturity, it has significant weaknesses and limitations. The existing blockchain application Bitcoin reveals that there are numerous issues with blockchain that must be addressed and solved to reach the maximum benefit. Studies have shown that blockchain still faces challenges in the terms of security, scalability, and decentralizations. The internal attacks on the blockchain weaken the network and the consensus layer, and because all nodes in the network have access to the complete record, privacy and confidentiality are also major concerns. Today, blockchain can only process seven transactions a second and is a matter of great concern as blockchain is supposed to be decentralized storage system. Current deployment of blockchain limits its full decentralization concept; only, few owners can control the entire network leading to the violation of the concept of blockchain.

Although the coming together of these two technologies holds promising results in dealing with the issue of security and reliability, which are presently a matter of great concern. Blockchain will definitely overcome the challenges in security of IoT. However, there are still some limitations of blockchain which needs to be addressed, in order to get efficient results. Some limitations are very basic like lack of proper legal standards and laws, proper knowledge, and technical infrastructure. But, there are some other limitations too which seek real attention like little developments in the technology leading to problems of ledger storage facility and speed and time taken in processing.

9 Conclusion

In this research paper, we have discussed various possible security issues that can be addressed by the integration of blockchain technology in IoT. The opportunity for blockchain integration with IoT has been outline and have also been discussed how it can overcome certain challenges and limitations of IoT. The potential for blockchain and IoT integration was depicted and decisively; the challenges of IoT with blockchain technology were further discussed in order to provide an underpinning notion for recognizing the demand for blockchain in IoT. This technique might be used in a variety of engineering fields, but the aspect of implementation needs to be properly deliberate before their real implementation.

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Routing Challenges in Vehicular Ad-hoc Network and Significance of Swarm Intelligence for Efficient Routing

Gagan Deep Singh, Anil Kumar, and Ankur Dumka

Abstract Vehicular ad-hoc network (VANET) has emerged as a new domain of network routing. It has its own challenges and limitations. The paper provides the significance of VANET over the mobile ad-hoc network. Further, it highlights some of the major routing issues with its traditional routing protocols. The paper also presents the features of VANET routing protocols and their constraints at different aspects like bandwidth, security, network scalability, and network topology. Then, research gap in VANET routing has been discussed and proposed swarm intelligence and metaheuristics approach to fill this research gap. Then, the paper has come up with a conclusion that swarm Intelligence algorithms can be integrated with the traditional routing algorithm to achieve the efficient routing solution of VANET in various traffic network scenarios.

Keywords VANET · Routing protocols · Swarm intelligence · Metaheuristics

1 The Vehicular Ad-hoc Network

The advancements in wireless communication technology and devices have opened a new dimension of research capable of repairing and organizing and rearranging the networks without any centralized authority or infrastructure. Recent enhancements in wireless communication technologies and devices have made vehicle-to-vehicle communications (V2V), and road vehicle communications (RVCs) are developed using mobile ad-hoc networks (MANETs). A new network has evolved from this

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and is called a vehicular ad-hoc network (VANET). This newly new communication technology of VANET has emerged for intelligent transportation system (ITS) and is capable of improved road safety, optimize traffic flow, and even in lesser congestion of the vehicular nodes. VANETs are actually evolved from MANETs [1].

VANET can be used as a driver's assistance for communication and coordination among each other that will minimize the critical situation in V2V communication, e.g., random braking, obstacles, accidents on the road, bumper-to-bumper jams, random increase in speed, pathways for emergency vehicles like fire, police, and ambulance. Along with these preventive applications, VANETs are also useful for comfort applications to drivers and passengers—for example, multimedia applications, Internet connectivity, weather forecast, and infotainments during drives. The "Crash Avoidance Matrices Partnership (CAMP), advance driver-assistance system (ADASE), FLEETNET, and CARTALK" are some of the famous applications which was developed by various automobile manufacturers and governments through public–private partnerships [2]. Figure 1 illustrates the typical VANET structure.

The working and framework of VANET are entirely different from the MANET. This environment of VANET manipulates major factors and requirements of artificial road topology, traffic flow system, trip models, roadside obstacle, traffic rush, and drivers' behavior. There are many points from which VANETs are not the same as of MANETs, such as a sudden change in the topology and random node mobility. It may vary with other ad-hoc networks by network architectures, unstable topology, suddenly disconnected networks, and communication [3].

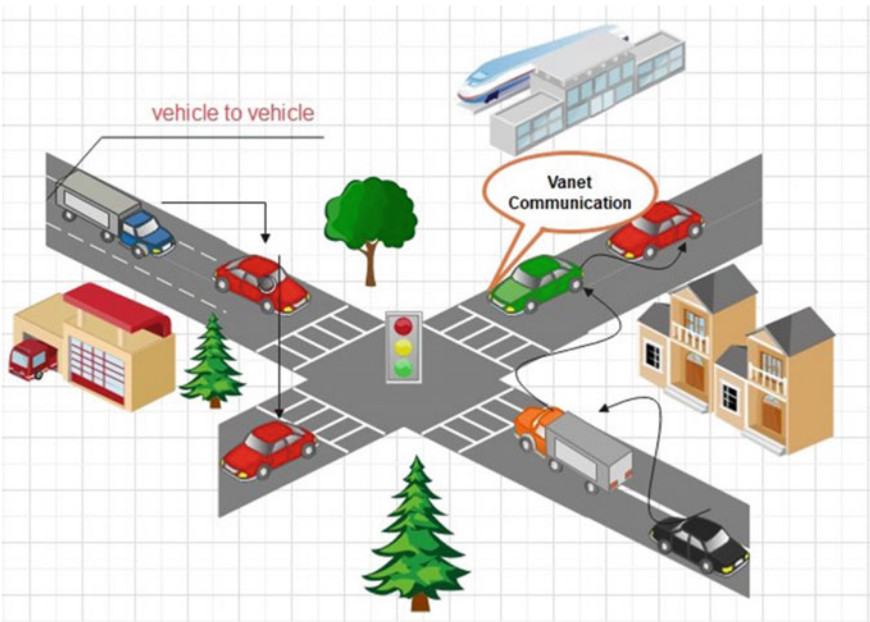

Fig. 1 Typical structure of vehicular ad-hoc network

There are many limitations in VANET, and these challenges need to be explored to achieve reliable and better services in a network. Hence, reliable and stable routing is one of the major issues in VANET. So, dedicated research in this field is required to implement accurate methods in realistic environments. Furthermore, the vehicles have dynamic behavior, and high mobility speed makes routing in VANET even more challenging.

2 VANET Features and Challenges

The features and characteristics of VANET separate itself from many other ad-hoc networks. Some characteristics of VANET, such as huge network size, high speed of nodes, and continuous mobility, make it difficult to stabilize node connectivity. Though, some of the various add-on features of entertainment, Internet, payment, and updates are also integrated with the vehicles as a driver's comfort in addition to V2V communication and safety [4].

It is essential to describe the prime challenges that affect VANET. Some of the prime challenges from a technical perception are discussed below.

2.1 Bandwidth Limitation

The big challenges of VANET are the absence of a central managing device like that of the router for the communication between nodes. Hence, productive use of bandwidth becomes essential in VANET [5]. Other objects like buildings and other vehicles may act as obstacles and cause deficiency in network signals.

2.2 Small Effective Diameter

A VANETs small productive network diameter results in weak connectivity in communication among nodes. Therefore, sustaining a network topology for a node for a longer duration is not practical. Hence, the presently available routing algorithms of VANET are not suitable for the larger diameter of networks [6].

2.3 Security and Privacy

As the nodes broadcast the information in VANET hence, receiving data from a trustworthy sender is a major concern [7].

All these bring new challenges to VANET communication. VANET-related research challenges need further research and innovative solutions to ensure satisfactory performance of VANET infrastructure, communication, security, applications, and services.

2.4 Autonomous and Infrastructure-Less Network

VANETs are formed by vehicular nodes of the autonomous system connected through wireless links without central management. This is an infrastructure-less network as networks vehicular nodes set up paths among themselves dynamically to transmit packets temporarily. Research on VANETs real-time communication improves routing performance in different mobility scenarios [8].

VANET security differs from wireless and wired networks because of its high mobility constraints, infrastructure-less framework, and the short-duration link between nodes. In wired networks, infrastructure has specific functional components, for example, routers decide destination routes, while network hosts send and receive messages.

2.5 Dynamic Changing Network Topology

VANET works without infrastructure and has a dynamic topology. The packet transmission and routing in this environment are challenging due to the shortage of life span of communication link, random change in speed, variation in density, and characteristics of different network environments. Topology frequently changes due to speed and vehicle movement. High-speed mobility models and predictions have a significant role in VANETs dissemination and design. Disconnection chances are high due to its dynamic topology. High mobility in VANETs leads to regular separation of network and route disconnection, the need for re-computation of topology information [9]. These routing protocols in VANETs have been categorized into five different types: as shown in Fig. 2.

Position-based routing, topology-based routing, cluster-based routing, broadcast routing, infrastructure based, and geocast routing protocols [10].

High mobility and frequent network topology changes are the most challenging issues in VANET. Network topology varies in VANETs when vehicles change their velocity and lanes. These depend on drivers and road situations and are not scheduled in advance [11].

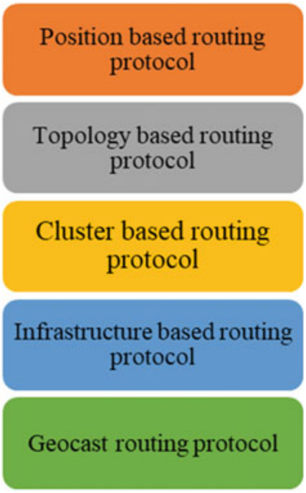

Fig. 2 Categories of VANET routing protocols

2.6 *Network Scalability*

Scalability is a very crucial characteristic in large and especially distributed networks and systems. The network scalability is the property to manage extra incoming nodes without altering or degrading the network performance and additional manageability. The number of active nodes (vehicles) affects the network connectivity and has the likelihood of congesting wireless channels. Protocol designs also impact scalability [12].

VANETs comprise potentially multiple vehicles, so protocol mechanisms should be scalable and efficient regarding mobility management-based overhead. Unfortunately, the feature common in topology protocols is degradation as link possibility grows, making scalability difficult.

Limited capacity also leads to scalability concerns for future VANETs. In addition, a V2V network with few nodes or low data traffic works well, but networks with many nodes or high data load break down. So, new strategies for VANETs data dissemination have to be designed, keeping scalability and capacity in mind [13].

2.7 *Bandwidth Constraint*

Position-based protocols, unlike topology protocols, do not need the route maintenance process. Instead, the route is established when needed, thereby reducing undue bandwidth constraints already low in VANETs. This approach results in huge control overheads restricting the use of limited wireless resources like available bandwidth. That ensures information delivery with extensive bandwidth usage.

Bandwidth constraints the wireless links, having lower capacity than wired links. Fading, noise, and interference affect wireless communication throughput. Inter-vehicular communication is at the core of many industries and academic research initiatives that aim to enhance transportation systems' safety and efficiency. The ranking is thus critical and enables the most significant data to be transmitted under bandwidth constraints [14].

2.8 Location-Dependent Contention

Data transmission rate has to be adaptive in VANETs as wireless channels are time varying and location dependent. When VANETs enter critical areas and become localization system dependent, GPS issues and problems like non-availability may not be robust enough for some applications. So, there is a need to develop new localization techniques to overcome GPS limitations [15].

2.9 Security

The simple and effective security mechanism is a big issue for deploying VANETs in public since the security of the VANET system is susceptible to several attacks. These false warning propagation messages are similar to actual warning message suppression, thus leading to accidents. So, security is a major concern in such networks. Moreover, most nodes are vehicles that can form self-organizing networks without knowing each other whose security is very low and very vulnerable [16].

There are many security challenges in the vehicular network that are addressed with different areas of many known security primitives like symmetric and asymmetric cryptography, data aggregation, strong authentication, and cooperation enforcement. Hence, security in VANETs is reliant on detecting and correcting malicious data [17].

2.10 Energy Efficiency

Reducing energy for data transmission and improving VANET's energy efficiency is accomplished using a two-tier data delivery mechanism. It also considers energy-efficient roadside access point scheduling. A scheduler capable of satisfying communication requirements of vehicles in the vicinity of an AP while minimizing energy needed using AP power control is considered [18].

As sensor nodes can disappear over time, wireless sensor networks (WSNs) use such methods for replication, yet space and energy-efficient data storage. Also, monitored data have to be encrypted to protect it from any unauthorized access.

An optimal schedule of turning on/off the deployed RSUs at a given time is performed to minimize energy consumption while maintaining VANET connectivity [19].

So, researchers should shift back to security problems rather than paying attention to energy efficiency.

3 VANET Routing Challenges

A major challenge in VANET design is developing a dynamic routing protocol to disseminate information from a node (vehicle) to another. The challenge is to reduce the delay associated with passing information from a node to another node. The other issue is to develop an efficient multicast and geo-cast protocol over VANETs changeable topology. Mobility of a destined zone reveals dissemination of a protocol packet to static or mobile multicast or geo-cast region. Current protocols consider static multicast or geo-cast region except for mobicast routing protocols [20].

The survey performed over the VANET routing protocols shows the existing challenges and the open research issues in VANET routing. Today's important research area includes the analysis of driver's behavior, signal loss, and the interferences that occur due to tunnels and high buildings [21]. Furthermore, designing an efficient VANET routing protocol is challenging due to its high node mobility and mobile node movement constraints.

During high mobility and rapid topology change, designing an efficient routing protocol to deliver a packet with minimum time duration having few dropped packets is critical in VANETs. Further, many researchers are focusing more on designing and developing a routing protocol to suit rural and dense environments with high vehicle density and close distance between them. Designing an efficient routing protocol impacts many factors; out of which, the first is to enhance system reliability by leveraging between them.

The next is to reduce the interference that occurs due to the existence of high buildings. So, there exists new challenges for VANET routing protocols as traditional routing protocols may be unsuitable for VANETs. Researchers are currently designing new VANETs routing protocols by comparing and improving current stimulation tests [22]. The major VANET routing challenges is depicted as per Fig. 3.

3.1 Research Gap

The existing routing algorithms for VANET routing are not that robust, which can meet the expectation of various routing scenarios. Many researchers have attained great success in various areas of VANET. But, many challenges are required to be overcome and a few issues that can be investigated [23]. Although, much research has been already available in the areas of VANET routing protocol and its performance

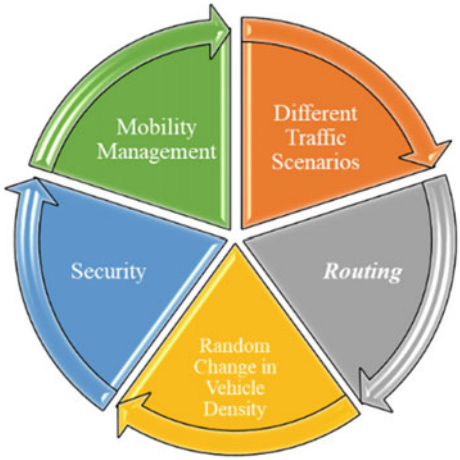

Fig. 3 Research challenges VANET routing protocols

[24]. However, due to the emergence of swarm intelligence, many fact-findings have yet to be validated [25]. Integration of existing standard routing protocols with swarm intelligence has shown better results [26]. VANET performance depends on various simulation scenarios, and none of the routings are best suited for every scenario.

3.2 Swarm Optimization Approach for Efficient VANET Routing

These days swarm intelligence has come up with the solution to real-life hard problems. Hence, many of the metaheuristics algorithms are proposed to increase the efficiency of routing in multiple network environments. The classification of the metaheuristics algorithm is shown in Fig. 4. Some of them are ant colony optimization, particle swarm optimization, bee optimization, firefly optimization, bat optimization, etc.

The genetic algorithm (GA) application in VANET is proposed by the researcher [27] and located the best generation of vehicles to be generated and managed a data flow while reducing the wireless network bandwidth consumption. Using random values of *£*, *P*, and *z*, the initial population size is reduced based on corresponding effect coefficients ($a1$, $a2$, $a3$).

In [26], researcher proposed a PSO approach for hybrid VANET-sensor networks for the two-lane placement problem is proposed and implemented. An integer linear program (ILP) model for a two-lane problem is first established. Then, a center PSO approach is proposed for the problem, and theoretical analysis is also derived for the same. Results showed that this approach performed well for moderate problems. Future work must consider heterogeneity, other objective functions, constraints, and

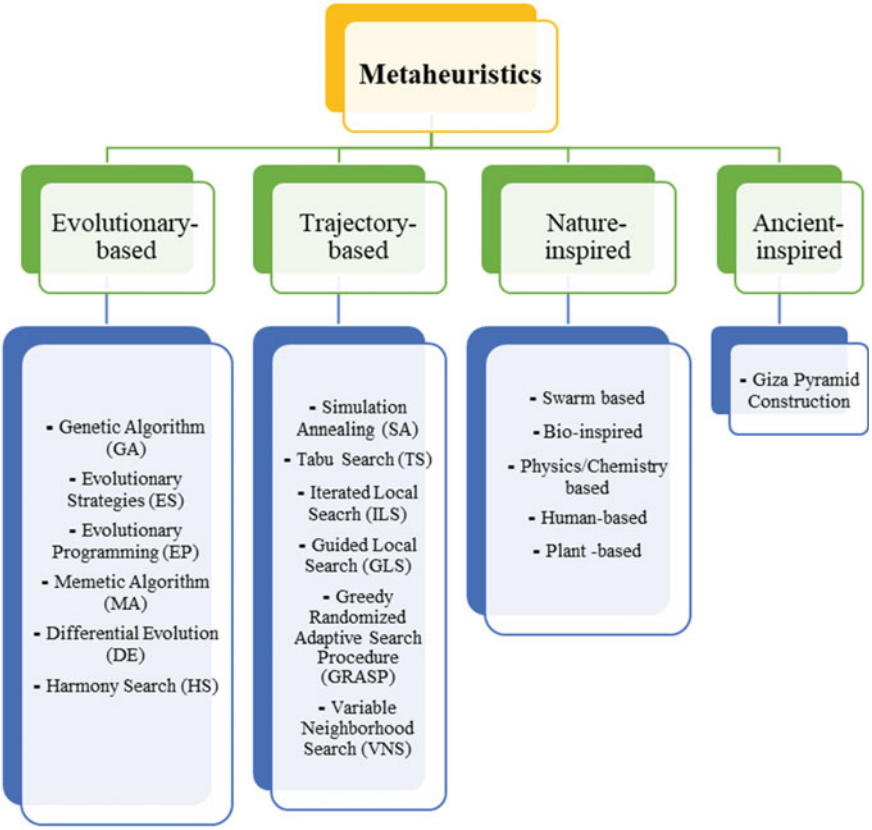

Fig. 4 Classification of metaheuristics algorithms

hybrid methods in practice. Another challenge dealt with is to propose a cross-layer design of the hybrid network.

With evolutionary-based routing being a predominant research theme, an efficient, trust-based, ant colony routing technique is used for a simple highway scenario-based VANET. Simulation results show that the new trust-dependent ant colony routing (TACR) performed better than mobility-aware ant colony optimization routing (MAR-DYMO) algorithm compared to routing overhead.

VANETs are unable to meet the exact needs and applications of all users. The VANET routing behaves differently in various traffic and network scenarios. None of the routings can provide the best results for all the network scenarios. Hence, in sparse and dense networks, the "minimum calculated desired time (MCDT)" technique is suggested, and data dissemination is performed using a context-aware congestion resolution protocol. Here, the MCDT determines the node connectivity through a peak-stable link [28]. "Modified lion algorithm (LA)" is also used to compare with GA, and performance analysis was done for cost, complexity, and convergence.

4 Conclusion

The efficient routing that is capable of supporting various realistic traffic scenarios is still under investigation. Many pre-existing standard routing protocols are presently available, but they have not integrated swarm intelligence for realistic city-based traffic scenarios. Hence, this problem must be the focus of the research work to integrate feasible best swarm intelligence-based routing algorithms. Then, it can be tested on desired VANET traffic scenarios using realistic VANET simulation tools such as veins. The performance can be calculated for traditional as well as real-city traffic scenarios taking two principle performance factors: packet data delivery ratio (PDR) and throughput. The results gathered from simulation tests of PDR and throughput will be used to conclude the efficiency of the devised routing algorithms in VANET.

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Convolution Neural Network Technique for Alzheimer Disorder Detection

Shriyanshi Jha, Nisha Rathee, and Nitish Pathak

Abstract Alzheimer's detection is a well-known issue of machine learning and image processing. There are different stages through which Alzheimer's disease can be detected. Preprocessing, segmentation, extraction of features, and classification stages are some of them. The method of GLCM is adapted in order to extract attributes. The convolution neural network (CNN) is implemented for classifying the disease infected and normal portion. Different parameters such as accuracy, precision and, recall are considered to analyze the performance. The suggested method is executed in MATLAB and the enhancement of results for detecting Alzheimer's disease is found 94%.

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Keywords GLCM · CNN · SVM · Alzheimer

1 Introduction

Alzheimer's disease is a degenerative disease, there is no cure found for this as of now. This disease leads to dementia in aged people worldwide. It has been found that millions of people suffer from AD all over the world. Alzheimer's disease is known to have a progressive syndrome. The brain's cells are degenerated and expired due to this disease [1]. This disease also causes continuous decay in thinking, behavioral, and social skills due to which the potential of a person to work self-reliantly is disturbed. The initial symptom of Alzheimer's disease is forgetting recent events or discussions. Various complications occur in the early phase of this disease. These complications may be severe and can cause death.

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Digital images have contained individual pixels. The discrete brightness or color levels are assigned to these pixels. The appropriate communication networks and protocols are utilized to process and assess these images accurately and access them in several regions at the same time. The PACS and the protocol are some of these protocols [2]. The entire digital image processing is assisted in the study of medication using digital imaging tools. Medical image processing works under five major fields.

Moreover, this process assists in transferring the designed algorithms into other application fields directly [3]. Previous knowledge about the image content is not required in the interpretation of this process. The image processing stage employs the MRI image to estimate the possibility of detecting Alzheimer's disease at the initial phase. These methods help in extracting the white matter and gray matter of input brain MRI scan. Magnetic Resonance Imaging is extensively utilized to detect brain tumors using imaging. A complete image of parts of the human body can be produced using the MRI. The radio waves and strong magnetic fields are employed for visualizing the inner body organs in this approach. Different phases are executed in the image processing to detect AS [4] in which MRI image acquisition is performed, image is pre-processed, segmented and classification is done. The initial phase utilized the MRI of the brain as input. In the next phase, an efficient image segmentation technique is implemented. The pixels are classified in two classes: white and black according to their brightness for the cropped image. The patient is classified in two cognitive or mild impairment, AD or healthy depending upon the figure of the occurrence of the black pixel.

2 Literature Review

Fuse et al. [5] used the information of brain structure to test the efficiency of a technique. The aim in objective was to classify the healthy people and patients with Alzheimer disorder [5]. This work employed a P-type Fourier descriptor as the information of the shape and analyzed the lateral ventricle without the septum lucidum. This work used an support vector machine (SVM) classifier to perform classification by combining multiple descriptors in the form of features. In the results of tests, the presented approach obtained 87.5% accuracy rate which was better than the accuracy (81.5%) achieved with a volume ratio of intracranial volume. It was generally utilized for evaluating the morphological variations conventionally. The obtained results suggested that it was more beneficial to use the shape information in diagnosis rather than the traditional volume ratio.

Angkoso et al. [6] discussed the application of gray matter (GM), white matter (WM), and cerebrospinal fluid (CSF) images along the ratio values per image to determine the identity of Alzheimer disorder [6]. This work acquired images with three different structural planes and extracted features according to the Kolmo gorov—Smirnov distance. This work used Supervised Neural Network Back propagation as classifier model. The test results obtained by combining different structural planes of MRI images revealed that WM or GM individually performed better than the scenario of a combination between GM, WM, and CSF.

Ismail et al. (2016) reviewed four fractional order filters employed for edge detection comparatively [7]. This work added random Gaussian noise and salt and pepper noise to these filtering methods to examine their performance in terms of noise. The peak signal to noise ratio (PSNR) of the identified imagery was compared numerically. This work performed comparison by considering two metrics called MSE and execution time. This work visually compared the potential of these filtering schemes for detecting edges in the clinical imagery. This approach could assist in the MRI-based detection of AD disorder.

Yue et al. [7] used Deep Convolutional Neural Network (DCNN) for extracting the most valuable descriptors of the structural MRI scans [11]. First, the preprocessing of structural MRIs was performed by following a strict process. Then, this work re-sliced each image rather than dividing the interested region, and then re-sliced images were fed directly to the DCNN. Eventually, the average accuracy of 94.5% for NC vs. LMCI, 96.9% for NC vs. AD, 97.2% for LMCI and AD, 97.81% for EMCI vs. AD, vs. LMCI 94.8% for EMCI was obtained followed by the identification of all stages of Alzheimer disorder. In the outcomes, the DCNN scheme performed superior to its rivalry schemes.

Ebrahimi-Ghahnavieh et al. (2019) paid attention on MRI-based detection of Alzheimer's disorder by means of deep learning algorithms. This work put forward an recurrent neural network (RNN) followed by a convolutional neural network (CNN) to infer the relation between the multiple images of each patient and performed decision making depending on all input slices rather than considering every slice. The results of tests depicted that the accuracy of the entire model could be improved by training the recurrent neural network (RNN) on features extracted from a convolutional neural network (CNN).

3 Research Methodology

All steps of the proposed scheme have been explained as follow.

3.1 Input Image and Pre-process

In the primary step, MRI images are adopted to detect Alzheimer's disorder. The data relating to MRI generated by Open Access Series of Imaging Studies was available both on their website and on Kaggle. It was found that this data helps train various machine learning models to identify mild to moderate dementia in patients. The longitudinal Magnetic Resonance Imaging data t having 150 subjects of age group of 60–96 was composed in this dataset. Each person is right-handed. There are 72 subjects which are grouped as non-demented in the study and sixty-four subjects are grouped as demented at the time of their previous visits and utilized in the entire study. Fourteen subjects are grouped as non-demented at the time of their initial visit and their characterization is done as "Demented" at a later visit. Subjects belong to the converted category. The conversion of MRI images is performed into gray scale images.

3.2 Segmentation

This step applies the threshold-based approach for segmenting the MRI images. The out's segmentation is applied in this step which can segment pixels. A global thresholding selection method named as "Otsu" which was proposed in 1979 by a Scholar Otsu is widely used. This method is found to be simple and effective. It uses only the gray value of the image. Computing a gray level histogram is required before we start running this method. One of the main drawbacks was that better segmentation results could not be expected in case of the one dimensional which considers only one kind of information which is gray level information. To address this issue, a two-dimensional Otsu algorithm was proposed. This algorithm was designed to work on the gray level threshold of each of the pixels and its spatial correlation information within the neighborhood. Therefore, the two-dimension algorithm provides satisfactory segmentation results even when applied to the noisy images. In this approach pixels below the threshold value are segmented into one segment and others in the second segment.

3.3 Feature Extraction

This step is to take out texture features. This is performed by applying the GLCM algorithm. The textural features of the input image can be extracted with the GLCM. Total of 13 features are extracted by the GLCM algorithm in order to detect the tumor.

$$\text{Energy} = \surd \sum_{i,j=0}^{N-1} \rho_{i,j}^2 \tag{1}$$

$$\text{Entropy} = \sum_i p_i \log_x i \tag{2}$$

$$\text{Contrast} = \frac{I_{\max} - I_{\min}}{I_{\max} + I_{\min}} \tag{3}$$

GLCM is known to be a feature extraction algorithm which is based on texture. This algorithm operates on the images based on the second-order statistics to determine the textural relationship between pixels. In general, this is performed using two pixels. The GLCM algorithm finds out the frequency of combinations of these pixels' intensity levels. The frequency of two pixels is responsible for the element of this matrix. The element of this matrix includes the second-order statistical probability values that depend on the gray level of the rows and columns. The transient matrix becomes large when the intensity values are wide, making it a time-consuming process load. This algorithm detects Alzheimer's disease by extracting textural features of the MR imaging.

3.4 Classification

This stage classifies the disorder and its risk level. The features mined by the GLCM algorithm are employed to train the CNN model. The CNN approach will be applied to categorize and localize the cancer part. All the data points of an individual class are separated by the best hyperplane. The identification of the best hyperplane is made with the help of classification provided by CNN. CNN considers the two classes with the largest margin to be the best hyperplane margin is defined as the maximum width between the hyperplane and the slabs parallel to it. In this case, there are no interior points found. CNN algorithm is used to separate the maximum margin in the hyperplane. CNN represents a subcategory of the deep discriminative architecture. The processing of two-dimensional data consisting of grid-shaped topologies, such as images and videos can be performed efficiently using this algorithm (Fig. 1).

4 Result and Discussion

Motive of the research paper is to detect Alzheimer's disorder. Alzheimer's disorder detection has various stages like preprocessing, then comes feature extraction and classification. Proposed model is based on the CNN model in which features are extracted using the GLCM algorithm. In the second scenario, the SVM classifier is used for classification and the GLCM algorithm is used for the feature extraction. In the third scenario, the features are extracted using the LBP algorithm. The three scenarios are compared in terms of accuracy, precision, and recall. The comparison of the models will prove reliability of the proposed model.

Accuracy: Accuracy is the ratio of count of points correctly classified to the total number of points multiplied by 100, as shown in eqn.

$$\text{Accuracy} = \frac{\text{Number of points which are classified correctly}}{\text{Total Count of points}} * 100 \tag{4}$$

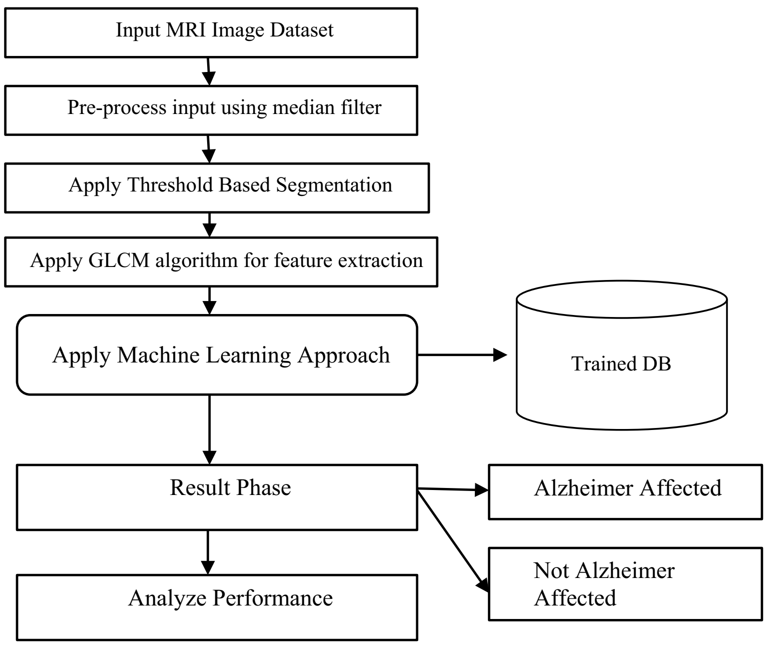

Fig. 1 Proposed methodology

Precision: It is the ratio of count of true positives to the count of true positives adding the number of false positives.

$$\text{Precision} = \frac{\text{Count of True Positive}}{\text{True Positive} + \text{False Positive}} \tag{5}$$

Recall: It is the ratio of count of true positives to the count of total number of elements that in fact belong to the positive class (Table 1).

$$\text{Recall} = \frac{\text{Count of True Positive}}{\text{True Positive} + \text{False Negative}} \tag{6}$$

Figure 2 shows the comparison amid the presented CNN approach and the SVM approach in terms of accuracy for the detection of Alzheimer's disorder. In contrast

Table 1 Performance analysis

Parameters	SVM classifier	LBP + SVM classifier	CNN technique
Accuracy	78%	80%	94%
Precision	0.78	0.80	0.94
Recall	0.77	0.80	0.92

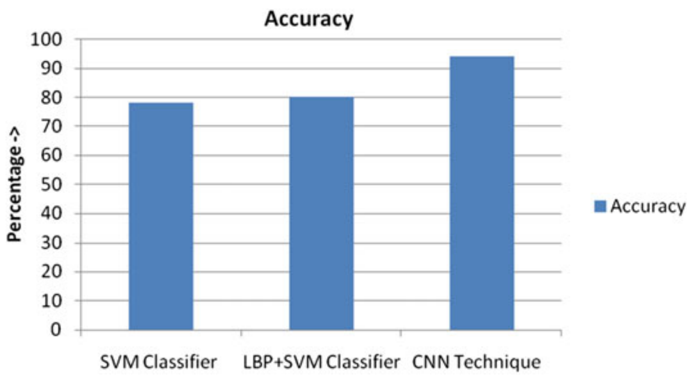

Fig. 2 Accuracy analysis

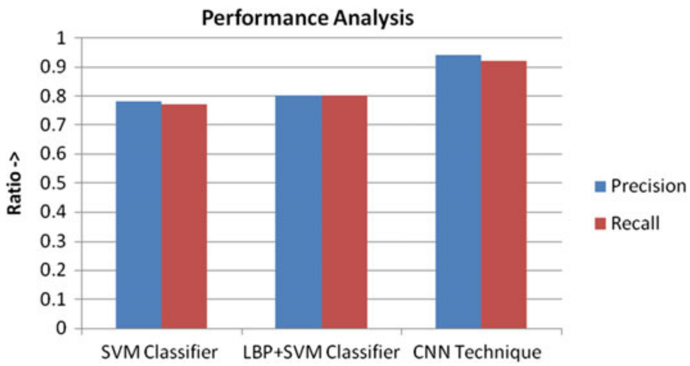

Fig. 3 Precision-recall analysis

to the SVM classification model, the CNN classifier obtains higher accuracy of 94%. The SVM model when applied with LBP algorithm it give accuracy of approx. 80%.

Figure 3 shows the comparison amid the presented CNN approach and the SVM approach in terms of precision-recall for the detection of Alzheimer's disorder. LBP model with the SVM classification model gives precision and recall value approx. 80%. CNN classifier obtains higher precision of 94% and recall of 92%.

5 Conclusion

This work concludes that detecting Alzheimer's disorder is a major challenge in the field of image processing and machine learning. Alzheimer is a brain illness and cannot be detected easily from the MR scans. This work put forward a new CNN and GLCM-based Alzheimer's disease detection scheme. The new technique provides around 94% of accuracy in the detection of AD. The purpose of the comparison is to prove rehabilitation of the proposed technique for Alzheimer detection. Further research is planned for detecting Alzheimer's disorder based on a hybrid algorithm.

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Biometric-Based Authentication in Internet of Things (IoT): A Review

Vijender Singh and Chander Kant

Abstract Due to emerging services of IoT in smart city, industry, smart home, personal assistant, etc., safe guards required at its different phases. The communication involves in IoT environment might affect with forged activities injected by intruders. Therefore, lots of efforts have to be taken in the security issues of IoT environment. Generally, we have two types of authentication by mean of pin or passwords and both have problem of stolen or forgotten, respectively. To avoid these problems one more authentication scheme is deployed here, i.e. biometric security, in this case nothing has to be carried out or remember. Biometric is more reliable and user friendly w.r.t. other traditional methods hence widely used now days. In this paper different issues and challenges of IoT are going to be discussing w.r.t. biometric security, e.g. where the biometric could be fitted in IoT environment to secure the IoT infrastructure.

Keywords IoT · Biometrics · Authentication · MFA

1 Introduction

In twenty-first century, Internet of things has become the interesting and most researched area in new emerging technology. IoT can recognize easily surrounding us like home automation, wearable healthcare devices, personal assistant, etc. Developing smart environment and attentive things (smart home, smart cities, energy, health and living) for energy, food, climate, smart society and smart health applications are core objectives of Internet of things [1]. It is defined as heterogeneous field, where multiple smart things or objects interact with each other and cooperate with their neighbours to reach common goals also [2]. Today, IoT finds various application in diverse sectors: the health (smart health devices for diagnosis and prevention), mobility (smart city and smart mobility), home (home automation, smart building), industry (Industrial Internet of Things—IIoT), agriculture (smart farming),

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the animal husbandry (wearable for animals), financial services (digital payment), the free time (smart band, fit tracker, smart watch). When the IoT approach is inserted in the residential environment we speak of Smart House. In this context, there are small micro-environments where several smart devices exist that are intelligent. The smart houses are examples of these micro-habitats and to be defined as such, the smart houses must have certain technological characteristics. A lower level of complexity is proposed by the home automation that provides homes equipments with smart technologies, having the ability to change equipment status and system through remote access by admin or the owners. Here, it is possible to identify two different levels of detail.

First, element is given by the "intelligent" component in home automation. In this perspective, the system of smart house, devices internal and external work in synergy, sharing data to automating the actions of the occupants by calibrating them to their interest.

The natural development of this approach aims to propose systems capable of learning from the activities and controls carried out by users in order to act in a preventive manner and optimize the home environment. Basically, the smart devices are design to know their owners in a broad sense. The virtual component has the algorithms for data processing and command management; moreover, it works to ensure that all elements of the system work correctly and in cooperation.

Second fundamental element of this structure is the control and communication interface between the smart system and the end user.

The connection between virtual and real component should be developed in a simple and intuitive way. Therefore, the owner can quickly and effectively control the home environment. Widely used applications are those related to video surveillance and access and attendance management (in particular by monitoring doors and windows). Currently less common areas concern intelligent irrigation systems, SOHO solutions (acronym for Small Office Home Office) and smart applications for the health, care and assistance of the elderly and sick. IoT has a greater impact on our daily life therefore some form of identification/authentication methods must be required for security and privacy concern. Form the literature; it is finding that token-based, knowledge-based and biometric-based approaches are the most commonly used approaches for user identification [3].

1.1 Biometric-Based Authentication

From a legal point of view, protection of user's data and security are the major critical issues in the context of development of IoT. Self-aware devices communicate with us and with each other, receiving and exchanging large amounts of data and personal information, often even so-called sensitive data such as those relating to health, etc. To access the data and control over the IoT environment some authentication protocols must be there. The authentication protocol helps in protect the data and access controls of IoT environment from the unauthorized user. Biometric-based authentication uses the biometric characteristics of humans for authentication, such as fingerprint, face, iris, retina, etc. Every person has different biometrics characteristics, even the twins has different biometric characteristics and bound to individual and difficult to stolen, lost or forgotten like tradition method, i.e. token, password. Different type of authentication protocols are used today, some of the protocols are OTP-based, single factor, mutual authentication, knowledge-based, MFA, etc. Authentication is the process by which a computer validates the identity of a user; multifactor authentication adds an additional layer of security and protection against one of the most common type of breach compromised credentials. The multifactor authentication facilitates the user who accessed the system by providing more security features [4].

Biometric plays an important role for authentication in IoT environment due to its friendly aspect. The advantage of biometric characteristics for authentication over passwords or tokens is that biometric features are bound to owner and difficult to forgotten, stolen or lost. Different types of biometric characteristics used for identification/authentication are shown in Fig. 1.

Generally, biometric used to identify whether the user is genuine or not by acquires the biometric data from user and extract feature set from acquired data and make the decision after comparing with the stored template [5]. But in IoT, biometric is used to authenticate the smart devices which want to operate within the IoT environment. Biometric-based authentication delivers accurate, secure and efficient results than traditional authentication techniques during the authentication of the devices.

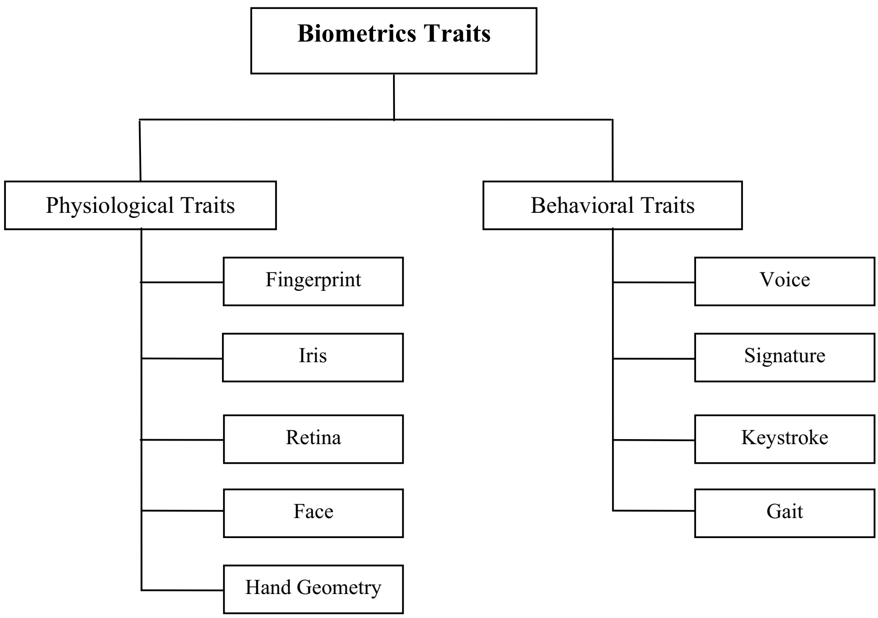

Fig. 1 Biometric traits

Biometric authentication system has two phases for identification and verification [6].

(a) Enrolment: biometric data is collected from the user and stored in template form.
(b) Authentication: newly captured data compare with existing stored data in the smart environment's gateway or cloud.

Smart Home, for example, different home appliances are connected to each other through gateway and the whole system controlled by a smart phone device with the app. All the smart appliances are registered on the gateway through the app; whenever anyone wants to perform some action the following steps will be performed:

i. Smart device send a request to the gateway
ii. Device authenticity by the gateway on the basis of the IP address of the requesting device. For device authentication, different security credentials like id-password/pin and biometric sample will be collected from the device through sign-in step, and matched with the existing data.
iii. If the input credentials will be same as passed during the enrolment, the device will be able to operate the environment otherwise failed to gain access.

Now, the question arise how the Biometric technology meets the IoT technology. The answer of this question will be given in the next section.

1.2 How Biometrics Meets IoT

Biometrics could be robust to protect the devices control and device's data from the unauthorized users. Today, we seen that most of the smart phones companies provides biometric sensors like fingerprint sensor, face sensor to authenticate the user's/owners. Many vendors produced smart wearable devices such as smart watches, smart ring that also work with the healthcare application. In IoT environment, the authentication is the research area where biometric technology merged like authentication of smart phones, smart home devices, remote login, data accessing form the IoT devices, online banking services, cardless biometric-based ATM, etc. The innovation of the IoT will continue at a quick pace, and biometrics will still penetrate all levels of technology.

2 Literature Survey

Here, a brief overview of the various existing authentication systems in IoT environment based upon the biometric technology.

A fingerprint-based authentication solution for IoT devices is proposed, and user authentication process is completed by fingerprint. Corresponding solutions for possible attack on IoT during authentication is also proposed for enhancement in security and reliability of the identity authentication by assuming that devices have fingerprint sensor and the links for communication are secure and reliable [7]. Multi-factor authentication system of smart devices for Smart Banking System is developed, where security is achieved by mobile application. If all the security credentials are true, then the user can access the functionality of the application. AES algorithm used to encrypt the data on cloud to protect it from intruders. The various factors used in this approach are—biometric, OTP, Smart Card, Strong passwords [8]. Every day myriad of services and applications of different areas are merged with IoT. Therefore, single factor or two factors authentications are not sufficient and reliable to provide secure communication. To overcomes this problem, a less vulnerable authentication protocol based on pairing cryptography and face biometric is proposed to secure node to node communication and IoT infrastructure. A detailed study of sensors and smart-phones is discussed where the face image captured and sent it over the IoT platform for node to node security [9]. A lightweight multifactor authentication protocol for remote user was proposed to collect the real-time data from the sensor. To access the system, the user authenticated by the gateway and IoT node. Based on XOR and hash operations, 3FA (smart devices, Password, biometrics), mutual authentication and shared session key and key freshness the user is authenticated at gateway and IoT node [10]. For security enhancement, a MFA scheme is proposed which provides formal analysis and security with the help of Burrows-Abadi-Needham logic. The efficiency analysis of proposed work reveals that the approach can protects system from possible attacks and enhance the Cao and Ge's approach [11]. A key agreement and authentication scheme Bio-AKA is proposed to gain the necessary security features by utilization of advantages of fingerprint and Physical Unclonable Function (PUF) [12]. ECG based user authentication protocol is proposed for the smart devices, data confidentiality and privacy preserving. To support the result, different cryptographic attacks are analysed and find that the proposed scheme is not vulnerable to attacks [13]. For real-time user authentication, ECG features-based authentication protocol is proposed to identify the unknown persons. The analysing process depends on DCT coefficients extracted from a single measured ECG; ECG signal is captured only for three seconds. Implementation part of the approach is done with the Raspberry Pi 3 system and TCP/IP protocol is used to transfer the data for verification process [14]. A biometric-based user privacy preserving scheme in which encrypted information (data) is maintained on the cloud is proposed. Firstly, system's correctness is achieved after that sensitive biometric data privacy and secret key values are captured and preserved confidentially. For efficiency, proposed scheme has been tested against listed attacks [15]. A novel lightweight MFA protocol is proposed and among the user mutual authentication is achieved. For security enhancement, biometric identification improves the non-repudiation. Author described the security analysis and their logical proof in the support of their protocol [16]. Hash and XOR based 3FA protocol is proposed to secure the IoT applications. Burrows-Abadi-Needham (BAN) logic and AVISPA simulation tools are used to provide high security compared result with the existing protocols and stated that proposed system will be better for healthcare sensors networks [17]. To protect user privacy, biometric-based authentication system is proposed, where fingerprint is used and two stage transformations are performed. Cancelable biometrics requirements are fully satisfied by proposed authentication system, i.e. diversity and revocability, accuracy and non-invertibility. The proposed system provides better performance, low computational costs and good fit for limited memory smart objects. Three different types of attacks are described with 0.1% FAR and 0% FAR sets for medium security and high security, respectively [18].

3 How Biometric Can Improve IoT Devices

As the IoT grows at high rate in recent years, the security of the IoT devices become a big challenge. For security purpose many experts are focusing on new emerging and effortless technologies that are quite simple and user friendly. The biometrics technology could be the best from new emerging technologies. It has the feature that is not hack-proof. Therefore, biometric provide convenient security layer in IoT devices. According to the needs or requirements, different biometric traits can be used like fingerprint, face, iris, retina, etc. As a result, without the owner/registration authority permission, it is difficult to access the IoT devices, data or performing task in smart environment [12, 19]. To understand the concept let us take an example of smart city; a city in which ICT is used to enhance operational efficiency, share data with citizen, delivers better government services for the welfare of citizen. Optimization of functions, deliver quality services and growth of economic with emerging technologies and data analysis approach are the major goals of the smart environment.

All smart devices are registered on the cloud server through the Registration Authority and only the registered devices are allowed to perform tasks and access the data from IoT environment as shown in Fig. 2 [20].

Above diagrams shows a scenario of smart city where industry, power house, logistics are connected to the others through the Internet and corresponding devices are registered by registration authority. At registration time, users/owners and device details are collected, i.e. device address, name, contact, address and fingerprint stored on the cloud server. Whenever, someone wants to perform task or try to gain access must pass the correct security credentials (id-password and biometric traits), if security parameters matched with the stored details in database then device will access the IoT environment otherwise denied the access request.

4 Applications of IoT

During COVID-19 pandemic, innovations in IoT are in full swing. IoT finds applications in the most diverse sectors: smart home, the mobility, healthcare, smart industry, agriculture (smart farming), the animal husbandry, financial services but the main application is the remote access which is core reason of IoT. We can see IoT from

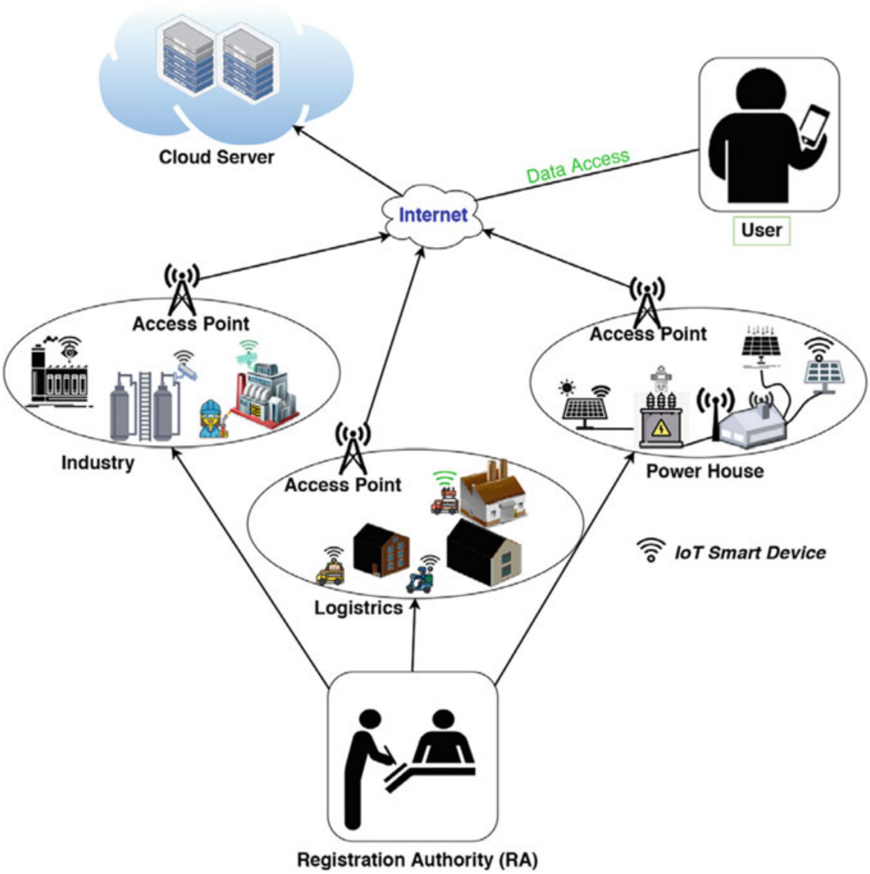

Fig. 2 Registration and authentication in smart city

home (Smart Home) to business like Industrial Internet of Things (IIoT) [21]. Most common applications of IoT are given below:

- Smart Home
- Smart Wearable/Health Care
- Smart City
- Remote Handling
- Smart Farming/Agriculture
- Chain Supply Management
- Smart Retails, etc.

5 Challenges

Biometric features are permanent for the life and the biometric authentication systems would vulnerable to attack. These features cannot be kept secret as it can be collected from users surrounding environment for example, fingerprint from glass (only expert can do). Major problem with the biometric system is the sensor interoperability and also have the possibility of data compromising during transmission (remote access). Server can stores the data without user consent and violate the user's privacy. Fault tolerance is one of the major issues in smart medical devices [22, 23]. The power consumption and storage capacity are another challenges for adaptation of biometric technology in IoT enable devices [8].

6 Conclusion

The size of IoT environment growing fast and affect our daily life. Anyone can access the IoT device and harm our life. Therefore, a security layer must exist to secure the IoT devices from unauthorized access. Different authentication techniques are implemented to secure the IoT devices, i.e. mutual authentication, digital signature, OTP and multifactor. MFA is robust for authentication and provide additional layer of security than the other.

In our work, three different methods are discussed. Biometric plays important role in MFA to secure the devices from unauthorized access which comes under the third method, i.e. "Something You Are". For accessing any devices in IoT environment, MFA allow only when all the inputs are correct that makes the system more robust. By entering the correct inputs, user unlocks the entire system, thereby earning the complete access to the data. Different types of physiological biometric traits can be used in MFA for security purpose, i.e. fingerprint, iris, retina, face, etc. depends on applications. The biometric-based MFA will be the best choice for remote handling of devices, online payment, smart airport, Smart locker, etc.

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ExpressMailer: Fast, Customizable, and Secure Mail Service

Hardik Asher, Rugved Bongale, and Tushar Bapecha

Abstract Almost everyone uses a mail service at some point in their life. We all are completely dependent on Gmail-like applications. When such services are down, we face a lot of trouble. Also, privacy is an issue of concern nowadays. The idea behind this application is to create a mail service that has highly customizable components and gives an organization complete control over privacy. We have used techniques that require less computational power making it affordable for all. The main highlights of the application are everyday mail, chat, video call, and spam detection using machine learning, email search optimization, and data privacy using cryptography. A product is created where a user can use the electronic mail functionality to send, receive emails, with added features like search mail, star, and mark as important. The spam detection algorithm will automatically send emails to the spam folder based on various parameters defined, using machine learning algorithms. Encryption and decryption of the mail contents are done using asymmetric cryptographic algorithms. Also, for searching mails in application, proper study and indexing for documents have been done to give emphasis on faster retrievals.

Keywords End-to-end encryption · Firebase · Keyword extraction · Spam detection

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1 Introduction

Mail plays a vital role in the everyday lives of people around the world. It is a binding medium of expression that connects people from the farthest corners of the world to express and relate their views with each other through the embodiment of the protagonist/narrator. We all are completely dependent on Gmail-like applications. When such services are down, we face a lot of trouble. Privacy is an issue of concern nowadays where companies prefer having control of the security of their data on their own. The end product will be a Web app which will be a single-page multi-route application covering all the important and most commonly used functionalities of Gmail. It will be built using Firebase, thus making it scalable from the first day. React js is used for responsive and smooth design.

After knowing that Whatsapp was going to change its privacy policies. It was expected that users would start using alternatives like Signal/Hike but that wasn't the case. Analyzing Signal/Hike versus WhatsApp situation, users don't tend to accept the changes because users were used to the UI they were using for a long time. Thus, we tried to keep the UI as similar as Gmail.

2 Related Work

Kumar et al. [1] give a comprehensive review of the spam detection technique including data preprocessing and model evaluations based on Naive Bayes, support vector machine, decision trees, and k-nearest neighbor approaches. The random forest algorithm is also talked about more extensively in [2]. From [3], we can infer that the support vector machine algorithm is also very effective in spam detection. Nandhini and Marseline [4] mainly give an overview of the performance evaluation methods which we have used to check the performance of our spam detection algorithm and model. Clustering and active learning approaches have been talked about in [5]. We decided to go with the random forest approach out of all the abovementioned approaches for the reason that splitting a decision among various decision trees and then taking the majority output was giving a very high accuracy as portrayed further. Both [6, 7] talk about TF-IDF or term frequency times inverse document frequency for assigning weight to words in a text. This approach is used mainly for search algorithm but is also used in spam detection to assign weight to a word in context and to highlight words that are very frequent in a document but not across several other documents to look for spam words.

3 Materials and Methods

3.1 Materials

The software will operate on PCs, laptops, etc. In the existing scenario, a Web site is created to deploy this software.

Hardware Requirements:

OS: Windows 10/Ubuntu.
CPU: Intel Core i5.
RAM: 4 GB.
Hard disk: 50 GB.

3.2 Methods

Spam detection: We have implemented spam detection on our Web site to filter out spam emails from a user's inbox [8]. Email spam is one of the major challenges faced daily by every email user in the world. Daily, email users receive hundreds of spam mails having new content, from anonymous addresses which are automatically generated by robot software agents. The traditional methods of spam filtering such as black lists and white lists (using domains, IP addresses, mailing addresses) have proven to be grossly ineffective in curtailing the menace of spam messages. This has brought about the need for the invention of highly reliable email spam filters. Recently, machine learning approaches have been successfully applied in detecting and filtering spam emails. The main purpose is to develop a spam email filter with better prediction accuracy and fewer features. The algorithm applied was a random forests algorithm that uses decision trees and provides high accuracy.

A random forest algorithm gives high accuracy because it uses decision trees as a part of supervised learning algorithm. It uses the bagging method to enhance the overall result. Random forest algorithm relies on several decision trees based on small parts of the given dataset and averages the decisions to enhance the accuracy of that dataset. Rather than complete relevance on one decision tree, it takes the majority of the predictions from each tree, and then predicts the final result. It can handle big datasets and can automatically balance them when some classes are more infrequent than the others.

For our algorithm, we have used some predefined libraries. The natural language toolkit (nltk) consists of programs and libraries for natural language processing. The count vectorizer is used to tokenize a text collection and build a set or a vocabulary of some well-known words, and it is also used to encode the new documents in the vocabulary. Term frequency times inverse document frequency (TF-IDF) is also used in spam detection to highlight words that are very frequent in a document but not across several other documents to look for spam words. It assigns a weight to every word and checks how relevant a word is in pure text. Entropy measures the randomness of words in the text.

The dataset was from Kaggle with 4993 unique values, 71% ham emails, and 29% spam emails. The dataset can be found at [9].

Algorithm used is as follows:

Step 1 Read the dataset and extract values of message (text), label (spam or ham) and length and then split into training and testing data.
Step 2 Extract the lemma or the base form of each word in the text.
Step 3 Apply feature transform using count vectorizer and TF-IDF.
Step 4 Then using nltk, perform the language processing.
Step 5 Lastly, the random forests algorithm is used on this feature-transformed data to finally prepare the model.

For model assessment, the following are the scores received for the above model:

- Accuracy = 95.899%
- Precision = 94.533%
- Recall = 90.021%
- F score = 92.222%
- AUC = 0.94047.

Search function: Users can easily search for emails with the help of search functionality. Searching usually requires high computational resources. Therefore, we used a technique that satisfies search requirements to a great extent and uses less computational power. The search is based on recipient/sender email, important words from an email that is ranked by frequency-based algorithm [7]. To extract keywords from the document, we have used the TF-IDF algorithm.

(a) **Term Frequency (TF)**

It measures the frequency of a word in the document. Let's consider a document D consisting of N words, $D = \{t_1, t_2, t_3, \ldots.\}$. If a word t appears n times in D, then its term frequency tf would be given as:

$$\mathrm{tf} = \frac{n}{N}$$

(b) **Inverse Document Frequency (IDF)**

It is the measure of importance of the word 't' in the document.

$$\mathrm{idf} = \log \frac{\text{total number of sentences}}{\text{number of sentences with term } t}$$

Both term frequency and inverse document frequency are used to calculate the TF-IDF scores which is a product of TF score and IDF score. This TF-IDF score is the deciding factor to extract top keywords from the given mail.

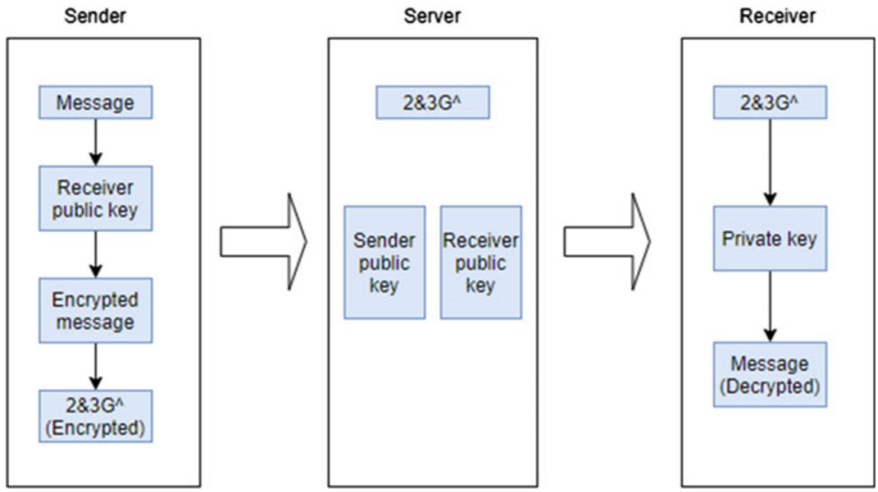

Fig. 1 End-to-end encryption

$$\text{TF - IDF} = \text{TF} * \text{IDF}$$

End-to-end encryption: Giving privacy the utmost importance, we have used end-to-end encryption which provides secure communication and does not allow third-parties to access data while being exchanged. End-to-end is based on public-key encryption. The mail sent will automatically encrypt itself, and decryption is possible only at the intended receiver's end (see Fig. 1). The algorithm used for encryption is SHA-512.

4 Implementation

- **User profile and authentication**: The user will be able to log in or register to the system by using his mail id, Google authentication, or Facebook login. This data are encrypted and stored in the firebase database. It is properly indexed by inbuilt firebase indexing to allow fast retrieval of user profiles.
- **Spam detection**: Email spam detection can be implemented using various techniques [1]. We opted for a random forests algorithm for the detection of email spam [2]. The email is broken down into a series of words, and the number of times a word is used is calculated. We have set a threshold for the maximum number. With a 95.89% accuracy, the random forests algorithm works best. The Python notebook can be hosted on an API using flask, and the mail subject and body are passed through the flask server. The API will return a response as spam or ham.

- **Keyword-based search**: Keywords are picked from the mail by using frequency-based algorithms [9]. Also, the added functionality is provided to the user where he can add his keywords or labels to this keyword list which is then stored in the database. When the user searches for a mail, search is done on this keyword list rather than the entire mail. This saves a lot of computation power.
- **Video calls**: The Web site provides the functionality of video conferences, one-to-one video calls, and also private rooms. It is end-to-end encrypted and can manage up to 100 participants. Moreover, multiple participants can share their screens and provide HD audio–video. To achieve this, we have used jitsi meet which is a fully encrypted, 100% open-source video conferencing solution.
- **Chat**: We have used firebase collections and subcollections to store the chat data and used sockets to provide a real-time chat experience.
- The **User Interface** was made using React Js, and the back end is implemented using Firebase. User data are stored in Cloud Firestore. The email body is also stored in Cloud Firestore in hash format. Other variables such as starred, marked important, spam/ham are also stored along with email body and timestamp. The keywords are extracted from the email subject and body which helps to enhance searching through emails (Fig. 2).

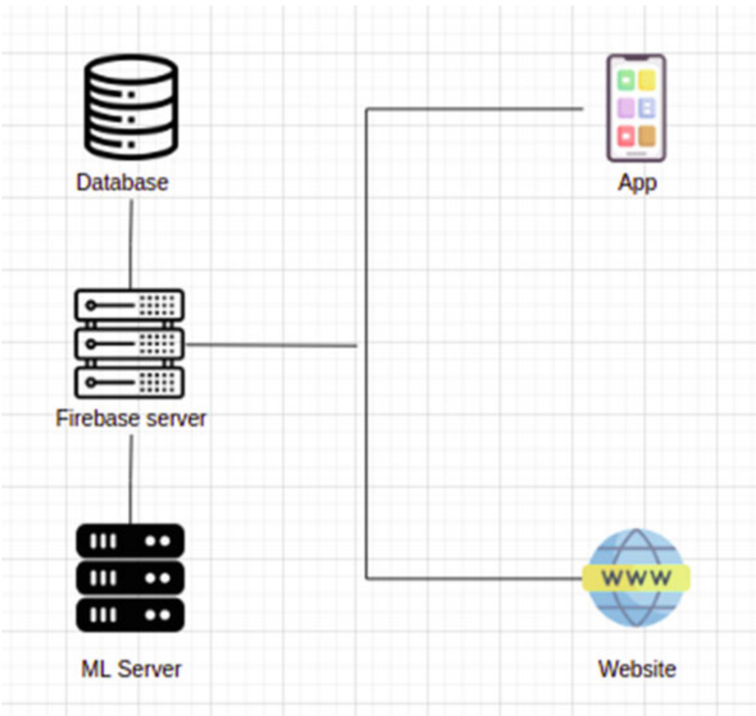

Fig. 2 System architecture

5 Testing

We have performed selenium testing in Python using chrome driver. Unit tests were written for major features like sending mail, chat, and search functionality of the application. Keeping the target URL as the application URL, we also generated the reports for the same which required almost 65 s to test the three mentioned features. All the tests successfully passed considering different scenarios based on the features.

6 Conclusion

In this paper, we developed a mailing application with an inbuilt spam detection mechanism and security provided by end-to-end encryption. SHA-512 was used for securely storing the hash values of the mails sent from senders to their specific recipients. Considering the use of different applications like Gmail, we made a simple and clean UI design that is easy to adapt and use. At the last, we did proper selenium testing on different features of our application. The future scope of this project is to provide private–public features for attachments and improvise the current searching, encryption algorithms in depth.

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Air Monitoring System Using IOT

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Abstract Air contamination is each continental's issue. Air contamination makes the life of people more miserable. The whole human would disappear one day because of this giant "Air Pollution" as impure air can cause severe health issues. Not only air pollution outside due to industrialization and vehicles, indoor air pollution from homes and office environments can also cause severe health problems like allergies, asthma, and even, severe air pollution can lead to nervous problems. Indoor air quality may depend on dust, gases from inside due to cooking, smoking or from nearby outside vehicles, humidity, and temperature. Though the dust is cleaned in the room, it may accumulate again based on the usage of the room or dust from outside. The proposed work focuses on IoT-based air quality monitoring system to observe the air quality continuously inside a room. The system collects data related to temperature, humidity, dust, and gas and stores the values in a database and also displays on LCD attached to IoT system. When the quality decreases more than a certain level, using GSM module, a message will be sent to house owner's mobile to take care of cleaning process or using air purifiers.

Keywords Air quality · Arduino Uno · GSM · Humidity · Internet of things · MQ135Sensor · Temperature

1 Introduction

Among different pollutions like air pollution, water pollution, thermal pollution, soil pollution, and noise pollution, air pollution is the most dangerous one as it directly relates to mortality [1]. As per *the Guardian* reports, 90% of people around the world are getting only polluted air for breathing [2]. And as per WHO reports, outdoor air pollution is causing more than 4 million premature deaths per year globally, and apart from industrial and vehicular pollution, indoor air pollution is also one of the causes for the increase of ambient air pollution [3]. Indoor air quality may affect the

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children, old age people in the form of allergies, lung diseases, or it may even cause cancers. People with asthma may suffer more because of poor air quality [4, 5]. This paper proposes an IoT-based continuous indoor air quality monitoring system using Arduino board dust, temperature, humidity, and gas sensors. The values from these sensors can be seen on LCD board attached to the system, and the data was also stored in a database for further analysis. Whenever the dust sensor value increases more than 8 ppm, message will be sent to house owner's mobile with temperature, humidity, and dust values and with an alarming message to take care of the children using GSM module. The proposed system is very useful to be placed in any of indoor environments like homes, offices, schools etc., as it is very cost-effective.

2 Literature

An indoor air quality monitoring system was developed using low-cost sensors in [6]. The system studied air quality in the kitchen environment using Bosch BME680 sensor, microcontroller and was able to store the data in Web server. An IoT-based real-time air quality monitoring system with low-cost sensor was built using semiconductor sensors of MQ series and Arduino board. The system had taken care of power consumption issue also by putting microcontroller in sleep mode when not in use [7]. An air quality measuring system called smart air was demonstrated in [1]. Designed using a microcontroller, different pollutant detection sensors and a modem, the system can measure temperature, humidity, and gases like CO and CO_2. In the paper [8], for the monitoring of indoor air, wireless smart system is used to sense the pollution inside areas. LED light is used in this system, and the light is lighted accordingly, and the data will be displayed in the database of Web server. This paper is developed on IoT technology, and the air quality is measured and transmits to the web server. In the developed system [9], it is used to monitor the air quality over a Web server using Internet and triggers an alarm when the quality of air goes beyond the threshold value, which shows the quality of air on the LCD which is measured in PPM. The MQ135 and MQ6 sensors are used for detecting the most harmful gases. Authors in [10] describe the prototype based on IoT concept by using the concept of cloud. This device monitors the environment in which the air contains the pollutant gases and provides the certain precautionary measures to the people. IoT-based monitoring systems were also developed in [11, 12], and after collecting data through IoT sensors, how the data is stored in cloud was also discussed in [13–15].

3 Proposed Work

In the proposed work, indoor air monitoring system is shown by the architecture diagram in Fig. 1. This system mainly focusses on the dust particles along with the temperature and humidity sensors. The dust sensor used in this project is

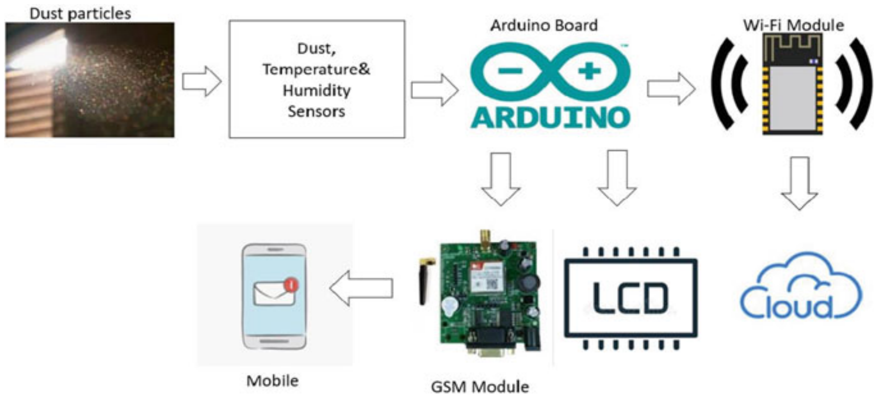

Fig. 1 The architecture of indoor air quality monitoring system

GP2Y1010AU0F, ranges up to 500 ppm, and the specification of each pin is described in Figs. 2 and 3. To connect the sensors to Arduino, dust sensor V0 pin is connected to the A0 pin of Arduino UNO, and the V-LED and Vcc pins can be connected to 5 or 3.3 V of Arduino UNO. To connect temperature sensor to Arduino, connect Vcc to the 5 V of Arduino, data pin to the digital pin of UNO and GND pin to the

Sensor Pin	MCU Pin	Description
VCC	2.5V ~ 5.0V	Power Input
GND	Ground	Ground Connection
AOUT	I/O	Analog Output
ILED	I/O	Module Driving Pin

Fig. 2 The specifications of dust sensor module

1	Vcc	Power supply 3.5V to 5.5V
2	Data	Outputs both Temperature and Humidity through serial Data
3	Ground	Connected to the ground of the circuit

Fig. 3 The specifications of temperature–humidity sensor

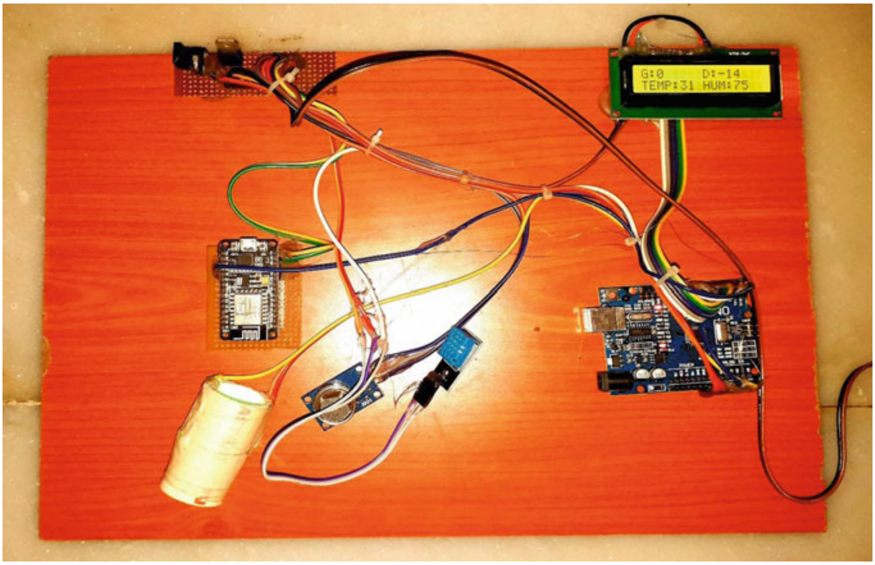

Fig. 4 How the sensors are connected to Arduino UNO, and to the Wi-Fi module, the values are displayed in the LCD in which user can see

GND. The whole connection of the system is shown in Fig. 4. The values that are detected are displayed in the LCD. These values are stored in the cloud by using the Wi-Fi module which are stored in Excel sheet for future work. The GSM module is connected to Arduino by connecting TX pin of GSM module to RX pin of UNO, connect RX pin of GSM module to TX pin of UNO, connect GND pin of GSM to GND of UNO. If the value of dust is greater than 10 microns, then the alert message is sent to the owner's mobile including the corresponding temperature and humidity including a note to take precautions.

4 Experimental Results

Figure 5 represents the line graph dust vs. time by considering a day as an example. At 9:00, the dust is not cleaned, the dust particles in the house are high, and message to the user will be sent. Then, at 11:00, the house is cleaned, and the value of dust particles decreased. Later, the dust particles increased due the outside environment, and the values of dust particles increases as the time increases. When we clean again, the values of dust particles will be decreased. The values in the Excel sheet Fig. 6 are stored by considering 2 min of time including date and time in which they can be used for future work. When the dust particles are increased, the user gets an SMS about the value of dust and gives message to take care of the children which is shown in Fig. 7 and also suggests to take some precautions accordingly.

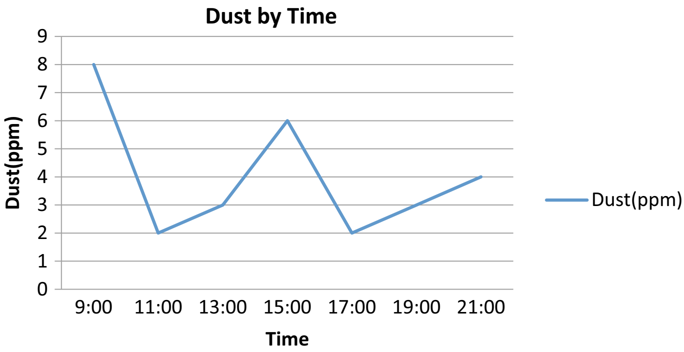

Fig. 5 Graph of the dust particles

DATE	TIME	TEMP	HUMIDITY	GAS	DUST
7/2/2021	19:05:42	30	81	66	3
7/2/2021	19:05:45	30	81	64	3
7/2/2021	19:05:47	30	81	65	4
7/2/2021	19:05:50	30	81	59	5
7/2/2021	19:05:52	30	81	60	3
7/2/2021	19:05:55	30	81	58	3
7/2/2021	19:05:58	30	81	61	5
7/2/2021	19:06:01	30	81	63	4
7/2/2021	19:06:04	30	81	58	3
7/2/2021	19:06:07	30	81	59	2
7/2/2021	19:06:09	30	81	60	3
7/2/2021	19:06:13	30	81	62	2
7/2/2021	19:06:16	30	81	62	3
7/2/2021	19:06:20	30	81	61	2

Fig. 6 Values displayed in the excel sheet which are detected by sensors like temperature, humidity, dust, and gas updated with time and date

5 Conclusion

Arduino-based indoor air quality measurement system was developed using temperature, humidity, and dust sensors and tested in the house environment. The system will continuously monitor the quality of air and shows sensor readings on the LCD display and sends data to excel file. When the dust values increase more than a threshold value, message will be sent to house owners mobile. The system can be applicable to measure the indoor air quality in class rooms, office environment also.

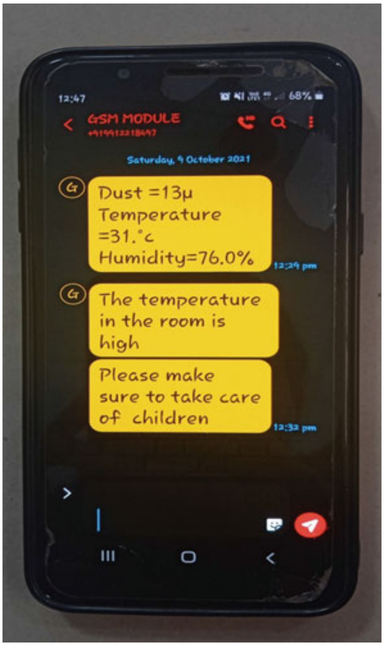

Fig. 7 Message to mobile when dust quality value increases

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Residual in Residual Cascade Network for Single-Image Super Resolution

Anirudh Aggarwal, Mohit Bansal, Tanishq Verma, and Apoorvi Sood

Abstract Digital images are of great significance in today's scenario, where almost every single domain relies on them from agriculture to businesses to the military for their specific purposes. To convey the context, a more precise image gives more idealization and personalization to the aspect one wants to build. The precise images connote high clarity and distinct characteristics which is represented by a parameter known as resolution of image. This paper focuses on upscaling the resolution of image using a fast, lightweight artificial neural network (ANN)—RRCasN. The proposed model surpasses the traditional methods and competes with modern ANN-based architectures in terms of size of the model and quality of the high-resolution image produced. This paper also introduces a novel approach for normalization in place of batch normalization.

Keywords Artificial neural networks · Generative adversarial networks · Super resolution · Resolution enhancement · Residual networks · Image processing

1 Introduction

"Super resolution" (SR) is the method of upscaling an image with the intention of preserving the most amount of details within the image. The basic working is depicted as providing an image of low resolution (LR) as input and receiving the

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up-scaled version, a higher resolution image as output. The details in the high-resolution (HR) output are filled in where the details are substantially undefined [1]. SR approaches aim to retrieve as much information as possible as present in HR images from limited LR information and enlarge the picture without creating any distortion. These approaches make use of different parts of the LR images, or other peripheral images, to generate HR images [2]. The vast diversity in which SR is applicable, makes it is a popular and interesting topic of research. Different methodologies have been proposed like patch-based methods [3, 4], statistical methods [5], edge-based methods [6, 7], sparse dictionary methods [8, 9], and prediction-based methods [10, 11], etc., to increase the image resolution with their various applications in our daily life like medical diagnosis [12], surveillance [13], earth-observations remote sensing [14], astronomical observation of planets [15], biometric information identification [16], etc. [2]. SR, on one hand, can aid astronomers in studying outer space by enhancing the resolution of celestial images, and on the other, it poses as a vital component in biometric identification, including enhancement of resolution of faces [17, 18], fingerprints [19], and iris images [20] for its usage in various fields.

A popular method for image resampling is bicubic interpolation [10] which upscales LR images of small sizes to an extent. HR images require a high level of fidelity which often lacks in the resulting images of bicubic interpolation. The images are not perceptually satisfying, and a lot of high-frequency details are lost. Artificial neural networks (ANNs) have performed quite well in this field in lieu of the advancement in the field of deep learning. From an introductory and simple architecture to a complex and full-fledged network, with their high approximating capacity and hierarchical property, they have proved to be a popular choice over traditional methods for the task of super resolution [21]. Most of these architectures are of large sizes according to their complexities which use the mentioned properties to a large extent and consume resources accordingly.

The aim of this paper is to apply artificial neural network-based methods to tackle SR tasks: modeling and training a lightweight ANN to increase the pixel resolution of an image while maintaining its spatial resolution using neural networks which works even with low availability of resources.

This paper contributes to the field of super resolution in following ways:

- A lightweight GAN-based architecture which uses Residual-in-Residual Cascade block for generating up-scaled high-resolution images by a factor of 4, and
- M-Sigma normalization, a novel normalization technique to capture the dynamic range of color channels in place of batch normalization.

2 Related Work

The pioneer in the domain of super-resolution was the contribution of "Super-Resolution Convolutional Neural Network" (SRCNN) by Dong et al. [22] through which the use of neural networks approaches increased drastically. It was a deep convolutional neural network with a simple architecture which performed well on the CPU. Several network architecture designs and training strategies such as residual learning [23], recursive learning [24, 25], memory network [26], deep back-projection network [27], channel attention [28, 29] have consistently enhanced the SR performance, especially "Peak Signal-to-Noise Ratio" (PSNR) value.

Introduction of "Generative Adversarial Networks" (GANs) [30] in SR presented a strategy which not only outperforms the overall speed but also recovered the finer texture details when resampling to large upscaling factors. "Super Resolution using Generative Adversarial Networks" (SRGAN) [31] used perceptuality as the evaluation criteria for generating photo-realistic images. A deep resolution network (ResNet) with skip-connection aimed at evaluating against a novel perceptual loss using high-level feature maps of "Visual Geometry Group" (VGG) [32] network and aiming away from mean square error (MSE) as sole optimization target, yielded the result to be a new state-of-the-art with the high upscaling factor of $4\times$. The principle of the using hierarchical features came forth in residual dense network (RDN) [33], generating images with more details by convolution layers of "Residual Dense Block" (RDB) where local feature fusion helped in preserving the features progressively. In RDB, a "contiguous memory mechanism" was used to read the state from the preceding RDB.

High-frequency details were missing in PSNR-oriented approaches. Their output had over-smoothing effect as the PSNR metric do not consider the subjective evaluation of the human observers. "Enhanced Super-Resolution Generative Adversarial Network" (ESRGAN) [34] came forward as the "Enhanced" version of SRGAN by using more effective relativistic average GAN. Employing the underlying architecture of ResNet, all the batch normalization layers were taken out, as suggested by "Enhanced Deep Super-Resolution Network" (EDSR) [35] and "Residual in Residual Dense Block" (RRDB) was introduced as the primary block of the network. Using RRDB in the main path (not branches), network capacity was increased due to the dense connections. The focus was on the artifacts for which an enhanced perceptual loss was proposed, which used features before activation for brightness consistency and texture recovery.

Although all of the mentioned architectures gave acceptable results, their main drawback was their sizes. Being complex and extensive with substantial resource requirement for computation make them non-economical for commercial use. However, some noticeable architectures which were small in size, like cascading residual network (CARN) [36], information distillation network (IDN) [37] that were at par with heavy sized models came up. Block state-based recursive network (BSRN) [25] was a recursive network which utilized the recursive part of the model to track the status of current image features easily. The "block state" helped in the storage of historical features. It used recursive residual block (RRB) consisting of three concatenated convolution layers and one concatenated "Rectified Linear Unit" (ReLU) layer. This allowed it to perform efficiently in terms of the number of model parameters, quality measures (PSNR, structural similarity [SSIM]) and speed. Laplacian pyramid super-resolution network (LapSRN) [38], a CNN architecture, contributed through parameter sharing and local skip connections in the field of SR. It outperformed various CNN-based models in terms of speed and accuracy and progressively generated HR images in a coarse-to-fine fashion.

3 Proposed Method

3.1 Network Structure

The residual in residual cascade network (RRCasN) has mainly three components: (a) Residual in Residual Cascade Blocks (RRCBs), (b) Global Residual Learning (GRL) [33], and (c) UpSampling Block (USB). A low-resolution image (LR) is given as input to the generator and corresponding high-resolution image (SR) with 4 $\times$ upscaling factor is the received as the output of the generator. The first convolution (conv.) layer is used to extract shallow features from the LR image. These shallow features are passed to the RRCBs for extracting more low-level features. GRL stabilizes the training process. After extracting low- and high-level features, USB is used to resample the image for generating the SR image. UpSampling block consists of two groups of one Conv. layer with ParametricReLU (PReLU) [39] activation function followed by sub-pixel convolution layer (pixel shuffle) given by Shi et al. [40]. Last two conv. layers are used to finally generate images with high-frequency details and a high level of fidelity (Figs. 1 and 2).

The RRCasN contains three RRCBs, which are inspired by the "Residual in Residual Dense Block" (RRDB) suggested by ESRGAN [34], and cascading residual network suggested by CARN [36]. These blocks extract features from images in LR space. Each RRCB contains three "Residual Dense Blocks" (RDBs) consisting of three conv. layers with Leaky ReLU [41] activation function. The states of preceding conv. layers are concatenated to the current conv. layer to utilize features from all the other layers. Residual connections with residual scaling [42] are used to improve the information flow between different RDBs. The residual connections help address

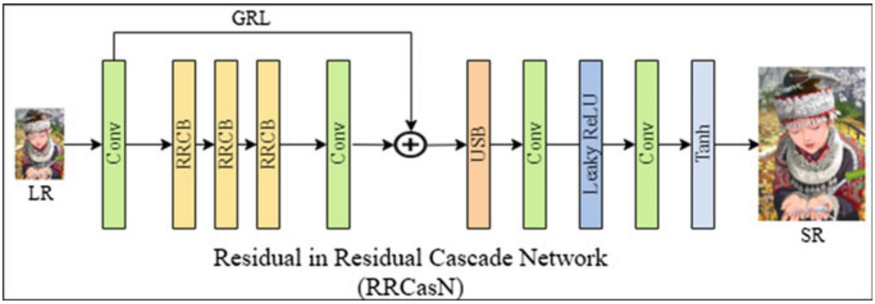

Fig. 1 Residual in residual cascade network architecture

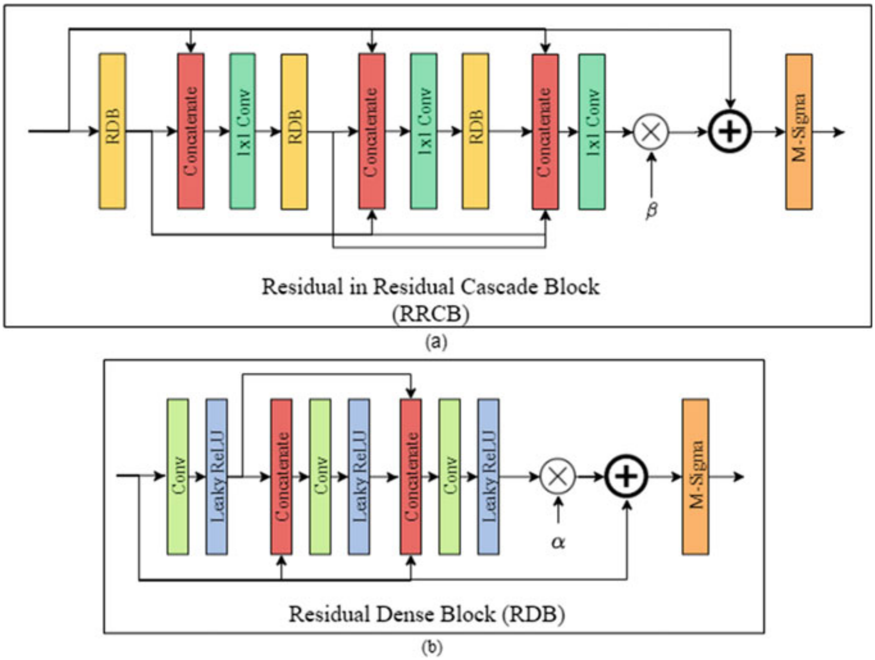

Fig. 2 **a** Residual in residual cascade block, **b** residual dense block

the issue of vanishing gradients arising in deep neural network models. The degradation problem indicates that the solvers may have difficulty approximating identity mappings by several nonlinear layers. For the residual learning reformulation, if identity mapping is ideal, the solvers will move the weights of several nonlinear layers towards zero to reach identity mappings [43]. Residual scaling is used to prevent instability in the learning process. Multiplication of residuals with a constant α, in RDB, between 0 and 1 is done, and then, they are added to the main path.

In each RRCB, the output of the preceding RDBs is concatenated with the output of current RDB. After concatenation, a convolution layer with 1×1 filter size is used to decrease the number of channels. This layer is also used to fuse features from all the preceding RDBs to a single feature set. Similar to RDBs, residual connections with residual scaling are also used in each RRCB for better information flow between each RRCBs. Here, β is used as constant for residual scaling. M-Sigma normalization is used to normalize the output of each RRCB and RDB block.

3.2 M-Sigma Normalization

As suggested by EDSR [35], and ESRGAN [34], batch normalization (BN) layers are not used. Instead, this paper proposes a novel improved normalization technique, termed as M-Sigma normalization, to normalize the outputs of RDBs and RRCBs. M-Sigma normalization takes in the input data (X) and outputs the normalized result (Y) according to Eq. (1). Here, M signifies the number of inputs combined or concatenated to produce the resultant output. Multiplying the standard normalization [44] with a factor of $(1/M)$ kept the effect of the standard deviation of the input from diminishing, which was otherwise resulting in the pixels to have similar intensities in each color-space channel.

$$Y = \frac{(X - \mu)}{(M * \sigma)} \tag{1}$$

where μ and σ represent the mean and standard deviation of input data X, respectively.

3.3 Discriminator Architecture

The discriminator is a convolution neural network for determining the authenticity of the input image. The proposed discriminator architecture is inspired by the SRGAN adversarial network architecture [31]. It differs from SRGAN architecture in the way that no activation function is applied to the output of the final convolution layer. For optimal training, the weights for the discriminator are constrained to fall in the range of $[-0.01, 0.01]$. The discriminator updates its weights using the backpropagation algorithm.

3.4 Loss Functions

For training the discriminator, the actual high-resolution images are fed with the classification value of $\{+1\}$, and the generated high-resolution images are fed with classification value $\{0\}$. The "Mean-Squared Error" (MSE) [45] loss is used as the discriminator loss for training the discriminator model. For training the generator, a combination of several different losses is used given by Eq. (2). SL and W_{S} represent the style loss and the weightage, respectively, CL and W_{C} represent the content loss and the weightage, respectively, L_{MSE} and W_{MSE} represent the MSE loss and the weightage, respectively, L_{GAN} and W_{GAN} represent the GAN [46] loss and the weightage, respectively. The content and style losses are used to check the model's ability to capture the content and style of an image [47]. The MSE of the subsequent difference between the contents and styles of the actual HR images and the generated HR images is treated as the content and style loss, respectively.

$$L_{\mathrm{GEN}} = (W_s * \mathrm{SL}) + (W_c * \mathrm{CL}) + (L_{\mathrm{MSE}} * W_{\mathrm{MSE}}) + (L_{\mathrm{GAN}} * W_{\mathrm{GAN}}) \tag{2}$$

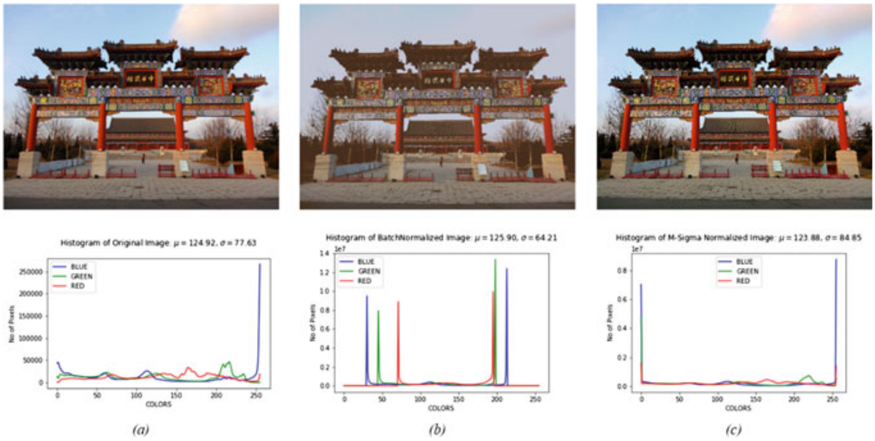

Fig. 3 **a** Original LR lama temple image, and its histogram, **b** generated HR image using batch normalization, and its histogram, **c** generated HR image from using M-Sigma normalization, and its histogram

4 Experimental Results

4.1 Ablation Study—M-Sigma Normalization

M-Sigma normalization is adopted as the normalization layer instead of batch normalization [48]. For the purpose of comparison, the Lama temple image from the DIV2K dataset [49] is used. Batch normalization possessed an averaging effect on the images compared to the original LR image as evident from Fig. 3a, b. The resultant image was lacking the dynamic range. The dynamic range was getting worse due to the reduced deviation of pixels intensities, in each channel, evident from the corresponding histograms.

Multiplication of a factor of $(1/M)$ with the standard deviation in the equation, M representing the number of inputs combined or concatenated to produce the resultant output, increased the deviation of pixels in each channel to a broader range. This helped in overcoming this loss of dynamic range as evident from Fig. 3a, c.

4.2 Results

DIV2K (DIVerse 2 K) dataset [49], consisting of 800 pairs of HR (2 K resolution) and LR images, has been used for training RRCasN. For training, 64 × 64 size LR images are generated with the batch size is set to eight; and the images are randomly flipped and rotated to create a more diverse dataset. Testing is done on four widely used benchmark datasets: Set5 [50], Set14 [51], B100 [52], and Urban100 [53] which

Table 1 # of parameters in different models

Model	# of parameters
BSRN	742,000
LapSRN	872,000
SRGAN	1,550,486
RRCasN	**1,563,397**
CARN	1,592,000
ESRGAN	16,910,000

Bold significance is our model/network results in the table

contains images of varied content, texture and details. PSNR and Structural Similarity Index (SSIM) [54] are employed for evaluation of model.

The results profile, the output of the proposed model, conventional methods, and PSNR-oriented models for comparison. The emphasis is on the number of parameters in the proposed model against the other methods, as shown in Table 1.

The task was carried out by generating LR from the images of the benchmark datasets that were considered as HR. Then, the generated HR from our model were compared to the results of other models. The performance of RRCasN was higher as compared to the conventional bicubic interpolation method for image upscaling to a factor of 4×. The (PSNR, SSIM) values for RRCasN surpass the bicubic interpolation method: (27.10, 0.81) by bicubic against (30.17, 0.87) by RRCasN for Set5; and (21.81, 0.66) by bicubic against (24.09, 0.76) by RRCasN for Urban100. It can be observed from Figs. 4 and 5 that RRCasN transcends the approaches in terms of perceptual quality. The texture and details are more pronounced and are more visible in RRCasN as compared to BSRN and CARN. The images generated using BSRN have a sketch-like look while CARN and RRCasN look more photo-realistic. Also, the quality of images produced by RRCasN is quite comparable, even almost similar

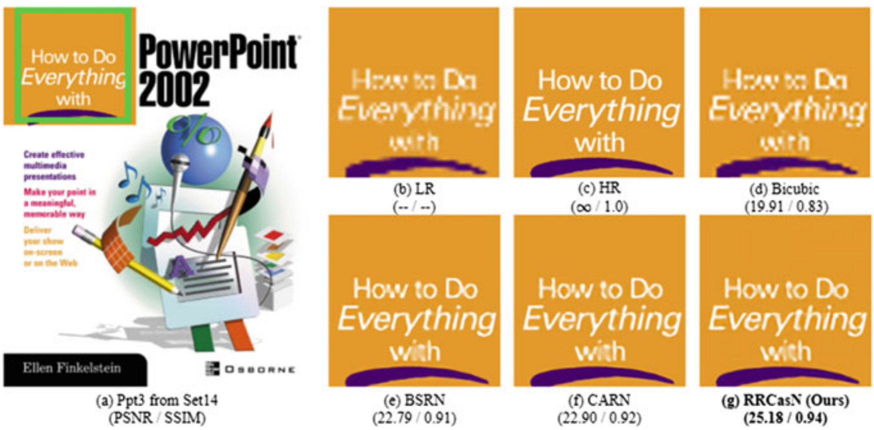

Fig. 4 Model comparison for ppt3 from set14

Fig. 5 Model comparison for 302,008 from B100

to CARN, considering the difference between the amount of training: CARN was trained for $6*10^5$ iterations on Div2K dataset while RRCasN has been trained for 1×10^5 iterations.

5 Conclusion

The current study has introduced a GAN-based neural network architecture, the RRCasN model, for increasing image resolution. It compared the model with other well-known methods and models. The results show that it outperforms them in terms of quality measures while being small in size, a smaller number of parameters, and being trained for less amount of time. The model uses RRCB as the basic block for the generator which consists of three RDB blocks. The RDB further consists of a novel method of normalization, M-Sigma normalization, which is used to normalize the output. The loss function for the critic is MSE while the generator loss is a combination of style, content, modified MSE, and GAN losses. The promising results show that this model can be used for real-time purposes in increasing the image resolution by $4\times$ factor.

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Road Traffic Monitoring System Based on Splunk

Krutrth Ganatra, Olson Noronha, and Chintan Bhatt

Abstract In the digital era machine data is one of the fastest growing data. Making use of such data to solve our day-to-day life problems sometimes it becomes hard as many forms of such data is not easily understood and readable by the user because those data come from the different devices such as sensors, web servers, application etc. in different form i.e., JSON, CSV file etc. So, to overcome such problems, in this paper we have discussed how "Splunk" can be used as a tool based on the user requirement. Every country has its own structure and based on the structure of the country; roads are made in the country for the people living there to make their day-to-day communication easy between different places. So based on the structure the road width and length of road differ from area to area and so the traffic of the vehicles. So, at some places the road is wider and have a smaller number of vehicles so there we consider no or less traffic and at some places the roads are narrow and have large number of vehicles passing there by so there we consider it as the heavy traffic.

Keywords Big data · Splunk · Traffic monitoring

1 Introduction

As we are moving more and more towards the digital era, we see every company whether a small-scale business or a large-scale business, has started generating data to make their work easy by placing sensors in industrial error or through web servers or through the applications. It is found that the Internet generates around 2.5 quintillion byte data every day. Facebook generated 4 petabytes of data every day in 2020. On an average 500 h of video are uploaded on YouTube every minute.

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Over the past few months, we are seeing that prices of crude oil like petrol and diesel are creating trouble for the common man but Joe Kaeser the CEO of Siemens believes that there is something more crucial than the petrol and diesel which is creating trouble and he calls it—“Data”. In one of the tech forums Kesar says that “Data is the oil, same say the gold of the twenty-first century—the raw material that our economics, societies and democracies are increasingly being built on”. According to the size of data it is generally classified as Big Data, Very Big Data and the Massive Data. In the Traditional database management system generally known as RDBMS we can only analyses the structured data, unstructured data and semi structured data but it has got some limitations which can be overcome by using “Splunk”. So, in this paper we have used “Splunk” as a tool for the Road Traffic Data Generated. Depending on the infrastructure of the country and number of the sensors placed in the country data is being generated on the regular intervals and we can analyze that data and base on that the user can reach to some solution like building a flyover, Increasing the road width, place more or a smaller number of traffic lights based on the requirement and the scenario. Also based on the data we can get to know which area seems too more busy or less busy.

2 Literature Review

When Arista EOS combined with Splunk it provides a powerful and effective way for network traffic analysis without the need of hardware [1]. Increase in traffic leads to the traffic congestion which becomes a hindrance in the development of the nation so to overcome this a study was done on the traffic congestion so that a sustainable traffic management system can be made [2]. The traffic analysis specifically for Los Angeles, California, USA was done using Hadoop and its components and it was found that during the morning 7–9 am traffic was maximum. This analysis was done only on the limited few days of data available [3]. Congestion detection algorithm was used to measure the speed of the vehicles and their average waiting time at the road-crossing. The output of this paper can later be used by the road research organization for their study purpose and as they can develop some output using the results [4]. To get better information about road traffic both types of technology should be used i.e. fixed objects like sensors and wider range objects like mobile devices. Using both the types of devices for gathering the traffic data gives us more details about the vehicle moments [5]. In most of the road safety studies it was found that traffic data integration has been a serious factor. So, a study was made on traffic data which can be used for the road safety studies [6]. A study was done on the traffic at the Paliekkara toll plaza from the year 2013 to 2017 to develop the road for the increasing traffic. This study was specifically done to make sure the proper development of roads takes place properly at that place and the resources get properly utilized in the development of the infrastructure [7]. Development of the nation results in the development of the result which overall results in the people buying their own vehicles and as a result there is an increase in road traffic. So, a study was made how we can use data science technologies to predict the traffic congestion [8]. As the buying of cars in the markets is increasing which leads to an increase in traffic and as a result there is an increase in the accidents so to decrease the number of accidents analysis on the dataset was done which had few parameters like speed of vehicle, type of accident, time of accident, alcohol consumption etc. The output of this can be used by the committee creating the traffic laws [9]. A study was done on the UK traffic accident data to establish a model for predicting the severity of the injuries. The data used for this analysis was from 2005 to 2019 and as a result of this paper a model using the Machine learning and XGBoost was developed. The further work on this can be carried out using the parallel processing libraries [10].

3 Splunk Architecture

3.1 Working of Splunk Architecture

The following components work together in the industrial area to collect the data (Fig. 1).

Splunk is a software platform that allows you to analyses, visualize and search your data that is being gathered from the different components of the user infrastructure. It takes data from the different components such as sensors, applications, devices and other user added components in the infrastructure. The data collected through the device goes to the Forwarders used. Forwarders are classified as the Open Platform Communications (OPC) Servers and Non-Open Platform Communication

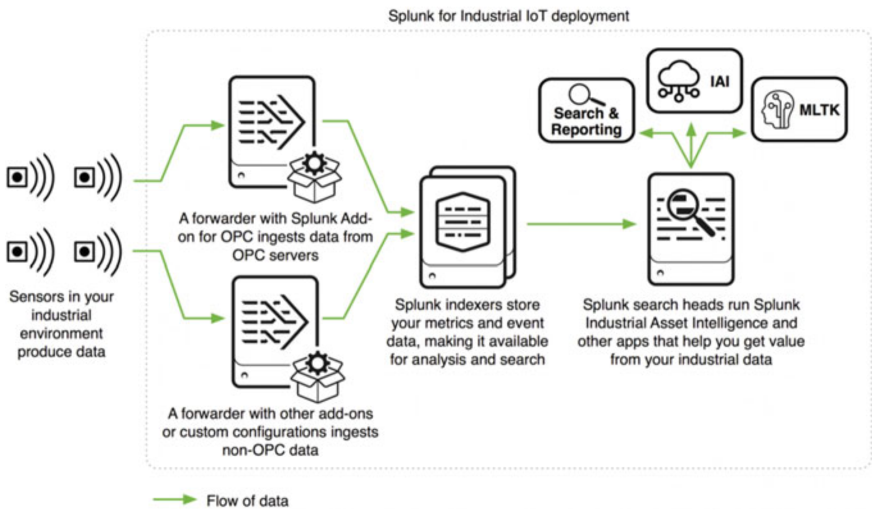

Fig. 1 Workflow of data in Splunk [11]

(Non OPC) Servers. The OPC servers are the servers that uses the Splunk standard designed Add-on to receive the data that is collected via sensors in this scenario from the infrastructure and the Non OPC servers are the servers that also has splunk designed Add on to receive data but those Add on are designed by Splunk for the specific user i.e. Those add-ons are called as custom add-ons which splunk designs specifically for its user and are user specific.

The data from the forwarder further goes on the indexer through the indexQueue where there are multiple indexes created as per the user requirement and the application that the user is using for searching and analyzing the results. The data received by the indexers gets processed and that processed data gets stored in the index as events which are later used for the searching and analyzing the data. Splunk has a feature called "Index Clustering" which helps store multiple replicated copies of the data based on the replication factor. This feature helps the user for easy data security, disaster recovery and improved search performance. Also, the data forwarder from forwarder to indexer gets acknowledged using the feature called "Indexer Acknowledgement" to make sure that all the data from the forwarder is received by the indexer and there is no data loss.

Indexes are basically the flat files on the indexer. These indexes are basically classified as the event type and the metric type. The event type index is the default index which stores all types of the data and the metric type index stores the data that satisfies the metric that is passed for the index.

The data stored on the indexer can be accessed by the user for the searching, analyzing and visualizing purpose through Search Head(s). Search Head(s) are basically the user-friendly UI where the user can install the splunk applications based on the user requirement from the multiple applications that the splunk has for the different use. Later on, using that application and index data stored on the indexer user can get the desired output as per the user requirement. Because of making the user work easy and designing a user-friendly UI, today splunk has more than 15,000 customers in more than 110 countries.

3.2 Advantages of Splunk

Splunk helps in monitoring, visualizing, analyzing and searching for large amounts of data. It works with versatile technologies and also as an independent software. Splunk can also be used as a cloud application which is highly scalable and reliable for the users. The users choose splunk because of the following reasons:

(1) **Search Processing language (SPL)**

SPL is a highly powerful language for getting the user required output from a large amount of data with high efficiency. It can also perform statistical operations on the user data. Also, users can draft the custom splunk queries based on the user requirement and can get the efficient output that the user requires.

(2) **Provides variety of Applications**

Splunk has some standard build applications, add-on and data sources that the user can use based on the requirements i.e. The applications and add-ons based on IT Operations, Security, Fraud and Compliance, Business Analysis, Utilities, IOT and Industrial Data, DevOps and many more. Also, not only that Splunk also helps to design the custom application and add-on based on the user requirement for the specific user. Using the applications and Add-on the day-to-day work of working with the data becomes easy.

(3) **Dashboards**

Splunk makes the visualization of the data easy and faster through the dashboards. There are different types of dashboards in Splunk such as Risk analysis, Risk managements, Investigation, Ingestion trend and many more which makes the user work much easier just through the visualization. Just like custom Application Splunk also can design the custom dashboards for the users.

(4) **Accelerate the Business**

Splunk helps to identify and resolve the real time problems which helps to boost the business and get the solution for the real-world business problems. Also, it helps old business data to be searchable, so overall we can say that using splunk we can get all the business data at the one place and using that data we can analyses the business problems and get the solution at a much faster rate. Splunk also ingest all the types of the data so there is no restriction for any type of the data.

(5) **Troubleshooting becomes faster**

There are multiple logs generated in then user system on the daily basis, so if some of the issues occurs due to some specific logs then in sometimes becomes difficult to know that which logs are creating the errors for the user, so at that time using splunk btool troubleshooting can be done much faster and the user can detect the errors very soon and reach to the solution.

Thus, we can say that Data to everything i.e., Splunk makes our work easy as it can work with Any Structure, Source, Time Scale, Insights and action.

4 Experimental Results

4.1 Monitoring of Road Traffic Data Using Splunk

Just like increasing data, increasing road traffic have also created many problems for many of the metro cities which leads to traffic congestion which results in increase in travel cost and time, increase in pollution which affects the human health, increase in accidents etc. Also, sometimes emergency public vehicles such as ambulances,

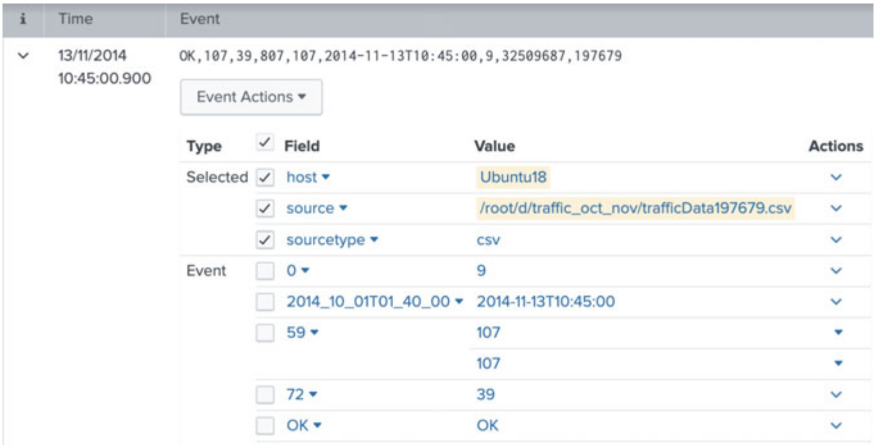

Fig. 2 Event in Splunk after data index

police cars, fire brigade, etc. are not able to reach on time because of the heavy traffic. So, to overcome this problem, the paper describes how splunk can be used as a tool to analyses the high traffic data based on the user requirement as every city has its own infrastructure and depending on the infrastructure, we can decide how many vehicles means no traffic, less traffic or heavy traffic. The data used for this paper has been taken from the following *data set collection* where we have considered 25 vehicles to be normal scenarios and above their value means there is some traffic in that area. So, before we started with the analyzing and visualization of the data, we created an index in Splunk and indexed the data on that index. Each data entry gets stored in the form of the event on the index (Fig. 2).

Splunk itself removes the noisy data from the dataset that the user has. Because of this advantage, the splunk user can directly work on the raw datasets and no pre-processing of the data is required. Since the data uploaded on the index was from the multiple files each file having its own format so to make a one standard format Field Extractor was used so that all the files have one standard format and the user can work with all the files together (Fig. 3).

Once we got all the data in the one standardized form, different splunk queries using SPL were done on the data to get the output.

So, the queries we tried can be classified as:

1. Get the vehicle count based on the timestamp (Fig. 4)
2. The vehicle count based on the city and street (Fig. 5)
3. Number of times the vehicle counts greater than 25 appear (Fig. 6)
4. Get the vehicle count and the city name where there are more than 25 vehicles at a time (Fig. 7).

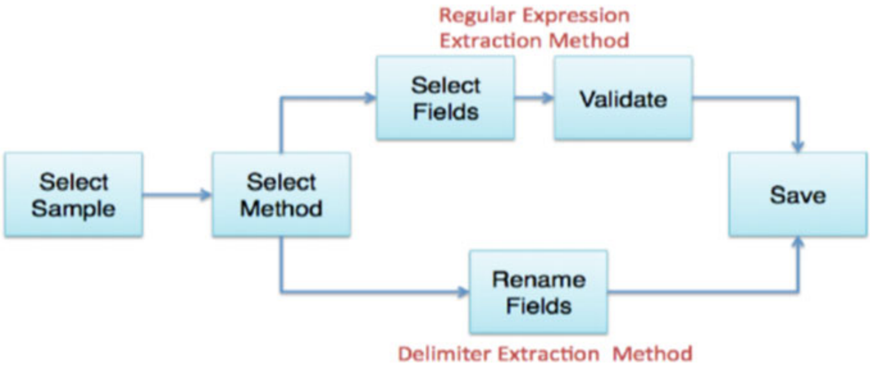

Fig. 3 Field extractor methods [12]

REPORT_ID	TIMESTAMP	Values(vehicleCount)
158324	2014-10-01 3:35:00	5
158324	2014-10-01 3:45:00	2
158324	2014-10-01 3:50:00	5
158324	2014-10-01 3:55:00	3
158324	2014-10-01 4:00:00	2
158324	2014-10-01 4:05:00	0
158324	2014-10-01 4:10:00	3
158324	2014-10-01 4:15:00	4
158324	2014-10-01 4:20:00	7
158324	2014-10-01 4:25:00	6
158324	2014-10-01 4:30:00	9

Fig. 4 Vehicle count based on the timestamp

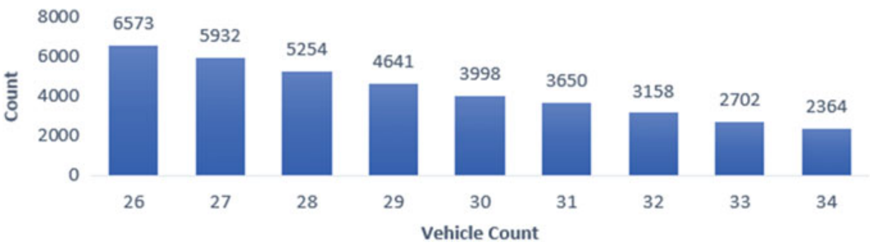

Fig. 5 Top 10 cities where vehicle count is greater than 25 at a time

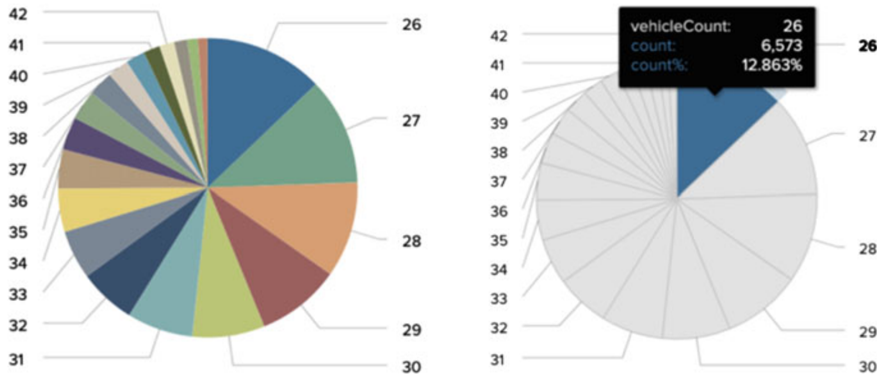

Fig. 6 Top 20 cities where vehicle count is greater than 25 at a time

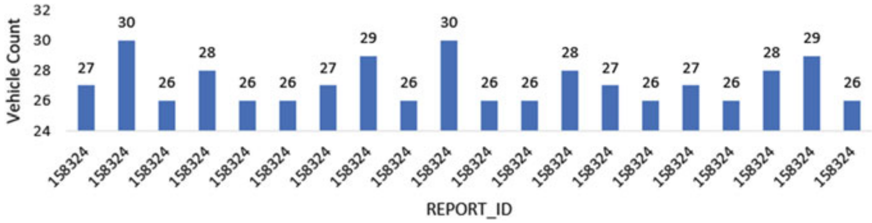

Fig. 7 Top 20 cities where vehicle count is greater than 20 at a time

5 Conclusion

As every city has its own infrastructure and based on the infrastructure roads are designed. In the city multiple factors contribute to traffic but using the splunk every city can analyze the traffic data and get to know what causes this traffic, where and when the traffic is less and provide analytics to find an optimal solution based on different scenarios.

6 Future Goals

Based on the infrastructure of the city, roads are designed in the city. In different cities different factors come into picture when we analyze the traffic data on that city. So, using splunk the user can analyze the traffic of their city based on their required parameters and can get to know where the traffic is more or less at what time of the day. Also, the output of this paper can be used more precisely when we are working with known infrastructure of the city.

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ELMO Embedding for Sarcasm Detection

Joon Jyoti Deka and Achyuth Sarkar

Abstract Sarcasm is the new form of message or text widely used on social media and micro-blogging sites and commonly used to convey messages or information in a hidden way. Sarcasm can be used for a variety of purposes, such as criticism or ridicule. However, this is difficult even for human recognition as the meaning conveyed is not simple. Hence, sarcasm recognition is helpful for analyzing sentiment of data extracted from various sites. Sentiment analysis is identifying and summarizing the attitudes and opinions of Internet users toward a particular topic. In this chapter, we emphasize the use of deep contextualized word representation through pre-trained ELMo models that can model complex characteristics of word use (e.g., Syntax and Semantic). Our model achieves an accuracy of 74.15%. In general, we give our preference to ELMo embeddings for the task of sarcasm detection.

Keywords Sentiment analysis · ELMo embeddings · Deep learning

1 Introduction

The popularity of social media is growing. With increasing popularity, social media is emerging as a platform for people to share their views and feelings. People react on a post or picture shared by others, write reviews on products, and express their opinions on different topics on these public platforms. Corporate and government organizations analyze this data available in the public domain to understand the sentiment of their customers or people. Sarcasm, in recent days, has emerged as a way to express their views and share information. It may convey a negative sentiment hidden under some positive utterance or sentences. Sarcastic comments contain hidden meanings that are very hard to understand and analyze for machines as well as for humans also. As a result of this, sarcasm detection has emerged as a popular topic in sentiment analysis. Sarcasm detection is a type classification problem in natural language processing. Traditionally, sarcasm prediction research was predominantly

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based on rules and statistical data [1]. Lately, with the increasing popularity of neural networks, studies have shifted toward deep learning approaches due to it their ability to learn automatically [2, 3].

In this paper, our work is based on embeddings from language models (ELMo) word embeddings that consider complex characteristics of words in a contextualized manner. The ELMo embedding is used on top of deep learning model. We build a BiLSTM model with ELMo embedding as the embedding layer. We also build a RNN model with Glove embedding layer on top. These two models are compared to each other.

The remainder of the paper is organized in the following way: We presented our methodology in Sect. 3 before discussing the experimental setup in Sect. 4. In Sect. 5, we discussed the results. Finally, a summary concludes the paper.

2 Related Work

As part of the natural language processing field, sarcasm detection has evolved as a new research area and has quickly gained popularity. The detection of sarcasm has traditionally been accomplished through a wide range of methods. Bamman [4] in his work has analyzed the relationship of author and the audience. Characteristics derived from the message context are also taken into consideration.

Bouazizi [5] developed an approach based on patterns to detect sarcasm. Sentiment, punctuation, syntactic semantic, and pattern-based features are used. Kreuz and Caucci [6] in their work study the linguistic features and came to conclusion interjections and punctuation plays a key role in identifying sarcasm. Joshi et al. [7] used four different features, including lexical, pragmatic, implicit, and explicit congruity for detecting sarcasm in a text corpus. Eisterhold [8] from his research found that it is possible to predict sarcasm by the previous and following sentences. Muresan [9] in his work analyzed the impact of lexical and pragmatic features on detecting sarcastic utterances in a sentence.

Recent years have seen an increase in popularity of deep neural network-based approaches in natural language processing, and it has been frequently used for sarcasm detection. A significant reason due to which deep neural networks have immense success over time is their capability to learn and gather knowledge about features automatically. Hazarika et al. [10] proposed a method that considers both contextual and content information for classification. They extract non-textual information from an open discussion thread along with stylistic and personality aspects encoded from user embeddings. Kumar [11] proposed a multi-head attention-based BiLSTM network that focuses on different areas of the comment to analyze the details of semantics in sentences. Zhang [12] developed a bidirectional synchronized recurrent neural network, which captures syntactic and semantic characteristics and a network of pooling neurons that extracts con. contextual features from the tweets. Poria et al. [13] have developed a CNN-based approach that utilizes pre-trained CNN to extract feelings, emotions, and personality traits to detect sarcasm. Gosh et al. [14]

in his work have analyzed sarcasm detection based on a particular type of context, i.e., conversation context. He has addressed two issues, which are whether modeling a conversation context helps sarcasm detection and if we can figure out which part of the conversation triggered sarcasm. Riloff et al. [15] introduced a bootstrapped learning method that can collect the positive sentiment phrases and negative activities or states from tweets. Based on these collected lists, we can recognize sarcastic tweets. Amir et al. [16] have developed a deep neural network that automatically detects sarcastic utterances by learning and exploiting user embeddings for both content and user. Cai et al. [17] focused on multi-modal sarcasm detection for tweets. Image attributes and text, image features are taken as the three modalities, and a multi-modal hierarchical fusion model is employed for the sarcasm detection task. Mishra et al. [18] introduced a method based on cognitive features extracted from the patterns of eye movement of the readers. Their work implemented a cognitive feature-based model for sarcasm detection.

3 Methodology of Our Model

The following sections describe the procedures that were followed in our work. Figure 1 outlines our general approach for detecting sarcasm. It starts with data preparation. At first, we divide the dataset into a train and a test sets. After that, we perform data preprocessing on the training set. After removing all unnecessary characters and words, we lemmatize the training corpus that removes inflectional endings in words and return words to its dictionary form. At last, we change the four different class of sarcasm into numerical form where each sarcasm class label gets its numerical value. Then we, import the ELMo embeddings and passed it as an embedding layer on top of bidirectional LSTM deep learning model.

3.1 Word Embeddings

For our experiment purpose, we take two word embedding techniques (1) ELMo embedding and (2) Glove embedding. A deep bidirectional language model is used by ELMo, and it is trained on large text data to produce vector form. For every token t_x, a single layer in biLM calculates a set of 2L + 1 representations

$$R_x = \left\{ h_{k,j}^{LM} | j = 0, \ldots, L \right\}$$

R-layers are collapsed by ELMo into one vector,

$$ELMo_x = E(R_x : \Theta_e)$$

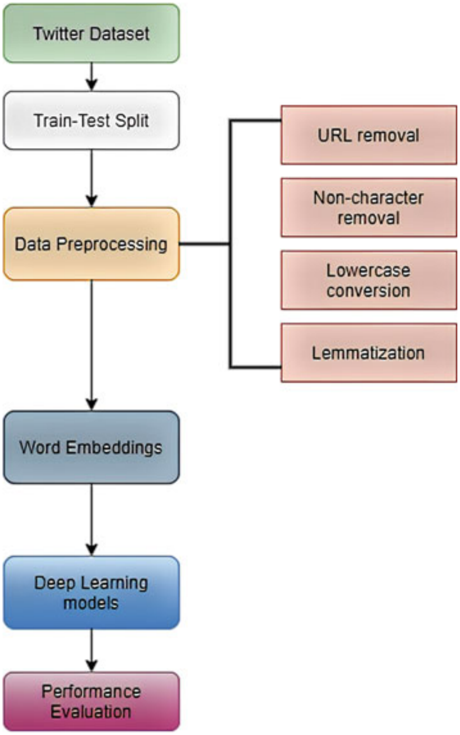

Fig.1 Diagram of work-flow of the experiment

Given a sequence of tokens, it forms a context-independent token representation using pre-trained word embeddings, then the model formed a context-dependent representation.

Glove embedding creates an embedding matrix. It calculates the ratio of co-occurrence probability of a probe word in relation with two words in the corpus. If w_i, w_j are two words and w_k is the probe word, then a function F calculates the probability

$$F\left(w_i, w_j, w_k\right) = \frac{P_{ik}}{P_{jk}}$$

The ratio tells us about the interrelation between the words w_k, $w_{i,}$ and w_j. Glove calculates the elements that are hidden between words to predict their probability of occurring together and produce an embedding matrix of the vector representations.

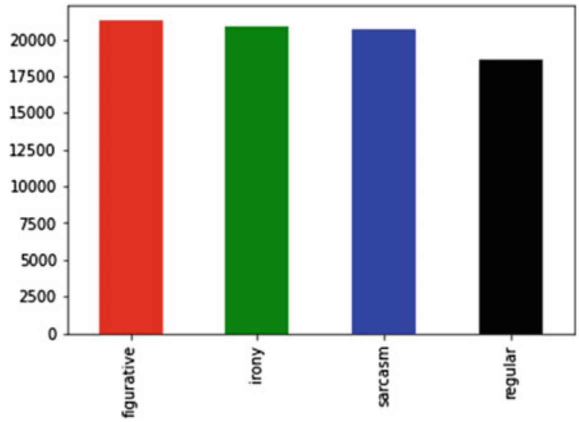

Fig. 2 Distribution of tweets in each label

4 Experimental Setup

4.1 Dataset

In this experiment, a public Twitter Sarcasm dataset is used. This dataset contains more than a million comments or tweets that are of four types: sarcastic, irony, regular, and figurative. Our dataset is made up of two fields: (1) user's comments/tweets and (2) the label of the comments (sarcastic/irony/figurative/regular). Figure 2 depicts the number of tweets in each label. We can see that the maximum number of tweets is in the figurative category and the regular class contains the minimum number of tweets. After that, we lemmatize the text corpus remove

4.2 Model Configuration

This segment illustrates the preprocessing and hyper-parameter settings that we have applied.

(A) **Preprocessing and Word Embeddings**

At first, we sliced the dataset into two separate training and testing sets in the ratio of 70:30. After splitting the dataset, we cleanse the data on the training set to get rid of irrelevant aspects from the tweets. The test set is used for validation purpose and kept as unknown raw data. We clean the data by deleting URLs, different punctuation symbols, white spaces, and numbers. We bring all the text corpus to lowercase alphabets. After that, we lemmatize the text corpus to remove inflectional endings in words and return words to its dictionary form. We then changed labels of the tweets to a numeric set using label binarizer so that each label has its numeric value. Finally, we apply pre-trained word embeddings, ELMo [19] that generates vectors bypassing text through the deep learning model. It analyzes the terms within the situation that they are applied. For our RNN model, we use Glove embeddings that produce an embedding matrix of vectors representation of words.

(B) **Hyperparameters and Training Details**

For our deep learning models, we apply a pre-trained ELMo model that consists of 93.6 million parameters, 2 highway layers, and LSTM hidden layer size of 4096 and output size of 512. In our ELMo-BiLSTM model, we have an input layer with input shape of 1, i.e., one sentence at a turn. We pass the ELMo embeddings with the help of lambda layer. Return from the embedding layer is transferred to a BiLSTM layer with weight of 1024. We use dense layers with hidden feature of 512 and 256 and with an activation function as 'ReLU.' We specify the dropout of 0.5. In the output layer, we used an activation function 'softmax.' For our glove-RNN model, we use an embedding layer on top with embedding matrix as weights. The hidden units of the dense layers are set to 100 and 32 with activation function as 'ReLU.' Activation function of the output layer is set as softmax.

Models are trained by using Adam optimizer [20], loss function equals to categorical cross-entropy and 'accuracy' as metrics. Batch size of 128 and the number of epoch are set to 6 to train our models. We did the training of the models on the training dataset, and behavior of the models is assessed on the test set after each epoch. Interpretation of the models is made with the help of precision, recall, and F-score values of the test data.

(C) **Evaluation Metrics**

In our analyses, precision, recall, and F-score are used to analyze the behavior of our model. Ratio between sentences that are correctly predicted and the total number of sentences is termed as precision. Ratio of the sentence that is predicted correctly to the actual number of correct sentences is called recall, and F-scores represent the means of precision and recall. These are calculated as follows

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

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

$$\text{F-score} = \frac{2(\text{Precision} \times \text{Recall})}{\text{Precision} + \text{Recall}}$$

where TP is the number of true prediction, FP is the number of sentences that are falsely predicted, FN is the amount of sentences that are predicted as false but actually true.

5 Results and Discussion

As discussed, we build deep learning models with deep contextualized word representation with the help of ELMo embeddings. These are already trained on a huge set of textual data. We add these embeddings to BiLSTM deep learning model. We have likewise built a RNN which uses Glove embeddings and is also a form of word embeddings, and the embedding matrix is passed into RNN through an embedding layer. We analyze our models on various metrics and found that performance of the BiLSTM model with ELMo embedding is quite satisfactory than that of the RNN model with Glove embedding. The BiLSTM model with ELMo embedding outperforms the RNN model with Glove embedding. We can see the data loss graph of BiLSTM model in Figure 3, as we can see that as the number of epoch is increasing, the data loss of both training and validation sets is decreasing and both ends at a value of 51.13% and 50.02%, respectively. As both the training and validation loss are decreasing and their difference is low, we can say that the model prevents overfitting. The graph in Figure 4 plots the accuracy score of ELMo-BiLSTM model for train and validation set. We observed that the accuracy of the train set increases and becomes constant after that at a value of 73.89%. The accuracy of the validation set, on the other hand, remains constant throughout all the epoch, and after the last epoch, the validation accuracy becomes 74.15%. An accuracy score of 73.68% was achieved for the Glove embedding-based RNN model on the train set, and a score of 73.71% was achieved on the validation set. Data loss in the training set is 50.60% and 50.11% in the validation set. From Table 1, we can say that on basis of the results obtained on the validation set, BiLSTM model with ELMo embedding on top exceeds the RNN model with Glove embedding.

The ELMo embedding models the complex characteristics of words and also how the uses of words can vary across different context. Vector produced are function of layers of bidirectional language model. Representations are character-based and use clues from robust representations for tokens that are not seen in training. Whereas, Glove produces global vectors. Using features that are hidden, the co-existence count

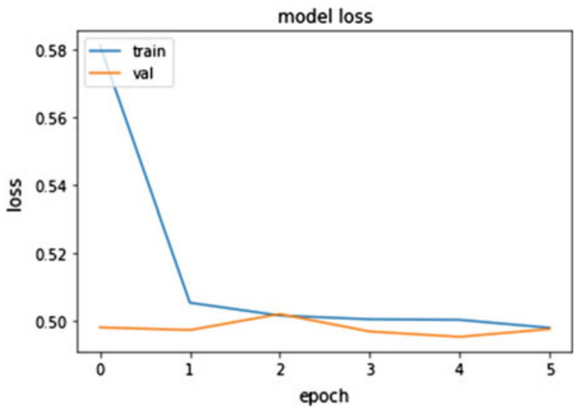

Fig. 3 Data loss graph of ELMo-BiLSTM model

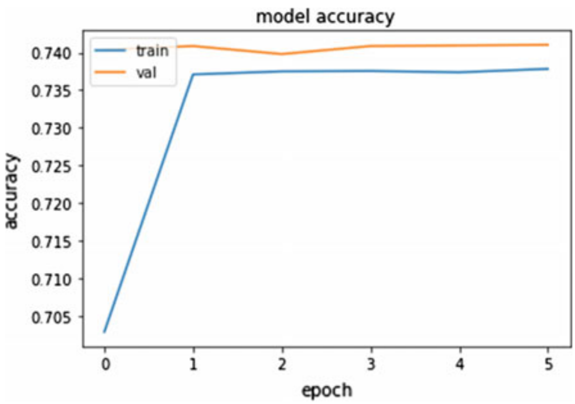

Fig. 4 Accuracy graph of ELMo-BiLSTM model

Table 1 Comparison table

Models	Accuracy (%)	Data loss (%)
RNN (Glove embedding)	73.71	50.11
ELMo-Bidirectional LSTM	74.15	50.02

is predicted by calculating the comparability between words. Glove embedding gives same vector representation for same word occurring in different sentences but ELMo word embedding takes the context in which the word is used in consideration and based on that gives different vector representation for different context. Glove cannot grasp the context of the word and fail to produce separate vector representation. This makes the ELMo embedding more effective than the Glove embedding.

6 Conclusion

Sarcasm is the unique form of satire. Using sarcastic, ironic messages, and post is increasing in social media platforms. Sarcasm is nowadays used to scrutinize or to express opinions about diverse issues related to politics, society, etc.

In this study, we have focused on the problem of detecting sarcasm using ELMo embedding. We used a Glove embedding-based RNN model and an ELMo embedding-based bidirectional long-short term memory (ELMo-BiLSTM) for detecting sarcasm from sentences. A public Twitter Sarcasm dataset for this purpose. We split the dataset into training and testing sets. Performed data preprocessing to clean the data and applied pre-trained word embeddings. Our ELMo-BiLSTM model incorporates an embedding layer that uses the ELMo word embeddings to generate vector representations of words. The ELMo vector representation of a word depends on the entire sentence and therefore gives different vector representations for the same word, summing up the contextual information of the comment. Glove embedding represents the co-existence of the word and thus gives the same vector representation for a word in a different context. Our results show that the ELMo-BILSTM surpasses the Glove-RNN model. It is observed that due to different vector representations of words according to the context in which they were used, ELMo embedding-based model performs better, and data loss decreased by 0.09% and accuracy of the model increased by 0.44% compared to the Glove embedding model. The difference in the input sizes and hidden units has also affected the performance of the models.

In the future, we would like to experiment with the ELMo embedding with other deep learning models. We would experiment with the model configuration and introduce different feature extraction techniques that can extract features related to sarcasm.

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Secure Smart City Infrastructure Using Digital Twin and Blockchain

Saikat Samanta, Achyuth Sarkar, and Yaka Bulo

Abstract A digital replica of any physical system or process is referred to as a digital twin (DT). In general, a DT is a software program that accepts real-world data of a physical system at ground level as inputs and creates useful outputs in the form of insights. At the moment, the manufacturing industry and business are concentrating their efforts on this technology. Due to the outbreak of COVID-19, the entire globe has turned to virtual meetings and live video interactions in various fields as health care, business, and education. We explore the most recent viewpoints and future technology trends that are most likely to drive DT in this study. The incorporation of blockchain in DT will allow the network to efficiently monitor and manage resource consumption and sharing. The idea of a digital twin of a smart city is presented in this article. Smart city development aims to enhance not just the city's overall performance, but also its basic infrastructure, procedures, and facilities, as well as its socioeconomic wellbeing. In order to strengthen security and privacy in smart cities, we examine how security may influence the DT. We offer a complete analysis of blockchain-based DT in this article. Overall, our study aims to give insightful direction for digital twin security and privacy research.

Keywords 6G · Artificial intelligence · Industrial IoT · Machine learning · Wireless communication

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1 Introduction

The ideas of smart city and DT technologies are discussed in this article. This technique depicts an object's virtual and physical representation. Blockchain is considered to be a crucial technology for digital twin applications. Blockchain is a distributed ledger system that uses cryptography and hash functions to construct a chain of data blocks that are created when an event happens and validated in a decentralized manner using consensus methods. Blockchain is currently being utilized in various application domains in smart cities, while it was exclusively used for cryptocurrency [1]. To make network deployment easier, network decentralization will be required. Due to its built-in security characteristics, blockchain will also meet the stringent security needs of future communication systems. The decentralization, security, and scalability of blockchain may be great by choosing the right blockchain components based on the application needs.

We study the literature on integrating blockchain and DT systems in this paper and show how they can work together efficiently and effectively. Our study focuses on the major advantages of using blockchain in DTs and provides suggestions for further study.

The remaining paper is divided into parts. Section 2 discusses the literature review, while Sect. 3 presents the background. Section 4 explains DT applications in the smart city. Section 5 discusses the DT challenges. Section 6 presents discussions of this research. Section 7 concludes our work.

2 Literature Review

There is so many considerable research that has been conducted on DT with blockchain technology in recent years. We summarize some recent literature analyses and show how our approach differs from previous research.

Barbara R. Barricelli et al. published one paper on DT design applications in 2019. This research focuses on existing definitions of DT and explores the fields in which DT applications are created [2]. The authors of [3] analyze the fundamental characteristics of a DT, outline a software architecture, and show two application scenarios. The author in [4] explores the use of DTs and blockchain to address major issues such as divergent data repositories, untrustworthy data distribution, and defect diagnostics. In [5], the author gives a thorough examination of current issues and enabling technology, as well as recommendations and reflections for diverse stakeholders. Another article fully covers the main components of DTs and current applications in the industry [6]. The authors in the article [7] discuss how blockchain may be used to restructure and change DTs to ensure secure manufacturing. In addition, a unique digital twin shopfloor (DTS) idea based on the digital twin is discussed in [8]. The article [9] offers a unique manufacturing blockchain of things (MBCoT) architecture for the design of a secure IIoT with permissioned blockchain.

The ideas mentioned above present a broad vision for future research and innovation in these fields. We propose a blockchain integrated DT with the best resource management and data sharing via smart contracts to manage data access in smart city infrastructure.

3 Background

In this section, we discuss some basic knowledge regarding digital twin (DT), digital twinning in smart city and blockchain.

3.1 Digital Twin (DT)

Computer-aided design (CAD), which allows for static three-dimensional (3D) product design and representation, serves as the foundation for DT. This is a 3D-designed product or solution more dynamically. It is recommended that a DT represents and offers the same information as to its physical counterpart. DTs are most often used for modeling, monitoring, and control, but they may also be used to compute and manage system status and operations [10]. The use of a DT allows users to represent and interpret the attributes and current state of a real or virtual item. A prominent technology for bridging multi-stakeholder teams is the digital twin. Vendors may quickly educate and train stakeholders in value networks and provide more extended customer support for customers using this technology.

3.2 Digital Twinning in Smart Cities

Digital twins are a new field of research and a hot topic in the industry with applications in health, manufacturing, construction, transportation, energy, and smart cities. The smart city's virtual and real-world aspects are integrated via DT systems [11]. A German city's digital twin focuses on displaying heterogeneous data to include residents in urban planning choices. Cloud systems that combine data from several smart city data sources include Smart World Pro, Open Cities Planner, and Platform of Trust. Smart World Pro combines graphic 3D city models, architectural geospatial information, IoT devices, and other data sets to create a virtual reproduction of real-world smart city entities. Smart city developers may use the Open Cities planner platform to combine data types such as 3D models, pictures, papers, geographic and vector data [12].

3.3 Blockchain

Blockchain an immutable series of cryptographic blocks is linked together. Hence, previous accounting ledger documents cannot be altered, and current records must be checked by a third party. Multiple transactions are received from one node and broadcast to other nodes on the network in a newly generated block. Blockchain opens up new possibilities for organizing many untrustworthy actors and allowing shared governance [13]. A smart contract operates on the blockchain and adds blocks. Hyperledger includes six distinct distributed ledgers, only three of which are currently functional. It also offers a set of tools and libraries for usage with different distributed ledger systems. Fabric is also one of the hyperledger's open-source projects. Hyperledger fabric is a distributed ledger technology platform that uses pluggable components to address enterprise-grade problems as a permission blockchain [14]. It is utilized to deliver blockchain solutions for businesses.

4 Digital Twin Potential Application for Smart City

The applications of DTs are shown in Fig. 1. It will begin by outlining the various applications for DTs, as well as the domain, industries, and specific challenges that the technology may solve. The key to the city digital twin's efficient functioning

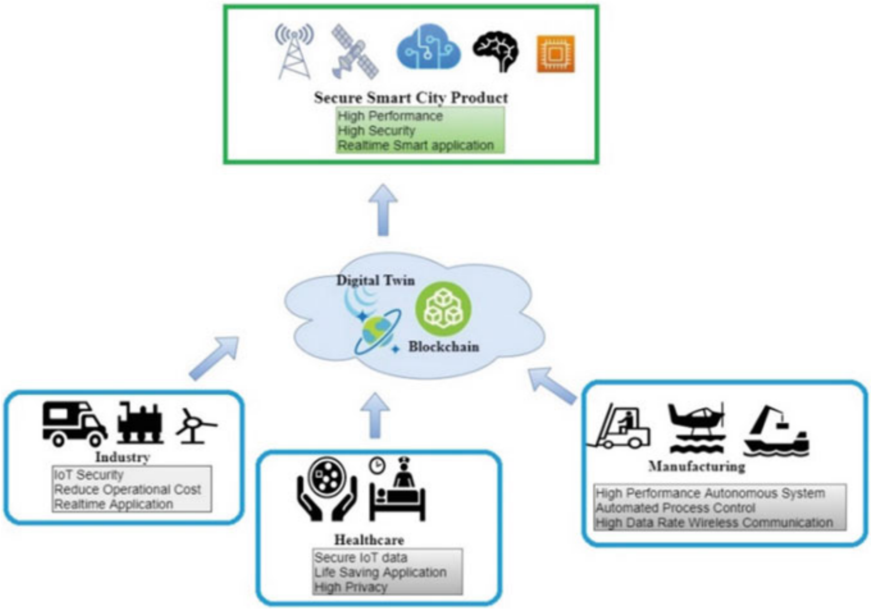

Fig. 1 Digital twin applications and security requirements in smart cities

is a constant flow of data created by various sources in the smart city's digital infrastructure.

4.1 Manufacturing

The important use of this DT has been identified which is in the manufacturing industry. The area where DTs are being used is in the automobile sector, most notably by Tesla. Artificial intelligence (AI) increases testing accuracy by using data analytics on real vehicle data to anticipate present and future component performance [15]. A wide range of applications for DT usage can be found in the construction industry. DT might be useful during the construction phase of a building or structure [16].

4.2 Health Care

Another area where DT technologies are used is in health care. The potential use of DTs in the healthcare industry is only rising as connection improves. DTs can be used in combination with AI systems to create more accurate predictions and choices. It is much more critical in health care to simulate and respond in real time since it might mean the difference between life and death. Predictive maintenance and continuous repair of medical equipment might potentially benefit from the DT.

4.3 Industry

In a patent application filed in 2016, General Electric (GE) described their usage of a DT. Siemens has created the "MindSphere" [17] platform, which embraces the Industrial 4.0 idea with a cloud-based system that links machines and physical infrastructure to a DT. It aims to change organizations and provides DT solutions by utilizing all connected devices and billions of data streams.

5 Challenges of Digital Twin in Smart City

This section focuses on the challenges of DT in smart cities. The main challenging problems are shown in Fig. 2.

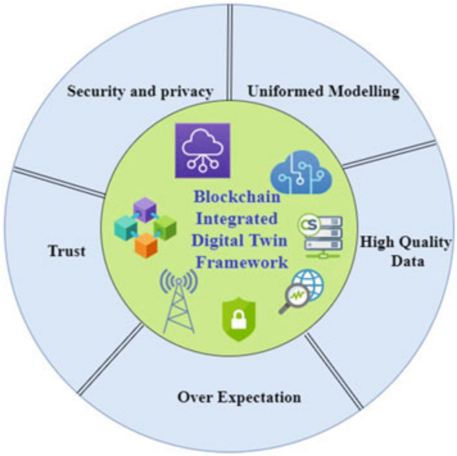

Fig. 2 DT challenges in smart cities

5.1 High-Quality Data

The next difficulty revolves around the data required for a DT. Despite the high data speeds, the high frequencies make overcoming the high path loss a significant challenge. It must be high-quality data that has a continuous, uninterrupted data stream.

5.2 Security and Privacy

The privacy and security issues related to DTs are the problems in the workplace. To overcome this obstacle, data analytics and IoT must adhere to current security and privacy standards.

5.3 Trust

The best method for overcoming trust issues is model validation. It is critical to ensure that DTs work as intended to maintain user trust [18]. The enabling technology will provide additional visibility into the procedures used to guarantee that privacy and security practices are followed throughout development, therefore addressing trust issues.

5.4 Over Expectations

The benefits and drawbacks of DT expectations must be considered to take proper action while creating digital twin systems. The problems of Industrial IoT and data analytics are also common challenges for the use of this technology.

5.5 Uniform Modeling

The modeling of such systems is the next issue in all types of DT development because there is no uniform technique for modeling. There must be a common process from the original concept through the simulation of a DT.

6 Discussion

In this part, we will look at challenges and precautions that focus on the design of blockchain-based DTs as shown in Table 1.

In addition, we highlight issues that have yet to be solved. We give a thorough discussion on a reliable blockchain-based DT that attempts to solve some of the lingering problems in previous efforts. Current technology advancements

Table 1 Precaution for different challenges of DT in smart city

Types	Challenges	Precaution
Problems with data	Data collection methodologies	Consider the granularity of your data
DTs' Representation	Representation of a real item that is accurate Replications help to contextualize DTs	Make cognitive DT solutions a part of your daily routine Integrate the tasks of transaction management
Infrastructure expenditures	Infrastructure management has a high cost	Spending on software and hardware should be planned ahead of time
Ethical and moral concerns	There is a lack of commercially sensitive information	Collaboration and dissemination of data and model knowledge
Barriers to standardization	There is a lack of unified data and models Blockchains that do not communicate with one another	Creating a universal platform for DTs Data integration across several blockchains
Concerns about the environment	Energy usage as a result of the computationally demanding mining phase	Utilization of an effective consensus mechanism

have assisted industrial verticals in developing services and applications targeted at automation, customer happiness, quality of service (QoS), business enhancement, and return on investment (RoI) [19]. Adoption of the Industrial IoT and associated technologies represents a significant step forward for the smart sector. Technology is rapidly being used to solve problems that are related to its original purpose, and one of such difficulties is the need for secure data processing and transmission. Many sectors that focus on enhancing human lives like IoT, smart cities, industries, customized health care, and other fields can benefit from combining DT with blockchain technology.

7 Conclusions

Smart city development is a popular concept for addressing sustainability issues. Figuring out where these AI algorithms may be used is another interesting research topic. The article examines each topic in detail, emphasizing how researchers are building DTs while also addressing obstacles and essential enabling technologies to help future work. The majority of DT research is focused on the industry, as demonstrated by the high number of publications in this domain.

In addition to the smart city idea, this article discussed digital twin technology as a tool for urban development. We performed a deep and complete evaluation of the design and implementation challenges of existing blockchain-based DTs solutions in the market. In addition, we highlighted a series of future research and implementation issues of blockchain-based DTs. We believe that this research will help academics to overcome the obstacle of blockchain-based DTs in industrial applications.

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Deep Learning-Based Prediction, Classification, Clustering Models for Time Series Analysis: A Systematic Review

Nitesh N. Naik, K. Chandrasekaran, M. Venkatesan, and P. Prabhavathy

Abstract Analysis of time series is a prominent issue in the field of data analysis. With large amount of existing data in time series, multiple algorithms for analyzing time series data are being proposed. A variety of deep learning models are being designed to enhance the diversity of datasets related to time series across different fields. In comparison with the existing methods, only few have incorporated deep neural networks to perform this task. In most of the cases, deep neural networks are being applied for image data but it can also be used for sequential data such as text and audio. Here, we throw light on the recent advancements in hybrid deep learning models which consist of combination of various frameworks of deep neural networks with statistical models that have led to an improvement in time series analysis. Deep learning models are categorized into discriminative, and generative models provide an insight into the data based on the perception of conditional or joint probability. In this paper, we have surveyed newly devised algorithms and limitations of prediction, classification and clustering for time series analysis which describes how the temporal information can be merged into the analysis of the time series data.

Keywords Time series · Prediction · Classification · Clustering

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1 Introduction

Time series which consist of a group of temporal observations has led to the wide attention in numerous designs and development in the domain of deep learning and artificial intelligence. Several applications provide the basis of time series prediction in forecasting and control. Therefore, a variety of models are being discussed for solving the time series prediction problem like support vector machines, filtering-based frameworks, and autoregressive integrated moving average [1]. As we have high-dimensional data also called as big data, the existing conventional methods for time series analysis were not able to process this data. Deep learning defines architectures that employ multiple number of layers to signify hidden features at an advance as well as abstract level. Deep neural network (DNN) models are being extensively used in many domains related to prediction, classification, and clustering of time series which includes areas like multi-sensor fusion [2] and remote sensing [3]. Time series has been used in various applications involving an area of decision making like financial predictions and retail. There exist a wide variety of traditional forecasting methods which are also termed as parametric models such as structural time series models [4] and exponential smoothing [5]. Deep learning has attained a big success in the field of classification of images and processing of natural language data. There are numerous approaches which are using the features of automation processes for time series forecasting which demonstrated the selection of model based on certain parameters [6], and also, the application of Gaussian processes with deep learning is demonstrated in [7] and time series prediction is being also carried out using time delay neural networks [8].

This paper demonstrates a comprehensive review of various methods used in the past two decades. Even though this paper highlights the time series analysis techniques, we have also discussed a few of the previous works that are formative to this field. The main contribution of this paper is summarized as:

(i) Familiarizing numerous terms related to time series and the different terms related to time series analysis. (ii) Categorizing the deep learning for time series analysis into various steps (i) time series prediction/forecasting (ii) time series classification, (iii) time series clustering. (iii) Exploring the existing literature and limitations in the field of deep learning for time series analysis.

The remaining part of the paper is arranged as follows: Sect. 2 focuses on time series analysis. Sections 3, 4, 5 describe all the deep learning methods for prediction, classification, and clustering with their summary and limitations for future work. We conclude the review in Sect. 6.

2 Time Series Data and Analysis

Definition 1. A given time series $T = [t_1, t_2, t_N]$ is a well-ordered set of real values. The length of T is equal to the number of real values M.

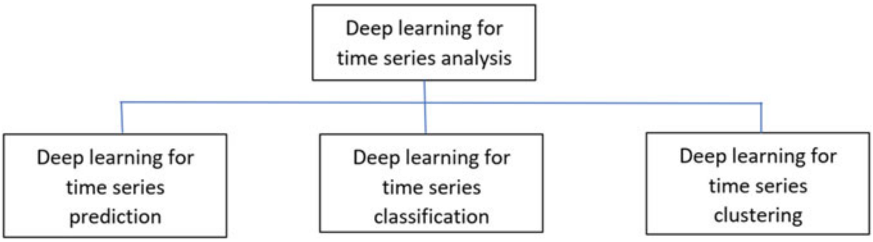

Fig. 1 Categories of deep learning for time series analysis

Time series data consist of gathering of observations at regular intervals which are attained by taking repeated readings over a period of time, e.g., sales figures of a month, inventory data in a quarterly fashion, and bank balances on daily basis are examples of time series. Time series analysis consists of techniques for analyzing time series data in order to extract meaningful statistics and other characteristics of the data. Time series data can be considered as univariate or multivariate. In univariate, same variable is used to collect the sequence of measurements and as in multivariate, where multiple variables are used to collect the sequence of measurements [9]. There are three main categories for time series analysis as follows:

(i) Time series forecasting/prediction: given a set of historical data, the aim is to predict or forecast the next value of the time period. In stock prediction, the prices of the previous days can be used to predict what will be the price for the next day.
(ii) Time series classification: Makes use of supervised learning algorithms that could aim to build classifiers that decide automatically about the new series type wherein we are given the labeled time series data which is also known as training data. ECG helps in recording the electrical voltages in the heart, and it helps in detecting if the heart is in normal condition or it is abnormal.
(iii) Time series clustering: Makes use of unsupervised learning algorithms which aim to group the unlabeled data of time series into a set of different clusters. Depending on the temperature data, we can cluster different clime types and defined it as per its features. Figure 1 depicts the hierarchical flow for time series analysis with the inclusion of deep learning models in terms of prediction, classification, and clustering.

3 Deep Learning for Time Series Prediction

The following papers represented how to model deep neural networks for time series prediction/forecasting. In [10], they discussed the combination of trained predictive models in a discriminative approach with a DNN that performs modeling of the joint statistics on a set of variables related to weather. In [11], they used RNN with DL called as deep forecast for the prediction of wind speed which is spatiotemporal in nature. In [12], authors have analyzed and presented a conditional time series forecasting method which is purely based on CNN making use of WaveNet architecture which allows to extract temporal relationships between time series. A general model for time series regression with probability is presented in [13]. They accommodated both the covariates of static and temporal data which are to be learned across multivariate series. A Significance-Offset CNN is developed in [14], which is a deep CNN for performing regression of asynchronous time series which is multivariate in nature. In [15], they combined state-space models with deep recurrent neural networks for forecasting the time series. The work in [16] modeled the traffic flow as a process of diffusion on a directed graph, and they introduced DCRNN for prediction of traffic data that involves both spatial and temporal dependency in the flow of the traffic. An empirical assessment of temporal convolutional network with causal convolution is presented in [17] for task related to sequence modeling [18]; they introduced recurrent marginal structural network in the field of epidemiology which uses the property of sequence-to-sequence architecture for predicting the expected outcome. A hybrid model is being developed in [19] called as deep momentum networks that combine trading rules based on deep learning into the volatility scaling architecture of time series momentum. A transformer architecture is being applied in [20] for the prediction of time series data by incorporating a CNN self-attention network with the production of queries and keys for the better understanding of the local context.

In [21], they proposed a temporal fusion transformer (TFT) which incorporates architecture based on attention levels and a high-performance forecasting. The authors designed a time series model in [22] based on RNN in combination with Gaussian copula process which has a covariance structure with low rank which allows to lower the computational complexity and also handle marginal distributions related to non-Gaussian processes. A conditional generative model for multivariate data is developed in [23]. A deep learning framework for multi-horizon prediction of time series data with the advent of temporal attention mechanism that also captures the latent patterns in the historical data is being adapted in [24]. In [25], they proposed the concept of demystifying CNN deep learning models for analysis of time series data. A global local framework for prediction using DNN is being adapted in [26] which allows to uniquely characterize the time series in an exchangeable manner. In [27], they proposed a model for deep forecasting of high-dimensional data called as DeepGLO which has the feature of thinking at global level and acting at local level.

The paper in [28] incorporated a dynamic computational graph neural network model that allows a standard exponential smoothing model to be mingled with LSTM into a common framework consisting of hybrid and hierarchical methods of forecasting. A novel framework called as G-Net is being presented in [29] which is sequential deep learning framework designed for G computation that can process complex time series while the imposition of assumptions of minimal modeling and also gives an estimate of the population-level treatment effects which varies with time. The authors in [30] introduced a recurrent neural filter (RNF), which uses the architecture of recurrent autoencoder that predicts dissimilar representations for each step of the Bayesian filtering which is being captured by a series of encoders and decoders. In [31], they made use of stacked autoencoder for feature learning from the time series data of traffic flow for the prediction of road segment level. In [32], they made use of deep belief network to forecast the traffic flow of future based on the observations of the previous traffic flow. In [33], consideration of the issue of taxi demand prediction was done and they exhibited a specific area as a time series of the taxi demand. In [34], an integration was performed of sequence-to-sequence model and LSTM to predict the speed of the traffic of a road segment. The model in [35] amalgamated traditional methods of prediction of wind speed in combination with threshold denoising (WTD) and adaptive neuro-fuzzy inference system (ANFIS) with a RNN. In [36], they developed a model using LSTM for classifying individual with autism spectrum disorder (ASD) and it controls directly from the fMRI time series of the resting state. In [37], they developed an unsupervised model known as DCAE deep CNN autoencoder for feature learning of mid- and high-level data from large-scale tfMRI time series summarized in Table 1.

4 Deep Learning for Time Series Classification

Definition 2. A dataset $D = \{f(X1, Y1)\ldots\ldots(XM, YM)\}$ is a collection of pairs (Xk, Yk) where *Xk* is a time series with *Yk* as its equivalent label (or class) vector. The aim of TSC consists of training a classifier on a given dataset D in a way to map from the space of probable inputs Xk to a probability distribution over the class variable outcomes *Yk*. The following papers represented how to model deep neural networks for time series classification.

The authors in [38] adapted the use of classification of image models using deep ConvNets which tries to generate an artificial image which is an illustration of the class of interest. In [39], they performed classification of images by making use of deep CNN by activation function like ReLU also reduced overfitting with the features such as data augmentation and dropout. In [40], a review of early TSC approaches is provided using deep learning models used for early time series classification. This proposed a framework in [41] in an offline manner to exclusively encode temporal patterns as spatial in the form different types of images which are known as Gramian angular fields and Markov transition fields. In [42], the learnt features are applied into a multilayer perceptron (MLP) for classification. In [43], the paper proposed a cycle deep belief network model for the classification of multivariate time series in comparison with the performance of the DBN and KNN. The work in [44] considers design of a fully CNN that makes use of an operation on causal filtering, and it permits for the rate of the output signal to be similar to that of the input signal with the use of a UFCNN. Stacked LSTM autoencoder networks were made used in [45] in an unsupervised or self-supervised manner. The work in [46] made use of recurrence plots which perform the conversion of time series to 2D texture images, and then a deep CNN classifier is applied on the images.

In [47], they proposed a novel end-to-end model called as multiscale CNN (MCNN) that carries out the task of feature extraction and classification in one

Table 1 Summary of research work done in time series prediction

Research work	Approach used	Limitations
Aditya et al. [10]	Deep belief network	Time component not considered with large distance, no guide sensing for weather prediction
Amir Ghaderi et al. [11]	Recurrent neural network with LSTM	Cannot predict the forecast of individual graph node at time t
Borovykh et al. [12]	WaveNet (CNN + Dilated convolution)	Inability to learn long-term dependencies on intraday data
Wen et al. [13]	LSTM with forking sequences	Explicit multivariate prediction and joint distributions modeling not addressed
Binkowski et al. [14]	Significance-offset CNN + Autoregressive model	Assumption of independent offset values for each past observation
Rangapuram et al. [15]	Deep state-space models	Not working for all instances of state-space models, missing non-Gaussian likelihood
Li et al. [16]	Diffusion convolutional RNN (DCRNN)	Underlying graph structure prediction not based on moving objects (evolving data)
Bai et al. [17]	Temporal convolution network (TCN)	More memory during evaluation, potential parameter change for a transfer of domain
Lim et al. [18]	Recurrent marginal structural network	Cannot handle biased treatment responses over time
Lim et al. [19]	Deep momentum networks	Non-stationarity data cannot be handled, missing of time series momentum
Li et al. [20]	Transformer + Convolutional self-attention	Low sparsity strategy in self-attention
Lim et al. [21]	Temporal fusion transformer (TFT)	Inability to analyze crucial variables for prediction, non-identification of significant regime changes
Salinas et al. [22]	RNN + Gaussian copula	Harder to overfit
Wen et al. [23]	Deep generative quantile copula model	Quantile and copula part not parameterized by flow-based models
Fan et al. [24]	LSTM + Deep attention model	Unable to predict from the entire time period history
Siddiqui et al. [25]	TSviz (Visualization of time series)	Unstable predictions due to noise factor may occur

(continued)

Table 1 (continued)

Research work	Approach used	Limitations
Wang et al. [26]	Deep factor models with random effects	No comparison with variational dropout or deep ensemble non-probabilistic models for uncertainty
Sen et al. [27]	DeepGlo (Global matrix factorization + TCN)	Global and local features may be wrongly predicted depending on size of dataset
Smyl et al. [28]	Dynamic computation graph with deep ensemble with LSTM	Assumption of continuity for in sample and out sample prediction of the time series
Li et al. [29]	G-Net (Gcomputation + Sequential DNN)	Incorporation of prior causal knowledge missing
Lim et al. [30]	RNF (Recurrent neural network + Bayesian filtering)	RNN parameters are fixed once training phase finishes
Lv et al. [31]	Stacked auto-encoder	Prediction layer uses only logistic regression
Soua et al. [32]	Deep belief networks + Dempster–Shafer theory	Works efficiently only for stream data
Rodrigues et al. [33]	DL-LSTM	Inability to perform data fusion
Liao et al. [34]	Seq2Seq deep neural network	Non-accurate forecast on large datasets
Cheng et al. [35]	Wavelet thresholding + RNN + Adaptive neuro-fuzzy system	Less utilization of RNN as sub-model
Dvornek et al. [36]	LSTM	Need of huge resources for training
Huang et al. [37]	Deep convolutional autoencoder	Learns only hierarchical dynamical connectivity

single framework by performing transformations. An adaptive cost-sensitive learning strategy was developed in [48] to modify temporal information using deep learning models to tackle imbalanced time series classification problems. A data augmentation technique is proposed in [49] which uses DTW distance to overcome overfitting small time series datasets with the inclusion of the weighted version of the DTW averaging technique. In [50], a tensor scheme along with deep learning model known as multivariate CNN (MVCNN) is being developed for classification of multivariate data and it also handles data which has lagged features. In [51], they investigated how to apply transfer learning on a deep CNN on the target dataset by fine-tuning the network that is being pretrained on similar kind of source dataset for the TSC task. The work in [52] devised an algorithm known as multiobjective model-metric (MOMM) learning for approximation and classification of TS data. A meticulous approach for learning features for human activity recognition problem is being discussed and developed in [53]. In [54], a new model is designed based on the deCNN and SAX discretization to learn the representation for multivariate time series. In [55], they introduced an early classifier approach which incorporates reinforcement learning agent called as deep Q-network at an end-to-end level. TimeNet a multilayered RNN known as TimeNet is designed in [56] which is the encoder network of the designed autoencoder as deep RNN which is based on sequence-to-sequence models that converts time series of varying length into vector representations of fixed dimensions. In [57], they presented an earliness-aware deep CNN (EA-ConvNets), and the architecture learns the features by using deep hierarchy of shapelets which captures the salient properties in each time series in combination with a dynamic truncation model which helps in focusing on the early parts of each of the time series. The algorithm proposed in [58] is made up of classification of MTS data by making use of a RNN and adaptive differential algorithm. Firstly, they used RNN for training the MTS sample into various state clouds. The classifiers achieved from this As summarized in Table 2.

5 Deep Learning for Time Series Clustering

An architecture known as DeepTrust which is a combination of deep stack autoencoder, Gaussian mixture (GMM) and Dirichlet Gaussian process model is being proposed in [59] for clustering of gene expression time series. The work in [60] focused on new prediction technique based on ensemble framework based on decomposition called adaptive sub-series clustering-stacked residual LSTMs-multi-level attention mechanism (ASC-SRLSTMs-MLAttn) to cluster multivariate time series data. In [61], a similarity measurement technique based on CNN is being proposed. The framework in [62] consists of deep interpolation model which is divided into seq2seq model, reinterpolation model, and clustering model which is used to extract latent descriptions from the sparse and irregular time series which are sampled vital signs of time series which are being measured at six hours period. A DL-based method to overcome the issue of selecting types of treatments as per patient's requirement is being developed in [63] known as variational deep embedding with recurrence (VaDER).

In [64], bidirectional-LSTM with microclustering is proposed. Deep temporal clustering is being presented in [65] which makes use of autoencoder reduction of the temporal dimensionality and a layer of temporal clustering for assignment of cluster. A visualization method is also applied to view the region of interest data for the time series. The proposed method in [66] uses DeLTa where the one-dimensional time series data is converted into a 2D image. In [67], they discussed and proposed a method known as deep temporal clustering representation (DTCR), which is using K-means and seq2seq model. In addition, a sample strategy is also being devised on fake date with a task on auxiliary classification which enhances the capability of the encoder. Recurrent deep divergence clustering is being discussed in [68]. A two-stage deep learning-based approach is used in [69] wherein the characteristics of the data are being learned to create labels using unsupervised learning to transform it to supervised approach by incorporating an autoencoder which is used to model the known as well as the hidden nonlinear characteristics of the time series data. In

Table 2 Summary of research work done in time series classification

Research work	Approach used	Limitations
Simonyan et al. [38] Krizhevsky et al. [39]	Deep inside convolutional networks Very large deep CNN	Image specific saliency maps not incorporated Temporal features not considered
Santos et al. [40] Wang et al. [41]	ECTS Tile convolution neural network	Only early classification approaches highlighted Modeling of time series through GAF and MTF images not done
Zheng et al. [42]	Multichannel deep CNN (MC-DCNN + MLP)	Initialization and momentum parameters not considered
Wang et al. [43]	Cycle deep belief network	Each restricted Boltzmann machine (RBM) has to be trained independently
Mittelman et al. [44]	Undecimated fully convolutional neural network (UFCNN)	Only capture dependencies that occur within the overall extent of the causal filters
Mehdiyev et al. [45]	Stacked LSTM encoder network + MLP	Longer time for training the pretraining and the fine-tuning phase
Hatami et al. [46]	CNN + Recurrence plots	Inability to classify small sample size of data over time
Cui et al. [47]	Multiscale CNN (MCNN)	Designed only for univariate time series
Geng et al. [48]	LSTM + Temporal fully convolutional network	Cost-sensitive strategy not extended to multiclassification task
Ismail et al. [49]	Deep residual networks + DTW	Variant weighting schemes for the DTW-based data augmentation technique not done
Liu et al. [50]	Multivariate CNN + Tensor	Imbalance problem in the preprocessing stage not done
Ismail et al. [51]	Fully convolutional neural network	Optimization algorithm may get stuck in local optimum for a bad source data
Gong et al. [52]	MOMM (multiobjective model-metric RNN)	Less improvement in computational efficiency
Yang et al. [53]	Deep CNN	SoftMax function used does not support null rejection
Song et al. [54]	Deconvolutional network + Symbolic aggregate approximation (SAX)	Integration of grammar induction approach not done
Martinez et al. [55]	Deep Q-network	No dynamic adjustment of the reward function parameters over training data

(continued)

Table 2 (continued)

Research work	Approach used	Limitations
Malhotra et al. [56] Wang et al. [57] Wang et al.[58]	TimeNet (Multilayered deep RNN) Earliness-aware deep convolutional networks (EA-ConvNets) Echo state network + Adaptive differential evolution algorithm	Prone to overfitting Works only on univariate data Prediction layer uses only logistic regression Fruit fly optimization and genetic simulated annealing could have been done

[70], they proposed the first method that concurrently determines appropriate deep illustrations and also clusters with temporal boundaries, with the clustering procedure incorporating to supervisory cues for apprising temporal boundaries and training the projected deep learning architecture. Variable length multivariate time series data clustering is being proposed in [71]. A standard clustering approach is being applied in [72] to network states in spite of the input series. K-means algorithm is applied to the network states, and clustering is being embedded with deep reservoir systems as summarized in Table 3.

6 Conclusion

In this paper, we demonstrated an overview of the state-of-the-art time series analysis techniques with deep learning in various domains. More than 300 papers, mostly from the last 10 years (2010–2020), have been studied to provide a comprehensive review of the present trend of research on three major families of time series data analysis, and also, to indicate various limitations giving good directions for future work. The research articles have been considered from three different types that have been categorized into time series prediction, classification, and clustering. A comprehensive analysis for this survey is being provided in this paper which has discussed individually on time series prediction [73] and classification [74, 75] and not in a merged approach. At the end of study, it is clear that the time series analysis using deep learning techniques is still a widely opened field for research having ample scopes, especially in further enhancing the existing models with integrated scientific theories.

Table 3 Summary of research work done in time series clustering

Research work	Approach used	Limitations
Ozgul et al. [59]	DeepTrust (DeepAutoencoder + GMM + DPGP)	Diversity and augmentation of data not done
Liu F et al. [60]	ASC-SRCLSTM-MLAttn	Only one target series is predicted
Ding et al. [61]	Convolutional neural network	Performs only two-step clustering
Li et al. [62]	Deep interpolation network	Early identification of phenotypes not done
Jong et al. [63]	Variational deep embedding with recurrence (VaDER)	Cannot be used as a generative model, multifaceted data
Jahangir et al. [64]	Bidirectional-LSTM with micro-clustering	Double LSTM may lead to cost factors for clustering high dimensional data
Madiraju et al. [65]	Deep temporal clustering	Improper optimization of DTC maybe lead to ineffective clustering
Anand et al. [66]	DeLTa (CNN)	Cannot choose layout aligned and layout independent features autonomously
Ma et al. [67]	Deep temporal clustering representation (K means + seq2seq)	Missing values in time series not addressed
Trosten et al. [68]	Recurrent deep divergence-based clustering	Sequence length dependency works only for short sequences <60 timestamps
Tavakoli et al. [69]	Autoencoder	Computationally expensive, noise factors may lead to improper clustering
Tzirakis et al. [70]	CNN + Agglomerative clustering + Temporal segmentation	Improper use of supervisory cues-based loss function gives rise to bad clusters
Lenco et al. [71]	DeTSEC (RNN + Attentive gated encoder)	Constrained clustering setting not included
Atencia et al. [72]	Deep reservoir computing	Shallow dynamic clustering

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Energy Management Strategy with Plug-In Hybrid Electric Vehicle

Mohit Kumar and Deepesh Sharma

Abstract It is normally considered that EVs which are generally known as plug-in electric vehicles (PEVs) offer pollution-free environment and help in reduction of gasoline (petrol/diesel) use compared to conventional or traditional motor vehicles. The population of EV is increasing rapidly in worldwide because of their environmental friendly nature and money saver. But nowadays, EVs are also used for reduction of peak load in grid during peak hours by using EV as mobile battery. Sharing electric power resources among distribution and power frameworks is the focal point of V2G to make a convincing new financial aspect. V2G (Vehicle-2-Grid is an innovation that empowers energy to be pushed back to the power Grid from the battery of an electric vehicle) is considered as one of the most hopeful technologies to implement the world clean energy goal (Chukwu. in The Impact of V2G Placement on a Feeder Line. IEEE, 2020 [1]). Projected V2G entrance levels across utility clients are a promising piece of information that V2G may rule the market soon. This proclaims the development of V2G parking areas. This paper discuss about energy management using EVs or vehicle to grid. This document provides all the information about energy management and how practical energy management may work with the help of EV. The electric vehicle interest/supply model was figured as a lining hypothesis issue, showing stochastic attributes. This paper tends to demonstrate energy management power request and supply just as an assessment of its power market possibilities.

Keywords Electrical vehicle (EV) · Vehicle-to-grid (V2G) · Smart grid · Reusable power · Fast charging station (FCS) · Battery storage

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1 Introduction

In today's contemporary world, carbon emission is always a threat for environment which draws intention and focus of researchers towards it. A lot of researches keep on going in this area, and effort is made to reduce the daily carbon emission rate by the various types of transportation system. As a result, an effort is to explore better transportation system and keep on finding an opportunity as well as a solution for the replacement of current transportation system in order to consume less fossil fuel, and EVs may have active role in the grid network as a part of distributed energy resources concept, which is characteristic of power system structure implementing microgrids [2–4]. So, electric powered vehicles have introduced in the transportation system to cut down the demand of conventional fossil fuel-based vehicles. An electric powered car has been introduced which is a quite good option within the near local destiny area. As a result of that, a sharp rise in demand of electric motors has been noticed. These new chargeable loads will result in introduction new challenges and problems for electric networks. Since these vehicles may be charged at home and corporate Automobile Park and having these have direct connection with distribution networks, it has attracted much interest within the auto and the electric power industries [5–8]. Under this situation, it could create problem and make direct impact on distribution networks. EV is an electric drive-based transportation system which uses electric motor along with some electrical energy storage batteries device [9].

The problems associated with EVs include voltage deviation, losses during charging periods, overloading of transformer and feeder, poor voltage profile, unbalancing and harmonics etc. In order to get rid of these problems, new technology has been introduced called V2G. V2G is especially wonderful by providing extra features such as load levelling, better regulation and reserve [10]. In V2G, it is cable to eliminate all type of problem as mentioned earlier and can use EV in efficient manner. Many researchers have investigated how V2G can ameliorate power losses [11], and the main idea to introduce charging system is to reduce adverse effects on electrical distribution networks. So by incorporating a coordinated charging or clever charging technique for EV charging during base load and use their reserved battery so that it reduce the stress in its peak load periods. It has shown that coordinated charging of PHEV can lower power losses and voltage deviation with the aid of knocking down out top energy and improve the load profile. So keeping in view of these adverse effects during charging situations, a study has been carried out to reduce the impact of PHEV on the electric networks. By collecting the specification and necessary information about all the EVs which currently available in the market, it is easy to calculate and determine the total reusable power given back to the grid when all the EVs gets fully charged either from home or office or automobile parking by using V2G system. Here, a grid-connected EVs via V2G system are used which help to maintain EV battery level all the time while connecting to V2G. While designing the circuit of the charging station, many elements have to be taken into consideration like finding area having sufficient parking area for vehicles, estimate the demand for fast charging slots in the place etc. The impact of fast charging station (FCS) for the connected distribution grid is an important point of power engineering.

2 Methodology

Specification of EV and calculation of reusable power using MATLAB.

Programme-1 specification of EV available in INDIA, namely in Table 1:

From the above Table 1, some specifications have given including battery capacity, distance travelled by the electric vehicle in battery pack, average distance travel in single full charge battery pack.

In this paper, there are some constants which need to be considered and defined as follows:

1. As an EV travels from home to office and vice versa, by considering that, one side maximum distance travelled is 50 km in a city. It means that overall distance travelled by EV is 100 km per day.

Table 1 Specification of EV in India

Electric vehicle	Battery pack (kwh)	EV travel (km)	AVG distance (km)
Tata Nexon EV	30.2	312	312
Tata Tigor EV	30	213	213
MG ZS EV	44.5	340	340
Hyundai KONA electric	39.2	452	452
Mahindra E Verito	21.2	140	140
Audi e-tron	95	400	400
Porsche Taycan	79.2	333–407	370
BMW i3	42	150–200	175
Jaguar I-pace	90	470	470
Nissan leaf	40	230–250	240
Volkswagen ID3	45	330	330
Mahindra XUV300EV	40	200–300	250
Mahindra Ekuv100	15.9	140	140

2. Consider that EV is fully charged before leaving home.
3. Consider that during all the transmission and V2G process there is only 20% losses in power appear.

Program-1

$$BCL = \frac{FBC(TD - DT)}{TD} \quad (1)$$

BCL battery capacity left after daily travel in EV (KWh).
FBC full battery capacity (KWh).
TD total distance travelled in single charge (KM).

$$TL = -(BCL \times 20\%) \quad (2)$$

$$ReP = BCL + TL \quad (3)$$

where daily total travel (DT) = 100 km.

Total loss (TL) = 20%

By using above formulas and after doing all calculations, it results into some new parameters as follows:

$$\text{MReP} = \text{Maximum Reusable Power}$$

$$\text{mReP} = \text{Minimum Reusable Power}$$

Daily Load Curve and Managing Peak Load

In programme-2, the daily load data on a dated 1 August 2020 from SLDC, Delhi, on Hourly basis has been taken in to consideration and carried out the actual information about management of peak load integrating electric vehicles Table 2.

In the above load curve data, only the office timing from 9 am to 5 pm is taken in to consideration for the reduction of maximum peak load by integrating electric vehicles using V2G technology.

Program-2

DL daily load data.
BL mean of DL.
*NM*Re number of maximum reusable power EV

$$NM\text{Re} = \frac{(DL - BL)}{m\text{Re}P} \quad (4)$$

Table 2 Daily load data per hour on 1st August, 2020

Time (Hourly)	Daily load data (DL)
0–0:55	59,300.74
1–1:55	56,352.26
2–2:55	52,546.01
3–3:55	49,497.97
4–4:55	47,413.12
5–5:55	45,290.8
6–6:55	43,382.85
7–7:55	42,101.28
8–8:55	41,006.32
9–9:55	42,294.84
10–10:55	45,498.78
11–11:55	48,614.59
12–12:55	50,822.71
13–13:55	51,899
14–14:55	54,960.53
15–15:55	53,672.54
16–16:55	50,105.53
17–17:55	48,148.59
18–18:55	46,346.57
19–19:55	47,303.44
20–20:55	49,685.51
21–21:55	52,458.85
22–22:55	55,388.95
23–23:55	57,087.58

PLM peak load management by maximum reusable power

$$PLM = NM\mathrm{Re} \times M\mathrm{Re}P \tag{5}$$

PLm peak load management by minimum reusable power.

Results

Profile of the ability of the respondents.

According to the formulas mentioned in above program 1, all calculation about that how much energy by one EV saved by it at the end of the day which is not useful for that day there, for it can be reused by connecting it grid load using V2G technology and use that power as reusable power.

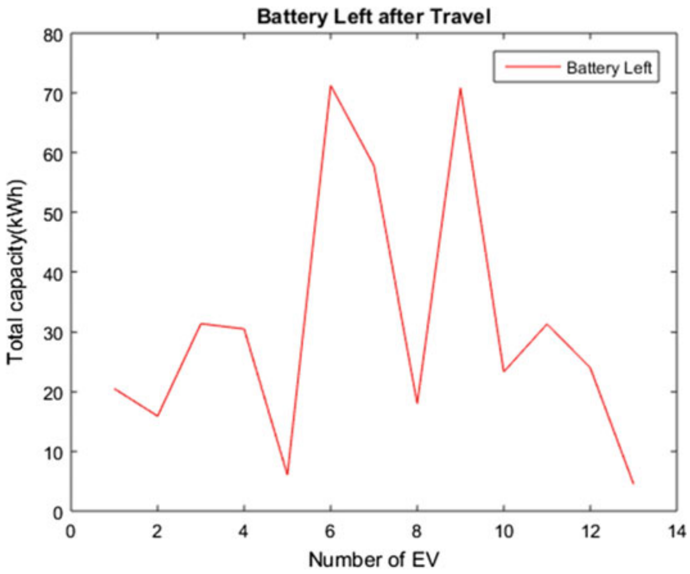

Fig. 1 Battery left after travel 100 km

With the help of above table findings in which type of EVs is more beneficial for V2G and other EVs are less beneficial for V2G by measuring their reusable power and all the calculations comparing all EV presently available in India by their reusable power is shown in Fig. 1. The above graphs in Fig. 1 shows battery left after 100 km travel of each vehicle and shows the battery capacity left in EV. RED colour—battery left after removing 100 km distance travel charge used.

The above-mentioned graph in Fig. 2 shows comparisons between Battery capacity left in EV after 100 km and overall losses happen in transmission and V2G process. GREEN colour—total Losses, i.e. battery losses, transmission losses in V2G, stand still losses etc.

CYAN colour—reusable power or difference between battery left and Losses. In Fig. 3, reusable power is the overall power left in an EV at the end of the day. Now, with the help of above calculation, the reusable power can be find out very easily and can pre-collect it from EV during connecting to V2G.

The above graph shown in Fig. 4 with different colour of waves in which,

RED colour—battery left after removing 100 km distance travel charge used.

GREEN colour—total losses, i.e. battery losses, transmission losses in V2G, stand still losses etc.

CYAN colour—reusable power or difference between battery left and Losses.

PEVs are the most potential suppliers of energy at any time [12]. By using above graph, it can be easily seen battery left, total losses and reusable power of different EVs in a same graph. With the help of this graph, we find out two EVs in which one of them provide maximum reusable power and another one of them provide minimum reusable power. With the help of that, two range of maximum or minimum reusable

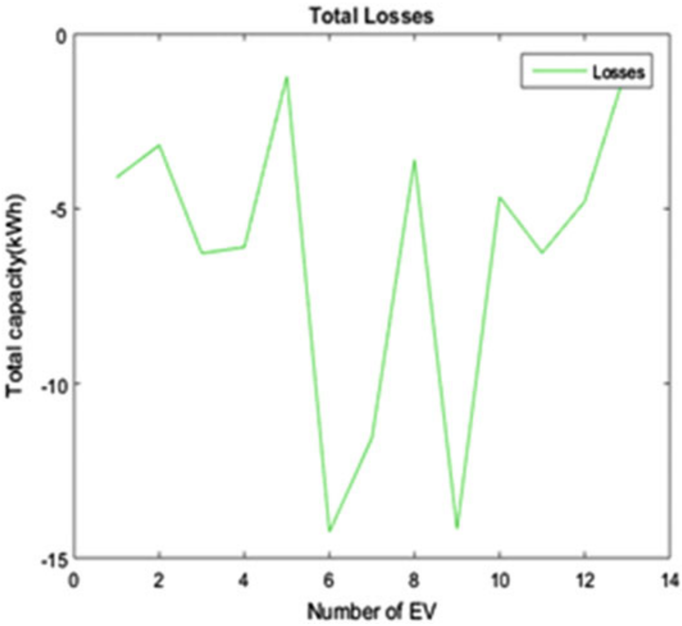

Fig. 2 Total losses in EV

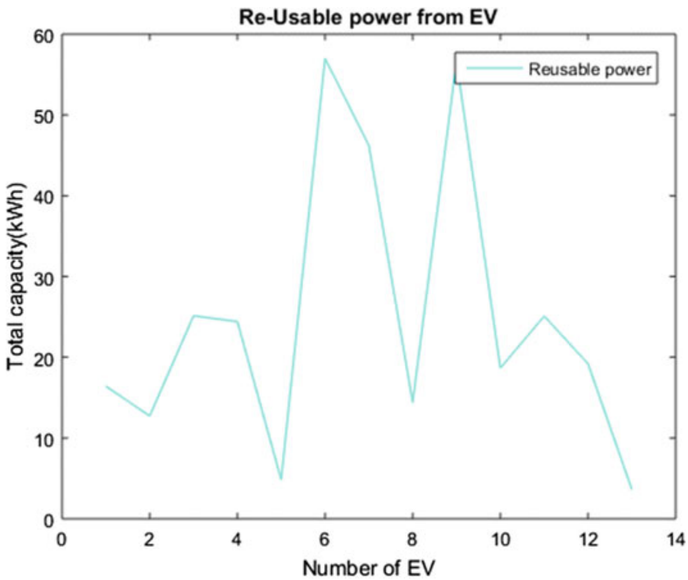

Fig. 3 Reusable power from EV

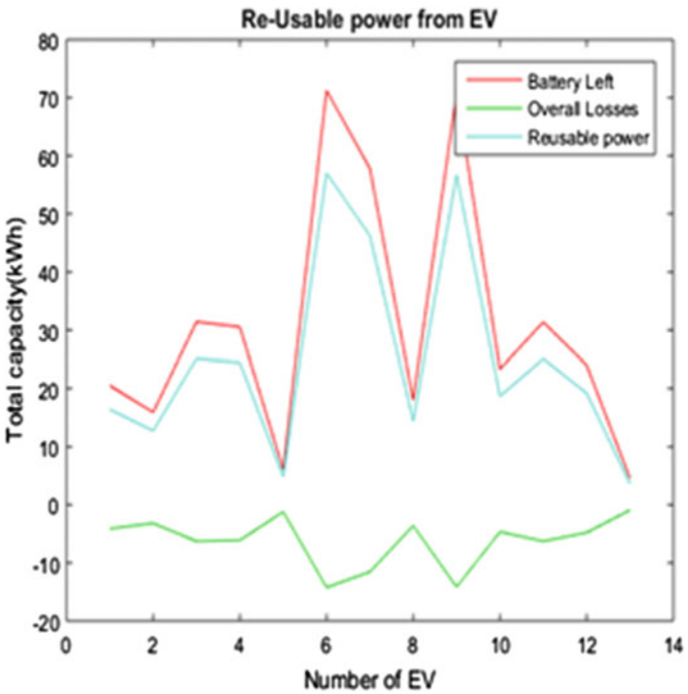

Fig. 4 Battery left, overall losses and reusable power from EV

power can be used.

$$\text{Minimum reusable power (mReP)} = 3.634\ \text{kwh}$$

$$\text{Maximum reusable power (MReP)} = 57.0\ \text{kwh}$$

After that, a daily load curve of 1 August 2020 from SLDC, Delhi, from 9 am to 5 pm office time is taken in to consideration. The fast-charging station (DC FCS) requires three-phase transformer that converts medium voltage to lower AC voltage levels. EV provides ancillary service to maintain the balancing between generation and electricity load either locally in the microgrid [12]. Latest technology and business models are on the way of development to organize the interface between EVs and V2G that are connected, as well as their interaction with the main grid. Controlling and benefitting from those interactions are the main key challenge to both the microgrid and the macrogrid [13, 14] Table 3 and Fig. 5.

With the help of above data, a load curve using MATLAB software has been drawn, which helps to understand daily load and peak hour, and with the help of this data, we take its minimum value as the base load Fig. 6.

Table 3 MATLAB program 1–battery capacity left, total loss, reusable power

Electric vehicle	Daily travel (km)	Battery capacity left (kwh)	Total loss (kwh) (20%)	Reusable power (kwh)
Tata Nexon EV	100	20.52	−4.104	16.416
Tata Tigor EV	100	15.915	−3.183	12.732
MG ZS EV	100	31.411	−6.282	25.13
Hyundai KONA electric	100	30.527	−6.105	24.421
Mahindra E Verito	100	6.0571	−1.211	4.845
Audi e-tron	100	71.25	−14.25	57
Porsche Taycan	100	57.794	−11.56	46.236
BMW i3	100	18	−3.6	14.4
Jaguar I-pace	100	70.851	−14.17	56.68
Nissan leaf	100	23.333	−4.667	18.667
Volkswagen ID3	100	31.363	−6.273	25.09
Mahindra XUV300EV	100	24	−4.8	19.2
Mahindra Ekuv100	100	4.542	−0.909	3.634

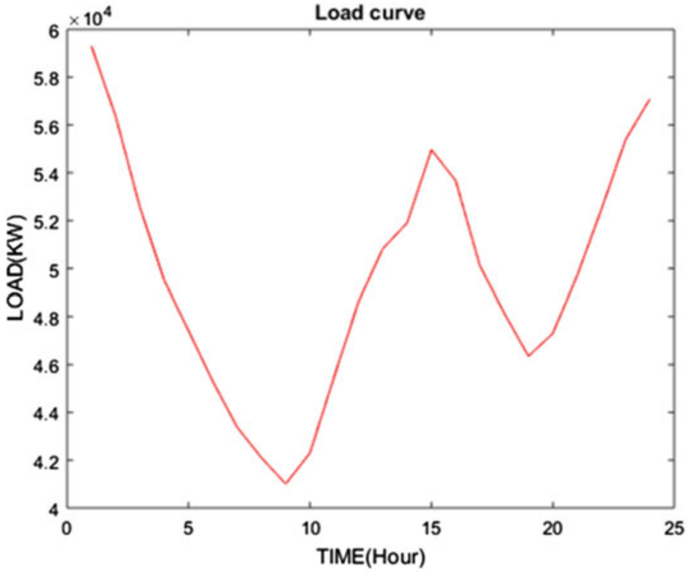

Fig. 5 Daily load curve of 1 August 2020 A = Daily load curve shown in Fig. 5

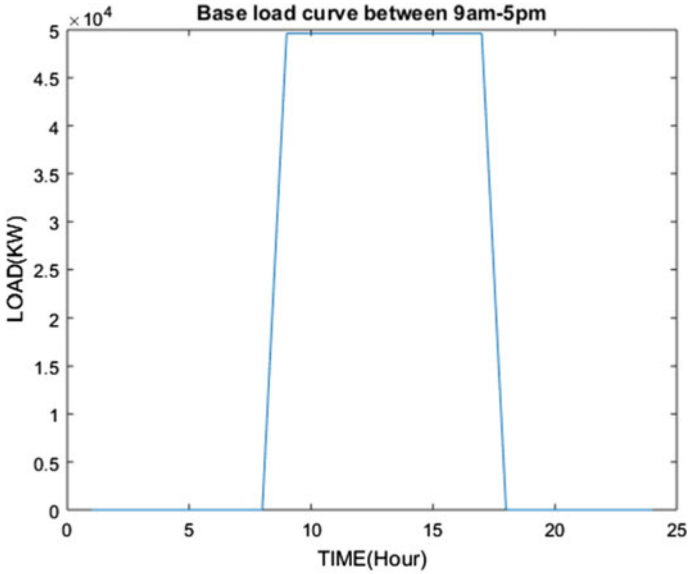

Fig. 6 Base load of daily load curve from 9 am to 5 pm. a = base load of daily load curve A (9am to 5 pm). a = mean/average value of A = 49,633 KWh

By using ‘A’ and ’a’, peak load and base load difference at various hour can be calculated. Now, by this load, we can find out how EV is needed in V2G, according to their reusable power, to settle this load difference present in between base load and daily load curve.

The above-mentioned Fig. 7 shows the peak load management by using EVs which are able to provide maximum reusable power by V2G i.e. 57KW Audi e-tron.

If this type of electric vehicles are used, then number of EVs will be reduced; peak load will be reduced, and load will be flattered according to the base load in the office timing, i.e. 9 am to 5 pm. Reusable power which is almost flat and equal to the base load curve during office working hour Table 4.

The above-mentioned figure shows the result or peak load management by using EV which are able to provide minimum reusable power by V2G, i.e. 3.6343 KW Mahindra Ekuv 100, calculated in programming 1, (in the above table all negative number of EVs represent that the Load curve is below the considered Base Load and the positive number of EVs represent that the Load curve is above the considered Base Load and the numbers shows that the total number of EVs required for increase or decrease the Load curve to the Base Load curve). If these types vehicles Table-1 are used, then number of EV will be maximum, i.e. and peak load is reduce till base load in the office timing, i.e. 9 am to 5 pm. Reusable power which is almost flat and equal to the base load curve during office hours Fig. 8 and Table 5.

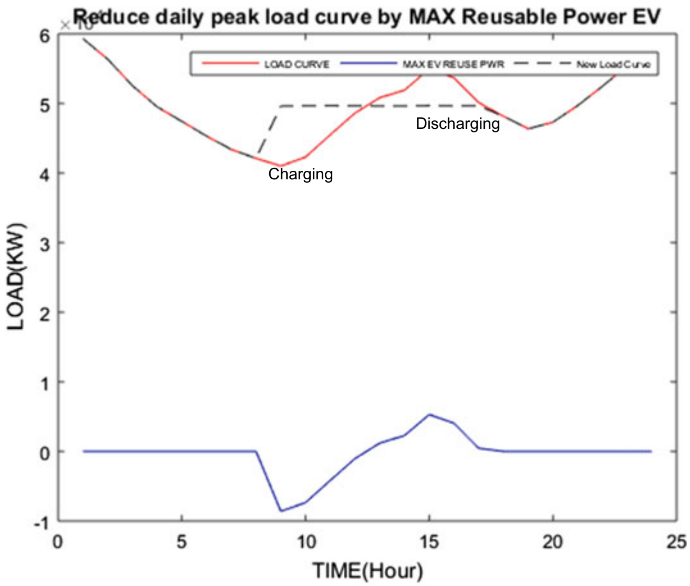

Fig. 7 Reduce daily load curve by using maximum reusable power

Table 4 Number of maximum reusable power EV needed according to time

Time	Number of EV
8–9am	−151
9–10am	−129
10–11am	−73
11–12am	−18
12–1pm	+21
1–2pm	+40
2–3pm	+93
3–4pm	+71
4–5pm	8

3 Discussion

In this paper, the specification of various EVs is currently available in India and consider overall travel 100 km per day by each model of EV, and each EV is fully charged before leaving home is taken into consideration. With the help of ReP of different EVs, the comparison of each value is carried out and found out maximum and minimum values of EVs. With the help of maximum and minimum ReP, the peak load is reduced accordingly, and it also shows how many numbers of EV are required for reduce peak load.

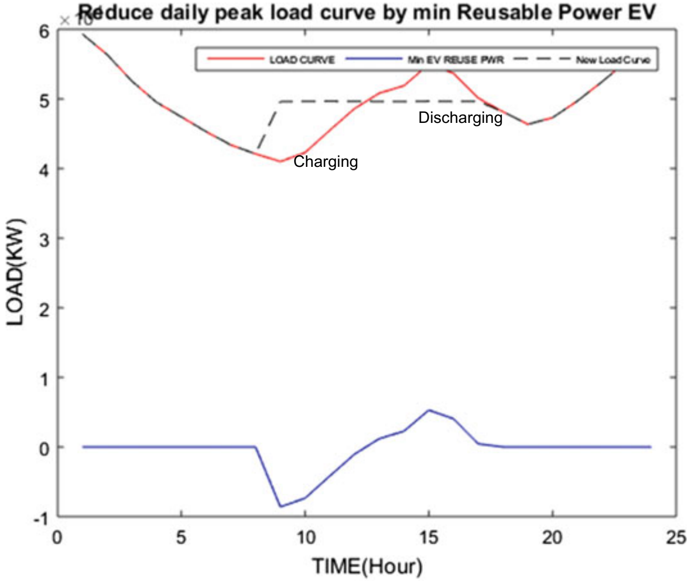

Fig. 8 Reduce daily peak load curve by minimum reusable power

Table 5 Number of minimum reusable power EV needed according to time (in the above table all negative number of EVs represent that the Load curve is below the considered Base Load and the positive number of EVs represent that the Load curve is above the considered Base Load and the numbers shows that the total number of EVs required for increase or decrease the Load curve to the Base Load curve)

Time	Number of EV
8–9am	−2374
9–10am	−2019
10–11am	−1137
11–12am	−280
12–1pm	+328
1–2pm	+624
2–3pm	+1466
3–4pm	+1112
4–5pm	+130

4 Conclusion

First of all we consider three assumption for our V2G model i.e. 1- each EV travel 100km per day, 2-EV is fully charged before leaving home, 3- V2G process take 20% loss. after that we took presently available EVs in INDIA and with the help of PROGRAM-1 we select 2 EV in which first one with Maximum Re-Usable Power and second one with minimum Re-Usable Power. In PROGRAM-2 we took Daily Load data from DELHI-SLDC(State Load Dispatch center) from 9am-5pm(considered as office time)and assume the average of Daily Load Data as Base Load after that with the help of PROGRAM-1 findings we implement on PROGRAM-2 and reduce the Peak Load and in result we get the total number of EVs required for satisfy Peak Load curve according to Maximum and minimum reusable power.

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Cryptocurrency, the Future of India

Prashant Singh and Rajni

Abstract While some discerning investors are increasingly becoming disenchanted with virtual currencies like **Bitcoin** as a result of recent price drops, others believe it is too early to declare it a dead end. In this study, we try to find an answer to the burning question: to invest or not to invest? The paper looks at a variety of facets of cryptocurrency platforms in an effort to address the research's key questions, "Will cryptocurrency be the next money platform?" and "Will cryptocurrency be the next currency platform?" "Is it possible to use virtual currency platforms?" In this paper, we try to elaborate these issues. For this, we collect primary as well as secondary data for the analysis. The primary data was collected from Delhi. The respondents were asked question about cryptocurrency to understand the preliminary impression of cryptocurrency's use, development, trustworthiness, and future expectations. Due to the vast amount of cryptocurrency that is flowing through multiple systems, the massive expansion and growth of using and implementing cryptocurrencies, and the possibilities that cryptocurrencies provide, the finding of our research suggests that cryptocurrency is quite likely to be the future currency platform.

Keywords Cryptocurrency · Bitcoin · Virtual currency · VC · FinTech · Currencies · Blockchain · Regulator · Investment · Trustworthy

1 Introduction

Businesses all over the globe have started using technology to increase the accuracy and decrease the task time for financial processes and services. FinTech as the name suggests is the mixture of finance and technology. With the world economy progressing at a rapid speed, the tech sector is taking over. But over the years, the

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definition of FinTech has changed as well. From the last few years, the FinTech sector is growing at a rapid speed. On global level, the FinTech sector is about to reach $45 billion at the end of the year. Finance sector shifted from analog to digital between 1967 and 2008. After the financial crisis that took place in 2008, many changes have been made in the finance industry. 2020 specifically was the year that called for digital services which involved financial services. During the lockdown, everything went digital. This was the real testing period of the security that FinTech is based on. Financial activities like insurance, mobile wallets, cryptocurrencies, robotics and artificial intelligence in finance are what's new in the market nowadays. We are living in a world where even plastic money has been replaced by Unified Payments Interface (UPI), and there are numerous new methods of making cashless payments. "Many Europeans in countries such as Greece, Italy, and Spain have converted their real money to cryptocurrencies, specifically Bitcoin, due to concerns about the future of the economy" (Greenwood). This means that users' confidence in virtual currency has grown to the point where they are using it to protect their savings. "If Bitcoin stabilizes there is a possibility that people could feasibly trust the Bitcoin currency more than those of central banks." The survey indicates that people do not find virtual currency (VC) trustworthy because it is not regulated, for example, RBI or any known stock exchanges of India**.** The Reserve Bank of India (RBI) has warned residents about the hazards of cryptocurrencies on numerous occasions. While the country's government has not openly banned cryptocurrencies, it also has not endorsed them. In terms of India, the following months will indicate the direction in which the crypto industry will move. People are concerned that if hackers and bad people breach the system and figure out how to create virtual currencies, they would be able to make as much money as they want. By simply altering account balances, it will be possible to create phony virtual currency or steal virtual currency. In the E-business and E-commerce industries, exchanging virtual currency for real currency is a hot topic.

In certain nations, trading cryptocurrency for cash is outright forbidden, whereas in others, it is either permitted or unregulated.

Investors who want to diversify their portfolio will be put off by the regulatory uncertainty. "Perhaps providing a regulatory structure would lead to a surge in cryptocurrency demand in India." According to a survey, India had about 50 lakh cryptocurrency traders and users in 2018. If a structure to regulate the blockchain market is set up, then many more people will start investing in cryptocurrency.

There have been many advancements in the cryptocurrency market, but is it safe? Is buying bitcoin safe? What are the risks involved if one invests in cryptocurrency? Why is not there a regulator for cryptocurrency? Many such questions remain unanswered, therefore, a mystery in itself.

In this paper, we elaborate on a study conducted with respect to the trends related to the investors of cryptocurrency. We develop a sound understanding as to how many individuals from a group of people are willing to invest in cryptocurrency without a regulator, with a regulator and those that are indifferent toward the need of a regulator.

1.1 FinTech in India

India is one of the fastest-growing FinTech markets in the world. India, along with China, has the world's highest FinTech adoption rate. FinTech companies in India are redefining financial services in the nation. Various government efforts in India, such as the Jan-Dhan Yojana and Aadhaar, are encouraging the FinTech business. The implementation of the Unified Payments Interface (UPI), which provides a solid platform for increasing financial inclusion in India. Demographically, males and females adopted FinTech apps at a rate of 88% and 84%, respectively, while those aged 25 to 44 are the largest users of FinTechs at around 94%, while FinTech adoption is around 73% globally in the same age group. (https://bfsi.economictimes.indiatimes.com).

1.2 FinTech Startup in India

India continues to see a boom in FinTech development, fueled by the creation of new FinTech firms and a steady stream of technical breakthroughs. The funding boom has been seen in FinTech sector in India, with funding increasing at a compound annual growth rate (CAGR) of 98% in the previous few years. Nowadays, more than 2000 FinTech companies are working in India, and this number of FinTech companies is increasing day by day. Various FinTech startups that have made their way up the ladder are Paytm, Razorpay, Cred, ETMoney, MobiKwik to name a few. Payments account for the biggest proportion of FinTech companies in India, followed by loaning, personal finance, insurance technology, regulatory technology, etc. "According to EY's FinTech Adoption Index 2017, India has evolved to become the market with the second-highest FinTech adoption rate of 52% among 20 economies globally over the previous few years. This holds true for each of the five categories of services with digitally active Indian consumers displaying 50–100% higher adoption rates than global averages" (EY FinTech Adoption Index 2017).

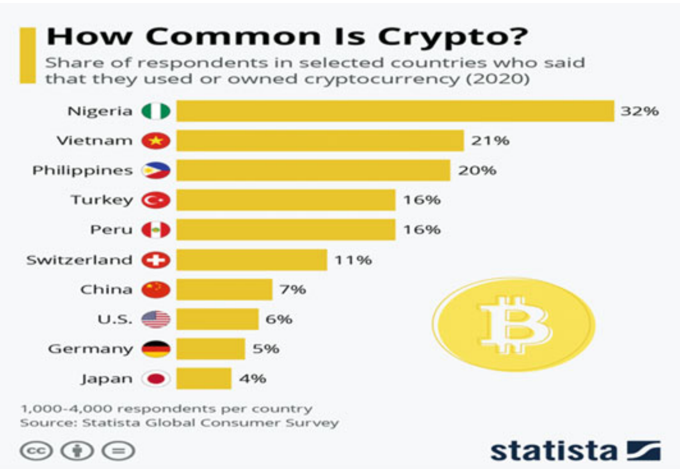
1.3 FinTech and Blockchain

FinTech is transforming the financial industry, and companies that develop blockchain in this field will have a significant competitive edge in the future (Shah 2019). The routing committee on FinTech recently released a paper. The value of Blockchain was highlighted by the Ministry of Finance, GOI, with a special mention of four blockchain applications. The FinTech industry is being transformed by blockchain technology in a variety of ways. Blockchain is being used in capital markets, insurance industry, banking industry and public sector. In capital markets, it has helped in decreasing the time of transferring securities and decreased cost of trading because of removing intermediaries.

1.4 Cryptocurrency

Cryptocurrency (CC) is any type of digital money that can be used in a variety of money transactions, be it virtual or physical. Cryptocurrencies are precious and immaterial resources that can be used electronically or virtually in a variety of applications and networks, including different online social networking applications and websites, online games, and other similar applications and networks.

The first to offer the cryptocurrency exchange and trading services in India were BtcxIndia, Unocoin and Coinsecure. Others have been added to the list over time, such as Zebpay, Koinex and Bitcoin-India (Shailik Jani. Thanks to the development of crypto trading and exchange platforms, India's crypto industry has grown from a tiny level in 2013 to what it is now. The country also offers a number of over-the-counter (OTC) crypto stores in addition to these online exchanges. While the country's demonetization program in 2016 encouraged broad acceptance of cryptocurrencies, the market's expansion was quickly hampered by reality. India accounts for just 2% of the global cryptocurrency market, despite its enormous population. According to a survey by Analytics Insight, Indians had spent roughly $ 6.6 billion in cryptocurrencies through May 2021. This represents a 600% increase from $923 million in April 2020. It is estimated that around 1.5 crore Indians have invested in cryptocurrency. In the blockchain and cryptocurrency field, there are currently over 350 firms. The government is taking a cautious approach to cryptocurrencies, owing to the high level of investor interest and the quickly growing cryptocurrency industry.



It can be observed from the above figure that India is not among the top 10 countries where cryptocurrency is common. To understand why India has not been using cryptocurrency, we conducted this research.

2 Review of Literature

Various studies have been conducted on the role, challenges, growth and opportunities of development of FinTech sector in India. According to Arner et al. [1], the recent evolution of FinTech, led by startups, creates challenges for regulators and market participants. They examine FinTech's evolution over the last 150 years and, based on their findings, argue against its too-early or strict adoption. The essential issue, according to Kandpal and Mehrotra [2], is that FinTech arose more as a requirement as a result of advances in the areas of financing services and rapid technological advancement than as a result of a need for such services. The combination of technology and financial services means that a variety of applications and platforms are being established and developed to make it easier for use. Jani [3] examined cryptocurrency systems and discovered many issues and obstacles that put the financial system in jeopardy. She discovered that the lack of legislation is the primary source of concern in cryptocurrency systems.

According to Vijai [4], FinTech allows for digital transactions that are safer for the user. FinTech services provide the advantages of lower operating costs and more user-friendly interfaces. FinTech services in India are among the fastest growing in the world. FinTech services will transform the Indian financial sector's habits and behavior of the Indian financial sector. Bitcoin is a creative and technologically advanced solution for a globalized future that is unpredictable. This might be a viable option for processing payments across geographical boundaries. Bitcoins, if properly regulated, have the potential to assist future generations in addressing concerns relating to financial transactions in numerous forms [5].

Rajeswari and Vijai [4] examine FinTech adoption, FinTech news network, Indian FinTech industry structure, and FinTech startup in India, as well as FinTech trends in India. FinTech provides consumers with more efficient financial services and products. As a result, the development of the FinTech industry is critical for both the global and Indian financial sectors.

On the basis of above studies, we can say that the studies on the awareness and knowledge regarding investment in cryptocurrency are still missing. We want to fill this gap by doing this research work. The paper looks at a variety of facets of cryptocurrency platforms in an effort to address the research's key questions, which are "Will cryptocurrency be the next money and currency platform?" and is it possible to use virtual currency platforms?"

3 Objective

According to the study of the available literature, FinTech services in the Indian context are still in their infancy, as we look on researches. The majority of the literature is in the form of reports prepared by various consulting firms, with a particular emphasis on issues and challenges, growth for FinTech services and types of services provided by companies, among other topics; hence, the present study focuses on:

1. To examine India's FinTech ecosystem.
2. To understand the respondent awareness regarding the cryptocurrency.
3. To know respondent knowledge regarding investment in cryptocurrency with or without the regulation.

3.1 Hypothesis of the Study

1. The respondent would be significantly aware about FinTech ecosystem.
2. The respondent would be significantly differ regarding awareness about investment in cryptocurrency.
3. The respondent would be significantly aware about cryptocurrency.
4. The age and the awareness regarding investment in cryptocurrency would be significantly associated.
5. The respondents would be significant differ in awareness and willingness to investment in cryptocurrency.
6. The respondent would significantly differ in willingness to investment in cryptocurrency with or without regulator.

3.2 Research Methodology

This study is an attempt to study the awareness and knowledge regarding investment in cryptocurrency. The data for this has been collected from primary sources by means of a self-explanatory questionnaire. In order to develop questionnaire, extensive review of existing literature was conducted. The study used structured non-disguised questionnaire to collect primary data. In order to minimize the respondent's response error, close-ended questions have been considered in questionnaire. The pilot testing of questionnaire was conducted on 10% of the total sample size. Reliability of the questionnaire statements was test using Cronbach Alpha reliability statistics. The value of Cronbach's Alpha (0.820) was found adequately high to consider the questionnaire reliable and consistent. The convenient random sampling method is used to collect the data from the respondents. The primary data is collected through online questionnaire. The data has been collected from Delhi and NCR regions. The reason for selecting these regions is that we are assuming that respondents are more aware about these virtual currency in these regions. We have collected a sample of 220 respondents. Out of these, 209 samples were found to be valid and used for the study. The sample data include both males and females. We have used the SPSS version 26 for data analysis. We have used cross tab analysis and chi-square test to test the above hypothesis.

4 Results and Analysis

In order to better understand how users exchange virtual currencies, we conducted a survey that looked at some of these issues. Table 1 describes that 57.4% are from the age group 21–30, while 38.8% are from 31 to 40 age group. The remaining 3.8% are from the age group 41–60. 60% of the respondents are working while 40% are graduate students.

4.1 Awareness Regarding Investment in Cryptocurrency

Table 2 shows the respondents' awareness regarding cryptocurrency. Those who were polled were questioned if they had heard of this form of virtual currency, specifically **cryptocurrency**. Around 52.6% of them have never heard of **cryptocurrency** or any other peer-to-peer virtual currency, although only 47.4% were aware of it.

Table 1 Demographic details

Demographic profile		
Age group	N	%
20–30	120	57.4
31–40	81	38.8
41–60	8	3.8
Profile of respondent		
Graduate students	84	40.6
Working	125	59.4

Table 2 Age group and awareness regarding Bitcoin chi-square test

Age group	Awareness regarding investment in Bitcoin				
	N	%	N	%	Chi square
20–30	118	98.3	2	1.7	90.403***
31–40	32	39.5	49	60.5	
41–60	8	100	0	0	

*** $p < 0.001$

Table 3 Awareness and willingness to investment in cryptocurrency chi-square test

	Willingness to investment in cryptocurrency				
	Yes		No		
Awareness regarding investment in Bitcoin	N	%	N	%	Chi-square
Yes	78	49.4	80	50.6	1.037
No	21	41.2	30	58.8	

Out of the 47.4% that know about cryptocurrency, only 38.3% are willing to invest without a regulator. These subjects were indifferent to the fact that if there should be a regulator or not. Regardless of regulator or not, they are willing to invest in cryptocurrency and take the risks. In order to get more insight into the awareness and willingness of participant regarding investment in cryptocurrency, we tested the following hypothesis by using non-parametric statistic chi-square.

The result of independence chi-square test shows significant association between age group and awareness regarding the investment in Bitcoin with x^2 $(1, N = 209) = 90.403$ $p = 0.001$ $\varphi = 0.496$. The value of phi coefficient was 0.496 which indicates the moderate effect size. The finding showed that the participants in the age group of 20–30 are more aware about the bitcoin as compared to others age group.

4.2 Awareness and Willingness to Investment in Cryptocurrency

The chi-square value is found to be insignificant indicating that the respondents are aware but do not have willingness to invest. The result does not show any significant association between awareness and willingness to invest in cryptocurrency (Table 3).

4.3 Willingness to Investment in Cryptocurrency With/Without Regulator

Table 4 reveals that there is significant association between willingness to invest in cryptocurrency without a regulator; the X^2 $(1, N = 209), = 23.766$ $p = 0.001$ found significant. The phi coefficient is 0.337 < 0.5 indicating that the effect size is very less. The finding showed that if the respondent are willing to invest, then they are ready to invest without a regulator also. If they are not willing to invest, then even the absence of regulator does not affect them.

Similarly, Table 5 reveals that there is a significant association between willingness to invest in cryptocurrency and the presence of a regulatory body. The X^2 value $(1, N = 209), = 19.479$*** $p = 0.001$ was found significant. The phi coefficient is 0.305

Table 4 Willingness to investment in cryptocurrency without a regulator, chi-square test

	Willingness to invest in cryptocurrency without a regulator				
	Yes		No		
Willingness to investment in cryptocurrency	N	%	N	%	Chi-square
Yes	55	55.6	44	44.4	23.766***
No	25	22.7	85	77.3	

**** P = 0.005

Table 5 Willingness to investment in cryptocurrency with regulator, chi-square test

	Willingness to invest in cryptocurrency with regulator				
	Yes		No		
Willingness to investment in cryptocurrency	N	%	N	%	Chi-square
Yes	54	54.5	45	45.5	19.479***
No	91	62.7	19	17.3	

**** P = 0.001

< 0.5 indicating that the effect size is very less. The finding of the results reveal that the people are not willing to invest even if there is regulator in the market as people are aware that these are digital currency and government has no control over these types of cryptocurrency.

4.4 Willingness to Investment in Cryptocurrency and Perception Regarding Cryptocurrency Will Be New Mode of Exchange

Table 6 reveals that there is a significant association between willingness to invest

Table 6 Willingness to investment in cryptocurrency and perception regarding cryptocurrency will be new mode of exchange chi-square test

	Cryptocurrency new mode of exchange						
	Yes		No		May be		
Willingness to investment in cryptocurrency	N	%	N	%	N	%	Chi-square
Yes	67	67.7	24	24.2	8	8.1	6.702**
No	55	50	41	37.3	14	12.7	

** P < 0.005

in cryptocurrency and perception regarding cryptocurrency will be a new mode of exchange. The X^2 $(1, N = 209), = 6.702^{**}$ $p < 0.005$ was found significant. The phi coefficient is $0.116 < 0.5$ indicating that the effect size is very less. The finding of the results indicates that participant who are willing to invest in cryptocurrency are of the view that cryptocurrency will be the new mode of exchange.

5 Discussion

The finding of the results indicates that the awareness regarding the cryptocurrency is increasing day by day in India. Now that the RBI in March 2020 in a landmark decision revealed that all cryptocurrency-related activity, including investment and trading, will soon be legal in the country, the willingness to investment in cryptocurrency is also increasing. But still, it is not too much popular in India. The reason for its low investment is that before March 2020m investment in cryptocurrency is illegal in India, and even still, there is no regulatory bodies which look into the investment in cryptocurrency. That is why it is not becoming too much popular. The second reason for its non-popularity among investors is that in India, the investor is more interested in investing in fixed deposit, mutual fund, share market and gold. The awareness is still very less among the investors regarding the investment in cryptocurrency. But as this is the new currency of the new generation, there are significant benefits of investing in these cryptocurrencies such as the transaction is simple and quick, international transactions are less time-consuming, no transactions costs involved, no middleman, secure and confidential transactions. The result also indicates that as the people are getting more aware about the cryptocurrency, they are willing to invest in cryptocurrency.

6 Conclusion

This research paper tried to look at a variety of facets of cryptocurrency platforms in an effort to address the research's key questions, which are "Will cryptocurrency be the next money platform?" and "Will cryptocurrency be the next currency platform?" Is it possible to use virtual currency platforms?" We find from the literature that in India, the investment in cryptocurrency is very low. There is no regulator for this currency in India. The results of the study show that cryptocurrency is very likely to be the future currency platform due to the enormous quantity of cryptocurrency that is flowing through multiple systems, the massive development and growth of utilizing and implementing cryptocurrencies and the possibilities that cryptocurrencies bring. The advantages of cryptocurrency systems are numerous. Respondents, on the other hand, are unaware of the full implications of cryptocurrency usage. Users should exercise extra caution when using cryptocurrency before it is properly regulated and monitored.

6.1 *Scope for Further Research*

The relationship between real financial laws and the legal status of implementing cryptocurrency platforms should be looked into from a variety of perspectives. Furthermore, the degree of adoption and acceptance needs more thought and research for broad groups and samples. In terms of using and exchanging cryptocurrency types, trust and confidence are critical factors that should be explored further. The scope of the research can be expanded to include designing use-cases for cryptocurrency applications in India's various sectors.

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A Review of the Contemporary Soil Monitoring Systems in Modern Farming

K. A. Ashika and S. Sheeja

Abstract Agriculture is one of the primary sources of income. More productivity in crops leads to secure lives. The world population is getting increased. Our approach to agricultural practices should be wise. Then only we can continue the demand–supply chain. Efficient farming practices give more productivity. Agricultural activities have been improved from traditional practices by the introduction of artificial intelligence and Internet of things. This paper briefly explains the role of soil monitoring systems in the agricultural life cycle. A generic architecture of the soil monitoring system is designed here. Systems with novel ideas, features, functions or components proposed by researchers in their recent studies are listed in this paper. This paper will be useful to researchers who want to know the recent developments in the area of automated soil monitoring systems.

Keywords IoT · Soil monitoring · Sensors · WSN · Artificial intelligence · Smart farming · Agriculture

1 Introduction

Agriculture plays an important role in human life. As the population is getting increased, food production also needs to be increased. Traditional farming practices were not automated. The knowledge and hard work of farmers played a key role in their success. Many uninvited or unexpected events adversely affect the successful production of crops. The methods adopted by them were time-consuming and affected productions also. Since farming practices were not automated, more labourers were needed to perform various tasks associated with farming.

Traditional farming depended on seasonal rainfall. Animals were used to plough the field. Persian wheels were used for irrigating lands. Farming required a great amount of labour and hence provided many job opportunities in the agricultural field.

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Agriculture life cycle of each crop depends on various factors. Humidity, temperature of the environment, and rainfall are some of the major factors. The climatic changes that we see today are the result of various human activities like deforestation, pollution etc. These changes make it difficult for farmers to take appropriate decisions regarding the farming practices. But the introduction of artificial intelligence and Internet of things changed the whole practices associated with farming such as soil monitoring, irrigation, planting, and harvesting. This paper briefly explains the architecture as well as role of soil monitoring systems in the agriculture life cycle. It also explains various methods, devices and technologies proposed by researchers for soil monitoring recently.

Internet of Things. IoT is the interconnected network system in which every node sends/receives data [1]. These data can be collected and analysed for intelligent purposes using various techniques. Smart farming uses sensors to collect data from the farmland. These data are used to make decisions for further actions.

Artificial Intelligence. It is the application of human intelligence to machines through various algorithms. Artificial intelligence is now applied in all the aspects of human activities. New models and algorithms are being introduced to accomplish various tasks related to agricultural activities also.

2 Agricultural Life Cycle and Role of Soil Monitoring System

The life cycle of agricultural activity and role of soil monitoring systems in each step of the life cycle are shown in Fig. 1.

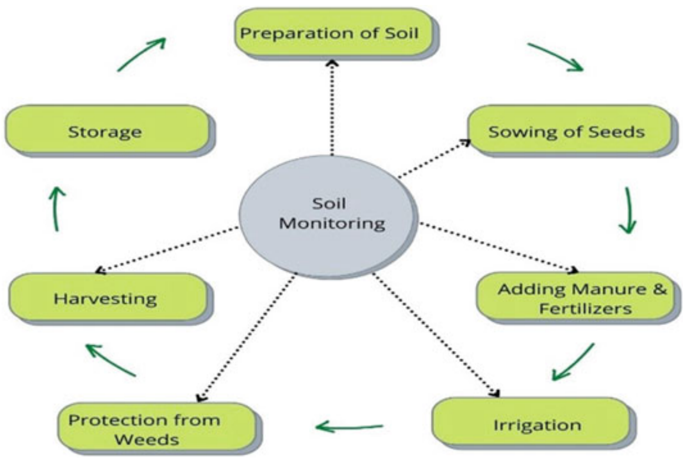

Fig. 1 Steps in agriculture life cycle

2.1 Preparation of Soil

Soil is an important factor for good crop production. Soil should be prepared first by ploughing, levelling etc. It will help to loosen the soil and let the air get into the soil. Soil monitoring system has an important role in this step. Technology helps the farmers to find out a positive solution for every problem [2]. Soil monitoring systems can help the farmers to know about soil moisture, pH and other nutrient values of the soil and recommend proper actions using artificial intelligence.

2.2 Sowing of Seeds

It is the process of placing seeds in the soil to germinate and grow into plant. All soils will not be suitable for all seeds. Soil monitoring system can check the soil parameters and can predict suitable crops by using appropriate machine learning algorithms. Only suitable crops will give a good yield. It is one of the important things that the farmers have to take care of.

2.3 Adding Manure and Fertilizers

Manures are obtained from natural sources and are eco-friendly. Fertilizers are made synthetically in the factories. They can add required nutrients to the soil. The nutrients present in the soil has great role in the production of good quality crops. Soil monitoring systems can check the nutrients present in the soil and recommend the required amount fertilizers or manures needed for the farmland. It can also recommend the frequency of applying them according to the crop and soil using artificial intelligence.

2.4 Irrigation

The process of supplying water is known as irrigation. It moisturizes the land and helps in germination and growth of plants. Traditional method of irrigation incudes chain pump, lever system and pulley system. To supply water efficiently and intelligently, new methods had to be introduced. The new soil monitoring systems can monitor soil moisture, temperature, humidity, rainfall, weather etc. Such systems can intelligently predict the required amount of water for the crops using machine learning techniques. They can even water the crops automatically or can give instructions to the farmers according to the current status of the field. Manures and fertilizers can be distributed through the irrigation. It is risk even if the moisture level is high or low [3].

2.5 Protection from Weeds

Weeds are the unwanted plants that grow along with the crop in the soil. Weeds absorb nutrients, water etc. along with crops which affect the growth of the crop. Thus, it decreases the agricultural productivity. Manual removal or weedicides are used to remove the weeds. Now, automated methods are available to remove weeds by identifying them using AI methods. Soil monitoring system analyses the soil nutrients and moisture during all these times. If any attention is needed, the system can alert the farmer or do proper actions such as irrigation and nutrient supply. Farmers do not have to go and check the status of soil manually.

2.6 Harvesting

We harvest entire plants or economical parts such as root, seed and grain of the plant when it matures. In modern farming, harvesting is automated using AI techniques. Then, it is moved to a more secure location for processing, consumption or storage. The soil monitoring system monitors the status of the soil and do proper action during these times also.

2.7 Storage

Storage is an important phase. In order to guarantee the food supply during all the periods, they have to be stored securely.

3 Architecture of a Generic Soil Monitoring System

1. Sensors collect data such as rainfall, soil moisture, pH, humidity and temperature in real time and send to the gateway.
2. Aggregation and transmission of the data takes place in the gateway. Data can be uploaded to the cloud system and can be used for further processing or analysis [4].
3. Since data are stored in the cloud, farmers can see the information through any devices (laptop/mobile/tab etc.) from anywhere in the world. Data analysis can be done in real time and can recommend/perform necessary actions required

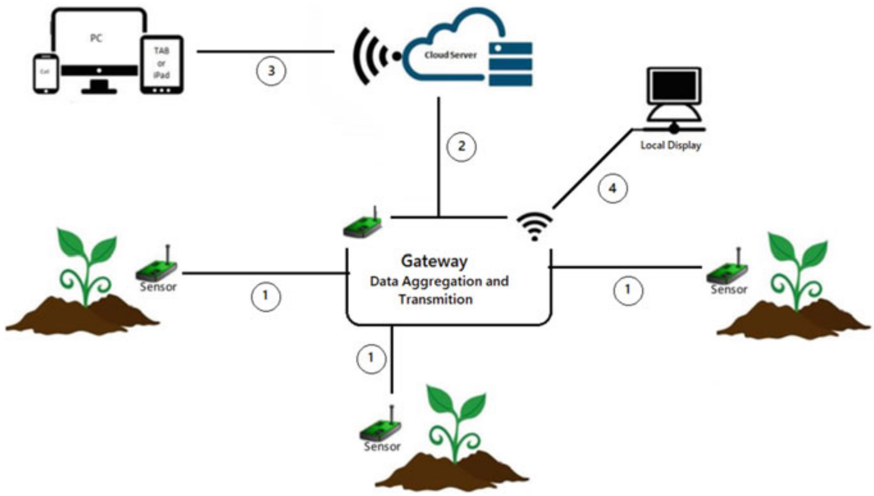

Fig. 2 Architecture of a generic soil monitoring system

in timely manner. The system can send alert to farmers whenever any action is required according to the soil conditions.

4. Farmers can see data read from the sensors through local computer as well if it is connected to gateway (Fig. 2).

4 Recent Works in Soil Monitoring Systems

Soil fertility is one of the most important factors to be considered in agriculture. Various parameters can be used to measure the same. They are soil structures, temperature, humidity, PH, nutrient levels etc. Image processing can be used to get soil structures. Others can be measured using sensors [5]. In [6], soil moisture has been studied along the depth of the soil as a different approach. It determines the time of water supply to reach the roots of the plant. Research on various aspects of the soil monitoring is being conducted worldwide. Researchers try to implement new technologies and methodologies to make the soil monitoring easier. Some of the studies being conducted on soil is presented below. Kamelia et al. [5] proposed a system for real-time monitoring of soil pH and moisture and obtaining results on the website. In [7], Kuchkorov implemented a method that combines GNSS sensing data with sensors (TDRs) to determine soil water index changes which gives improved reliability to the results. Kumar et al. [6] presented a method to manufacture low-cost home-made soil moisture sensor.

IoT has improved farming practices a lot. But other important factors such as cost, energy efficiency, range and durability are also to be considered. In [8], authors propose low-power, long-range IoT network to monitor soil moisture remotely.

Sophocleous [9] presents soil quality monitoring system based on a screen-printed soil-sensing array. Automatic Soil moisture control using IoT is proposed in [10]. Appropriate actions take place through actuators. The authors implement a WSN-based soil moisture monitoring system for outdoor environment in this work [11]. EWMA event detection technique is applied to extend the life of WSN. Ayyasamy et al. [12] offer a soil monitoring system for managing farmland's surplus water log. The suction motor removes extra water from the field. Effective microclimatic parameter collection and controls for greenhouse-based agriculture are presented in [13].

Bolla et al. [14] present a method which input real-time land pictures and do requirement prediction from the result of image processing. The suggested system in [15] utilize cloud environment and also determine the amount of water to be delivered to the field. In [16], authors propose a method which gives crop and fertilizer recommendations based on the land selected. Authors in [17] compared ID3 and C4.5, and they got increased accuracy for the hybrid model. Gururung et al. [18] proposes a comprehensive, cost-effective, scalable, solar-powered and self-sufficient agriculture irrigation system which can be used in both commercial as well as small farms. In [19], the authors suggest a system that continuously analyses soil parameters using NPK tester and advises the appropriate amount of fertilizer for agriculture. Authors in [20] have done an experiment and proved that each sensor should be calibrated before using it to avoid wrong interpretations. Tian [21] proposes a new method Cosmic-Ray Neuron Sensing (CRNS) to measure mean soil water content on a hectometer scale. Kamelia et al. [22] propose IoT-based wireless communication method to monitor humidity and pH of the soil.

The following table shows the recent works researchers have been done along with the properties collected and sensors, microcontrollers or technologies used (Table 1).

5 Benefits of Modern Farming Practices

Some of the benefits of the modern farming practices include increased productivity, increased efficiency, decreased environmental hostile impact, management in unexpected natural conditions, cultivation upon demand, improved crop management practices, shooting and planting seeds using UAVs at specific locations, driverless tractors, easy labour-intensive tasks, reduced harvesting time, collection and organization of data for farmers, identifying type of crop to be grown in any location, efficient supply chain management etc.

Table 1 Functionality, properties, sensors, microcontrollers and technologies in various studies

Author	Intention of the system	Properties collected	Sensor/ micro controller/technology used
[5]	Identify pH and humidity in real time and display on a screen	pH, soil moisture	FC-28 soil moisture sensor, ETP-110- pH sensor, Wemos D1 R2 microcontroller planted with the ESP8266 Wi-Fi, ADS115, ThingSpeak webserver
[7]	Identify soil water index changes	Temperature, humidity, water	TDR (time domain reflectometer) sensors, GNSS (Global navigation satellite system) Raspberry Pi, groundwater sensing sensor; water quality sensor; soil quality sensor; air temperature and humidity sensor
[6]	identifying soil moisture using low-cost home-made soil moisture sensor	Soil moisture	Home-made soil moisture sensor, Arduino Uno
[8]	Low-power, long-range and low-cost IoT network to monitor soil moisture	Ambient temperature and humidity (BME-280 sensor), soil moisture and soil temperature	LoRa, LeasyScan, in-house designed capacitive soil moisture sensor
[9]	Low-cost and standalone soil quality monitoring system	pH, temperature, dissolved oxygen	Screen-printed soil-sensing array-potentiometric pH sensor, a conductivity sensor, a platinum resistance thermometer and an amperometric dissolved oxygen sensor, ESP32
[10]	Monitoring and automatic control of soil moisture content	Soil moisture, temperature, humidity	Soil moisture sensor, rainfall sensor, temperature sensor and humidity sensor (DHT-22), Arduino microcontroller, Zigbee modules, Raspberry Pi, actuators, and pumps, ThingSpeak cloud server
[11]	Soil moisture monitoring	Soil moisture	Zigbee Tx, EWMA, event detection algorithm, soil moisture sensor, PIC 16F877A microcontroller, Raspberry Pi 3, Dropbox cloud storage

(continued)

Table 1 (continued)

Author	Intention of the system	Properties collected	Sensor/ micro controller/technology used
[12]	Manage waterlog in the field and weather forecast	Humidity, pH, temperature, soil moisture, water level	Soil moisture sensor, pH sensor, water level sensor, DHT-11 sensor (humidity and temperature), Arduino, cloud storage brokerage (CSB)
[13]	Automatic greenhouse watering and temperature control scheme	Temperature, moisture, soil humidity, light intensity	Arduino Uno, e CC2530-temperature sensor, SY-HS-220-humidity sensor, SN-M114-soil moisture sensors, light-dependent resistor (LDR)
[14]	Suggest suitable nutrients and crops to the farmers	pH, moisture level, nutrient content of the soil	Raspberry Pi, Wi-Fi, camera is interconnected with Raspberry Pi
[16]	Recommends crops, fertilizers and its duration based on soil	Temperature, humidity, soil test values, pH, water requirement	Temperature sensor, humidity sensor, camera, ANN, linear regression, decision tree, k-nearest neighbours, XGBoost, MATLAB
[18]	Wireless soil moisture sensor network for agriculture for improved and efficient water usage in farmland	Soil moisture, soil temperature, relative humidity, air temperature, solar panel voltage, charging current, battery backup voltage, individual and total supercapacitor voltage, enclosure box temperature	Raspberry Pi, Wi-Fi, EC-5 soil moisture sensor, soil temperature sensor, BME280 temperature sensor, solar radiation sensor
[19]	Recommends required amount of fertilizers for the farmland	Soil moisture, soil temperature, pH, nutrients	FC28—Soil moisture sensor, NPK tester, DS18B20-soil temperature sensor, soil pH sensor, Arduino microcontroller, ESP8266 Wi-Fi module, AWS cloud platform, node MCU
[22]	IoT-based wireless sensor network for monitoring pH and humidity of the soil	Soil moisture, pH	pH sensor, YL69 sensor, virtual wire for radio modules, Ethernet for Ethernet shield module, PubSubClient for MQTT protocol

6 Conclusion

By using sensors, Internet of things and artificial intelligence, we can improve lots of operations of agriculture. This paper explains the role of soil monitoring systems in each step of the agricultural life cycle. It compares the traditional methods with new soil monitoring systems. The architecture of a generic soil monitoring system is also explained here. Recent works that have been done in soil monitoring systems are also studied and explained. There are limitations in various systems as some are designed to work only on limited parameters or limited conditions while others are concentrated to improve specific parameters only. Many studies are going on in this field. We expect improvements in all the steps of agricultural activities in future.

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Reliability Modelling and Analysis of an Industrial Bakery Plant Using Boolean Function Technique

Surbhi Gupta, Aastha Chaudhary, and Shefali Kanwar

Abstract The modelling of an industrial baking plant is discussed in this work with the goal of analysing its reliability and its mean time to system failure. The authors obtained a forecast of the reliability of the production line by evaluating subsystems and apparatus to identify the production capabilities and weak areas of a sophisticated high-tech food manufacturing facility. A complicated reliability block diagram (RBD) of the production site has been constructed from components and operating processes in this context. In this paper, various reliability parameters have been computed to investigate the performance of an industrial bakery plant. A model depicting the working process of the plant consisting of 13 components is developed. The model is then formulated and solved using the algebra of logic and expressions for reliability parameters are evaluated using Boolean function technique. The reliability of the whole system has been observed when the failure rate follows the Weibull distribution and exponential distribution. Also, MTTF, i.e. mean time to failure, which is considered as an important reliability parameter has been computed using numerical examples. The goal of the analysis is to develop a plan for implementing and improving the design and machineries arrangement. This enables the production lines to run more efficiently. This methodology might resolve the reliability-related issues in the food processing industries. This method is used to avoid the issue of complex calculations in reliability analysis which can be found in techniques like SVT and RPT.

Keywords Bakery plant · Reliability · MTTF · Exponential distribution · Weibull distribution · Boolean function technique

1 Introduction

Reliability is an important factor for any industry but has a huge impact on the food industry as it directly impacts the lives of people. The quality of the food product

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matters the most, and it can be hampered if there are stoppages in the system due to failed components. Thus, much research is done on RAM analysis on different food production lines. Tsarouhas [1] implemented TPM technique on a pizza production line. They worked to achieve a safe environment for work and to attain good quality. Tsarouhas [2] made predictions for maintenance and planning using year-old data from an ice-cream plant. Sharma et al. [3] implemented BFT technique to analyse the performance of a juice packaging production line. Also, Tsarouhas et al. [4] implemented a statistical method on a juice bottling plant to carry out the RAM analysis based on the 45 months data. Bertocci et al. [5] implemented an RDB (reliability block diagram) method on the bakery production line to improve the design and arrangement of the system. One of the most crucial sectors in the food industry is the dairy sector and Tsarouhas and Arvanitoyannis [6] implemented a series of trend and correlation tests to carry out the RAM analysis. Tsarouhas [7] reviewed the RAM analysis and evaluated critical points of a food production line to improve the performance and maintenance by identifying the areas which need work.

Iqbal & Uduman [8] analysed reliability of a paper plant using Boolean function and fuzzy logic. Adhikary et al. [9] implemented trend and correlation tests and Pareto analysis on a power plant line that uses coal as an energy factor in East India to carry out the RAM analysis and to plan and organize maintenance programs based on the results. Ahmad et al. [10] implemented various mathematical and statistical methods such as RBD, Markov process, simulation methods and fault tree method to formulate a model on a network of the communication system for reliability analysis. Agarwal et al. [11] implemented SVT (supplementary variable technique) to enhance the reliability of a cold standby system with redundant components. Sharma et al. [12] implemented the Boolean algebra method to formulate a model of a telecommunication line. The system has redundant components. Chandra et al. [13] worked on assessing the reliability of a metal sheet manufacturing plant by formulating a multi-state model using ANN technique.

2 Material and Methods

In this paper, the case study of a bakery plant is considered for analysis of reliability. To evaluate various reliability factors in the automated bakery production line, the Boolean function technique has been applied [14]. The focus is kept on the cooling and freezing process of the plant as the inadequate temperature can lead to microbiological spoilage of the products.

The Bakery Production Cycle

The bakery plant under consideration has been subdivided into 13 different subunits as shown in Fig. 1. The first stage in the cycle is the mixing stage. It involves mixing the ingredients to prepare the dough. The prepared bulk dough is then divided into smaller fixed-weight pieces which are made to pass through a conveyor belt towards

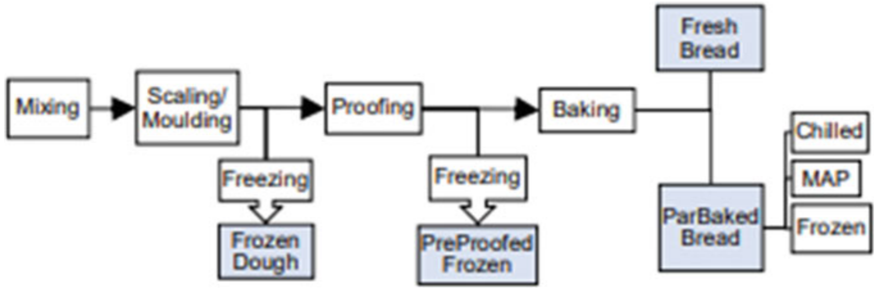

Fig. 1 The bakery production line

the next stage, i.e. the moulding/scaling stage. After the moulding stage, the process is divided into four parts which are described below. Part 1: Fig. 1 shows that in the next stage, the process is interrupted to freeze the moulded loaves before the proofing stage. This alternative process is called the frozen dough process, and a retarder is used to freeze the loaves as it controls the fermentation of yeast. Part 2: The next step in this part is the proofing stage where yeast is activated in the moulded dough. A dough proofer which is a warming chamber is used for this purpose. The proofed dough pieces are then allowed to cool down till they reach the temperature of 10°C. The next step in the production is the frozen dough process which is already described in Part 1. Part 3: The proofed dough is then baked using industrial convection ovens which release dry heat continuously. From this stage, the loaves can either be distributed commercially. Part 4: The par-baked product is then swiftly sent for storage. The par-baked product can be stored in three different ways. The first way is to refrigerate the product as refrigeration lessens the actions of the yeast. The temperature for refrigerating the product is kept from around 0 °C to 4 °C. The second way to store is to freeze the product using blast freezers by setting it around −40 °C. The third way is to use the MAP (modified atmosphere packaging) method for storing the baked products.

The 13 subunits are denoted as υ_i, where $i = 1, 2, \ldots, 13$ in the bakery production line under consideration. The symbolic diagram depicting the process is shown in Fig. 2.

3 Assumptions

The assumptions before initializing the computations are:

1. The entire system is in workable condition at the initial stage.
2. Repair facility is unavailable.
3. Each component is either in an operating state or in a failed state.
4. Each component's reliability is known beforehand.
5. The state is statistically independent for each component.

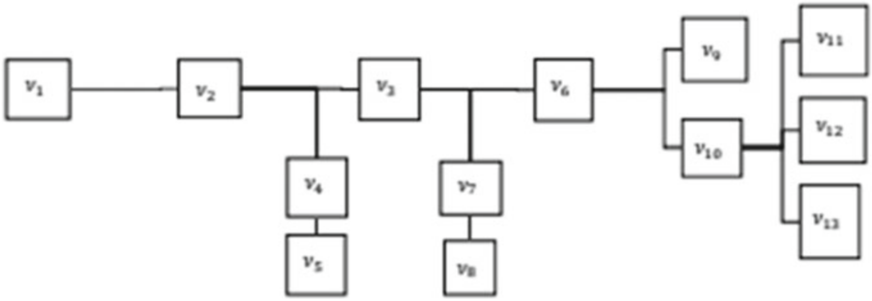

Fig. 2 The systematic configuration of the bakery plant

6. For all the components, the failure time is random.

3.1 Mathematical Symbols Used

ν_1: mixing stage
ν_2: scaling/moulding stage
ν_3: proofing stage
ν_4, ν_7: freezing stage
ν_5, ν_8: frozen and pre-proofed dough, respectively
ν_6: baking stage
ν_9: fresh bread
ν_{10}: par-baked stage
ν_{11}, ν_{12}, ν_{13}: chilled, MAP, frozen stages, respectively
||: logical matrix representation
$\wedge$: logical AND
$\nu_i (i = 1, 2, \ldots, 13)$: value is 1 when the component is in a good state and 0 when the component is in a bad state
ν_i': negation for ν_i, $i = 1, 2, \ldots, 13$
$\mathcal{R}_{\mathrm{i}}$: reliability of the ith component, where $i = 1, 2, \ldots, 13$
Q_i: unreliability of the ith component, where $i = 1, 2, \ldots, 13$
$\mathcal{R}_{system}$: reliability of the whole system
$\mathcal{R}_{\mathrm{SW}}$: reliability of the entire plant when failure rate follows Weibull distribution
$\mathcal{R}_{\mathrm{SE}}$: reliability of the entire plant when failure rate follows exponential distribution.

3.2 Mathematical Model Formulation

Using BFT, the working condition for the effective functioning of the bakery plant has been formulated in terms of the logical matrix as,

$$F(\nu_1, \nu_2, \ldots, \nu_{13}) = \begin{vmatrix} \nu_1 & \nu_2 & \nu_4 & \nu_5 & & \\ \nu_1 & \nu_2 & \nu_3 & \nu_7 & \nu_8 & \\ \nu_1 & \nu_2 & \nu_3 & \nu_6 & \nu_9 & \\ \nu_1 & \nu_2 & \nu_3 & \nu_6 & \nu_{10} & \nu_{11} \\ \nu_1 & \nu_2 & \nu_3 & \nu_6 & \nu_{10} & \nu_{12} \\ \nu_1 & \nu_2 & \nu_3 & \nu_6 & \nu_{10} & \nu_{13} \end{vmatrix} \tag{1}$$

3.3 Solution of the Model

Using algebra of logics, Eq. (1) is expressed as

$$F(\nu_1, \nu_2, \ldots, \nu_{13}) = \nu_1 \wedge \nu_2 \wedge \delta(\nu_3, \nu_4, \ldots, \nu_{13}) \tag{2}$$

where

$$\delta(\nu_3, \nu_4, \ldots, \nu_{13}) = \begin{vmatrix} \nu_4 & \nu_5 & & \\ \nu_3 & \nu_7 & \nu_8 & \\ \nu_3 & \nu_6 & \nu_9 & \\ \nu_3 & \nu_6 & \nu_{10} & \nu_{11} \\ \nu_3 & \nu_6 & \nu_{10} & \nu_{12} \\ \nu_3 & \nu_6 & \nu_{10} & \nu_{13} \end{vmatrix} = \begin{vmatrix} K_1 \\ K_2 \\ K_3 \\ K_4 \\ K_5 \\ K_6 \end{vmatrix} \tag{3}$$

Using the Orthogonalization algorithm, Eq. (3) may be expressed as

$$F(\nu_1, \nu_2, \ldots, \nu_{13}) = \left| \begin{array}{l} v_1\ v_2\ v_4\ v_5 \\ v_1\ v_2\ v_4'\ v_3\ v_7\ v_8 \\ v_1\ v_2\ v_4\ v_5'\ v_3\ v_7\ v_8 \\ v_1\ v_2\ v_4'\ v_3\ v_7'\ v_6\ v_9 \\ v_1\ v_2\ v_4'\ v_3\ v_7\ v_8'\ v_6\ v_9 \\ v_1\ v_2\ v_4\ v_5'\ v_3\ v_7'\ v_6\ v_9 \\ v_1\ v_2\ v_4\ v_5'\ v_3\ v_7\ v_8'\ v_6\ v_9 \\ v_1\ v_2\ v_4'\ v_3\ v_7'\ v_6\ v_9'\ v_{10}\ v_{11} \\ v_1\ v_2\ v_4'\ v_3\ v_7\ v_8'\ v_6\ v_9'\ v_{10}\ v_{11} \\ v_1\ v_2\ v_4\ v_5'\ v_3\ v_7'\ v_6\ v_9'\ v_{10}\ v_{11} \\ v_1\ v_2\ v_4\ v_5'\ v_3\ v_7\ v_8'\ v_6\ v_9'\ v_{10}\ v_{11} \\ v_1\ v_2\ v_4'\ v_3\ v_7'\ v_6\ v_9'\ v_{10}\ v_{11}'\ v_{12} \\ v_1\ v_2\ v_4'\ v_3\ v_7\ v_8'\ v_6\ v_9'\ v_{10}\ v_{11}'\ v_{12} \\ v_1\ v_2\ v_4\ v_5'\ v_3\ v_6\ v_{10}\ v_{11}'\ v_{12} \\ v_1\ v_2\ v_4\ v_5'\ v_3\ v_7'\ v_6\ v_9'\ v_{10}\ v_{11}'\ v_{12} \\ v_1\ v_2\ v_4\ v_5'\ v_3\ v_7\ v_8'\ v_6\ v_9'\ v_{10}\ v_{11}'\ v_{12} \\ v_1\ v_2\ v_4'\ v_3\ v_7'\ v_6\ v_9'\ v_{10}\ v_{12}'\ v_{13} \\ v_1\ v_2\ v_4'\ v_3\ v_7\ v_8'\ v_6\ v_9'\ v_{10}\ v_{12}'\ v_{13} \\ v_1\ v_2\ v_4\ v_5'\ v_3\ v_7'\ v_6\ v_9'\ v_{10}\ v_{12}'\ v_{13} \\ v_1\ v_2\ v_4\ v_5'\ v_3\ v_7\ v_8'\ v_6\ v_9'\ v_{10}\ v_{12}'\ v_{13} \end{array} \right| \tag{4}$$

3.4 Some Particular Cases

Case 1: When the reliability of each component is same and equal to $\mathscr{R}$.

Then.

$$\mathcal{R}_{\text{system}} = \mathcal{R}^4 + 2\mathcal{R}^5 + 3\mathcal{R}^6 - 7\mathcal{R}^7 - 6\mathcal{R}^8 + 12\mathcal{R}^9 - \mathcal{R}^{10} - 5\mathcal{R}^{11} + 2\mathcal{R}^{12} \tag{5}$$

Case 2: *When the failure rate follows Weibull Distribution.*

In this case, let H_i be the failure rate for the ith component of the system, where $i = 1, 2, \ldots, 13$. Thus, when H_i follows the Weibull distribution, the system's reliability at moment t is provided by,

$$\mathcal{R}_{\mathrm{SW}}(\mathrm{t}) = \sum_{\mathrm{j}=1}^{93} \exp\left(-\alpha_{\mathrm{j}} \mathrm{t}^{\mathrm{p}}\right) - \sum_{\mathrm{n}=1}^{92} \exp(-\beta_{\mathrm{n}} \mathrm{t}^{\mathrm{p}}) \text{ where } \mathrm{p} > 0 \tag{6}$$

Case 3: When failure rate follows exponential distribution (constant failure rate).

In this case, by substituting $p = 1$ in Eq. (9), we get the system's reliability at the moment t by.

$$\mathcal{R}_{\text{SE}}(\text{t}) = \sum_{\text{j}=1}^{93} \exp(-\alpha_{\text{j}}\text{t}) - \sum_{\text{n}=1}^{92} \exp(-\beta_{\text{n}}\text{t}) \tag{7}$$

Another important reliability parameter, mean time to failure denoted as MTTF is expressed as,

$$\text{MTTF} = \int_0^\infty \mathcal{R}_{\text{SE}}(\text{t})\text{dt} = \sum_{\text{j}=1}^{93}\left[\frac{1}{\alpha_{\text{j}}}\right] - \sum_{\text{n}=1}^{92}\left[\frac{1}{\beta_{\text{n}}}\right] \tag{8}$$

3.5 *Numerical Examples*

(1) Let the failure rate $\text{H}_i = 0.01$ for all $i = 1, 2, \ldots, 13$ and $p = 2$ in Eq. (9), we get the reliability of the system as

$$\mathcal{R}_{\text{SW}}(\text{t}) = e^{-0.04t^2} + 2e^{-0.05t^2} + 3e^{-0.06t^2} - 7e^{-0.07t^2} - 6e^{-0.08t^2} + 12e^{-0.09t^2} - e^{-0.1t^2} - 5e^{-0.11t^2} + e^{-0.12t^2} \tag{9}$$

Now, let the failure rate $\text{H}_i = 0.01$ for all $i = 1, 2, \ldots, 13$ in Eq. (10), we get the reliability of the system as (Figs. 3 and 4).

$$\mathcal{R}_{\text{SE}}(\text{t}) = e^{-0.04t} + 2e^{-0.05t} + 3e^{-0.06t} - 7e^{-0.07t} - 6e^{-0.08t} + 12e^{-0.09t} - e^{-0.1t} - 5e^{-0.11t} + e^{-0.12t} \tag{10}$$

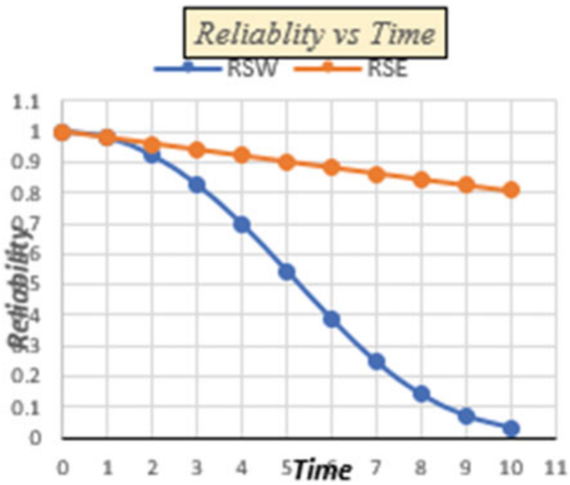

Fig. 3 Reliability vs time

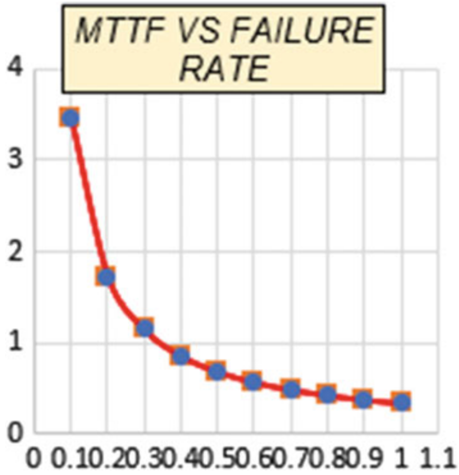

Fig. 4 MTTF vs failure rate graph

3.6 *Cost Analysis*

If S1 is revenue cost per unit time and S2 is the service cost per unit time, then expected cost can be obtained by (Fig. 5).

$$S(t) = S_1 \int_0^t \mathcal{R}(\mathrm{t})\mathrm{dt} - \mathrm{S}_2\mathrm{t} \tag{11}$$

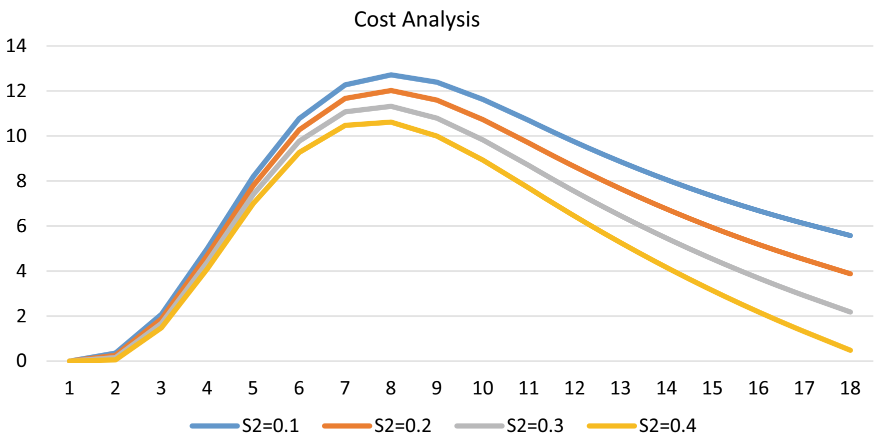

Fig. 5 Cost analysis graph

4 Results and Discussion

In this paper, various reliability parameters using the Boolean function technique have been determined after analysing the process of the bakery plant under consideration. A few examples were also taken to understand the behavioural pattern of reliability and its parameters in different circumstances. If the initial two stages of the system, i.e. the mixing stage and the moulding stage, fails, the whole system will fail.

From Fig. 1, it has been observed that reliability decreases with time as the components fail. The decreasing rate is less when the failures follow exponential distribution, while reliability decreases drastically when failure follows Weibull distribution.

From Fig. 2, it has been observed that in the beginning, the MTTF decreases gradually as the failure rate increases, but with time, as the failure increases, MTTF decreases vaguely.

5 Conclusion and Future Scope

In this paper, it has been observed that redundant arrangements may improve the functioning of the whole system. Due to the unavailability of a repair facility for the considered bakery plant, the Boolean function technique has been applied. When failure rate follows exponential distribution and Weibull distribution. To achieve the aim of the system's reliability in a continuous manner can be a huge task, and this issue seemed to resolve in this study. In this globalized world, machines and machine learning have huge importance. The components of a machine count completely on reliability analysis and to attain optimal reliability, a machine is required to suffer minimum failures within a specific period. The traditional methods of statistics may be unsuitable to find the reliability analysis, while the techniques involving mathematical models and optimization methods facilitate the accomplishment of the goal of reliability using a cost-effective way. Also, the traditional methods demand a huge sample size which further requires higher costs and more time. Unpredictability is a huge factor in failure analysis, and the complexity of the systems can make the issues more complex, but these can be resolved using analytical methods such as the BFT, simulation methods and Markov chain models. Further analysis of the most critical subunits will be planned to understand if and how it is possible to isolate the failure causes and limit the stops to continue our research activity for this real-world industrial case.

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Design and Implementation of Women Safety Smart Gadget Using IoT

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Abstract Everywhere it is said or considered as the common concept, i.e., women harassments. These kind of crimes are hitting the peak highs these days in the states, where women's as well as their parents are also feeling unsafe and insecure to stay or lead their lives in such place; also, they lack enough confidence to send their daughters for workplace, schools, and colleges. Even the actions which has to be done by law are stepping back due to the lack of clear or solid evidence in favor of the victim against the culprits. Henceforth, on considering all these thoughts in mind, we are stepping forward with the support of technical way which can be also mentioned as wireless communication, where a woman can secure herself also seek for the quicker recue from her surroundings or by nearby police station. In this work, one can proceed to the advance of an IoT device with the help of Android application that can turn safer moment of women. By which, women can have ultimate safety support just on pressing a single emergency switch/button of the device which will be sending the location of her to the nearby rescue team with the help of this device. The main advantage of the device is that it can be functioned in both online and offline mode. Suppose in absence of availability of Internet, the victim will still has the accessibility on the device to reach out the nearby cop's box and any volunteer support around there. A device designed with the help of Raspberry Pi, GPS, Bluetooth, GSM, etc. On combination of these, modules mutually offer the device to be more reasonable as well as ease to navigate.

Keywords IoT device · Raspberry Pi · Self-designed circuitry · Smart device · Smart gadgets

1 Introduction

Everyone is aware that women still undergoes unsafe incidents such as rape, acid attack, and molestation, which is creating fear to come out of their places at any

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period and neither they can wear the clothes as per their will. Presently, more devices and applications are existing in market, but they are ineffective. In practice, it is very difficult to operate manually when women are in danger conditions. Hence, one has to execute the solution without effort of human to operate the device. Due to the reasons mentioned above, it is quite natural that there is an aspiring need for the women safety and protection in the city [1]. The physical devices are connected in IoT through Internet [2, 3].

2 Present System

Few developers come up with some dynamic applications which will help different way in society. Free apps are designed to send message to police control and to family members. In the present scenario, different vendors developed a lot of modules for women safety issues. But our proposed smart device will have more advantages in low cost, reliability, and ease of use in comparing with existing modules.

2.1 Society Harnessing Equipment (SHE)

This is an embedded system with smart electronic device, in which it consists of internal electric circuit which generates around 3800 kV that will help women to escape, and also, it can transmit around 80 electric shocks, in case of the multiple attacks [4].

2.2 International Law Association (ILA) Security

This system has been designed by its co-founders, where particularly, three private alarms will shock and astray or disorient the active attackers, hence, guarded the women-victim from precarious conditions.

2.3 Adv-Electronics System for Women Safety (AESWS)

The live location of the victim can be tracked from where and when the attack is made on using the GPS facility with the help of this device. Even if necessary, the video of one minute can be recorded and sent to be more clear with the location of the victim, seeking for the rescue.

2.4 VithU App

An emergency app has been initiated on considering the TV crime series "Gumrah" aired on the Channel-[V]; to be more accurate, we are using this series as an example. On pressing the button (power) of smart device twice consequently or on holding long, the device starts to send the alert messages, along with the link by which user location to the contacts mentioned for every two minutes.

2.5 Smart Belt

The system can be designed in such a way that which acts as a portable device resembling the normal belt that the device consisting of Arduino Board, pressure sensors, body temperature sensor and screaming buzzer. Automatically, device will be activated once the pressure sensor threshold crosses, and the screaming alarm unit gets activated, and sirens will be sent on seeking for the help [5].

2.6 Pulse Rate Sensor

The LED flashes for every heartbeat when the heartbeat is detected by the detector that is how the heartbeat sensor gives the output in the digital form. If there is a variation in the heartbeat suddenly, it will inform to device. Four bands of frequencies are used to detect heartbeat with the range of 1.2 to 1.6 GHz.

2.7 GSM Module

The main cause of this module is to transmit the collected data to base unit from control section. The GSM module can be used to operate at the range of frequency 900 MHz [6, 7]. The module consists of uplink band ranging from 890 to 915 MHz and downlink band ranging from 935 to 960 MHz. In such way, the GSM module leads the advantages of FDMA as well as TDMA. In FDMA with channel spacing of 200 kHz, 124 carriers will be used, whereas in TDMA, each of the carriers had split into eight time slots.

2.8 Dual-Technology Motion Sensor

Detection of moving objects can be named as a motion sensor which forms a vital component of security. This is embedded into system to alert the victims in the prescribe area.

2.9 BLE (Bluetooth Low Energy)

It is a low-power short-range device, designed to inter-connect smart devices. Because of low power of 1000mAh, it has been used for audio and high data [8, 9].

2.10 Temperature Sensor

This is utilized to measure and monitor the temperature of the victim. The specification of this sensor is LM35 series and operates +10.0 mV/°C with accuracy of 0.5 °C. In critical condition or emergency case of victim, the body temperature will varied drastically, in that case, module will trigger to rescue the victim.

2.11 GPS Module

This is the basic module to measure the location of the victim with very fast response time. It determines latitude and longitude of module. Then, by the help of Google app, the combination of measured longitude and latitude are converted to URL.

3 Proposed Model

Figure 1 illustrates the smart wearable phone that connected to a smart-band via Bluetooth low energy (BLE). Figure 2 explains overall block diagram of smart band module. Through a specially designed application, the device communicates with a smartphone which will further interface between the phone and the device. The smart band will directs the data, i.e., body temperature along with the motion sensor, pulse rate so that the body can be continuously monitored through the application that will be preinstalled in the smart phone [10, 11].

The app guides the smart device to do the tasks as mentioned below that takes place in case of abuse or crime:

- Family member will be receiving the sent message from the victim.

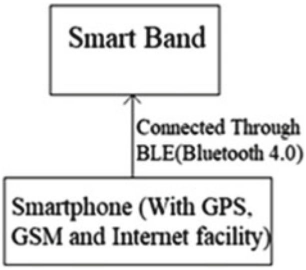

Fig. 1 Main block diagram

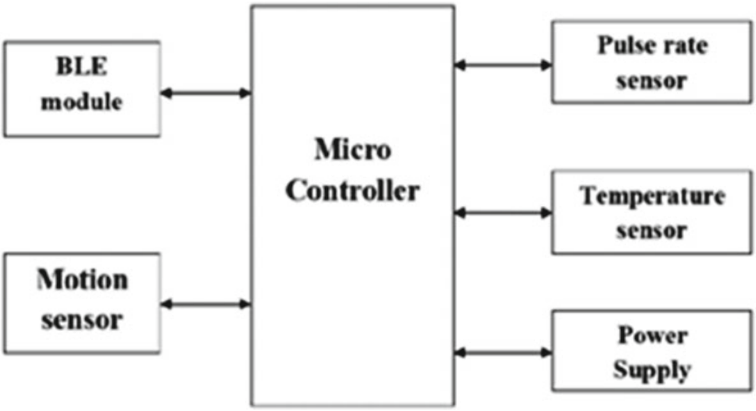

Fig. 2 Smart band module

- They will be receiving the location through telegram, SMS and email, and also, the device starts to record the video of 1 min for more clear proof.
- Police control room (nearest) will be also alerted by the co-ordinates requesting for the instant action.
- Also directs information to people nearby it.

Social platform can be provided through this app where the folks who have installed this particular app will be notified simultaneously so that those too can be acted as helpful hand in protecting the victim on time. On using the Internet facilities, this feature can be initiated effectively by the user. The GPS receiver and the unique information from the smart wrist unit will be collected by the control unit where further GSM module will be sending all message to the base station [12, 13].

4 Software Algorithm

There are few steps to trigger the wearable device when unusual actions of the victim are detected [14, 15]. The decision of wearable smart device is executed by output of different sensors embedded in it, which is as shown in Fig. 3.

Step 1: GPS module should be triggered once pins of transmitter and receiver are assigned.

Step 2: Bit rate and baud rate of the serial buffer should set to 4800 and 9600, respectively.

Step 3: Trigger the loop for the following action to be taken.

- Mobile number should be scanned from SIM.
- Calculate location by GPS unit.
- Translate latitude and longitude from GPS unit into Google URL.
- Combine this URL with standard messages.
- Transmit this combined information to preloaded emergency numbers, until reset of device takes place.

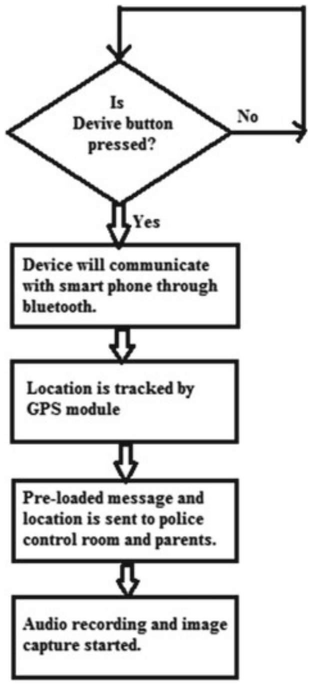

Fig. 3 Proposed work algorithm

5 Advantages

- On considering the women safety, this smart device is made more tiny and reliable with fast response time.
- A device will be providing immediate action in several kinds of critical conditions in such a way that women can seek for help on one simple pulling action.
- It is having the feature of offering instantaneous and correct position-based location via SMS, short message service, so that police and parents can track the her location.
- Run-time battery life durability of smart device is of 72 h, so no problem with backup battery.
- Smart device possesses high-rate connectivity with smart phone and with coverage range similar to Bluetooth which is approximately 5feet. So it is a high response application.

This application is also extended to catch chain snappers in zero traffic roads as well as in remote places of city.

6 Conclusion

The proposed work in this paper will describe how the woman in critical condition protects herself by using our smart wearable device with the fastest response time. The smart wearable device will embedded by GPS, GSM and many precision sensors. The GPS is main unit to calculate the location of victim, and after locating, it has to be converted into Google URL. Finally, it sends combined URL with preloaded message to ICE control and guardians. The entire proposed work will perform the real-time monitoring of location and detect violence with very good accuracy. The proposed device can be carried into purse or bag; in the future, it is made wearable too.

7 Future Aspects

The device can undergo for more features such as:

- Developed app can be downloaded from the Google Play Store, which will help in many kinds of security aspects.
- Suppose in switch-off condition of smart device, the process will be completed by our downloaded app, with the coverage area of 1 km.

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A Gamified Mathematics Module Using Selection and Sorting Algorithm for Learning Number System

Garvitraj Pandey, Tanya Singh, Maria Jude Praneet, Yash Darra, and Sudhanshu Gonge

Abstract Mathematics is one of the most important disciplines of science. Although science helps us perceive the world around us and deduce the same into a set of equations, Mathematics is what helps us understand this science. Implementing the mathematics and number theory concept in coding and computing is an important aspect in science and technology. Due to the current pandemic situation, there is no proper interaction between the student and teacher. To resolve such kinds of issues, there is a need for the proper interactive educational module. In this research work, the paper explains the gamification framework, and its time and space complexity of calculating and reflecting correct and accurate information to the students. This system work on reducing the learning gap between the student and their learning curriculum. There are different types of time and space complexity based on different types of algorithms. This paper explains the design and analysis of algorithms based on gamification framework implemented for the number system related to mathematics using selection and sorting algorithm. However, the different types of complexity are computed for various numbers by making interactive gamified platforms. This system also helps student for understanding and providing the accurate information of numbers as explained in the proposed system.

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1 Introduction

'Game' is the word which brings happiness to the face of every pupil, and 'study' brings out the opposite reaction. But when these two words combine to form a term like education games or study game, things change drastically. Gamification or game-based-learning, which is the way that makes teaching and learning effective [1]. Studies have shown that effective teaching and learning methodologies increase the teacher–students' interaction and make the learning process more productive than in a conventional approach [2]. Learning new concepts becomes easy when taught with the perfect pedagogy and proper interaction between teacher and students [3]. During the last two decades, the use of technology has grown immensely especially for the education sector [4]. The recent rise of research and consumer-related applications in the field of AR–VR and smart devices is enhancing software–user interaction and ultimately providing a great opportunity to implement an effective technology-based learning pedagogy [5, 6]. The core subject like mathematics which forms the basis of their entire education of the child needs to be given extra focus and attention. A perfect pedagogy and technology combination can be a boon to resolve the problems of the students in this subject [7]. The difficulty faced by the student during the coding curriculum which is adopted at the schools needs to be given attention. Such concepts of mathematics that have links with computing need to be taught in the appropriate way. As per today's scenario, there is a rapid increase in the interest of students toward computing and coding skills. Due to unavailability of proper content material, students find it difficult to surf the Internet and find the adequate solution to their desired problem. At the learning stage, the students are not aware of the different approaches and algorithms used to solve the same problem in different aspects. So there is a need for the module which not only imparts knowledge but keeps students engaged in learning curriculum. The shift to a new methodology from the old conventional-based approach imparts real motivation to the student to keep him engaged in learning new things regularly and enhance their knowledge. The adoption of new techniques to make students learn the flow of the program, and its design will be very much effective through gamification pedagogy [8]. Over time, the perception of people thinking of the games as a waste of time has been changed by the introduction of learning and educational-based games. There are numerous interactive ways to learn and implement the coding culture in students through a perfect educational module [9]. There has been a sudden increase in the implementation of the games in the education sector, teaching pedagogy and applying the gamification idea in resource material and teaching the academic concepts with proper visualization and interactive approach over time [10].

The COVID-19 pandemic has predominantly affected public health and created fear among the people from across the globe. Thinking from the health perspective of all the people, things were stopped for the while. To keep the education and study going, there was a rapid transition to the online teaching curriculum. The student and teacher started adopting the new methodologies for teaching and learning. There was a sudden increase in the number of smart phone and Internet users, and the curriculum of online teaching was brought up [11].

To enhance the learning of the student, the concept of gamification model is applied in this research work. The framework and model applied while designing the module use the selection and sorting algorithm that gives the output based on the random choice selected by the user. Further, this research work has been utilizing the best time and space complexity constraint. It is the most important factor in terms of perfect computational design. It also provides the accurate information related to the subject through this GUI used for learning module in mathematics as compared to other algorithms based on search engine and information retrieval techniques.

2 Literature Survey

Pedagogy is defined is a method of teaching. It encompasses all the teaching strategies and approaches to the teaching and learning process. Huang et al. [12] stated that factors like learning styles, abilities, and background of students play a vital role in deciding the use of a particular teaching strategy in effective learning. Motivation and engagement for proving the two most important prerequisites for the completion of any particular task. This fact is proved due to lack of engagement and learning motivation in dropouts across different schools and colleges [13]. Bhowmik et al. [3] explained the conventional teaching methods, which have failed to grab the interest of the various mindsets of different students. Hence, the implementation of characteristics and features which draw the attention of a learner to his/her course while maintaining an engaging atmosphere is necessary to tackle the above-mentioned predicament. [14]

Gamification is defined by various researchers as the introduction of game-like elements in non-gaming scenarios or contexts. The concept of gamification is derived from serious games, and there has been developing interest for the same as the research topic. Initially, serious games were not restricted to only education but the domains of health care, public policy, strategic communication, defense education, and training. Among these applications of serious gaming, education remained to be the most popular. Although this was the situation, educational games could only provide additional assistance to the conventional teaching pedagogy [8, 15, 16].

Bhowmik et al. [3] conducted a quasi-experimental study to determine the mathematical teaching efficiency of smart devices such as iPad to analyze the effectiveness and withdraw a proper conclusion. The results obtained by both the tests were discussed separately. The statistical data obtained from study were analyzed, and it was concluded that mathematics is made easy and interactive by application of smart devices and interactive learning curriculum and the effectiveness of implementing gamification pedagogy [3, 17, 18].

Some of the common problems that are faced while making an educational game are the communication gap between technical and non-technical staff, manipulation of internal game elements by non-technical staff, relevance of the context of gamification, and effectiveness of the game. Rafael et al. [19] proposed a designing framework for education application using gamification. It was implemented with the help of UML. This helps in representing a virtual visualization of games used in education system which acts as a main functioning of the designed system [12–25]. From the survey, it is observed that the whole task of creating an educational game is divided into different elements. These elements can be considered as components of the same including acts, scenes, actions, scenarios, characters, dialogue, education challenges, and objects. Brief descriptions of the same are as follows:

1. Act: It is the basic division of the whole game which helps in forming the structure of the game. It is also placed at the topmost position of the hierarchy of elements.
2. Scene: Scene is a further subdivision of an act that allows the creator, control over the educational detailing of the game. It begins, plays out, and ends just like that of a play.
3. Action: In order to work on minute details of the scene, it is further divided into actions which are the events that occur in the game.

Scenarios, characters, educational challenges, and objects are further divisions and subdivisions of the same which aid in providing much more detail and clarity to the framework. Ultimately, all these elements work together to provide a better context to the system and also make the game more effective [23].

Gamification of education aims to tackle the two most common problems faced by students. First one is the lack of motivation toward a discipline, and second is the dullness in the course structure. It tries to do the same by adding game-like elements which make the same experience more interesting and intuitive [5]. Nowadays, the gaming community has become more popular during these days of pandemic, and the combination of digital communication and Internet technology has enhanced the scope of gamification. People from all over the world engage in multiple activities, rankings, and team-matches follow suit [10]. Bruce et al. [7] has explained the motivation and enthusiasm of communities in gamifying the educational content. They end up providing a completely different atmosphere and a redesigned outlook to simple and boring tasks. This is the aim that gamification plans to achieve. This will simply, transform the dull and mundane tasks of learning into something engaging and definitely interesting [9, 25].

López-Fernández et al. [2] has conducted a case study in Universidad Politencia de Madrid (UPM) Spain. From the study, it was concluded that the students' group who opted for the game-based learning was seen to have a moral boost up and was quite enthusiastic. This case study further proved that games-based learning is preferred over traditional teaching, and there has been an increase in students' motivation and the effectiveness of learning [26–28].

3 Proposed Work

3.1 Software Design

During designing of this GUI, the SDLC models show the ways to navigate through the complex and demanding process of software building. The quality of GUI, time-frames, budget, user-friendliness, and ability to meet the expectations of the solution required largely depend on the chosen model. However, based on proper analysis of different available models in SDLC, 'Spiral Model' is found to be perfect, advanced, and reduces the time and space complexity by providing the accurate information of the mathematics regarding number system as compared to rest of the algorithm and models found in the literature survey.

The system facilitates the easy integration, efficient development, and faster deployment with the help of SDKs toolkit used during the development of the GUI. The research work also considers the compatibility of the OS for making GUI platform independent. The Python languages along with its cross-platform libraries are used. The UI and UX part of the GUI is given extra focus to make it interactive and user-friendly for the students who are handling the application.

The affiliated institutions are to be listed directly below the names of the authors. Multiple affiliations should be marked with superscript Arabic numbers, and they should each start on a new line as shown in this document. In addition to the name of your affiliation, we would ask you to give the town and the country in which it is situated. Do not include the entire postal address. E-mail addresses should start on a new line and should be grouped per affiliation.

3.2 Flowchart

In this algorithm, the working principle of the proposed work is explained in the following steps. There are certain symbols that are used in these algorithms, viz.

i btn represents the button.
ii chk represents the check.
iii dfn represents the definition.
iv dd represents the dropdown.
v exp represents the explanation.
vi fc represents the flowchart.

1. Start.
2. Click on the gs btn to start the GUI.
3. From the List of the Grades Displayed select the desired grade by clicking on any gd btn.
4. A new screen opens which provides the options, to begin with.

5. Select the part which you want to learn from the given list of options provided by clicking on the respective btn.
6. Select the Number, which you want to learn from the dd menu.
   6.1. The Number Selected from the dd menu will be treated as an input for dfn btn, exp btn, fc btn.
   6.2. Click the dfn btn to get the definition of the selected number.
      6.2.1. The number selected from the dd menu will be treated as the input for the function attached to dfn btn.
      6.2.2. The function searches the string in the database of numbers which is predefined.
      6.2.3. Once the number is found Result is displayed on the screen.
   6.3. Click the exp btn to get the definition of the selected number.
      6.3.1. Same steps are followed from 6.2.1 to 6.2.3.
   6.4. Click the fc btn to get the definition of the selected number.
      6.4.1. Same steps are followed from 6.2.1 to 6.2.3.
7. Enter the number in the entry widget which you want to check.
   7.1. The entered number in the entry widget will be treated as an input for the function attached to the chk btn.
   7.2. When chk btn is clicked the function executes and checks the number's validity with the algorithm running at the backend.
   7.3. Display the result on the screen, if the entered number belongs to the category of the selected number or not.
8. Stop.

3.3 Flowchart

See Fig. 1.

4 Parameter for Evaluation

The main aspects of this research work are to design and develop algorithm by considering the time and space complexity. The results show that it takes low time and space complexity for the development of the number and mathematics application required for educational curriculum as discussed in the result section. It is developed with the help of different libraries set of Python for building smart GUI. This helps in providing correct required data to the student related to different number set in mathematics. The work was carried out on Windows OS with minimum requirement of 2 GB ram, 250 HDD, and Core i3 processor. It was also tested on the Linux and Unix OS for evaluating its performance. It was found that the s/w implemented using platform-independent language executes smoothly without any technical glitches with low computational time.

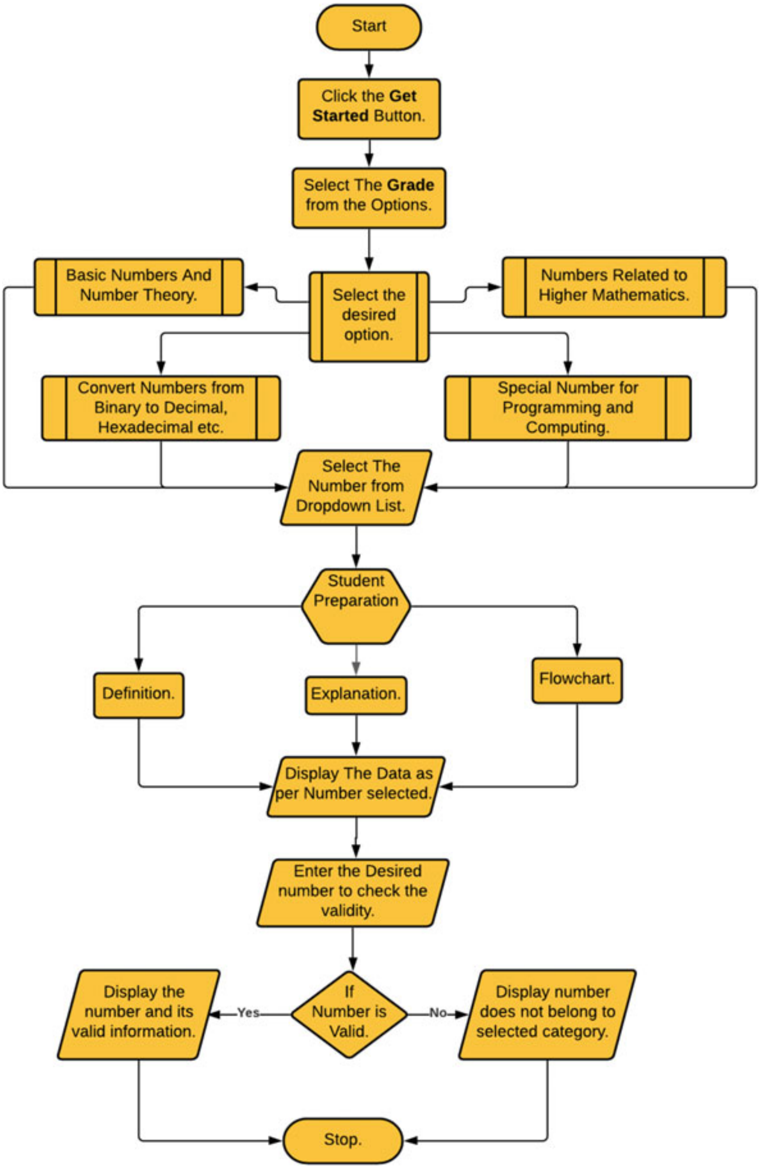

Fig. 1 Flowchart of the program

The comparative study of time and space complexity for different numbers, viz. (i) prime, (ii) even, (iii) odd, (iv) Duck, (v) automorphic, (vi) Keith, (vii) Mersenne prime, (viii) Pronic, (ix) Harshad, (x) perfect, (xi) Armstrong, (xii) palindrome, and (xiii) narcissistic, various conversions, viz. (i) decimal to binary, (ii) decimal to octal, (iii) decimal to hexadecimal, (iv) binary to decimal, (v) hexadecimal to decimal, and

(vi) octal to decimal along with some statistical functions, viz. (i) mean, (ii) median, (iii) mode, (vi) population variance, (v) standard deviation, (vi) harmonic mean and (vii) Geometric Mean is being carried out. The complete detail and working of the software structure are described in the result section.

5 Result and Discussion

The graphical representation shown in Fig. 2 explains the time complexity against different numbers present in the number set of mathematics as discussed in (parameter evaluation of section number). From the graph, it is observed that the time complexity taken by the Pronic number is found 0.025 s, which is very high as compared to that of the rest of the numbers considered in this research work. It also explains that the information regarding the Pronic number is found accurately with low time complexity using selection and sorting algorithm as compared to other algorithms used for computing time. The result obtained in this graph for the Duck number is found to be 0.00295 s which is very less than that of numbers used by GUI for computing time complexity.

However, for the rest of the numbers, time complexity varies between 0.0043 s and 0.016 s. The time complexity for even and odd number is found to be 0.00435 s because of the selection and sorting algorithm applied on the number set.

The graphical representation shown in Fig. 3 explains the time complexity of various number conversions that are included in the module as discussed in parameter evaluation. It is observed from the graph that octal to decimal number conversion takes the least time for computation, i.e., 0.00099 s as compared to other number conversion. However, decimal to hexadecimal conversion was found very high as compared to rest of number conversions discussed in the research work. The highest time complexity calculated of hexadecimal to decimal number conversion is

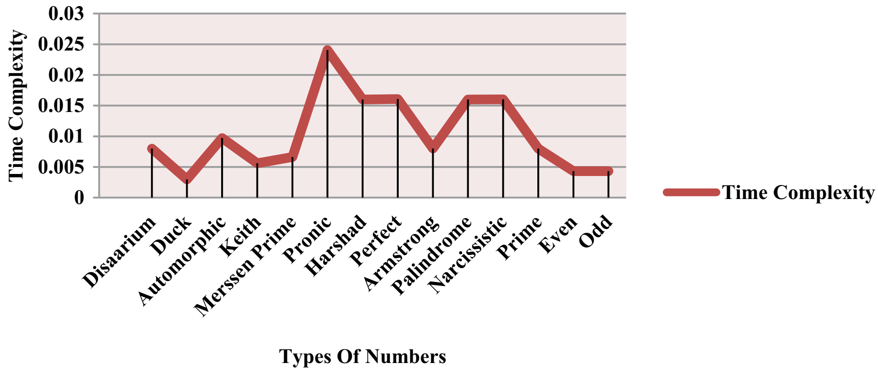

Fig. 2 Different types of number time complexity graph

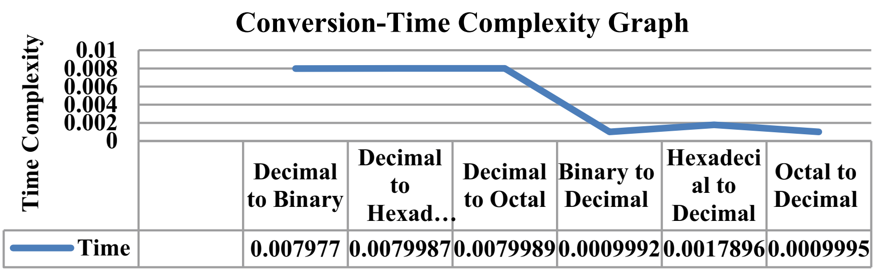

Fig. 3 Number conversion time complexity graph

0.007989 s. The graph also explains that number conversion from decimal to octal, decimal to hexadecimal, and decimal to binary found equivalent.

The graph explains binary to decimal, hexadecimal to decimal, and octal to decimal time complexity of converting number from one form to another. It is observed from the graph that the time complexity binary to decimal, hexadecimal to decimal, and octal to decimal, which is found very low as compared to that of rest of the number conversions. The graph shows conversion time complexity for hexadecimal to decimal is found slightly higher as compared to that of binary to decimal and octal to decimal number conversion.

Fig. 4 shows the time complexity taken by the software using selection and sorting algorithm. The graph represents the various function time complexity used to compute statistical functions applied in the mathematics, viz. (i) mean, (ii) median, (iii) mode, (iv) population variance, (v) standard deviation, (vi) geometric mean, and (vii) harmonic mean. It is found that time complexity for calculating the mode based

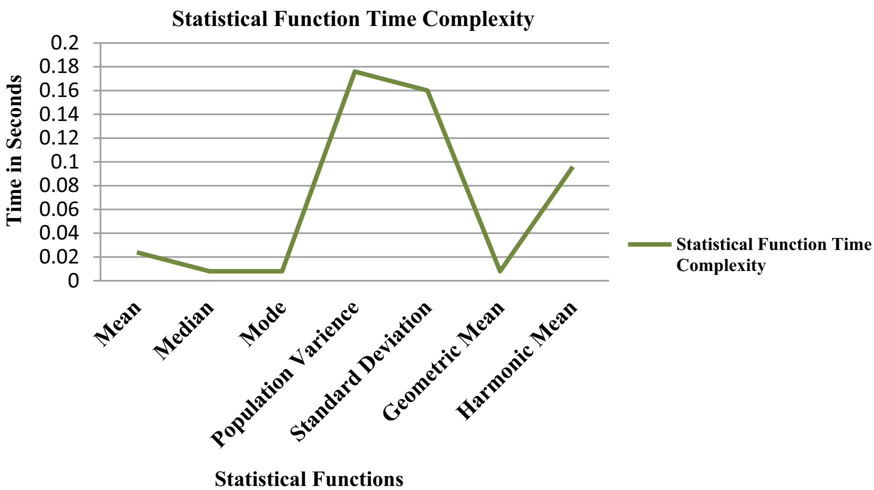

Fig. 4 Statistical function time complexity graph

on the user input is 0.0079985 s. The graph shows that mode function complexity was found to be very less as compared to that of other function considered in this research work. However, on calculation of population variance, time complexity is found to be 0.160059 s. It is also observed that the time complexity taken by the population variance function designed for computation is maximum as compared to other statistical function in mathematics. The graph depicts geometric mean calculated for the same dataset was found nearly equal to that of mode and geometric mean functions. The other statistical function considered in this work was found to have a computational time between 0.0239 s to 0.15998 s for same dataset. During this research work, it is observed that the time complexity is directly proportional to the increasing number value of the dataset.

The proper functioning of GUI was recorded during the final testing and some of the screenshot is taken to discuss its functioning. Fig. 5 shows the welcome screen with the note on the top 'Let's make math easy.' The message of the screen attracts the mind of K-12 students toward learning mathematics. This GUI is found better as compared to that of existing GUI found in survey that was used to make educational module.

After starting the GUI, the screen represents different class category of students belonging to class 6–12 as shown in Fig. 6. The Grade 6, Grade 7, Grade 8, Grade 9, Grade 10, Grade 11, and Grade 12 represent the level of different classes. As per the requirement of the student, he/she will select the grade to start their learning. This screen is provided with the illustration of the student. The caption, 'Hey! I'm in,' is specified to add a factor of immediate motivation while also making the learning scenario more relevant. The student on the selection of grade 11 (an example) moves to the third screen as shown in Fig. 7. It also represents the four different options for student to choose from, viz. (i) basic concept of number theory, (ii) conversion of numbers, (iii) numbers related to higher mathematics and (iv) special numbers used

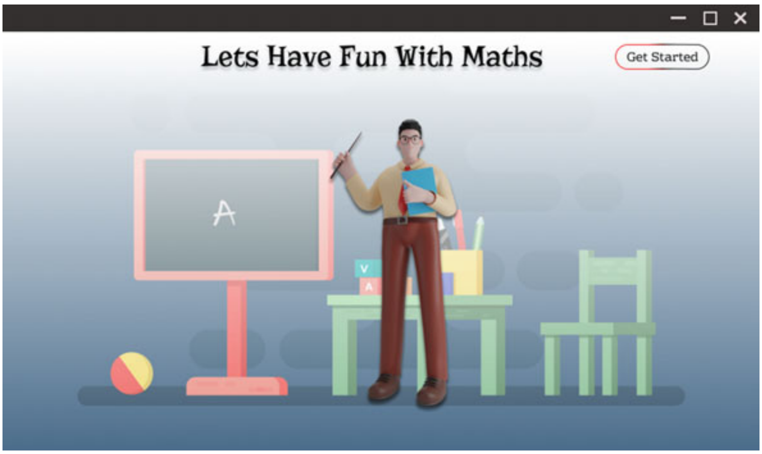

Fig. 5 Welcome screen of GUI

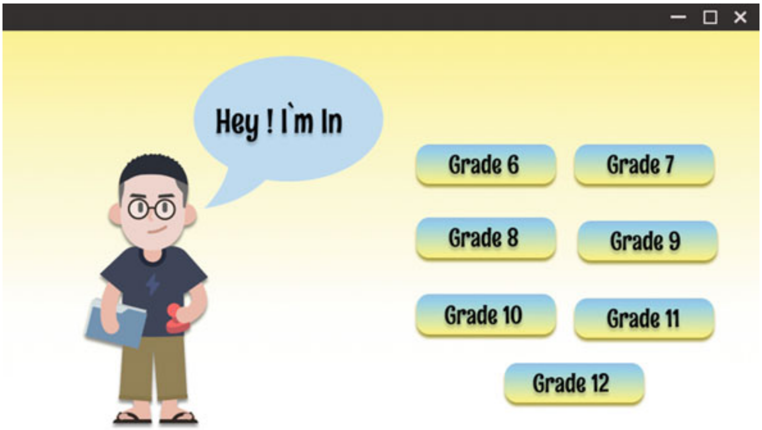

Fig. 6 Starting of app

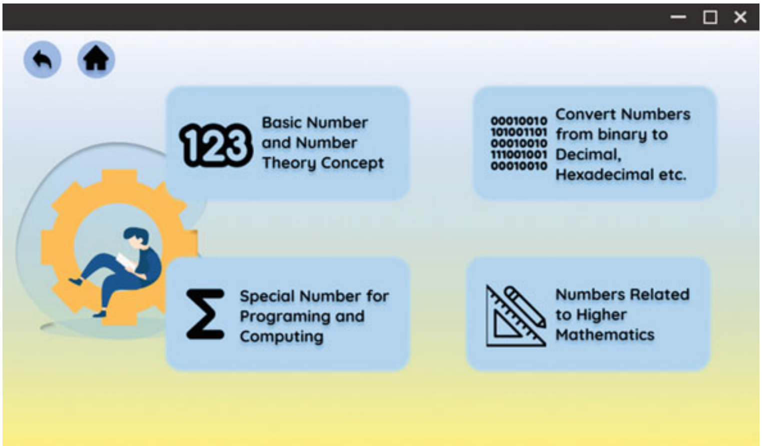

Fig. 7 Content selection page

for programming and computing for various applications. The student may click on the particular option as per his or her requirement for redirecting to new screen. Fig. 8 represents the output obtained after selecting the special umber for programming and computing button. This option redirects the student to new window where they can access the desired information of the special numbers, and it is the information used in programming applications.

The output screen as shown in Fig. 8 has a simple dropdown menu, entry widget, and check buttons. As the student selects the number from the list and clicks the definition button, it provides the definition of the number on the screen as shown in Fig. 9. A definition function is executed which takes the number selected from the

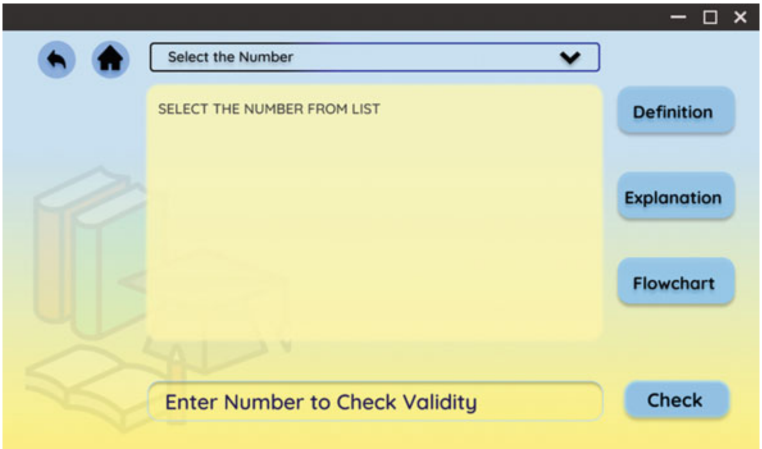

Fig. 8 Study module screen

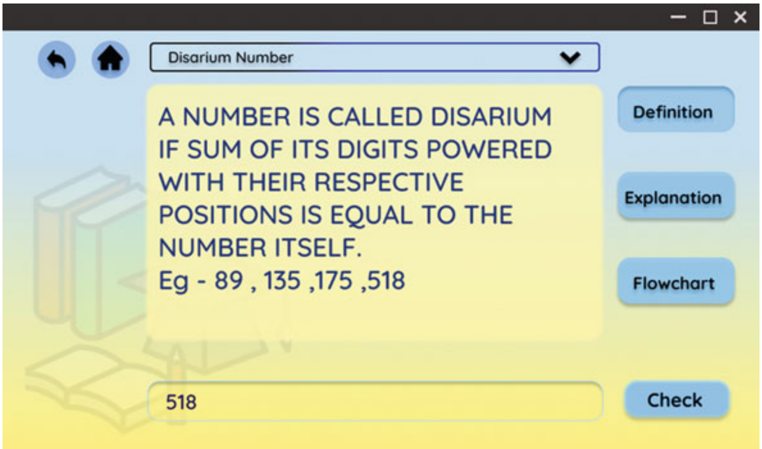

Fig. 9 Screenshot of explanation of number

menu box as an input and find its definition in the backend dataset and then display the definition of the number with the examples on the screen.

Simultaneously, students can use the other button functions such as the explanation button which when clicked takes the number selected from the list as input, and it displays the result on the screen. The third button is the flowchart button. The main purpose of this button is to display the flowchart of the particular number selected by the user. The app database has an interactive flowchart for each and every number. This helps students to get the knowledge of the flowchart and algorithm of the numbers, conversion, and other mathematical concepts. This results in enhancement of the student knowledge, which can be implemented by him or her in programming

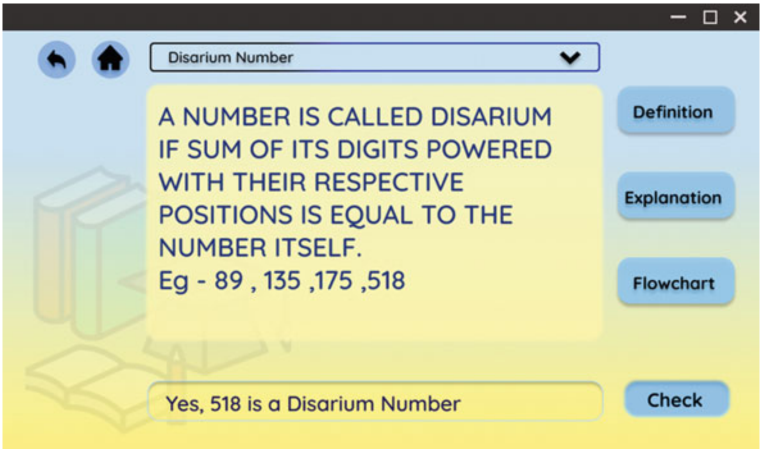

Fig. 10 Screenshot of checking validity

applications. It will become easy and enable him to get a proper understanding of that number. Student on clicking the entry widget will be able to input the numbers. On pressing the check button, it will check the entered number and provides the output on the command prompt on the display screen as shown in Fig. 10.

6 Conclusion

The paper explains about the working of selection and sorting algorithm used to find the information related to numbers and mathematics. This algorithm works in two patterns, i.e., (i) selection of number based on options and, (ii) sorting it in fraction of time before providing the desired result. The work explains the time complexity taken by the number conversion from one form to another as well as providing accurate information to the students. This application was developed for school students to fetch the mathematical information related to number system and its conversion. There are different types of number conversions such as binary to decimal, hexadecimal to decimal, octal to decimal, and vice-versa. The time complexity is calculated for this number conversion using selection and sorting algorithm. This algorithm is also used to compute the time for various statistical functions depicted in the proposed work. To understand the concept of numbers in mathematics, the gamification framework was designed for the students. This research explains implementation of app with the help of GUI library and Windows SDKs toolkit. The different properties of the app were found in form of quicker integration and faster deployment process while developing and maintaining it. The smooth functioning of GUI was observed. It also provides the property of scalability which made advancement more feasible. In further research, the other subjects like mathematical equations of physics, chemistry, etc., related to school curriculum will be carried out.

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SVM-Based Cloning and Jamming Attack Detection in IoT Sensor Networks

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Abstract Internet of things (IoT) devices are susceptible to numerous safety intimidations because of their limited features and abilities. In IoT, the wireless communications are generally shown intermittently amongst the power-limited nodes. IoT devices could certainly be seized, for instance, causing a node repetition attack. The wireless sensor network (WSN) should have an effectual, precise and reckless recognition mechanism that can perceive the occurrence of jammers and replicated nodes in the network. In this paper, support vector machine (SVM)-based cloning and jamming attack detection technique for IoT WSN is proposed. In this technique, the base station (BS) classifies nodes as cloned or normal by checking the distance measurements from the IoT devices. Simulation results have shown that the proposed SVM clone achieves high detection accuracy with reduced false positive rate and energy consumption.

Keywords Base station · SVM · IoT · WSN · Cloning · Jamming attack

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1 Introduction

IoT is a developing networking model which contains huge set of interconnected devices interact with each other to ease people-object communication. A smart city, for instance, contains numerous smart sectors like smart homes and smart hospitals that are significant IoT applications. Every IoT device is fortified with integral sensors and wireless communication abilities in a smart home situation. The sensors can collect data about the atmosphere and communicate with one another, along with the owner of the house and a principal monitoring system [1]. Numerous IoT arrangements have developed in maturity. While energy outlay is dangerous for the entire network lifespan, these devices also encounter difficult radio surroundings, persuading radio links of extremely changing abilities. These supposed Low power Lossy Networks (LLNs) profit from a huge variability of resolutions to fill the necessities of the end uses. Physical transmissions, medium access control and routing permit the organized devices to notify a base station that gathers, stores and processes the received data [2].

IoT devices are susceptible to numerous safety intimidations because of their limited features and abilities. Effectual fortification of data safety under the malevolent jamming attack is an essential, yet challenging concern. In IoT, the wireless communications are generally made intermittently amongst the power-limited nodes [3]. IoT devices could certainly be seized, for instance, ensuing in a node repetition attack (also called as a clone attack). A clone attack is tremendously destructive as it will be taken into account as genuine devices for clones with genuine identifications. These kinds of clones can hence easily do numerous malevolent deeds in the network by deploying an internal attack and inserting false data causing IoT situation dangers [4, 5].

In this paper, SVM-based cloning and jamming attack detection technique for IoT WSN is proposed.

1.1 *Proposed Contributions of the Work*

The contributions of the proposed cloning and jamming attack detection are listed as follows:

i. A monitoring node is selected from a set of nodes in the network, based on the probability distribution of sensor nodes.
ii. The BS determines the coordinates of the nodes from their pairwise distances.
iii. The BS periodically executes the SVM algorithm to detect the clone attack based on the measured distance and a distortion threshold value.
iv. In order to avoid false positives, the classified nodes are again cross-validated by the monitoring nodes to confirm the clone attack.

2 Related Works

Verma et al. [6] have examined the result of numerous routing attacks on the WPAN network. It can be decided from the experimental outcomes that routing attacks disturb network output seriously. Therefore, the augmenting attacks targeted on the IoT network may affect the entire network of smart devices. They have designed a defence system that perceives the all the routing attacks. Lee et al. [7] have suggested MDS clone, a new clone recognition technique based on multidimensional scaling (MDS). It seems to be splendidly suitable to IoT situations, as it (i) perceives clones deprived of the necessity to lookup the locations of nodes, and (ii) unlike earlier approaches, it can be used in hybrid networks that encompass both static and mobile nodes, for which no movement design may be presumed a priori.

Laguduva et al. [8] have familiarized an effectual ML-based method for cloning strong PUFs. They also presented a new discriminator model to recognize cloned and original PUFs with a great degree of self-assurance. They also presented a search-based method for recognizing the ideal model for a specified cloned PUF by means of three common ML models. Tedeschi et al. [9] have familiarized a new end-to-end security design method to handle safety concerns when improving manufacture devices with IoT connectivity to bring real-time situation observing for legacy production devices. The method takes into account finest practice and guidelines to express a novel domain-specific method, contributing to connecting the gap amid familiarizing IoT connectivity at the shop floor and protecting system and operational integrity. Rausch et al. [10] have offered a peer-to-peer method to perceive and restrict such opponents by forcing the topology of the mesh network. In doing so, they have done three chief aids. Initially, they offered visions from an introductory execution on an IoT platform utilised in real smart metre placements. Next, they suggested an ideal selection of peers that can aid to perceive a jammed node, while reducing the hazards.

Haseeb et al. [11] implemented a data protection framework in mobile IoT devices. It utilizes two functions for providing better security with reduced energy consumption. However, the performance was not analysed in a real-time environment. In [12], a hybrid approach has been used for feature selection in which an output of the filter method is used as an input of the wrapper method to enhance the classifier performance. In filter method, the candidate subset is selected according to the filter model and in the wrapper method, the filer model is evaluated using the classifier model. In this work, k-NN and RF classifiers have been used.

Srividya and Devi [13] presented an IDS based on the multi-strategic trust metrics for WSN. By using the three-trust metrics, it identifies the malicious nodes and the best path for data transmission. In AI-HydRa [14], a ML-based hybrid decision model is designed to obtain high detection accuracy with a less false positives. It combines RF and deep learning (DL) model to determine malware and benign files.

3 Proposed Solution

In this paper, SVM-based cloning and jamming attack detection solution for IoT WSN is proposed. In this work, the base station (BS) classifies nodes as cloned or normal by checking the distance measurements from the IoT devices. Initially, a monitoring node is selected from a set of nodes in the network, based on the probability distribution of sensor nodes. The BS periodically executes the SVM algorithm to detect a close attack based on the distance between the nodes and a distortion threshold values.

3.1 System Model

An IoT-based WSN is considered which consists of static and mobile nodes with BS. Each sensor measures the distance with its neighbours at each time period and transmits the details to the BS. The mobile nodes dynamically move into random l directions, since the mobility patterns of IoT nodes are unpredictable. In this article, we take into account an opponent that is able to act "clone attack". They are capable of constructing captured devices and store the genuine identifications from the captured devices inside numerous invented devices. In specific, we cope with clone attacks in which multiple affected nodes exist with the similar ID in the network.

3.2 Monitoring Probability

In this work, a monitoring node is selected for a to monitor a set of nodes. For electing the monitoring nodes, the probability distribution of sensor nodes is considered.

The probability that node a is monitored at security level l is given by

$$P(l/k) = \sum_{i=l}^{k} \binom{k}{i} p^i (1-p)^{k-i} \tag{1}$$

We describe the node degree as the number of its adjacent nodes at any time. Let m_i signifies the minimum degree of the adjacent of node N_i.

The minimum monitoring probability (MMP) confirms that each node in the network is checked at the preferred security level.

The method used by every node to define the MMP is demonstrated by the subsequent procedure.

Notations	Meaning
M_j	Node, $j = 1, 2 \ldots n$
Ne_j	Neighbours of M_j
ND_Ne_j	Node degree of Ne_j
$ND_{\min}$	Minimum node degree
l	Required security level of neighbours
$P_M^{\min}$	Minimum monitoring probability of nodes
ReqDegree	Request Degree message (request for sending the node degree from the neighbours)
RepDegree	Reply Degree message (Reply from the neighbours contains their node degree)

Algorithm – Monitoring Node Selection

1. Each node Mj broadcast a ReqDegree to Nej
2. If Ne_j receives ReqDegree, then
3. Ne_j send RepDegree to M_j
4. End if
5. If M_j receives RepDegree, then
6. Retrieves ND_Ne_j
7. Find k = Minimum(ND_Ne_j)
8. If k <=l , then
9. $P_M^{\min} = 1$
10. Else
11. $P_M^{\min}$ = Minimum(p) such that
$$\sum_{i=l}^{k} \binom{k}{i} p^i (1-p)^{k-i} \geq 1$$
12. End if
13. End if

3.3 Estimating Pair Wise Distances and Localization

A distance matrix DM is considered as input, which contains the distances among all pairs of nodes. The output is a set of coordinates created with DM. Every node computes its distance from its adjacent and informs this to the BS. Then, the BS utilises the rebuilt nodes' locations to build the network map. BS repeats these steps on the pairwise distances to determine DM and perform localization.

3.4 Support Vector Machines (SVM)

Before presenting our suggested clone detection technique, we offer a momentary background of SVM in this section which aids as the basis of our method. The features which reflect the device characteristics and behaviour related to clone and jamming attacks are considered. The features related to clone attack are: source and destination ids, their location information and the features related to jamming attack are channel response, retransmitted RTS or DATA, carrier sense failure rate and network allocator vector (NAV).

The training set is denoted as

$$(x_1, y_1), (x_2, y_2), \ldots (x_n, y_n)\,,\; x_j \in R^n\, y_i \in \{+1, -1\}$$

where x_j is the input vector of jth sample and y_j is the output scalar (+1 or -1).

SVM splits the positive and negative features using a hyperplane as

$$w.x + b = 0, w \in R^n, b \in R \tag{2}$$

Here, $w.x$ is the inner product of w and x.

SVM computes the best hyperplane by maximizing the margin.

The following conditions should be satisfied

$$w.x_j + b \geq 1 - \xi_j$$

$$w.x_j + b \leq -1 + \xi_j \tag{3}$$

Depending on the restraints of Eq. (2), the Eq. (3) can be written as

$$\frac{1}{2}\|w\|^2 + C\sum_{j=1}^{u} \xi_j \tag{4}$$

Here, C is an constant that denotes the cost of unsatisfied conditions.

The decision function is given by

$$\mathrm{g(x)} = \left(\sum_{i=1}^{l} \lambda_i y_i x_i..x + b\right) \tag{5}$$

where λ_i is a scalar for x_i.

3.5 Attack Classification

BS executes the following algorithm to detect the presence of clone attack in the network.

Notations	Meaning
Ni	Node, $i = 1, 2 \ldots n$
Nei	Neighbours of Ni
$d_{i,j}, j\varepsilon Ne_i$	Distance of Ni with each of Ne
$\langle t, i, \{(Nj, d_{i,j})\} j\varepsilon Ne_i\}\rangle$	Neighbour distance
xi	Training vector
yi	Label vector

Algorithm: SVM based Clone attack detection

1. Each Ni discovers Ne_i
2. N_i measures $\{(d_{i,j})\}$
3. N_i sends $\langle t, i, \{(N_j, d_{i,j})\} j\varepsilon Ne_i\}\rangle$ to BS at time t.
4. BS executes SVM classifier to detect the node with incorrect distance information
5. SVM determines the optimum hyperplane which splits the two classes, by exploiting the boundary.
6. By means of the x_i, y_i. the support vector method needs the resolution of the subsequent concern

$$\min_{w,b,v} \frac{1}{2} w^T w + C \sum_{i=1}^{l} v_i \quad (8)$$

subject to y $_y(w^T \varsigma(x_i) + b) \geq 1 - v_i, v_i \geq 0, i = 1,..l$

For attack classification, a group of pairwise distances of the nodes is got by the BS by transferring and getting distance enquiry packets. Then by using trilateral localization methods, BS assesses the coordinates of the equivalent nodes.

3.6 Cross-Validation by Monitoring Nodes

In order to avoid misinterpreting the clone nodes as valid nodes, the monitoring nodes need to double check the nodes which are initially considered as legitimate. After the monitoring nodes receive the validation request from the BS, they verify the location information by checking the node id and location from their neighbour table. If there is a conflict, then the nodes are confirmed as cloned nodes.

4 Experimental Results

The proposed SVMClone technique is simulated in NS3 and compared with the MDSClone [7] technique. The various types of sensors used in experiments are motion sensors and environmental sensors. Various IoT devices used are Camera and Smart phone.

4.1 Results and Analysis

In experimental evaluation, the attack interval is varied from 20 to 100 s.

Table 1 and Fig. 1 shows the % of affected packets measured when the attack interval is varied. Since SVMClone monitors all the nodes using monitoring probability, the percentage of affected packets in case of SVMClone is 17% lesser than MDSClone.

Table 1 Result table for % of affected packets

Attack interval (s)	SVMClone (%)	MDSClone (%)
20	40.0	50.0
40	45.0	54.0
60	50.0	60.0
80	52.0	63.0
100	56.0	67.0

Fig. 1 Percentage of affected packets for attack intervals

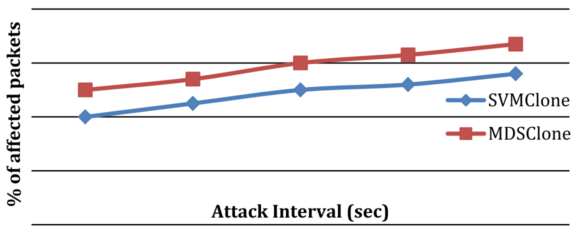

Table 2 Result table for detection accuracy

Attack interval (s)	SVMClone	MDSClone
20	0.997	0.991
40	0.984	0.98
60	0.981	0.976
80	0.975	0.971
100	0.97	0.964

Table 2 and Fig. 2 shows the detection accuracy measured when the attack interval is varied. Since SVM increases the accuracy of detection, the SVMClone attains 1% higher detection accuracy, than MDSClone.

Table 3 and Fig. 3 shows the false positive rate when the attack interval is varied. Because of the cross-validation mechanism by the monitoring nodes, the false positive rate of SVMClone is 29% lesser than MDSClone.

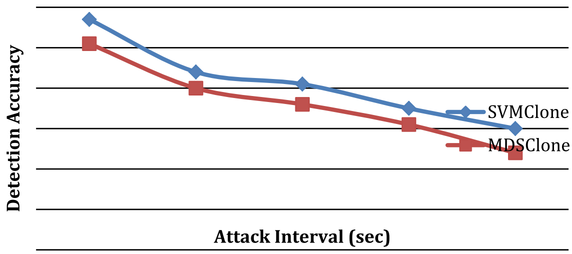

Fig. 2 Detection accuracy for attack intervals

Table 3 Result table for false positive rate

Attack interval (s)	SVMClone	MDSClone
20	0.083	0.119
40	0.113	0.159
60	0.181	0.245
80	0.203	0.289
100	0.223	0.314

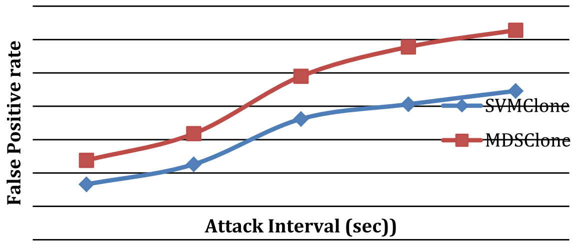

Fig. 3 False positive rate for attack intervals

Table 4 Result table for residual energy

Attack interval (s)	SVMClone (Joules)	MDSClone (Joules)
20	10.95	10.56
40	11.08	10.81
60	11.15	10.94
80	11.19	11.02
100	11.22	11.07

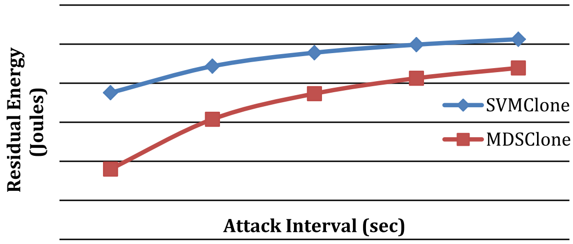

Fig. 4 Average residual energy for attack intervals

Table 4 and Fig. 4 shows the average residual energy when the attack interval is varied. Since SVMClone eliminates the jamming attack also, it has 2% higher residual energy than MDSClone.

5 Conclusion

In this paper, support vector machine (SVM)-based cloning and jamming attack detection solution for IoT WSN is proposed. In this work, the BS classifies nodes as cloned or normal by checking the distance measurements from the IoT devices. The proposed SVMClone technique has been simulated in NS3 and compared with the MDSClone technique. Simulation results have proven that SVMClone achieves high detection accuracy with reduced false positive rate and energy consumption.

As personal data is collected and transmitted over an IoT applications like smart home network, security and privacy concerns have become increasingly common and must be overlooked to take full advantage of the smart home atmosphere. The privacy and safety of the IoT data can be destabilized in several means. Unruly devices may make prejudiced attacks based on trust abuse. Attacks on IoT objects, particularly those related to trust, are a possible. Hence, the future work aims to provide solution for privacy protection and defend trust-based attacks of IoT.

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Evaluation of Time Series Models for Forecasting Daily Rise in Confirmed COVID-19 Cases During the Second Wave in India

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Abstract The spread of Coronavirus began in Wuhan, China and very steadily went on to be a global pandemic. This virus, later identified as COVID-19 virus, was found to be extremely contagious in nature. The people contracting the virus displayed several symptoms, and in some cases, the contraction of the virus also proved to be fatal. The earliest COVID-19 case in India was found on 30th January 2020, and thereafter, the country witnessed a steady growth in the number of infections. During the following year, in the latter half of March 2021 onwards, the cases began rising exponentially indicating the start of the second wave. The intention behind this research is to predict the future of the daily COVID-19 confirmed cases in India during the second wave. This is done by utilizing three time series models, 'Autoregressive Integrated Moving Average' (ARIMA), 'Long Short-Term Memory (LSTM) Neural Network' and 'Facebook Prophet'. The primary focus of this work is to compare and evaluate the three models to determine which model shows the least error. The results show that the performance of ARIMA is better than LSTM and Prophet. The error metrics show least amount of average error for ARIMA, followed by LSTM and Prophet.

Keywords COVID-19 · Corona virus · ARIMA · LSTM · Facebook prophet · Machine learning · Deep learning · Time series analysis · Forecasting

1 Introduction

The Coronavirus Disease 2019, also known as COVID-19 is the fifth pandemic that has severely crippled the entire world. This viral pandemic which originated in the city of Wuhan of the Hubei province of China has affected a large population of the

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world. This disease is highly contagious and the humans contracting the virus show signs of pneumonia, fever, dry cough, and so on [1]. It is important to contain the spread of the COVID-19 virus because of its highly contagious nature.

Epidemiological models can be categorised as, statistical and machine learning-based models and mechanistic models [2]. Statistical and machine learning models are data-driven, whereas, mechanistic models, which are developed by scientists, are complex and based on underlying theoretical principles on the spread of a disease. The development of such mechanistic models, however, requires investment of a lot of time and effort [2]. However, during a pandemic, there is a need to generate quick forecasts, and therefore, statistical and machine learning-based models can prove to be efficient under such circumstances.

We propose the use of three statistical and machine learning-based time series models, 'Autoregressive Integrated Moving Average' (ARIMA), 'Long Short-Term Memory (LSTM) Neural Network' and 'Facebook Prophet' for the prediction of the total number of daily confirmed COVID-19 infections in India during the second wave of the pandemic which saw the cases rising exponentially in the latter half of March 2021. The primary focus; however, is to provide a comparative evaluation of the three models to determine which model has the least error. We run the experiments to predict the daily confirmed number of cases throughout the month of April 2021 using a 5-day expanding window and analyse the impact this has on the predictions.

The numbers of COVID-19 confirmed cases in India have grown to twenty-seven million or more additional confirmed cases per day as of the time of this study [3]. Therefore, it is essential to have a forecasted number of cases in order to be equipped with the healthcare measures and embark on other essential strategies to accommodate the future infrastructural needs or planning and, also, for implementing containment strategies to prevent further spread of the infection. This comparative study of the error measures of the models could further aid in the decision-making process and help researchers have an insight into the forecast accuracy of these models and make informed decisions on which model would suit the forecasting needs better.

2 Related Work

COVID-19 has impacted several countries across the globe and many Machine Learning (ML) techniques have been used to predict the future impact of this virus on the global population. These predictive studies are being accomplished by researchers specific to certain countries or regions. The purpose of this experiment is to perform comparative analysis and determine the error measures of ARIMA, LSTM and Facebook Prophet on the COVID-19 data of India for predicting the confirmed number of cases throughout the month of April 2021 during the second wave in the country.

Khan and Gupta performed univariate time series prediction of COVID-19 cases in India using ARIMA and Non-Linear Autoregressive (NAR) neural network models [4]. Shastri et al. used deep learning models to perform time series forecasting and compared COVID-19 cases in India and United States of America [5]. Dhamodharavadhani et al. proposed the use of statistical neural networks (SNN)-based models and their hybrid versions to predict the mortality rate in India and thus predict the number of deaths in the country [6]. Mishra et al. compared two time series models, Artificial Neural Networks (ANN) and Fuzzy Time Series (FTS) with ARIMA and studied the short-term virus spread trend using these three models [7]. Mirza et al. analysed and forecasted the COVID-19 trend in India using ARIMA and Facebook Prophet models [8]. Sharma and Nigam used Exponential-polynomial regression, ARIMA and Exponential Smoothing Holt–Winters model to analyse the growth pattern of COVID-19 pandemic in India [9]. Pradeep et al. used ARIMA, Seasonal ARIMA (SARIMA) and Prophet to make predictions of cases of COVID-19 in India [10].

Kumar and Susan modelled the outbreak in India using the time series models ARIMA and Facebook Prophet, and evaluated the effectiveness of the models [11]. Unnikrishnan forecasted the daily number of COVID-19 cases using the ARIMA model in the various states of India where the cases were highly reported in order to access the growth rate of COVID-19 cases and select the best model [12]. Patawa et al. used ARIMA and Exponential Smoothing time series models to analyse and forecast the number of COVID-19 cases in India [13]. Gupta et al. predicted the active rate, the death rate and the cured rate in India using machine learning-based models such as support vector machine (SVM), Facebook Prophet and linear regression model [14]. Battineni et al. forecasted infections for four most affected countries, viz. United States of America, Brazil, India and Russia, using Facebook Prophet to predict the epidemic trend [15]. Roy et al. used ARIMA for predicting the weekly confirmed COVID-19 cases in India during the first wave. They also analysed the ‘spatio-temporal’ pattern of the distribution of COVID-19 cases in various regions [16].

Kumar et al. conducted a study for forecasting the COVID-19 cases in India using time series prediction model, ARIMA, to determine the epidemic pattern [17]. Swaraj et al. proposed an ensemble model by integrating ARIMA and NAR neural network for forecasting COVID-19 cases in India [18]. They found that this combination of the two models showed a notable decrease in the error measures. Tak et al. made use of ARIMA model to make predictions of COVID-19 cases in India [19]. Kulshreshtha and Garg predicted new COVID-19 cases in India using ML-based ARIMA and autoregressive (AR) models [20]. Singh et al. studies the effects of ‘lockdown’ and ‘unlock’ during COVID-19 in India using ARIMA model [21].

The approaches used for time series forecasting of confirmed COVID-19 cases in India, during the first wave of the pandemic, include ARIMA, NAR neural network, ANN, FTS, SARIMA, Facebook Prophet, SVM to name a few. The most popularly used model is ARIMA; it has shown considerable accuracy in the predictions. However, it can also be noted that a method integrating ARIMA and NAR neural network predicted more accurate numbers. The objective of our study is to implement the commonly used approaches for forecasting the COVID-19 daily confirmed cases in India during the second wave of the pandemic and offer a comparative analysis on the predictive accuracy of ARIMA, LSTM and Facebook Prophet. The study could help the authorities take preventive measures in tackling the pandemic and the analyses could help researchers in determining further improvements.

3 Algorithms

The algorithms used for time series forecasting of COVID-19 cases in India are ARIMA, LSTM and Facebook Prophet. We implemented these algorithms in Python using the libraries 'pmdarima', 'statsmodel', 'keras', 'tensorflow and 'fbprophet'.

3.1 ARIMA

It can predict future trends regarding time series data. It is a type of regression analysis model that assesses the potency of a dependent variable corresponding to other variables that differ. A standard notation of ARIMA has three parameters '*p*', '*q*' and '*d*'. '*p*' denotes the count of 'lag observations' in the model, '*q*' denotes the magnitude of the 'moving average window' and '*d*' represents the count of the times the 'raw observations' vary, also called as the 'degree of differencing' [22, 23].

We use 'autoARIMA' function from the 'pmdarima' library which is a wrapper for 'statsmodel' a module for statistical modelling. The 'autoARIMA' function operates like a grid search and finds the best values of '*p*', '*q*' and '*d*' by trying different variations of the three on the training data. It can do this by using ARIMA or SARIMA, If SARIMA is used, additional seasonal components are also generated, they are, '*P*' which denotes seasonal autoregressive order, '*D*' which denotes seasonal difference order, '*Q*' which denotes seasonal moving average order and '*m*' which is the seasonal period. In order to select the differencing terms, 'autoARIMA' uses a stationarity test and seasonality test for seasonal models. In our experiment, the model selected was ARIMA (2, 2, 3) after performing grid search on the training data [22, 23].

3.2 LSTM

'Long Short-Term Memory' architecture expands the Recurrent Neural Networks (RNN) memory which, typically have short-term memory. LSTM mitigates the 'vanishing gradient problem', which is when a neural network ceases to learn. LSTM has an array of gates enclosed in memory blocks linked via layers [24]. A LSTM unit comprises an 'input gate' that supplies an input to a cell, an 'output gate' that selects the relevant information from the current state and providing the output, and, a 'forget gate' that removes the information from the cell [24].

LSTM models can be univariate or multivariate, and in this experiment we use LSTM for univariate time series analysis. The model was implemented using 'keras' and ‘tensorflow’ [25]. When working with LSTM data preparation is a crucial step before modelling. We begin by transforming the training data to be stationary and make the statistical properties of the data constant over time using second order differencing, then we apply Yeo-Johnson transform [26] to bring data closer to norm and make it perfectly stationary, and lastly, we transform the scale of the data to 0–1. We then transform this data into a supervised learning problem using two lag observations to make a one-step prediction to be fed into the LSTM model.

The LSTM model uses single hidden layer of 150 bi-directional LSTM units. These units are an extension to traditional LSTM units and consider forward and backward direction of the data; lastly, we have a single output layer that is used to make a prediction [27]. The activation functions used are ‘Rectified Linear Unit’ (ReLU) and for output layer we used ‘adam’ as the optimizer with learning rate 01e−4 and Mean Square Error (MSE) as the loss function. We train the model for 3 epochs.

3.3 Facebook Prophet

Taylor and Letham proposed this model to forecast business time series [28]. It works effectively with data that has bold seasonal impact and various periods of historical data. Prophet is very potent towards missing data and trend shifts, and usually manages outliers effectively [24]. Implementations of the model is open source and available in Python and R.

In this experiment, we keep most of the default values of the parameters since Facebook claims that the model works well with the default parameters [28]. We only altered 3 parameters, i.e. ‘changepoint_range’ which was set to ‘1’, ‘changepoint_prior_scale’ which was also set to ‘1’ and ‘n_changepoints’ which was set to ‘100’. Change points are points in data that show a change in trend, where ‘changepoint_range’ determines how much percentage of data is to be taken into consideration, ‘changepoint_prior_scale’ determines how flexible the trend is, and, ‘n_changepoints’ sets the number of change points you want to incorporate.

4 Methodology for Predicting COVID-19 Cases in India

Time series models make predictions after being trained on some initial data. Though, these models will have to be retrained on new data as and when it is available. This enables the models to learn more from the data and make better predictions. A walk forward validation trains the models on an initial training data and then makes a prediction for ‘n’ days this represents a single time step which is then evaluated against the actual observations. The training window is then expanded by ‘n’ days to allow the model to retrain on actual observation. We do not change the model parameters when it is retrained. The detailed steps are as follows:

- **Data preparation**: For these experiments, we made use of the COVID-19 online data repository provided by Johns Hopkins University [29]. This repository stores the total number of confirmed cases, deaths and recovered cases from all the countries across the world and updated daily. We extracted the data of the daily rise in the confirmed cases for India from this repository, since the experiments required only the 'confirmed cases' numbers. We standardized the date format of the data to 'yyyy-mm-dd'. Data used was from 30th January 2020 to 30th April 2021.
- **Setting initial data for expanding window**: We made use of walk forward validation with a 5-day expanding window; therefore, we first selected the initial number of observations which trained the model. We used 427 observations from 30th January 2020 to 31st March 2021 to train the models.
- **Training**: We fit each of the models on the training set. This model once fit on the training data can make predictions for the future dates.
- **Predictions**: The models were then used to make predictions for the next five days. This represents a single time step.
- **Evaluations**: We compared the predicted values in the previous step with the known actual values, using three popular metrics for evaluating time series models. Based on the results, the amount of error in the predictions was measured and this enabled the identification of the model with the least amount of error.
- **Window Expansion**: We expanded the training window to include five more days of actual observations and repeated the process from the 'Training' step to the 'Window Expansion' step until we obtained the predictions up to 30th April 2021. This created a total of six time steps.

5 Evaluation Metrics

For the evaluation of performance and accuracy of the results of the three models, Mean Absolute Percentage Error (MAPE), Mean Absolute Error (MAE) and Root Mean Square Error (RMSE) metrics are used.

5.1 MAPE

MAPE measures 'the size of the error in percentage terms' [30]. It measures the percentage of error. Equation (1) represents MAPE metric in mathematical form [31].

$$\text{MAPE} = \left(\frac{1}{N}\sum_{i=1}^{N}\frac{\left|y_i - \hat{y}_i\right|}{y_i}\right) * 100 \tag{1}$$

where
y_i denotes the observed values of the time series at time i,
$\hat{y}_i$ denotes the predicted values of the time series at time i, and
$'N'$ denotes the number of observations.

5.2 MAE

MAE is computed as 'the average of the forecast error values, where all of the forecast error values are absolute' [32]. Equation (2) depicts MAE mathematically [31].

$$\text{MAE} = \frac{1}{N}\sum_{i=1}^{N}\left|y_i - \hat{y}_i\right| \tag{2}$$

where
y_i denotes the observed values of the time series at time i,
$\hat{y}_i$ denotes the predicted values of the time series at time i, and
$'N'$ denotes the number of observations.

5.3 RMSE

RMSE can be stated as 'the square root of the average of squared differences between prediction and actual observations' [33]. Equation (3) defines RMSE mathematically [31, 33].

$$\text{RMSE} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(y_i - \hat{y}_i)^2} \tag{3}$$

where
y_i denotes the observed values of the time series at time i,
$\hat{y}_i$ denotes the predicted values of the time series at time i, and
$'N'$ denotes the number of observations.

6 Results

We executed LSTM and Prophet algorithm implementations 30 times because of their stochastic nature, i.e. these ML algorithms used randomness while constructing a model from the training data. This resulted in different predictions each time we executed the models on the same training data; to solve this, we used model ensembling, i.e. we averaged the predictions made by the models during each of the 30 runs. This average was used as the final prediction in the case of the ML algorithms. ARIMA, on the other hand, produced the same predictions on multiple runs [34]. The predictions of the three models, ARIMA, LSTM and Prophet, for each of the six time steps of five days are tabulated in Tables 1, 2, 3, 4, 5 and 6, along with the numbers of 'Actual cases reported'. The evaluation metrics of the three models for the predictions are also presented alongside.

Amongst the three metrics used for the evaluation, the MAPE metric represented a percentage value, and according to Lewis's [35, 36] interpretation, a MAPE score less than 10% is considered as a highly accurate forecast. We observed that none of the models produced a MAPE score higher that 3.2%, which indicated that all the models produced accurate forecasts. However, out of the three models, we observed that the MAPE scores of ARIMA and LSTM are lower than Prophet. RMSE and MAE are scale-dependent metrics, which means their value depends on the scale of the data. Minimizing MAE leads to forecasts of the mean while minimizing for RMSE leads to forecasts of the median [37]. Both, RMSE and MAE metrics, also

Table 1 Predictions and evaluation for first time step from 2021-04-01 to 2021-04-05

Date	Actual	ARIMA	LSTM	PROPHET
2021-04-01	12,303,131	12,293,610	12,297,057	12,288,133
2021-04-02	12,392,260	12,363,610	12,376,698	12,353,287
2021-04-03	12,485,509	12,432,375	12,457,760	12,419,268
2021-04-04	12,589,067	12,500,969	12,539,907	12,483,298
2021-04-05	12,686,049	12,570,206	12,622,524	12,543,488
MAPE		0.46942	0.25769	1.17083
MAE		59,049.2	32,414.0	73,708.4
RMSE		70,591.1	38,733.0	86,766.8

Table 2 Predictions and evaluation for second time step from 2021-04-06 to 2021-04-10

Date	Actual	ARIMA	LSTM	PROPHET
2021-04-06	12,801,785	12,782,501	12,783,293	12,768,142
2021-04-07	12,928,574	12,884,870	12,879,016	12,863,626
2021-04-08	13,060,542	12,995,208	12,974,222	12,958,588
2021-04-09	13,205,926	13,112,140	13,068,767	13,053,424
2021-04-10	13,358,805	13,232,724	13,162,819	13,149,068
MAPE		0.52858	0.73888	1.63603
MAE		69,637.8	97,503.0	112,556.8
RMSE		79,047.7	116,165.6	128,834.1

Table 3 Predictions and evaluation for third time step from 2021-04-11 to 2021-04-15

Date	Actual	ARIMA	LSTM	PROPHET
2021-04-11	13,527,717	13,513,755	13,515,681	13,468,880
2021-04-12	13,689,453	13,672,791	13,674,614	13,597,116
2021-04-13	13,873,825	13,836,550	13,834,500	13,728,834
2021-04-14	14,074,564	14,004,277	13,994,730	13,862,829
2021-04-15	14,291,917	14,174,687	14,154,965	13,996,280
MAPE		0.36265	0.40126	2.12883
MAE		51,083.2	56,597.2	160,707.4
RMSE		64,101.7	73,540.24	181,792.9

Table 4 Predictions and evaluation for fourth time step from 2021-04-16 to 2021-04-20

Date	Actual	ARIMA	LSTM	PROPHET
2021-04-16	14,526,609	14,508,559	14,516,530	14,448,236
2021-04-17	14,788,003	14,727,733	14,746,338	14,635,824
2021-04-18	15,061,805	14,959,791	14,978,850	14,821,757
2021-04-19	15,320,972	15,201,235	15,213,070	15,003,151
2021-04-20	15,616,130	15,450,901	15,448,250	15,188,123
MAPE		0.60974	0.53624	2.81896
MAE		93,060.0	82,096.2	243,285.6
RMSE		105,832.6	98,534.9	272,442.3

Table 5 Predictions and evaluation for fifth time step from 2021-04-21 to 2021-04-25

Date	Actual	ARIMA	LSTM	PROPHET
2021-04-21	15,930,774	15,929,604	15,914,250	15,855,156
2021-04-22	16,263,695	16,255,146	16,221,083	16,122,229
2021-04-23	16,610,481	16,597,921	16,530,457	16,389,868
2021-04-24	16,960,172	16,957,556	16,842,306	16,657,530
2021-04-25	17,313,163	17,334,094	17,155,225	16,923,895
MAPE		0.05437	0.49094	3.21852
MAE		9165.2	82,992.8	225,921.4
RMSE		11,637.5	97,293.48	252,001.0

show the least error for ARIMA and LSTM as compared to Prophet. We observed from the metrics, as seen in Tables 1, 2, 3, 4, 5 and 6, that ARIMA model predicted more accurate results for the number of daily confirmed COVID-19 cases in India in Tables 2, 3 and 5. On the other hand, it can be observed from Tables 1, 4 and 6 that LSTM has performed better than the rest.

Table 6 Predictions and evaluation for sixth time step from 2021-04-26 to 2021-04-30

Date	Actual	ARIMA	LSTM	PROPHET
2021-04-26	17,636,186	17,661,728	17,667,534	17,623,028
2021-04-27	17,997,113	18,009,018	18,022,955	17,957,346
2021-04-28	18,376,421	18,360,022	18,378,950	18,294,371
2021-04-29	18,762,976	18,712,099	18,735,350	18,630,879
2021-04-30	19,164,969	19,062,233	19,092,015	18,968,186
MAPE		0.22149	0.17260	3.21952
MAE		41,491.8	32,059.8	92,771
RMSE		53,303.3	39,350.2	113,718.9

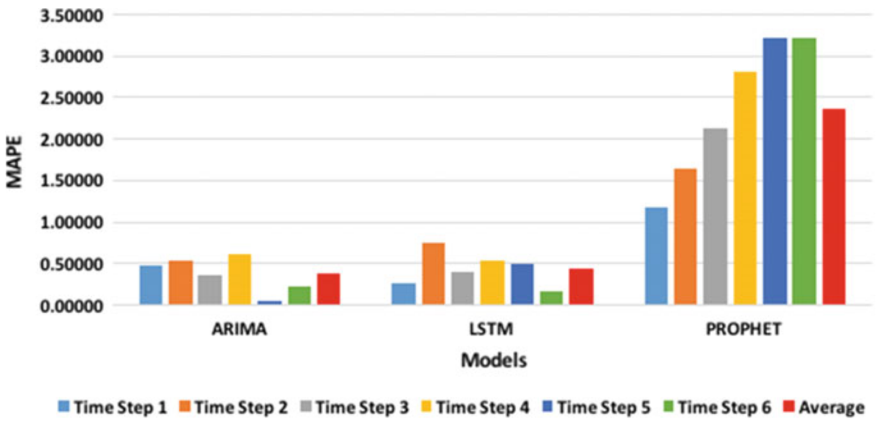

Fig. 1 Comparison chart of MAPE values of the models and time steps

The plots of the metric values for each of the models during each of the six time steps are given below in Figs. 1, 2 and 3. In Fig. 1, we observed the MAPE values and noticed that ARIMA has the lowest average value followed by LSTM and then Prophet. We also observed that although the average of Prophet being the highest is still less than 2.5% indicating that these models produce accurate forecasts. In Fig. 2, we observed that the MAE values and the plot illustrated that ARIMA has the lowest average value followed by LSTM and then Prophet. Similarly, in Fig. 3, we observed the RMSE values and noticed that ARIMA had the lowest average value followed by LSTM and then Prophet.

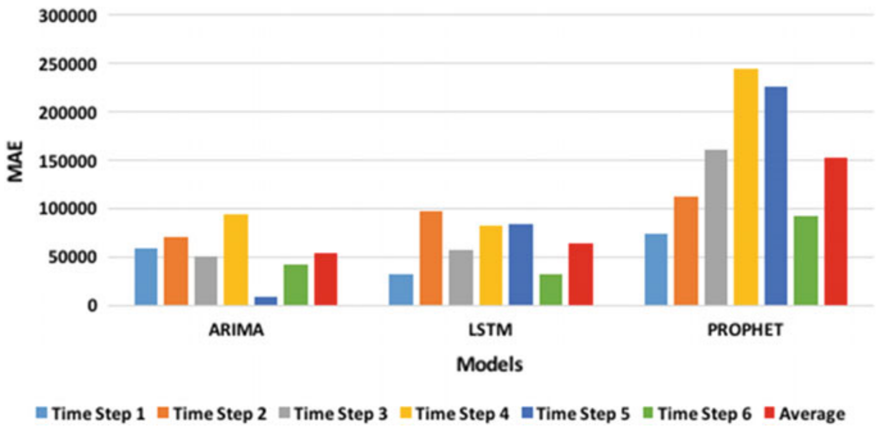

Fig. 2 Comparison chart of MAE values of the models and time steps

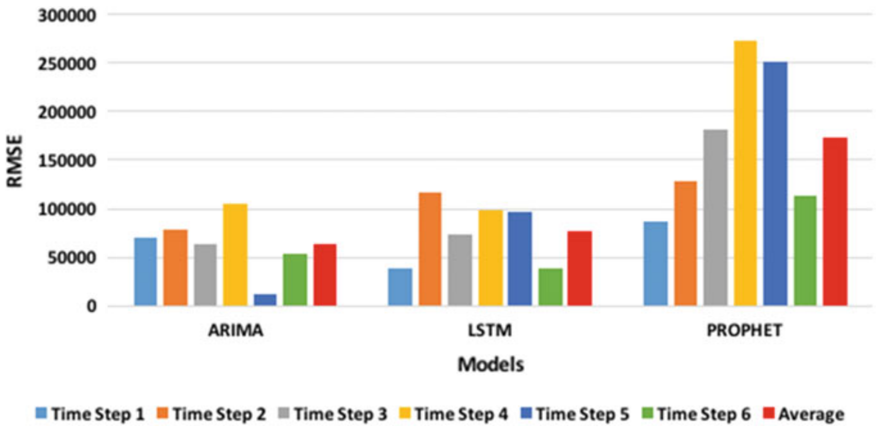

Fig. 3 Comparison chart of RMSE values of the models and time steps

7 Conclusion

The models used in our experiments are statistical, ML-based, data-driven models that are fast and dependent on the availability of training data [2]. In a pandemic, there is a need to generate quick forecasts. ARIMA, LSTM and Prophet are capable of doing that without much complexity as compared to the mechanistic models. Time series forecasting is rather challenging in terms of noise and latent influences. The results of time series prediction of daily confirmed COVID-19 cases during the second wave show that ARIMA and LSTM models have predicted the number of daily rise in cases quite close to the actual numbers. The three evaluation metrics, RMSE, MAPE and MAE, exhibit the least average error score for ARIMA model.

If the performances of the three models have to be compared, then the model that performs the best is ARIMA, followed by LSTM and then Prophet. ARIMA is a well-defined mathematical model that provides better forecasting on univariate datasets. If there is a huge amount of training data available then LSTM is capable of performing better with complex data. It has a tendency to over fit when the data is less; despite this, we see that it outperforms all the other models in some of the time steps.

The prerequisite for ARIMA is the calculation of some parameters that are computed based on the data. However, it is simple to implement and can work efficiently on a small dataset. LSTM functions effectively when the volume of data is huge and sufficient training data is available. Prophet operates effortlessly with time series data that has intense periodic effects. It has robustness towards missing values and trend shifts but is better suited for business applications.

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Biologically Inspired Hexagonal Image Structure for Computer Vision

Prathibha Varghese and G. Arockia Selva Saroja

Abstract Representation of digital images in hexagonal grid has been under investigation for past 40 years. The common digital image representation makes use of rectangular grid of square-structured pixel elements known as pixels. Hence, normally, rectangular grid for displaying and processing of images is used. Advanced processing power of modern graphic devices and innovative advancements incorporated in charge-coupled device (CCD) technology have made hexagonal sampling lattice a more interesting area for research. The hexagonal grid is superior to square structure due to high packing density, equidistant pixels, higher symmetry, less aliasing, good angular resolution and consistent connectivity. In addition to these benefits, an interesting inspiration behind using a hexagonal sampled lattice image is inspired from the human visual perception as this structure closely resembles human eye. Also, hexagon structure encompasses more area than any other closed planar geometry of identical perimeter rather than a circle. Hence, this structure will have high sampling density. Since there are no full-fledged hardware devices for capturing and displaying hexagonal image structure, image conversions have to be done as the preliminary step before proceeding with hexagonal image processing. This research review will give an overview of three different methods for hexagonal image sampling and various hexagonal software simulation schemes simulated images. Finally, to show the computational efficiency, run times of different methods are taken for different sized images.

Keywords Spiral architecture · Hexagonal image processing · Hexagonal pixel · Square pixel

1 Introduction

Energised from the human perception system and due to wide ability in regard of real-time processing, computer vision application areas combine three attributes of

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human visual system. Firstly, analysis is done in detail on how the visual contents are captured in human fovea which is a region inside retina which consist of photoreceptive cells called rods and cones which contributes to the sharpness obtained for the visual information. The photoreceptors inside the eye are arranged in hexagon pattern as shown in Fig. 1 [1]. To imitate this phenomenon, simulation of images on hexagonal grid is done using pixels of exact hexagonal shape. Secondarily, in central fovea, ganglion cells will not overlap in photoreceptive areas [2]. Correspondingly, simulated image framework follows a non-overlapping method. Thirdly, different movements such as eye tremor, drift and micro-saccades are found in human eye which process a chain offset images rather than static images [3]. Correspondingly, we habituate eye tremor movement to process image by incorporating a group of offset images processed by non-overlapping filters.

For circularly band-limited analog images, hexagonal sampling has proved to be an optimum sampling [4]. Hexagonal sampling and processing of images is more efficient when compared to square lattice as it requires 13.4% less samples [5]. In this modern technology era, hexagonal image processing finds its application in edge detection, image restoration, ultrasound image processing and image compression.

However, today's world predominantly focusses on rectangular/square grid for processing of images because of simplicity and familiarity to Cartesian co-ordinate system. Hence, almost all graphic devices including (CMOS and CCD) displays are established on square lattice. The traditional square grid is having 4-neighbourhood and 8-neighbourhood, and the separation between the pixels in the both directions is different as shown in Fig. 2.

This difference in distance will incorporate inconsistency while we do interpolation function with a kernel function. On the other hand, this will not happen with a hexagonal grid. In the hexagonal grid, there is only consistent neighbour of 6-neighbourhood, and all the pixels are of equidistant from the neighbouring pixels. So, in order to outsource hexagonal image, first task is to resample from the square lattice.

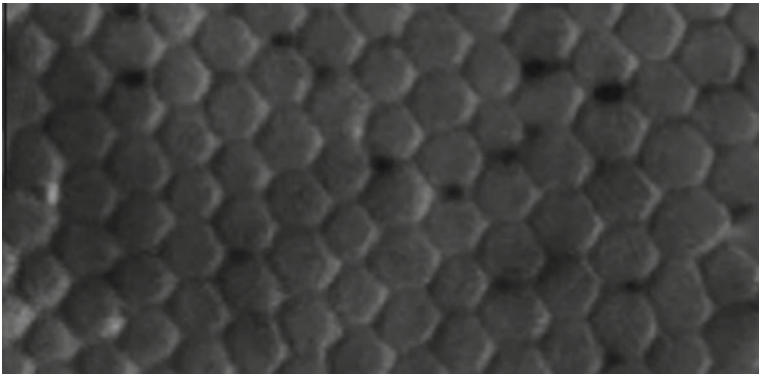

Fig. 1 Photoreceptors of human fovea

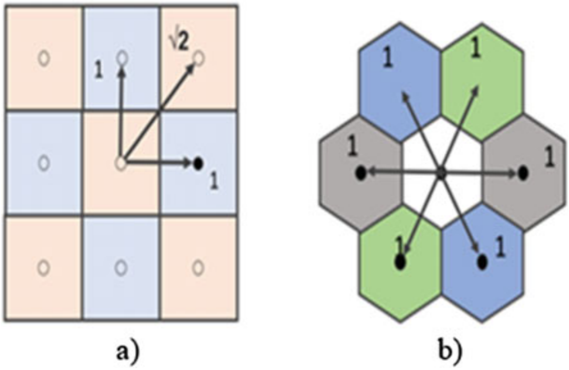

Fig. 2 Neighbours of a pixel

Fig. 3 **a** Rectangular grid, **b** simulated alternate hexagonal grid

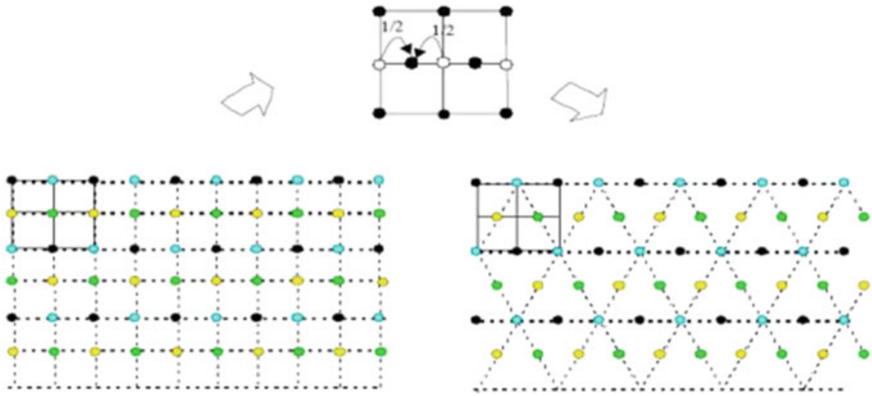

Fig. 4 Processing of half pixel shift grid

This paper is designed in the following order: Sect. 2 provides the details of different conversion methods. Section 3 presents simulation results of various conversion schemes and discussions. Section 4 presents the concluding remarks.

2 Software Simulation for Hexagonal Image Representation

As traditional acquiring devices acquire square sampled image, and there are no devices to acquire hexagonal sampled image. Hence, there are two main approaches to outsource hexagonal sample image.

- The first method is software simulation approach in which square sampled image is resampled to hexagonal sampled image.
- The second approach is by using a capturing device to get hexagonal sampled image.

There are a lot of techniques available to modify square pixel grid to hexagonal pixel grid are developed. Some of them are:

- Resampling technique
- Psuedo hexagonal pixel
- Spiral architecture.

2.1 Resampling Methods

The two different resampling method available are:

- Alternate pixel suppressal method
- Half pixel shift method.

2.1.1 Alternate Pixel Suppressal Method

Rajan et al. [6] proposed that hexagonal lattice can be simulated on the rectangular grid as shown in Fig. 3. In the newly simulated grid, each pixel is surrounded by 6-neighbourhood pixels. The modification on the existing rectangular lattice by alternatively bypassing the horizontal rows and vertical columns of the existing traditional square grid. The sub-sampling equation is defined as follows:

$$\text{pixel}_{\text{val hex}\,(i,j)} = \begin{cases} \text{pixel}_{\text{val}(2*i,2*j)}\,, & \text{if } i \text{ is even} \\ \text{pixel}_{\text{val}(2*i,2*j+1)}\,, & \text{if } i \text{ is odd} \end{cases} \tag{1}$$

There is no one to one correspondence between the pixels as they are suppressed in hexagonal counter parts. Consequently, the newly constructed hexagonal grid has only one-fourth number of pixels compared to rectangular grid. Hence, the modelled and processed images are not comparable to the hexagonal lattice.

2.1.2 Half Pixel Shift Method

Periasamy et al. [7] designed a method to obtain hexagonal grid from the traditional rectangular lattice using the following equation:

$$p^{\text{new}}(x, 2y) = p^{\text{old}}(x, 2y) \tag{2}$$

$$p^{\text{new}}(x, 2y + 1) = \frac{p^{\text{old}}(x, 2y + 1) + p^{\text{old}}(x + 1, 2y + 1)}{2} \tag{3}$$

This method is used in designing hexagonal wavelet which proves to be more computationally effective due to three axis symmetry of hexagonal pixels as shown in Fig. 4.

3 Psuedo Hexagonal Pixel

Wuthrich and Stucki [8] proposed new psuedo hexagonal grid structure, in which single hexagonal pixel represented known as hyperpel, which can be simulated by combining selected group of square pixels as shown in Fig. 5.

Jeevan [9] described a method for generating psuedo hexagonal pixels from square pixels. In these, hexagonal pixels created size is 9 * 8 constituting of 72 pixels. Only

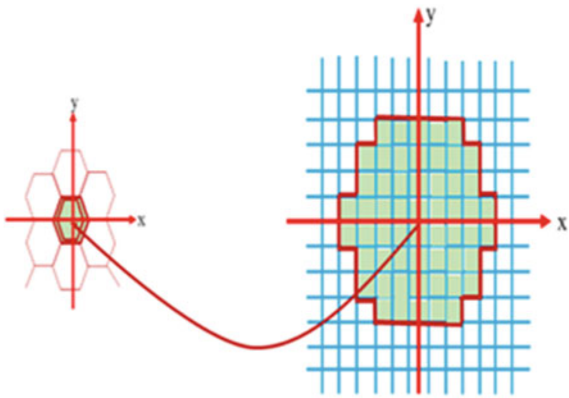

Fig. 5 Creation of Psuedo hexagonal pixel

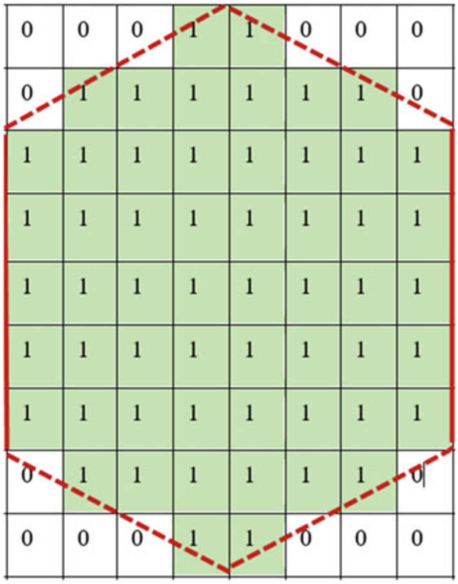

Fig. 6 Single hexagonal pixel

56 pixels are taken part for the generation of psuedo hexagonal lattice pixel as shown in Fig. 6.

The square grid pixels used for the creation of hexagonal pixels are marked 1s and others 0s. Using the above method, complete square pixels can be reconverted to hexagonal pixels.

The hexagonal lattice [10, 11] implemented through this procedure satisfies two fundamental properties of hexagonal structure. They are: (1) consistent 6-neighbours and (2) equidistant neighbours. This is shown in Fig. 7. The distance calculated from the centre pixel to the adjacent pixel is calculated as follows as shown in Fig. 7.

$$\sqrt{7^2 + 4^2} = 8.06 \simeq 8\,\text{units}$$

4 Spiral Architecture (SA) Addressing Scheme

Aroused from anatomical consideration of primates vision, Sheridian et al. [12] proposed spiral architecture addressing scheme. This addressing scheme begins from the centre of the image in terms of powers of seven in a curvilinear fashion as shown in Fig. 8. Spiral addition and multiplication works based on spiral architecture [12, 13]. In the conventional rectangular grid, group of 3 × 3 rectangles corresponds to unit vision which is having two different neighbourhood (4 and 8) [14, 15]. In SA, each pixel is having only consistent neighbourhood connectivity and have unique

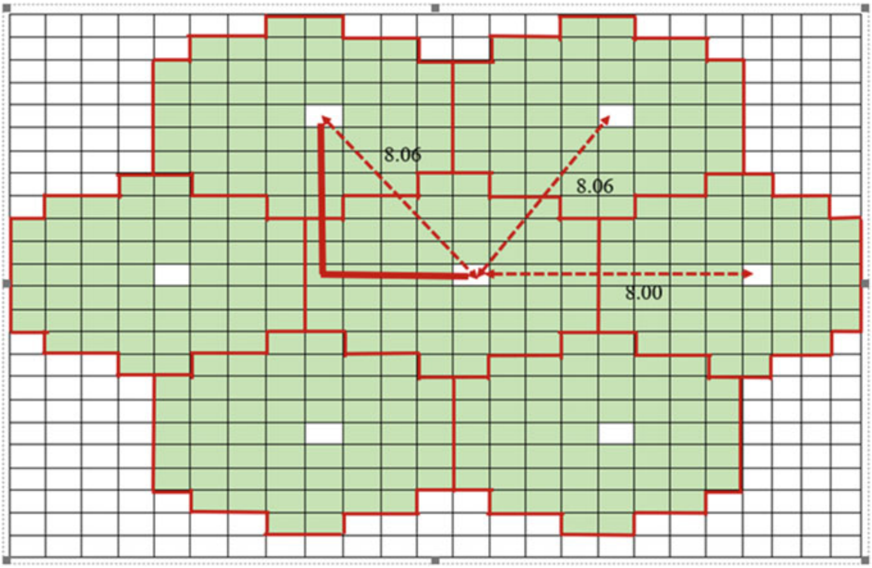

Fig. 7 Six neighbours and consistent connectivity

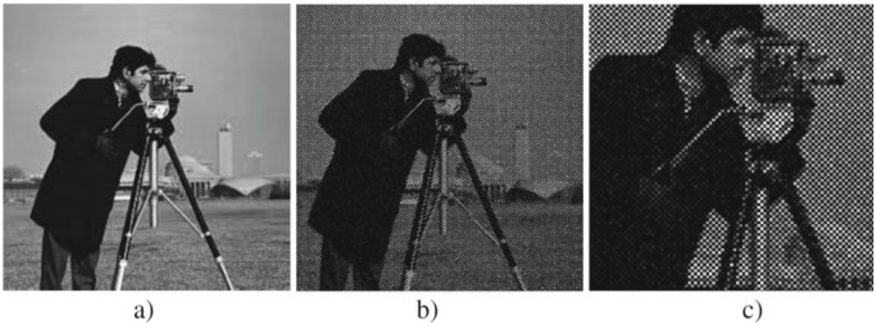

Fig. 8 **a** Rectangular grid image, **b** alternate pixel grid and **c** zoomed alternate pixel grid

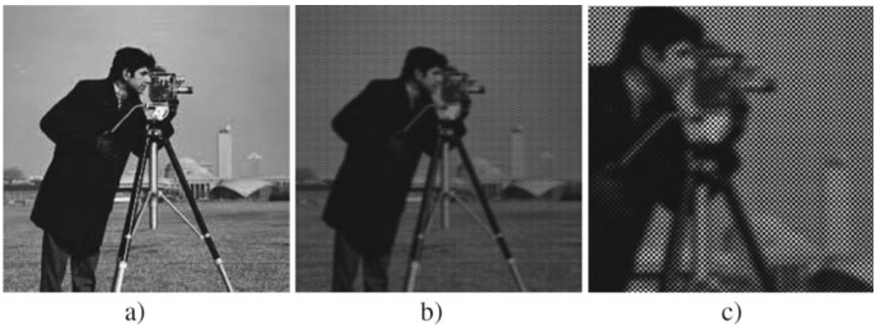

Fig. 9 **a** Original image, **b** half pixel grid and **c** zoomed half pixel grid

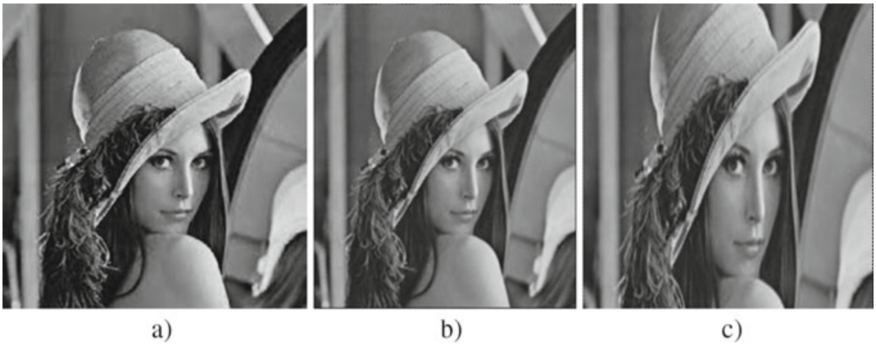

Fig. 10 **a** Original Image, **b** psuedo hexagonal pixel grid and **c** zoomed pseudo grid

distance to the centre point of seven hexagon unit of vision, so there is time saving in local and global processing. Chain coding scheme is used to extract object contour. The cluster size designed for hexagon is 7^n.

5 Simulation Results

This research work has been implemented in MATLAB with system specification and simulation result as described below:

Tool: MATLAB 2020a

OS: Windows 7 (64 bit)

Processor: Intel premium

RAM: 8 GB RAM.

Figure 8 shows the simulated result of the resampling technique using alternate pixel suppressal method. Simulated image using the resampling technique, half pixel shift method is shown in Fig. 9. Psuedo hexagonal pixel simulated image is depicted in Fig. 10.

Conclusively, to calculate the computational parameter efficiency obtained for all the hexagonal simulation approach, we calculated on images with multiple sizes and performed the run time comparison between all the three methods discussed above. In these performance analysis, six different images are taken, and results are discussed in Table 1 in which run times is shown in seconds ‘s’.

From Table 1, it is clear that run times of psuedo hexagonal method is much faster than the other approaches, particularly in the case of both low- and high- resolution images.

Table 1 Comparison of run times (s) for different hexagonal simulation methods

Input image size	Run time in seconds (s)		
	Alternate pixel suppressal method	Half pixel method	Psuedo hexagonal pixel
32 × 32	0.089	0.092	0.067
64 × 64	0.101	0.118	0.012
128 × 128	0.304	0.293	0.125
512 × 512	0.412	0.308	0.237
625 × 625	0.719	0.411	0.294
1025 × 1025	0.918	0.654	0.389

6 Concluding Remarks

Our objective in this research work is to find out a hexagonal resampling scheme which would provide more performance efficiency. This is the main motivation behind developing realistic hexagonal image framework. We simulated different simulation techniques to resample the images to hexagonal domain. The simulation result demonstrates that curved structures can be accurately represented in hexagonal domain. This is due to the skewed pixel effect in the resampling techniques. Also, it is proved that computational efficiency is higher for psudeo hexagonal pixel method from the run time performance analysis. The psuedo hexagonal pixel simulation which uses row-column addressing scheme does not require any complex computations. In this representation, hexagonal pixel provides three dominant axes which are of 60° apart which leads to the advantage of small angle rotation hexagon pixels presents image much better than square pixels. The construction of this structure also does not require any complex calculations and position of each newly constructed hexagonal pixel can be identified using a robust straightforward algorithm. In conclusion, it has come to notice that using hexagonal image rather than square image has several advantages mainly due to the consistent connectivity, high packing density and great computational savings. These merits makes hexagonal sampling more robust alternative sampling scheme compared to square image sampling. Furthermore, the work can be extended with different addressing scheme and computations along the vertical orientations.

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Metamaterial Antenna for Breast Cancer Detection Using Monostatic Radar-Based Microwave Imaging

Shruti Awasthi and Priyanka Jain

Abstract A metamaterial incorporated hexagonal shaped microstrip patch antennas (MPAs) have been presented in this paper. The proposed MPA and 3-D breast model with equivalent human breast's dielectric permittivity is designed in HFSS using finite element method (FEM). The detection of tumor is made possible by studying the reflection coefficients' variation and the specific absorption rate (SAR) of healthy and malignant tissues (containing tumor). The proposed antenna design is capable of detecting tumor of size up to 3 mm.

Keywords Microwave imaging · Metamaterial · 3-D breast structure · Reflection coefficient · SAR

1 Introduction

Breast cancer is the most fatal and deadly form of cancer, making it as the major cause of death among females. To increase the survival rate, early detection of the presence of malignant cells is required. Cancer detection can be achieved by studying the dielectric properties of biological tissues. It is observed that the permittivity of biological tissues is normally higher at lower frequency, and it reduces with higher frequency due to scattering phenomena [1].

The most popular detection techniques available are mammography [2], magnetic resonance imaging (MRI) [2], and ultrasound [3]. These techniques have certain disadvantages. They are ionizing, painful, costly, and do not provide good resolution. To overcome these disadvantages, microwave imaging (MWI) is considered as an alternative technique. MWI is cost-effective, non-ionizing, safe, and provides

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good resolution of the tissues under scanning. MWI is based on identifying the dielectric contrast between healthy and malignant tissues. This technique is broadly classified into two types—monostatic and multistatic radar-based microwave imaging technique [4].

In a monostatic technique, an antenna transmits the signal in the breast tissue, and on the basis of return loss values, tumor detection is done. The antenna used as a sensor should have high gain for efficient coupling of power into the breast tissues. Various types of antennas have been designed in the literature for cancer detection, namely monopole antenna [5], fractal antenna [6], patch antenna [7], and Vivaldi antenna [8].

This paper, therefore, presents metamaterial incorporated patch antenna which provides high gain and is successfully able to detect the tumor of radius 3 mm. The next section comprises of antenna designing followed by results obtained for the breast cancer detection.

2 Antenna Design

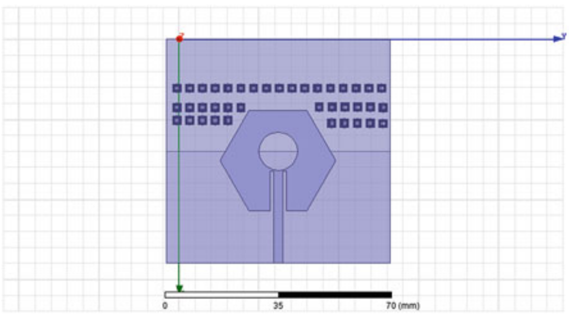
A hexagonal patch antenna with metamaterial added on the top of the substrate is implemented using FEM in HFSS. Figure 1 shows the proposed structure of antenna.

The antenna is of 70 mm × 70 mm with Rogers Ro 3003 (tm) used as substrate having permittivity as 3 F/m and 1.5 mm thickness. A circular slot of radius 6 mm is made on the patch. The dimension of the ground plane is 35 × 70 mm. For the detection of tumor, a 3-D human equivalent breast structure with human's breast tissues' permittivity and conductivity is designed in HFSS as illustrated in Fig. 2.

The permittivity and conductivity of the designed breast structure [4] are tabulated in Table 1.

The proposed antenna shows the return loss of −37 dB at 6.4 GHz and −22.5 dB at 8 GHz as shown in Fig. 3, providing the bandwidth from 6.1–6.7 to 7.7–8.2 GHz. The proposed antenna shows the maximum peak gain of 6.57 dB at a frequency of 9.4 GHz and 5 dB at 6.6 GHz as depicted in Fig. 4 which is appropriate for the breast tumor detection.

Fig. 1 Proposed antenna



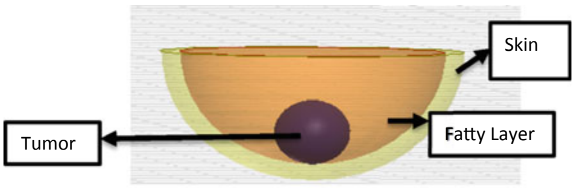


Fig. 2 3-D breast structure

Table 1 Permittivity and conductivity values of the 3-D breast structure

Breast layers (diameter) (mm)	Permittivity (F/m)	Conductivity (S/m)
Fatty layer (28)	4.8393	0.26229
Skin (32)	36.587	2.3404
Tumor (4, 5 and 6)	67	49

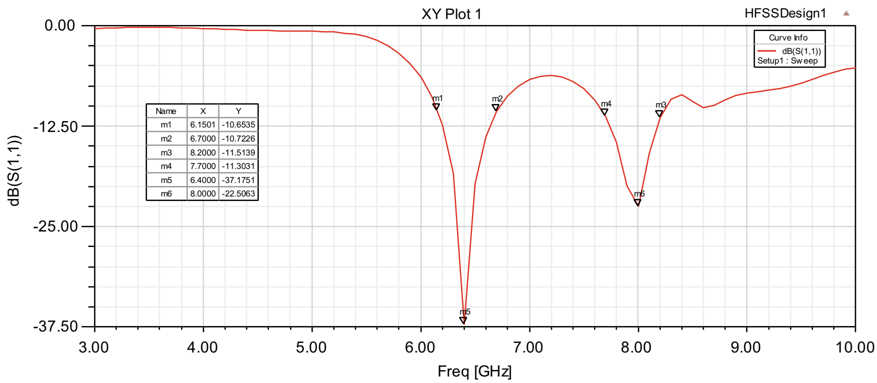


Fig. 3 S_{11} parameters of the designed antenna

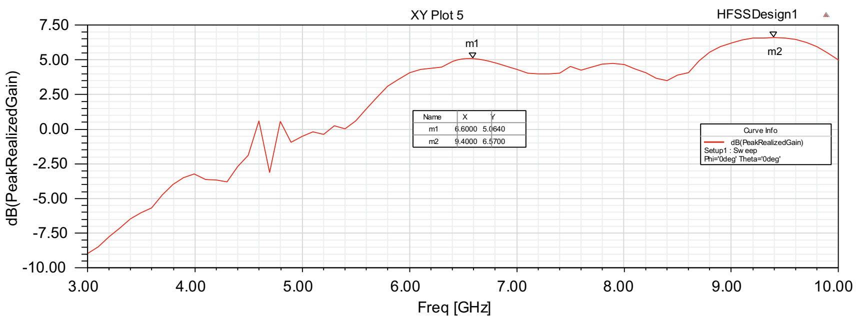


Fig. 4 Peak gain of the designed antenna

3 Metamaterial Design

The unit cell of the metamaterial consists of complimentary rectangular split ring resonators (SRR) and capacitive loaded strip (CLS) to achieve negative permittivity and negative permeability resulting in the negative refractive index which amplifies the power radiated by the antenna. Rogers Ro 3003 (tm) of thickness 1.5 mm is used as a substrate to design the 2 × 2 mm unit cell as shown in Fig. 5.

The SRR resonates through a perpendicular magnetic field, thus providing electric resonance, whereas CLS resonates with a parallel electric field, thus providing magnetic resonance. A perfect electrical boundary (Perf E) is applied perpendicular to y-axis walls, and perfect magnetic boundary field (Perf H) is applied perpendicular to z axis. Wave-port excitation is provided along x-axis. The rings are separated by distance of 0.2 mm starting from outer ring with length as 2.6 × 2.6 mm to innermost ring with length as 1.2 × 1.2 mm. The slots in between the rings are of 0.25 × 0.3138 mm (after optimization). The capacitive strip is of 3 × 0.3 mm. The S parameters obtained from the designed unit cell of the metamaterial is shown in Fig. 6.

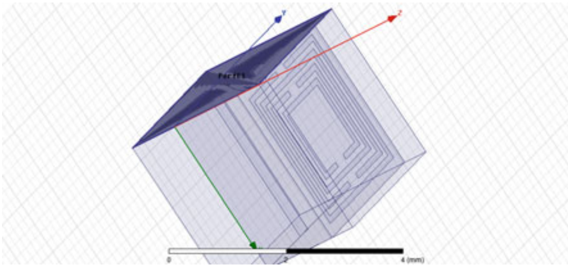


Fig. 5 Metamaterial unit cell

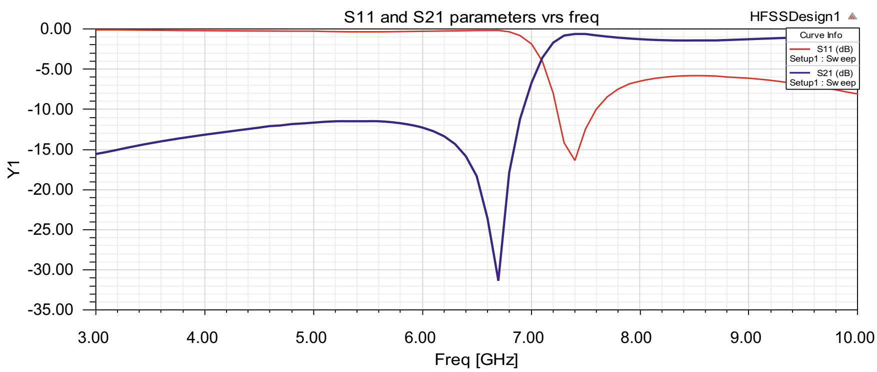


Fig. 6 S_{11} and S_{21} parameters of the metamaterial

The permittivity and permeability of the metamaterial are estimated using Nicholson-Ross-Weir (NRW) mathematical equations [9, 10] which are implemented in MATLAB. The obtained negative values of permittivity, permeability, and refractive index are illustrated in Fig. 7a–c.

The designed metamaterial shows negative refractive index values from 3–4.8 GHz and from 6.7–10 GHz.

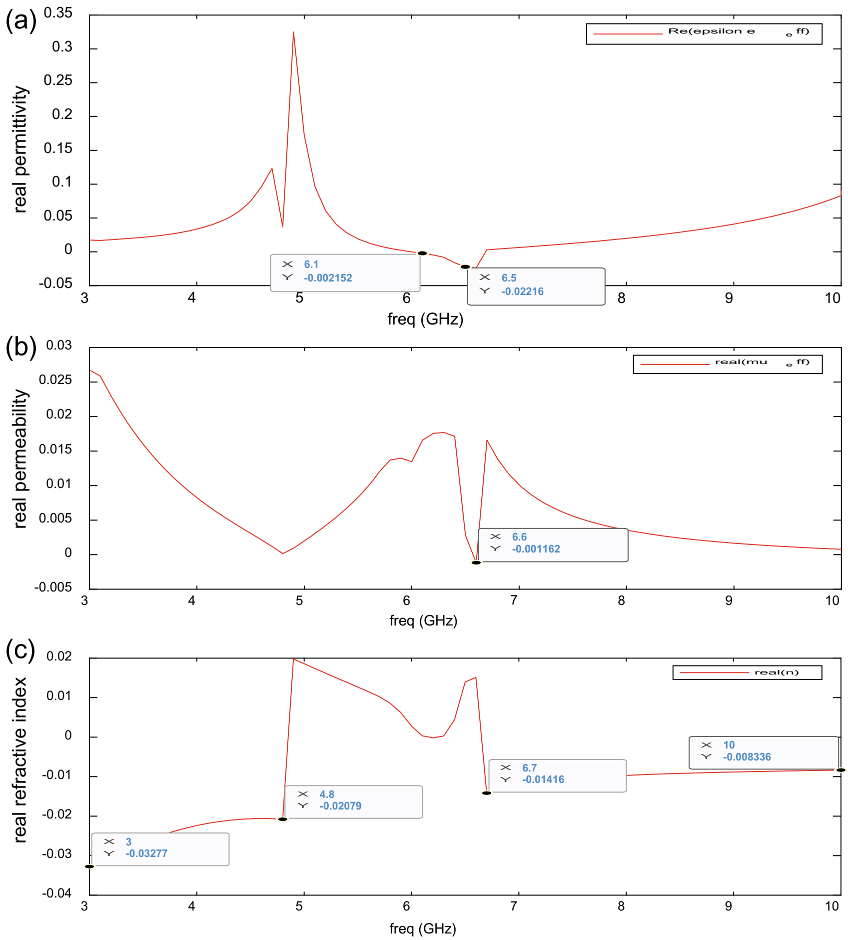


Fig. 7 **a** The real values of permittivity of the metamaterial. **b** The real values of permeability of the metamaterial. **c** Refractive index of the metamaterial

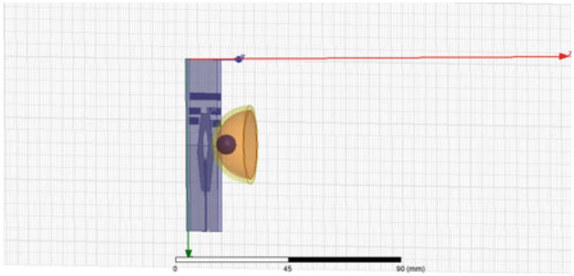


Fig. 8 Tumor detection by proposed antenna

4 Results and Analysis

Monostatic radar-based microwave imaging technique is used to detect the presence of tumor in breast. The proposed antenna is placed around the breast model for the detection of tumor as depicted in Fig. 8.

Since tumor cells have high water content, they tend to absorb more power. Based on the amount of power reflected by tumor containing breast tissues, the reflection coefficient values of malignant tissue are compared with reflection coefficient values of healthy breast tissues. The differences in reflection coefficient values provide significant proof for the presence of tumor inside the breast tissues. In this paper, tumor size of varying diameter is studied for the detection of breast cancer as shown in Fig. 9a–c.

When tumor size is 2 mm, power reflected is −33.5 dB in comparison to without tumor's reflection coefficient value, i.e., –27.78 dB. Figure 9a–c shows that as tumor size increases, more power is being absorbed by the tumor, resulting in lower return loss in comparison to healthy breast tissues (without tumor).

5 Specific Absorption Rate (SAR)

SAR is the energy absorption rate by tissues in W/kg on exposure to radio frequency (RF). The antenna calculates the SAR values to detect the presence of tumor.

In case of breast structure without tumor, the maximum value of local SAR is 127.76 W/kg as shown in Fig. 10. The phantom with tumor of size as 2 mm, 2.5 mm, and 3 mm has local SAR values as 128.31 W/kg, 137.48 W/kg, and 138.96 W/kg, respectively, as displayed in Fig. 11a–c. Higher values of SAR in phantom with tumor in comparison to without tumor case contribute to the confirmation of tumor in the breast. Thus, it helps in the detection of breast cancer.

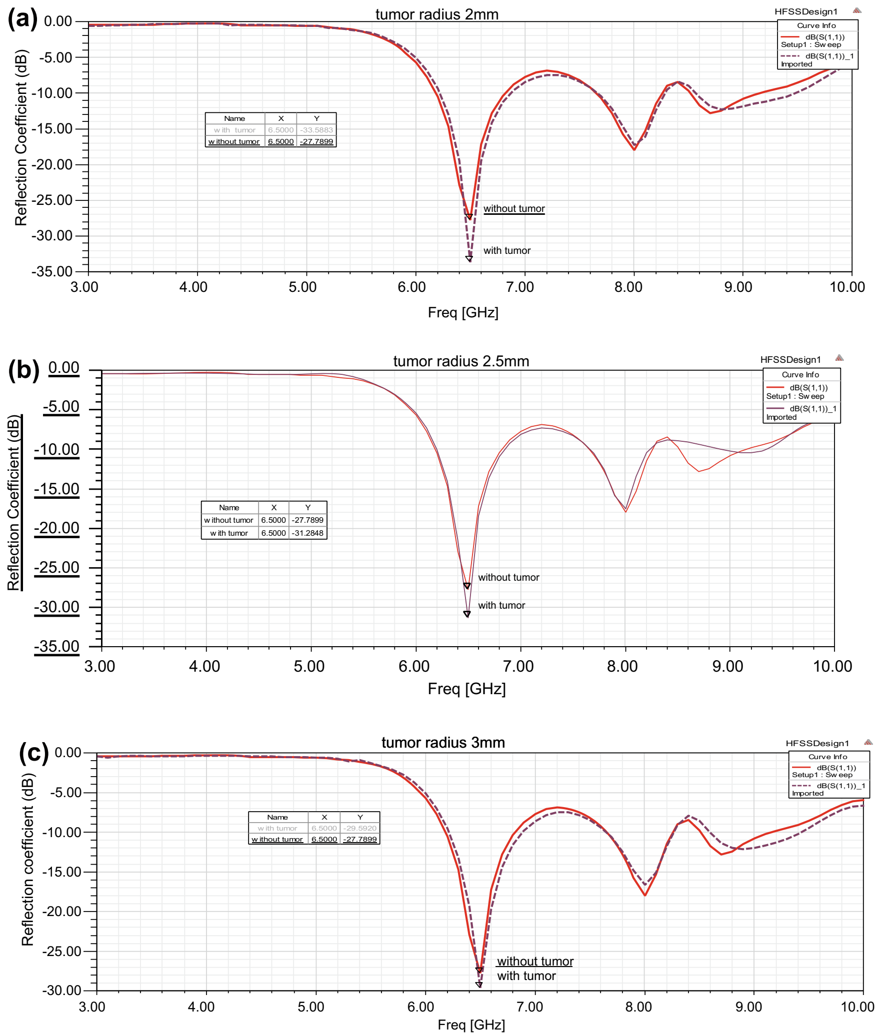


Fig. 9 **a** Comparison of reflection coefficient values of 2 mm tumor with healthy tissues. **b** Comparison of reflection coefficient values of 2.5 mm tumor with healthy tissues. **c** Comparison of reflection coefficient values of 3 mm tumor with healthy tissues

6 Conclusion

Metamaterial incorporated hexagonal patch antenna has been designed with resonant frequency at 6.4 and 8 GHz. Due to the addition of metamaterial structure, the maximum peak gain of 6.57 dB is achieved. The proposed antenna is then used to detect the tumor of size 2, 2.5, and 3 mm. The reflection coefficient values are analyzed for cases with tumor and without tumor in the breast tissues. Further, SAR values are computed for both the cases which gives the clear idea of the tumor's presence in terms of more absorption of power by the tumor cells. The future scope of this work is to analyze the transmission coefficient values as well as image reconstruction to detect the exact location of the tumor.

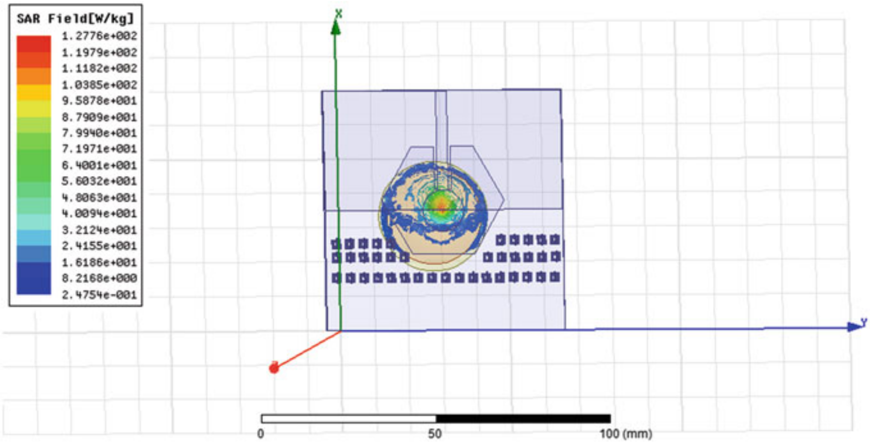


Fig. 10 Local SAR value of breast tissue without tumor

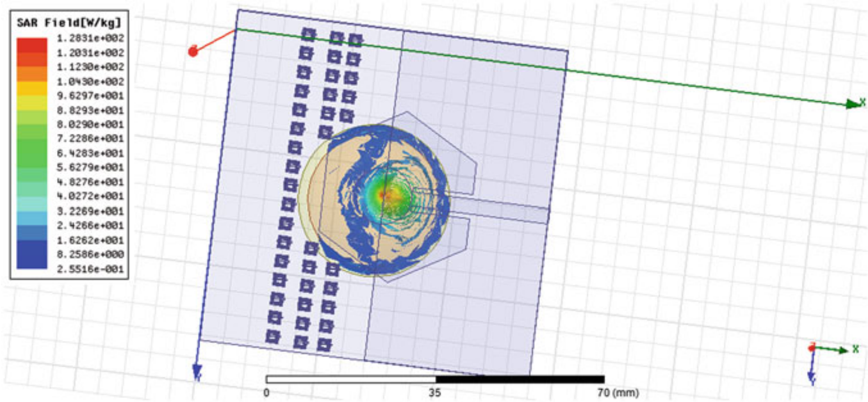


Fig. 11 **a** Local SAR value of breast tissue with tumor of size 2 mm. **b** Local SAR value of breast tissue with tumor of size 2.5 mm. **c** Local SAR value of breast tissue with tumor of size 3 mm

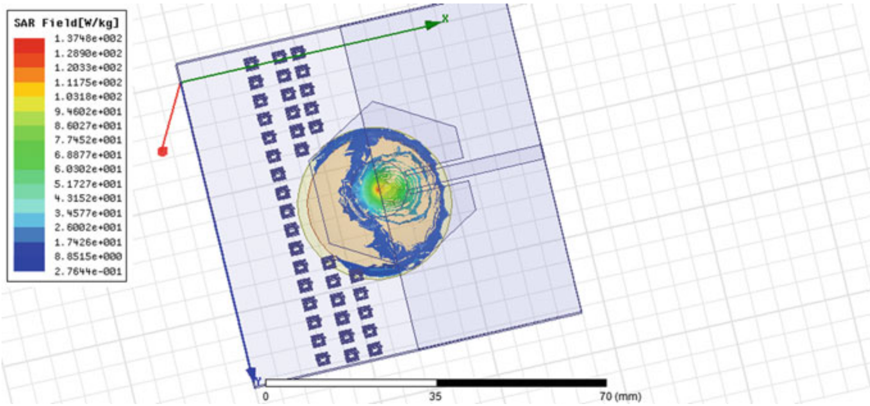


Fig. 11 (continued)

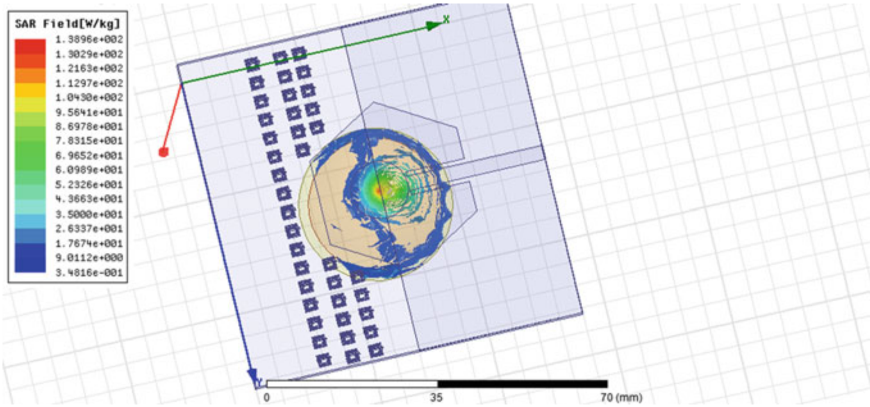


Fig. 11 (continued)

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Dimensionality Reduction Using Convolutional Autoencoders

Shweta Mittal and Om Prakash Sangwan

Abstract A dataset may consist of hundreds, thousands, or millions of features which represent the whole data. Greater the number of features in the dataset, higher will be the complexity of data analysis process, thereby increasing the time and space complexity of the algorithm. One of the possible solutions to reduce the complexity of analysis process is to use dimensionality reduction technique which helps in minimizing the complexity of an algorithm. Dimensionality reduction is an essential activity performed prior to any data analysis process to reduce number of features from the dataset. In this experimental study, convolutional autoencoder has been implemented to study the impact of kernel size and activation function on the accuracy of algorithm. From the experimental results, it can be concluded that (3 * 3) is the best choice for kernel size and PReLU is best suitable for activation function used in the convolutional layers.

Keywords Dimensionality reduction · Convolutional auto encoders · Autoencoders · Unsupervised learning · Deep learning

1 Introduction

Dimensionality reduction is a data preprocessing technique used to reduce the number of dimensions/features in the dataset. Principal component analysis (PCA), tensor stochastic neighbor embedding (t-SNE), independent component analysis (ICA), autoencoders, multi-D scaling are some of the popular dimensionality reduction techniques used nowadays as described in Fig. 1. Dimensionality reduction can be divided into two categories, i.e., feature selection and feature extraction techniques. Feature selection is done by selecting the subset of original attributes, whereas feature extraction is a process of deriving of new attributes from the original ones by attaining the set of principal components. Regressions and random forests are examples of feature

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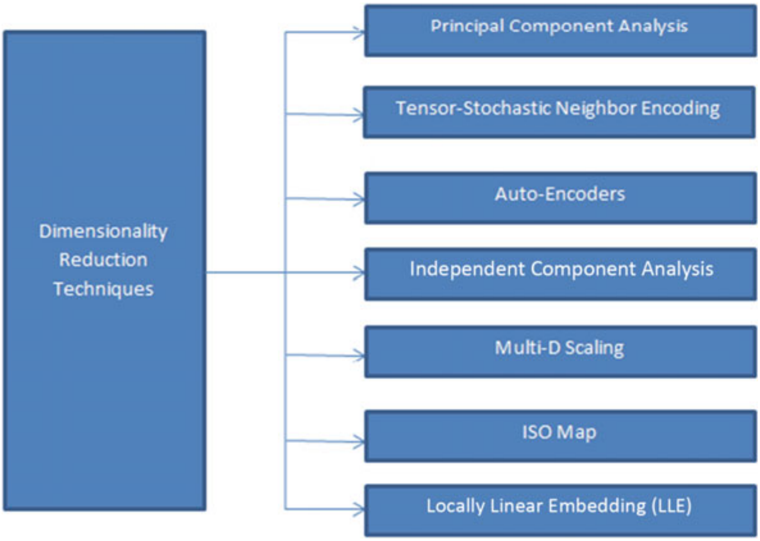

Fig. 1 Dimensionality reduction techniques

selection techniques, whereas PCA and autoencoders are examples of feature extraction techniques. Among the above-mentioned dimensionality reduction techniques, PCA and autoencoders are the most widely used techniques and are discussed below.

2 Principal Component Analysis

Principal component analysis is a statistical technique which makes the use of orthogonal transformation for transforming correlated variables into uncorrelated variables which can represent the whole dataset. PCA finds out new set of dimensions in such a way that all the new dimensions are linearly independent. These newly derived dimensions do not have any real meaning but only algebraic significance. Data normalization is a prerequisite step before executing PCA dimensionality reduction technique to avoid errors in the accuracy of algorithm. Min–max scalar and standard scalar are the frequently used data normalization techniques. Min–max scalar scales the data between minimum and maximum values, say 0 and 1, thus dataset will have low value of standard deviation, and effect of outliers will be minimized. Standard scalar normalizes the data such that mean of the data is 0 and standard deviation is 1. If the attributes present in the dataset are of different types and have different units, then it is good to standardize the data, else min–max scalar is recommended.

3 Convolutional Auto Encoders

Autoencoder is an unsupervised machine learning technique used to reconstruct the input pattern, de-noising the input, image reconstruction, feature extraction etc. It is basically divided into two parts: (a) encoder which down-samples the input and (b) decoder which up-samples the data back to the original size. The structure of decoder is symmetrical to that of the encoder. Autoencoder has its various variants depending on its architecture and types of input pattern, i.e., denoising autoencoders, robust autoencoders, contractive autoencoders, convolutional autoencoders, LSTM autoencoders, variational autoencoders, adversial autoencoders, relational autoencoders, and discriminative autoencoders [1].

Convolutional autoencoders (CAE) is one of the very popular variants of autoencoders primarily used for processing image data. Unlike PCA, CAE does not ignore 2D structure of data, and hence, are more capable of learning the spatial relationship among pixels. CAE is an unsupervised learning of optimal filters capable of learning the best spatial representation. It includes following operations.

Convolution: Performs convolution operation over input data and kernel weight matrix to obtain feature maps which helps in learning latent feature representation. The kernel matrix is square matrix initialized using various methods like random uniform, random normal, Glorot normal, truncated normal etc., and are generally of order 1 * 1, 3 * 3, 5 * 5, 7 * 7 and so on. For images of size larger than 128 * 128, kernel matrix of size greater than 3 * 3 is used; else, matrix of 3 * 3 is sufficient. If input image is of size a * b, *m* kernel matrix of size c * c, and padding is 'none', then '*m*' feature maps of size (a – c + 1) * (b – c + 1) is produced as output, else if padding is 'same,' '*m*' feature maps of size a * b is an output.

Pooling: It is used in the encoder part of the model to downsample the pixel by aggregating the pixel values. Maximum pooling, average pooling, sum pooling etc., are some commonly used pooling operations. If an input matrix is of size a * b and pool size is (2, 2), then it reduces the size of output by half, i.e., output matrix is of dimension (a/2 * b/2).

Upsampling: Upsamples the size of image as required and is used in the decoder part of the model. Say, if an input matrix is of size a * b and pool size is (2, 2), then it doubles the size of output, i.e., output matrix is of dimension (2a * 2b).

Convolution Transpose: Equivalent to upsampling + convolution and is used in the decoder phase of autoencoder.

Zero Padding: If image has odd number of pixels, say 75 and pool size is (2, 2), then output will have 37 pixels. Afterward, if upsampling is done, then final output image will have 74 pixels. As a result, some pixels are lost and size of output image is not equal to size of input image. Thus, to overlook such scenario, zero padding is used to insert a row of 0s at top, bottom, left, or right depending on the requirements.

Cropping: Crops the input based upon the specifications passed by the user in order to make required output image dimension. The arguments are generally passed as: (top, bottom), (left, right). Say, if we want to crop only left most layer, then we will pass ((0, 0), (1, 0)).

The network learns sparse connections among weights by having kernel size smaller than the input matrix, thus reducing the memory requirement and improving the efficiency of the model. Also, parameters or weight matrix of kernel are shared among various connections, which also results in efficient memory management of the algorithm.

Activation Functions Popularly Used in CNN: Activation functions are used in neural networks to learn the non-linear relationship among the data. One of the most popularly used activation functions used in convolutional layer is ReLU, which along with its variants have been discussed below.

ReLU: Known as rectified linear unit, it is the most commonly used activation function for the hidden layers in the neural network. It provides the output value same as its input value if input is greater than 0, else gives 0 as output (as described in Fig. 2). It is easier to train and provides better performance.

LeakyReLU: It is one of the variant of ReLU which provides the output value same as its input if it is greater than 0; else, gives alpha * x as output, where alpha is hyperparameter (as described in Fig. 3).

PReLU: Known as parametric rectified linear unit, another variant of ReLU which provides the output value same as its input if input is greater than 0; else, gives alpha * x as output (where alpha is learnable parameter of neural network). LeakyReLU and PReLU have an advantage over ReLU of overcoming vanishing gradient problem.

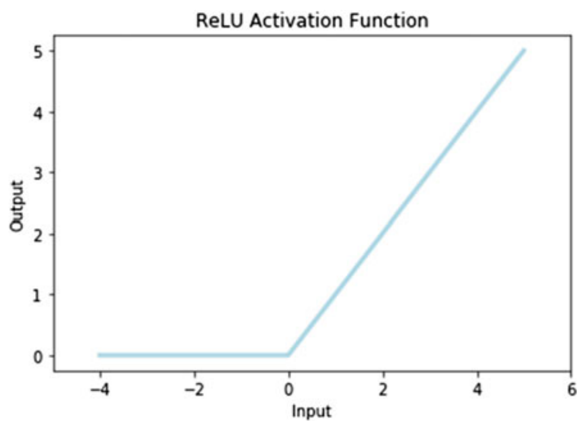

Fig. 2 ReLU activation function

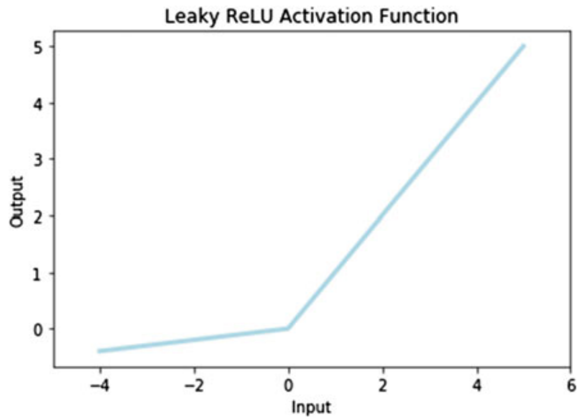

Fig. 3 LeakyReLU activation function

4 Literature Review

Convolutional autoencoders have been adopted by number of researchers for dimensionality reduction in the past decade, and the same has been discussed in this section. Masci et al. implemented Stacked CAE for feature extraction, and it was analyzed that pre-trained CNN performed better than randomly initialized nets [2]. Tan et al. implemented stacked convolution autoencoders(CAE) for detecting data hidden in cover images, and the results concluded that CNN trained using CAE provided superior performance than traditional CNN but was not able to compete with the spatial domain rich model [3].

Riberio et al. studied deep CAE using AdaGrad optimizer for finding anomalies in videos on UCSD pedestrian dataset, and it was concluded that use of RRE, i.e., regularization reconstruction error as a measure can distinguish between normal behavior and anomalies. Also, the proposed system allowed information from multiple sources which in turn improved the performance of the algorithm [4]. Chen et al. implemented convolutional autoencoders for presenting several descriptors to learn features automatically from raw data [5]. Performance was evaluated using recall and precision measure, and the results proved that AE can be successfully used for feature-based matching.

Cheng et al. presented and implemented CAE having symmetrical upsampling and downsampling architectures for image compression with additional components, i.e., PCA, quantizer, and encoder to generate the codes [6]. From the results, it can be concluded that proposed technique performs better than JPEG and JPEG2000. Maimaitimin et al. implemented stacked CAE for surface recognition of 3D data, and the results proved that use of surface condition feature in the proposed stacked CAE was effective for classification, and the model was sensitive to change in surfaces [7].

Zang et al. implemented simple autoencoders (SAE) and CAE for image compression and denoising and it was concluded that CAE was able to get better spatial representation [8]. Chen et al. analyzed CAE neural network for marking the lung nodule. Large unlabeled data has been used for determining parameters of convolutional layer while small labeled data has been used for fine tuning the parameters of the network and the results proved that proposed approach performed better than AE, CNN and MCCNN [9]. Du et al. too proposed and implemented Stacked Convolutional Denoising AE (SCDAE) for feature representation [10]. In the proposed model, Whitening layer has been added before the convolutional layer to minimize redundancy and correlation among pixels. From the results, it can be concluded that SCDAE outperformed SDAE and SSAE as the network made the use of denoising structure and patch wise training method.

Suganuma et al. presented and implemented Evolutionary CAE for image restoration and its performance was compared with the models using Adversial training and complex learning algorithms i.e. SII (Semantic Image Impainting) and Context Autoencoders against PSNR and SSIM values [11]. The proposed model outperformed the other two for number of datasets. Mao et al. proposed CAE with symmetric convolution and deconvolution layer with skip connections and it was analyzed that models with larger filter size and patch size performed better and leads to better performance [12].

Zhang et al. implemented PCA technique followed by linear regression for dimensionality reduction, and the proposed technique gave exact solution [13]. Arsa et al. applied deep belief network twice on Indian Pines Dataset, once as a dimensionality reduction technique, and then as a classifier [14]. As dimensionality reduction technique, data looks more separated in DBN than PCA, and as a classifier too, DBN gave more accurate results.

From the review on the work done by the various authors in this section, it can be concluded that CAE is very powerful and efficient technique for dimensionality reduction. By carefully choosing the filter size, number of filters, kernel size, activation functions, skip connections etc., performance of autoencoders can be optimized to give better results.

5 Proposed Architecture

In this paper, Skin Cancer dataset from Kaggle.com [15] has been analyzed to study the best possible architecture for Convolutional Autoencoders. The dataset is around 2.6 GB comprising 10,015 images of size 450 * 600 having 3 channels. Various attributes of the dataset are age, sex, localization, type of cancer, history etc. While pre-processing the data, it has been observed that attribute age has 57 undefined values which have been replaced by mean age.

Convolution Autoencoder has been built sequentially using Keras API which has several methods like Conv2D, MaxPool2D, ZeroPadding2D, Cropping2D, UpSampling2D etc., to ease the implementation of model. The model has been trained using

ADAM optimizer and Mean Absolute Error matrix has been used to determine the accuracy of the model. As size of images are very large and cannot be processed using TensorFlow framework, images have been resized to 75 * 100.

Image of size 75 * 100 * 3 has been provided as input to CAE. All the pixel values have been first normalized between 0 and 1 and then provided as input to the model. Training and Testing data has been divided in ratio 80:20. Input image has odd number of pixel values i.e. 75, thus to make the output dimensions equals to the input dimension, ZeroPadding2D has been used. The proposed network comprises of 5 Convolution layers, 2 MaxPooling layers and 2 UpSampling layer and the architecture has been summarized in Fig. 4. Network has been analyzed for various kernel sizes and activation function to determine the parameters which provides the least error.

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
zero_padding2d_8 (ZeroPaddin (None, 77, 102, 3)        0
_________________________________________________________________
conv2d_28 (Conv2D)           (None, 77, 102, 32)       896
_________________________________________________________________
p_re_lu_11 (PReLU)           (None, 77, 102, 32)       251328
_________________________________________________________________
max_pooling2d_11 (MaxPooling (None, 38, 51, 32)        0
_________________________________________________________________
conv2d_29 (Conv2D)           (None, 38, 51, 64)        18496
_________________________________________________________________
p_re_lu_12 (PReLU)           (None, 38, 51, 64)        124032
_________________________________________________________________
max_pooling2d_12 (MaxPooling (None, 19, 25, 64)        0
_________________________________________________________________
conv2d_30 (Conv2D)           (None, 19, 25, 128)       73856
_________________________________________________________________
p_re_lu_13 (PReLU)           (None, 19, 25, 128)       60800
_________________________________________________________________
up_sampling2d_11 (UpSampling (None, 38, 50, 128)       0
_________________________________________________________________
conv2d_31 (Conv2D)           (None, 38, 50, 64)        73792
_________________________________________________________________
p_re_lu_14 (PReLU)           (None, 38, 50, 64)        121600
_________________________________________________________________
up_sampling2d_12 (UpSampling (None, 76, 100, 64)       0
_________________________________________________________________
conv2d_32 (Conv2D)           (None, 76, 100, 3)        1731
_________________________________________________________________
p_re_lu_15 (PReLU)           (None, 76, 100, 3)        22800
_________________________________________________________________
cropping2d_6 (Cropping2D)    (None, 75, 100, 3)        0
=================================================================
Total params: 749,331
Trainable params: 749,331
Non-trainable params: 0
```

Fig. 4 Architecture of CAE for skin cancer dataset

6 Results

Model proposed in Section 3 has been implemented using Keras library to study the impact of kernel size and activation function on the runtime and accuracy of the model. As shown in Table 1, mean absolute error (MAE) observed using PReLU activation function is very low, i.e., 0.094 as compared to ReLU and LeakyReLU with the MAE values of 0.5228 and 0.1365, respectively. Further, it can be concluded that model trained using PReLU activation took more time to train, i.e., 10 hours, while LeakyReLU and ReLU activation function took 7.3 and 8.6 h, respectively. MAE value for ReLU, PReLU, and LeakyReLU over 50 iterations has been shown in Fig. 5, and it can be observed that MAE value decreases with increase in number of iterations for PReLU and LeakyReLU activation function.

With PReLU as activation function, algorithm was again run to study the impact of kernel size with the values of (1 * 1), (3 * 3), (5 * 5) and (7 * 7) and the results have been shown in Table 2. From the Table 2, it can be inferred that kernel size of 3 * 3 gave least MAE value of 0.094 while kernel size of 1 * 1, 5 * 5 and 7 * 7 gave higher MAE value i.e. 0.26, 0.095 and 0.112, respectively. It has been further observed that with the increase in kernel size, time required to train the algorithm also increases.

Table 1 Comparison of MAE values for ReLU, PReLU, and LeakyReLU activation functions

Activation function	MAE after 50 iterations	Runtime (h)
ReLU	0.5228	7.35
LeakyReLU	0.1365	8.62
PReLU	0.094	10.03

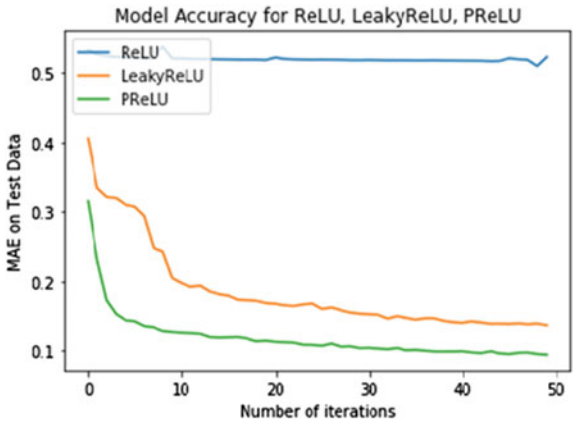

Fig. 5 Comparison of model accuracy for ReLU, LeakyReLU and PReLU activation function

Table 2 Comparison of MAE values for various kernel sizes

Kernel size	MAE after 50 iterations	Runtime (h)
1 * 1 kernel	0.261	4.966728246
3 * 3 kernel	0.094	10.02566369
5 * 5 kernel	0.0952	13.91023313
7 * 7 kernel	0.1125	22.77122048

7 Conclusion and Future Work

Feature reduction is a very important preprocessing step in the process of data analytics which can reduce time and space complexity of algorithm to greater extent. Convolution autoencoders is a popular feature reduction technique adopted by number of researchers in the past decade for dimensionality reduction of image datasets. In this paper, CAE has been implemented on Skin Cancer dataset to study the impact of kernel size and activation function on the accuracy of the model, and it has been concluded that kernel size of (3, 3) and PReLU activation function gave the best results in terms of MAE.

Performance of autoencoders can further be improved by employing several techniques such as k cross fold validation, batch normalization, regularization, dropout (few neurons, i.e., 20–50% are deactivated with some probability), image augmentation etc. Accuracy of algorithm can further be improved by choosing the optimal number of filters, filter size, and introducing skip connections and can be studied in near future on more complex datasets.

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Evaluating Usability in Learning Management System Using Moodle

Monika Arora, Indira Bhardwaj, and Sonia

Abstract This chapter aims to explore the use of e-learning technologies in virtual learning. It has examined the implications of the use of e-learning platforms available and also popular globally. The goal is to study the popular learning management system (LMS) in the world in various top universities. Data that form the basis of analysis were collected through the respondents using moodle in structured format. The respondents are aware of the usability features in moodle. The study was considered in October-2020 at Apeejay School of Management. The nine usability features were identified and evaluated. They are easy to use, efficient, effective navigation, memorability, satisfaction, mobile compatibility, fast load times, browser consistency and colour scheme. Although all the features are satisfied, the evaluation of feature fast load times and browser consistency got the low scores where the management has to be considered and take some action regarding this. Also, the features ease of use and efficiency got the highest score in all nine parameters. The range of all parameters is from 3.5 to 4.1 out of 5. This research contributes to the upgrading of LMS in future. As it is a cloud-based open source, more functionality can be implemented in future in the institute by the moodle administration team.

Keywords Evaluation · Usability · Moodle · LMS · e-Learning

1 Introduction

The learning management system in online education has been considered altogether has provided a different dimension to ways of teaching and learning. It has generated lot of excitement in both training and higher education. It proposes the way to

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provide learning to new audiences, and simultaneously, it proposes a great prospect fundamentally to change over their learning and delivery in a competitive landscape [1]. There are many institutes' that defines mad embraced the learning management system the rationales vary and broadly fall into the four broad categories:

- Expanding in learning. Most of the institutions have started taking their online classes. The institute does not want any loss of their students further. The online classes are not started for higher education but also it is happening for schools as well. This has also opened up the training needs in terms of faculty and management development programmes with nominal or no fees.
- This time it has opened up all the barriers and given a full opportunity to all the learners to step forward in the field of learning [2].
- Eliminating the capacity limitations. There has been a rush of students to occupy the first seats and ask the questions. The e-learning has eliminated the bricks-and-mortar capacities numbers and universities are ready to accommodate more. If you are taking a session of 50 in batch, you don't mind taking 100 in batch as there is no extra expenditure involved especially in the training sessions [3].
- Capitalizing on emerging market opportunities. Over time the concept of lifelong learning has fuelled the demand for learners. Earlier the average age of traditional studies was 18–24 years and came to an end. There is no age for learning. By capitalizing on emerging market opportunities and requirements, there are many educational institutions who are offering new courses and also getting significant revenue [4].
- Serving as a catalyst for institutional transformation. The latest technology usage and also enabled them in enrolling for online courses of international universities have put them in an increasingly competitive environment. There is no bar to distance and space [5].

Due to the massive use of Internet and ICT infrastructure, the institute is open to opportunities of learning manner. This can be possible with only the use of learning management system. The advantages of e-learning in comparison with traditional learning make education independent of time and location. More importantly, age is no bar and people can learn at any time anything. Moreover, e-learning assists teachers for the management of online courses [6].

The main purpose of this paper is to find out the factors of usability features of the learning management system (LMS).

2 E-Learning in Education

The use of ICT and the Internet has succeeded in e-learning in education. It started in 1990 as with the Internet. This has been associated with the Internet and has become popular because of the use of online delivery; at that time, only there were many concepts based on computers that became popular such as distance and distributed learning, computer-based and lifelong learning [7]. The use of the internet and good delivery will definitely have an added advantage using online education. For an online delivery of any courses, the basic things that are required are (a) Good course material (b) interaction with the instructor through phone or email. Prominent researchers have suggested the various techniques related to online work [8, 9]. Security aspects are also considered during cyber usage [10–12]. The new technology such as a platform where students and instructors can connect to each other. Hence, e-learning or distance learning or virtual learning can define the education delivery to a different concept, where same time, same place, face-to-face environment does not matter[13]. Online learning is unfair for some of the technical subjects. But over time, the use of simulators has provided a different dimension. There will be no barrier as such if it comes to the teaching and learning to the students by the instructor. Languages can also be taught online, and there can be revision videos that will be more helpful than the normal classes [14].

Similarly, computer-based education has in between interaction and questions to make it more interactive and active all the time [15]. This has become a need of an hour. This provision has taken forward a concept of collaborative learning and the facilitation of communication will help in assessment and grading [16]. Collaborative tools which offer a rich content-based, shared in virtual space, where all can interact with each other. There are many students who learn from many instructors. The interaction tools may be forum, chat, video conferencing, etc. The system called as learning management system is shown in Fig. 1.

The one of the popular LMS is moodle [15]. The advantage of using the LMS system saves time, and it is affordable, consistent, interactive, and also collaborative.

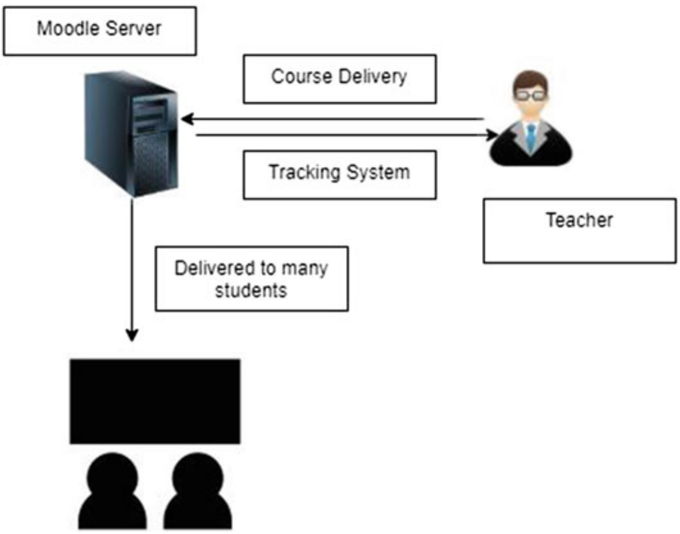

Fig. 1 LMS

All the notifications will be generated and forwarded to a registered email. The scope of a LMS where learning depends upon more and more interaction and connection. This will be done by maintaining the large collection of study material in this system. These tools will act as a distribution tool used for uploading the documents and to make them available to the system. It will also do the communication that is server, teacher to students, students to students. This will be the reaction and feedback discussion using the blackboards, forums, etc. [1, 17].

Basic requirement for any LMS is posting and support from hardware, software and security capabilities. This can be considered by using a domain and interface workflow. Also, the approval process learning, content creation and catalogue feature should be under the control of management or admin in LMS. The requirements of communication and collaboration data and data files for analysis are maintained by LMS. Moodle stands for modular object-oriented dynamic learning environment (moodle). Moodle is versatile that means it is complete in an online learning environment and a focal point of online collaboration, a repository of self-study courses and materials. Moodle contains collaborative synchronous courses independent and self-paced courses based on the philosophy of online learning the activities and heart of the course management system. Moodle is used by an educator and computer scientist with works on social constructionist principles in mind. The learning is particularly more effective when constructing someone or for others to experience. It can be anything from a spoken sentence on an Internet posting to complex artefacts like painting. The software package is based on the concept of social constructivism extends the above idea into a social group constructing things for one another. In collaborating, creating and a small culture of sharing aftereffects with their meanings when one is immersed with a culture like multiple things together and at many levels [18].

The moodle administrator has a flexibility to choose from user registration, manually entering users or user accounts, and can be drawn directly from the institution's existing databases [19]. There are many key nine factors which are effective in online learning. The evaluation of these factors is as under:

- Easy to use: The interface is very familiar with ease of use for consumers. The options to be used are easily available to the user. All the options are available and also best of the use whenever possible.
- Efficient: The use of the tool has actually increased the efficiency of the students. Such as marking the attendance submission of assignments and attempting the online and offline assignments.
- Effective Navigation: The performance of students can be measured as the aspects of effectiveness. The navigation in effectiveness will help the student to explore and is a positive sign for assessing the teaching material and also using the online learning management system. The instructions are like face-to-face instruction and are communicated firmly.
- Memorability: The use of instructions to navigate the full course by the students is easy and memorable. The student will relate, and memorize is easily related to use of the LMS features effectively and efficiently

- Satisfaction: The 100% use of the LMS in all the studied courses implied that the satisfaction in the user experience. The students and faculty members are using it in all their courses, and students are also following the instructions given by the management for the use of LMS, i.e. moodle.
- Mobile compatibility: The application-based moodle application is also available with all the features available. The students can use it either on desktop or in mobile according to their convenience. The application-based moodle connects fast to the network instead of using website URL.
- Fast load times: The load time in any website takes time. In case of moodle, it won't take much time. However, it has many hits at the same time.
- Browser consistency: There is a consistency in using any of the browsers. There are many browsers such as Internet explorer, Opera, Mozilla and chrome. The moodle page is opening as a consistency in all the browsers.
- Colour scheme: The colour scheme used in the moodle version is very colourful and also liked by the students. The dashboard is very colourful in case of using the moodle version, and it is liked by the students.

3 Data Analysis and Interpretation

Data for this was collected using an questionnaire. 57 students have responded in questionnaire. The features that were used to capture the concept of effectiveness are student involvement and participation, cognitive engagement, technology self-efficacy, perceived usefulness of the technology employed and the relative advantage of online delivery [20]. The correlations between the 9 features are calculated, and it shows that efficiency and ease to use have a very high correlation as 8.5 and the moderate correlation as 4.3 is fast load times and colour schemes as shown in Fig. 2 and Fig. 3.

A small questionnaire was prepared to evaluate the usability features of moodle. There was a 5-Likert scale ranging from strongly agree to strongly disagree. The students of ASM have filled the survey form the 50 respondents have participated, and it was found that as mentioned in Fig. 4.

Each student has filled out the questionnaire, and there are questions considering all the usability features as study-specific for this research paper it was composed. The most consideration of these parameters is discussed in the checklists for testing usability of e-learning systems [1–3, 6, 14]. The goal of this questionnaire is the expression as they are using the moodle for the last 6 months at their studies of students. There are some students who have the prior knowledge of other LMS in their previous college or they have ideas from other sources. The system and concerns on the usability features such as ease of use, efficiency, effective navigation, memorability, satisfaction, mobile compatibility, fast load times, browser consistency and colour scheme. The user had to complete easy tasks such as open chat and upload/download files.

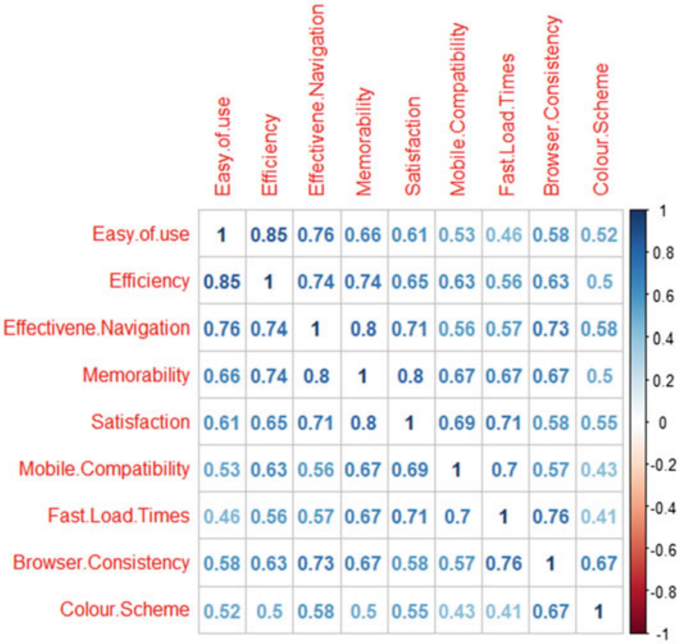

Fig. 2 Correlation between features

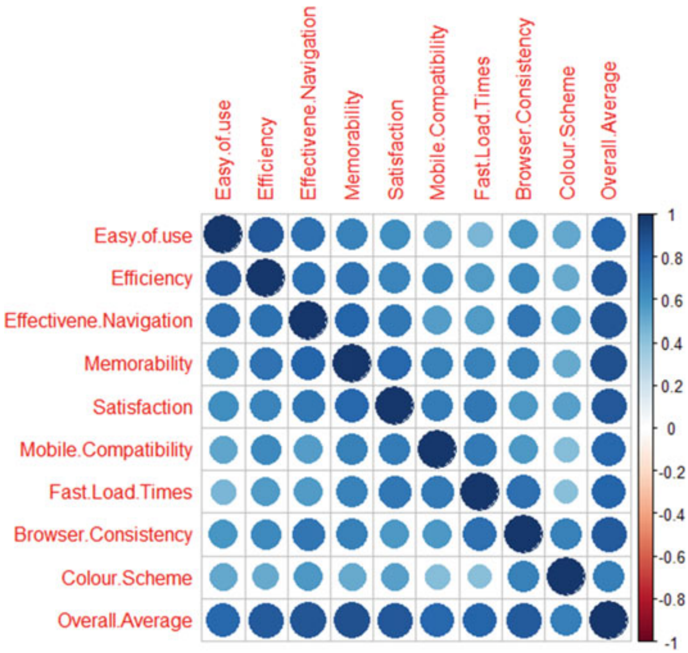

Fig. 3 Correlation between features using size

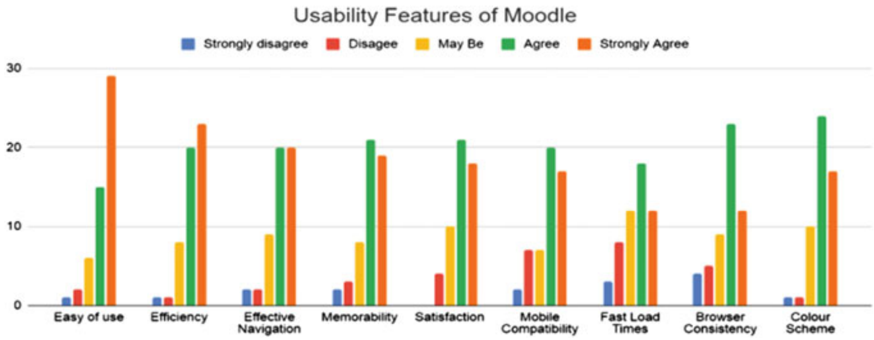

Fig. 4 Usability features of moodle

The three main variables affecting the effectiveness of online delivery are technology, instructor and student characteristics. This was suggested that students lacking the necessary basic skills and self-discipline may do better in a traditionally delivered mode. Similarly, the brightest and most motivated students may prefer to learn in an individual competitive environment rather than sharing their knowledge with less motivated, less bright students in a traditional classroom setting [16].

Learning management systems allow students to view multimedia lectures, communicate with their teachers and each other in learning communities, download course materials, take online quizzes and submit homework and classwork assignments. In addition, these systems are used for improving the internal faculty organization. The intricacies of these complex systems are resolved by including a lot of modules in their implementation. It is emphasized mainly on the coordination in any school between teachers, students and management. This has also provided the new dimension of teaching and learning off-site, where the students are online available in class and studying from their home or working place. This has increased the volume of self-paced learning, and it will also save the extra cost of travel and paperwork to develop better administration. It is more efficient learning to create a centralized learning system to enhance the ability to upload and manage the documentation containing the curriculum. These two modules have completely changed the direction of using an online platform. Also, the availability of teaching material and use of moodle has increased. The faculty has started more reading material, quizzes and articles on moodle to make students more interactive. The advantage of using an online platform is students can view their real-time attendance as well. Even they can view their grades, etc., the transparency between the students and faculty has increased. The confidence over the system has strengthened also. Enrolled users as students can also see their announcements, deadlines and notifications. Enrolled user as a teacher can create attendance, add material to the course, give grades, enrol students and add different activities to a course. The various activity reports can be generated using moodle.

Learning Material: The various blocks can be added to the moodle system based on its usage and priority. Every class forms a learning community having a participants group. There can be a self-course management feature in moodle as it is a modular architecture that makes adding new activity during the course creation a very simple process.

Communication: The chat module allows the real-time synchronous communication by learners in the module. Quiz in the moodle can create a question and the number of choices for the students that are random-based questions and options. There is a module called discussion boards where asynchronous group exchanges and shares the subject matter. The grades, assignments and participant list can be imported and exported and reused for the future courses.

Assignments: The lesson learners can be graded upon the completion quick quiz module, create all the familiar forms of assessment including true and false, multiple choice, short answer, matching question, random answers, a number questions with embedded answer questions. It can also include descriptive text and graphics, etc. The teacher/ administrator has full control over the settings for the course and restricts other teacher choices of course formats [21].

4 Results

The results of our analysis are recommendations to the moodle team all teachers and students, as use the moodle in the same way as they are using. The recommendations are forwarded to the moodle team, i.e. the speed of the website and also the moodle mobile version to be deployed. LMS will have a compressed and comprehensible implementation of moodle. As mentioned, that all the results have a very little variation and are towards the higher side. The calculated average interprets the same. The overall average for all the respondents is 3.8 out of 5, i.e. 78.33%. The summary of the study is presented refer to Fig. 5.

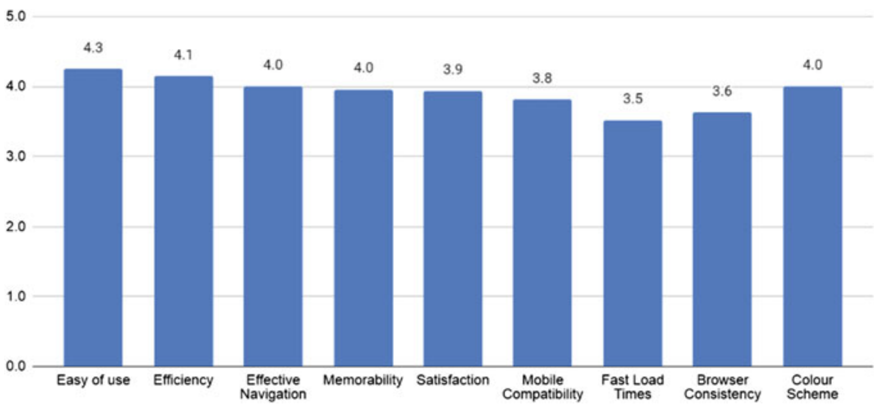

Fig. 5 Evaluation averages of usability features

5 Conclusion and Future Work

This paper discusses the usability features of LMS and also applied it to moodle. It was tested on various modules. The results are based on quantitative data along with expert opinions on who is using moodle at the level of administrator, teacher or a student. The recommendation of usage is it is easy to use, and the new moodle version has a variety of colours which are liked by the respondents. The respondents have a problem with the fast load time as in rural India, there is a problem with the Internet connectivity. Although the technical team says that it can take a load for 6000–7000 users at one time, future work can also be tested on the other LMS and has a better comparison between them. Then the search in comparison with other LMS will give a better understanding and future development.

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Extracting Cluster-Level Uncertainty from K-Means Clustering—An Example of Analysis of Uncertainty Inherent to Valuation Methodologies for Multiple Construction Projects

I. L. N. Prasad, K. V. G. D. Balaji, Chitti Babu Kapuganti, Ramesh Chandra Bagadi, and T. Santhosh Kumar

Abstract In this research investigation, we first propose a concept of extracting cluster-level uncertainty of any coordinate of a univariate dataset from K-means clustering of the dataset of concern. We also parallelly propose the notions of upper bound uncertainty and lower bound uncertainty to the afore-extracted cluster-level uncertainty of any coordinate of the dataset of concern. We then apply this concept on the rote uncertainties of some construction projects (already finished) of concern and compute their cluster-level uncertainties and also the lower bound uncertainty and upper bound uncertainty for each construction project. A scheme is also detailed as to how to compute the cluster-level uncertainty, the lower bound uncertainty and upper bound uncertainty to the uncertainty of a new unfinished or in the offing construction project. Valuation is essential for a wide variety of purposes. However, it plays a major role in the construction sector to ensure reliable project expense assessments and to minimize risk to financial institutions and firms. Valuation of infrastructure projects focused on a general approach without understanding the uncertainty of project depending on diverse building designs, and construction techniques lead to additional costs or underestimate. Valuation methods like income approach method, cost approach method, and market approach method are generally used for the valuation of projects. Cluster-level uncertainty is helpful since most of the building projects

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have some resemblance to present or previous projects, and thus, the proposed cluster-level uncertainty can be used to identify the financial or economic haziness of any building project in progress.

Keywords Construction valuation · K-means clustering algorithm · Linear regression · Uncertainty · Valuation methodologies

1 Introduction

Uncertainty in clustering is an inevitable aspect due to the large size of the datasets involved and the many clusters or groups that they can form into. A detailed information of uncertainty in clustering is detailed in [1]. [2] details visualizing clustering and uncertainty analysis if multivariate time series data. In [3], the authors study cluster validity and uncertainty assessment for self-organizing map pest profile analysis. [4] primarily presents uncertainty quantification of trajectory clustering applied to Ocean Ensemble Forecasts. There are many ubiquitous representations of uncertainty in clustering, and they change from application to application and problem of concern.

2 The Mathematical Equation of Cluster-Level Uncertainty: Lower and Upper Bound Uncertainties

2.1 Cluster-Level Uncertainty

We define cluster-level uncertainty as follows:

The cluster-level uncertainty of the point is computed after the points have been clustered using the K-means algorithm.

Cluster-level uncertainty implies that the uncertainty points belonging to a cluster have the cluster centroid as the uncertainty hinge when the data points are clustered using the K-means clustering algorithm. Cluster-level uncertainty specifically has two components:

Lower Bound Uncertainty (LBU). Lower bound uncertainty of cluster represents lower side uncertainty of the point (of concern) in the cluster. LBU is used to represent the lowest uncertainty of all points in the cluster. LBU for pth cluster C_p is given in Eq. (1), where i indicates the univariate data coordinate of the dataset of concern.

$$LBU = \left(\text{Uncertainty}(i) - \min_{i \in C_p}(\text{Uncertainty}(i))\right) \tag{1}$$

Upper Bound Uncertainty (UBU). Upper bound uncertainty of cluster represents upper side uncertainty of the point (of concern) in the cluster. UBU is used to represent the highest uncertainty of all points in the cluster. UBU for pth cluster C_p is given in Eq. (2), where i indicates the univariate data coordinate of the dataset of concern.

$$UBU = \left(\max_{i \epsilon C_p} \text{Uncertainty}(i) - (\text{Uncertainty}(i)) \right) \tag{2}$$

3 An Example of Analysis of Uncertainty Inherent to Valuation Methodologies for Multiple Construction Projects

3.1 Introduction

In the framework of a construction project (CP), valuation is defined as the technique of estimating or determining the fair price or value of a property/asset such as a building, a factory, land, and other engineering structures. The preparation of valuation for any project is considering an intricate process [5]. Particularly, the process of construction cost estimation encompasses a gamut of variable factors and it is essential to play a major role in the construction sector to ensure reliable project expenses assessments and to minimize risk to financial institutions and firms [6].

The purpose of a valuation is to buy or sell property, taxation, rent fixation, the security of loans or mortgage, compulsory acquisition, insurance, etc. The value of any property is based on its structure, life span, maintenance provided, site location, bank interest, etc. The most common types of valuation rely on either cost approach, market approach, or income approach-based stratagems [7].

A market approach method is a valuation approach which determines the value of a property by comparing it to similar properties in the vicinity that have been recently sold, along with proper adjustments for acreage, size, amenities, time, etc. This approach to value is mainly based on the principle of substitution [8]. This method assumes that an individual will compare prices of the subject property with similar properties and will purchase the property only when the cost is not more than the comparable [9].

The cost approach method gives the market price for the project equivalent to the cost of land and cost of construction, with depreciation. It gives more accurate results for newly constructed projects. It also summarizes the value of each sub-projects in a project [10].

The income approach method of valuation is primarily applicable to the valuation of income-producing or investment projects. This approach is a standard valuation procedure employed to convert expected returns from the project into present value for income-producing projects [11].

Uncertainty in construction project valuation can describe as the difference between the actual cost of the project and the initial cost estimate. Uncertainties are generally interpreted as factors that influence reaching project objectives. Many researchers express them from various perspectives. However, uncertainties occur when the outcome or activities are likely to differ from expectations. Every complex construction project is exceptional and unique [12].

Uncertainties in a construction project are multifaceted. Based on construction techniques and design, the cost of structure varies. A plethora of parameters such as availability of skilled labor, cost of construction material, quality of plans and specification, skilled supervision, time of construction, availability of tools and technology, issues of erection and execution, environmental impacts as well as the size and type of construction project play determinative roles [10, 13].

Uncertainty classification at a macro-level (cluster or group) is highly pertinent as if conveys information about the manner in which CPs with different uncertainties tend to have a cluster or group level uncertainty, attributable to the similarities in the CPs. Comprehending this uncertainty is envisaged to assist in the preparation for additional costs, if any, and also, ensure economical stance in case of negative uncertainties [14]. Furthermore, a large database/repository of uncertainties of all the CPs of a state is expected to help in calculating the general macro-level uncertainty for a project of concern, as it has some semblance with past projects. Variation is the difference between uncertainties calculated with the help of various valuation approaches. It helps in identifying the best suitable approach for a particular project [15].

Uncertainties and variations of valuation approaches of various construction projects typically resemble each other. In general, uncertainties in the valuation of new or ongoing construction projects are unknown [16]. The finding of this resemblance will make the user understand easily and handy while dealing with the valuation of new construction projects. Forming clusters and study their behavior, best suited for depicting the relationship between the type of project and uncertainties involved in a valuation [17].

This study presents the methodology for framing clusters of uncertainties by valuation approaches involved in various projects and studies their behavior for understanding the relationship using K-means clustering and linear regression. The present study also applies the proposed methodology using a case study that consists of fifty-eight projects by finding clusters for fifty-eight projects and to predict the uncertainty values by these cluster results for the remaining five proposed projects.

3.2 Problem Statement and Methodology

In this research investigation, the authors present a scheme to analyze bounds of uncertainty inherent to valuation methodologies in the construction industry.

Firstly, 63 construction projects are considered, and their uncertainties are computed for each of the valuation methodologies of cost approach method, market approach method, and income approach method.

For each of the valuation approach, these uncertainties are then clustered using K-means clustering algorithm. Using a proposed notion of cluster-level uncertainty, the authors compute the upper bound and lower bound uncertainties for the aforementioned thusly clustered rote uncertainties of the 63 Construction projects.

Furthermore, a notion of relative importance index and ensembling scheme is also proposed to ascribe importance coefficient to the bounds of (cluster-level) uncertainty of each construction project for the different valuation approaches used and combine the values of the three valuation approaches appropriately to get one value of bounds of (cluster-level) uncertainty, respectively.

Cluster-level uncertainty or the bounds of uncertainty are useful because they tell how much the uncertainty can vary. They are useful as most construction projects have some semblance with past projects, and therefore, one can use the cluster-level uncertainty to find the bounds of uncertainty of any construction project in progress, i.e., which has not been finished yet for which some prediction technology has been used to predict its rote uncertainty.

For validation purposes, the authors consider the above analysis for all 63 projects and we repeat this scheme on the first 58 construction projects, and for the next 5 construction projects, the authors use linear regression-based forecasting-based prediction to predict the rote uncertainties of the aforementioned last 5 Construction Projects.

Then, the rote uncertainties of the first 58 construction projects and the predicted rote uncertainties last five construction projects are considered, and these are clustered using K-means clustering algorithm.

The authors then compute the bounds of (cluster-level) uncertainties for each of the last five construction project uncertainties using the proposed notion of cluster-level uncertainty and use the proposed relative importance index and ensembling scheme to combine the values gotten by each of the three valuation approaches.

Finally, the authors compare these ensemble values of the bounds of uncertainties of the validation approach and the actual data case analysis.

The methodology includes calculating uncertainty percentage, forming clusters using the K-means clustering algorithm, finding cluster-level uncertainty, calculating the relative important index, ensemble formulation, and application of linear regression. Figure 1 shows the detailed flow process of this study.

Uncertainty percentage. The percentage of uncertainty is calculated for each project for all valuation approaches involved. It is found out using Eq. (3), where i indicates the number assigned to the project, and j indicates the valuation approach.

$$\text{Uncertainty }(j)_{\mathrm{i}} = \frac{\text{Actual Cost of project} - \text{ Estimated cost by Valuation Approach } (j)}{\text{Actual Cost of project}} \tag{3}$$

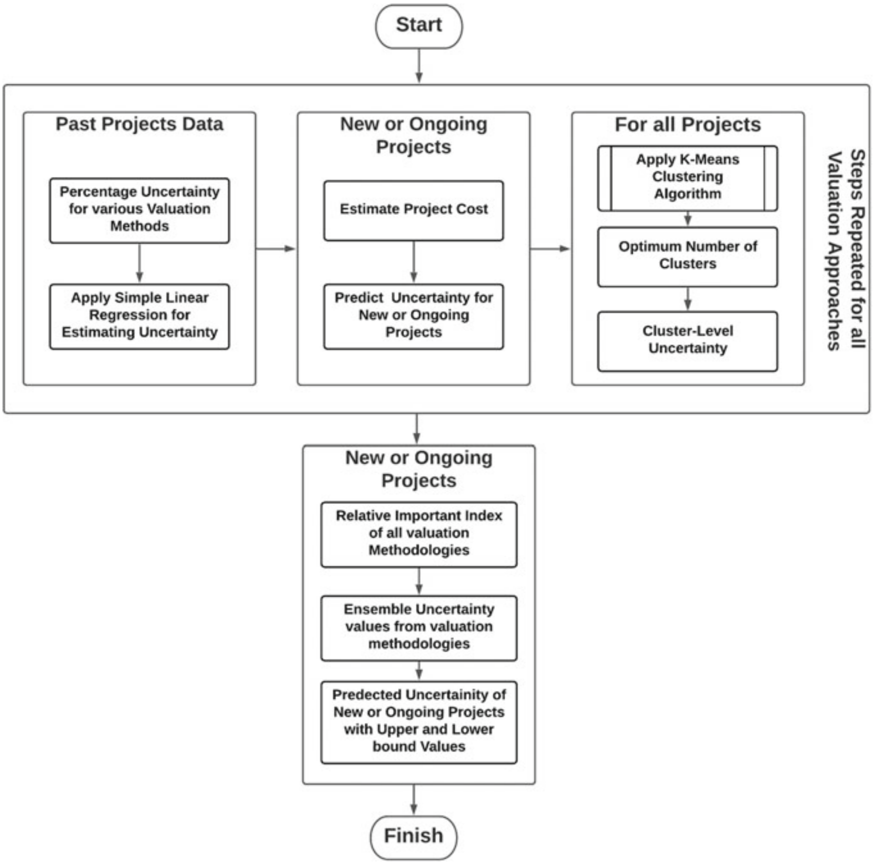

Fig. 1 Methodology flowchart

Simple Linear Regression. Linear regression helps to model the relationship between a dependent variable and one or more independent variables. Simple linear regression is applied for one independent variable. Multiple linear regression is employed when more than one independent variable present. Linear regression best suits for prediction and forecast models [18–22]. A simple regression, which implies a single independent variable, can accommodate most any functional relation between the left-hand side variable and right-hand side variable [21]. In general, it is easier to think about the relation between the variables as either linear or nonlinear as represented in Eq. (4).

$$y = A + Bx + \in \tag{4}$$

where y is the dependent variable, x is the independent variable, B is the slope of the equation, A is the y intercept of the equation, and $\in$ is the error.

K-Means Clustering Algorithm. Clustering is one of the most popular exploratory data processing methods used to get insight into the nature of the data. Clustering is the process of defining subgroups within a dataset such that data points in the same cluster have very similar properties, while data points from other clusters have different properties [22]. K-means clustering algorithm is an algorithm with iterative nature and tries to divide the dataset into a pre-defined distinctive number of clusters such that each data point fits into a single cluster only. This algorithm assigns data points to the cluster so that the sum of the squared distance between data points, and the cluster centroid is as minimum as possible.

Objective function. The approach followed by K-means algorithm is known as "expectation–maximization." Expectation is allocating data points to the nearest cluster. Maximization is to compute the centroid of every cluster. Equation [5] gives the objective function of the K-means clustering algorithm where $w_{ik} = 1$, if x^i belongs to the cluster k if not $w_{ik} = 0$.

$$J = \sum_{i=1}^{m} \sum_{k=1}^{K} w_{ik} \|x^i - \mu_k\|^2 \tag{5}$$

where x^i is the ith construction project uncertainty, μ_k is the mean or centroid of the cluster to which the point x^i belongs to (as ordered by the K-means clustering algorithm), k is the cluster number, K is the total number of clusters, m is the total number of points under clustering, i.e., total number of construction projects considered, here it is 63.

Steps involved in K-means clustering algorithm

Step 1: Firstly, we randomly choose K number of arbitrary centers among the n data points that are to act as the K clusters centroids.

Step 2: Now, for every such cluster centroid, we allocate points to it that are nearest to this cluster centroid than every other cluster centroid.

Step 3: Compute new centroids of points fit into each cluster again after such aforesaid assignments.

Step 4: Repeat the procedure from Step 2 onwards and keep repeating this procedure till

- Cluster centroids do not change over anymore, i.e., converge to some values.
- Points of a cluster stay in the same cluster.
- Maximum number of repetitions are reached.

Optimum Number of clusters. The optimum number of clusters for dataset is needed to determine because for initiation process, user need to provide arbitrary value of clusters (k). Optimum cluster number can be found out by developing elbow plot. Elbow method gives idea about the optimum k value based on the sum of squared distance between the clusters. A sample elbow plot is given in Fig. 2a.

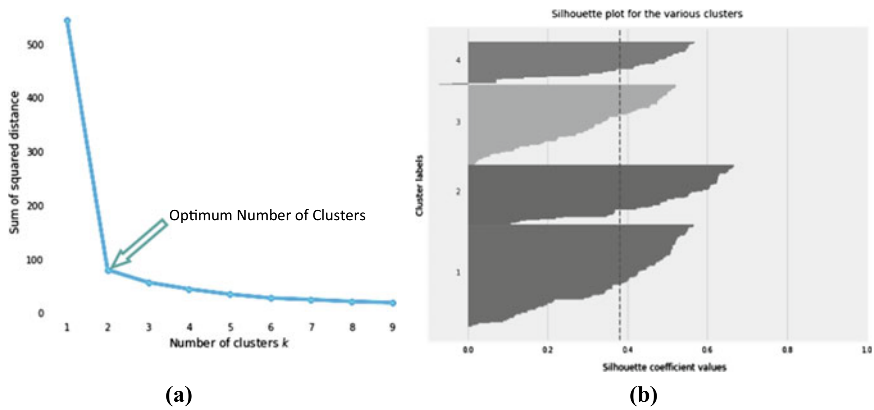

Fig. 2 **a** Elbow plot, **b** silhouette plot

Validation of Clusters. Clusters need to be validated for achieving optimum results. Silhouette analysis of clusters serves the purpose. In silhouette analysis, silhouette score measures the similarity an object with its own cluster (known as cohesion) and compares the object to other clusters (known as separation). Silhouette scores ranging from -1 to $+1$. Higher values of silhouette score represent higher cohesion and lesser separation. Variation of silhouette score represented in silhouette plot as in Fig. 2b.

Cluster-level Uncertainty. Cluster-level uncertainty is important because most construction projects have some similarities to past projects, and thus, the cluster-level uncertainty can be used to identify the uncertainty of any new and ongoing construction projects. The cluster-level uncertainty of the point after the points have been clustered using the K-means algorithm is detailed in [23].

Cluster-level uncertainty implies that the uncertainty points belonging to a cluster have the cluster centroid as the uncertainty hinge when the uncertainty points (representing the various construction projects uncertainties) are clustered using the K-means clustering algorithm. Clusters will be formed for each method of the valuation process for past project datasets based on uncertainties identified and assess the uncertainties of new projects or ongoing projects by mapping with the cluster-level uncertainty from the dataset [24].

Lower Bound Uncertainty (LBU). Lower bound uncertainty of cluster represents lower side uncertainty of the point (of concern) in the cluster. LBU is used to represent the lowest uncertainty of all points in the cluster. LBU for pth cluster C_p is given in Eq. (6), where i indicates the univariate data coordinate of the dataset of concern.

$$LBU = \left(\text{Uncertainty}(i) - \min_{i \epsilon C_p}(\text{Uncertainty}(i)) \right) \tag{6}$$

Upper Bound Uncertainty (UBU). Upper bound uncertainty of cluster represents upper side uncertainty of the point (of concern) in the cluster. UBU is used to represent the highest uncertainty of all points in the cluster. UBU for pth cluster C_p is given in Eq. (7), where i indicates the univariate data coordinate of the dataset of concern.

$$UBU = \left(\max_{i \in C_p} \text{Uncertainty}(i) - (\text{Uncertainty}(i)) \right) \tag{7}$$

Relative Importance Index (RII). RII relatively ascribes weights to the point of concern based on a property of the point. This method generally involves interpolation-scaling the property value within the range of 0–1. RII for projects is calculated using Eq. (8), i indicates the number assigned to the project, and j indicates the valuation approach [25].

$$RII_j = \frac{\left\{ \frac{\text{Uncertainty}(j)_i - \min\limits_{i \in C_p} (\text{Uncertainty}(j)_i)}{\max\limits_{i \in C_p} \text{Uncertainty}(j)_i - (\text{Uncertainty}(j)_i)} \right\}}{\sum_i \left\{ \frac{\text{Uncertainty}(j)_i - \min\limits_{i \in C_p} (\text{Uncertainty(j)}_\text{i})}{\max\limits_{i \in C_p} \text{Uncertainty}(j)_i - (\text{Uncertainty}(j)_i)} \right\}} \tag{8}$$

Weighted Relative Importance Index (W-RII). Weighted RII represents weightage to be given for each method of valuation for new and ongoing projects. W-RII is given in Eq. (9).

$$W - RII_i = \frac{RII_i}{\sum_i RII_i} \tag{9}$$

Ensemble Formulation Ensemble formulation is a method of combing of results from a various number of approaches. This gives us the most probable value of the true result.

Lower Bound Ensemble Uncertainty. The lower bound ensemble uncertainty is given in Eq. (10); here, n indicates the total number of valuation approaches considered for computing uncertainty.

$$EU(LBU(i)_<) = \frac{\sum_{j=1}^{n} \{RII(j)i\} \{\text{Uncertainty}(j)i - \min\limits_{all\ i \in Ci} \{\text{Uncertainty}(j)i\}\}}{\sum_{j=1}^{n} \{RII(j)i\}} \tag{10}$$

Upper Bound Ensemble Uncertainty. The upper bound ensemble uncertainty is given in Eq. (11); here, n indicates the total number of valuation approaches considered for computing uncertainty.

Table 1 Details of case study

Total number of projects considered	63
Number of projects considered for the dataset	58
Number of projects considered for prediction	5
Number of valuation approaches applied	3
Valuation approaches applied	Market approach method Cost approach method Income approach method

$$EU(UBU(i)_{<}) = \frac{\sum_{j=1}^{n}\{RII(j)i\}\{\max_{\text{all } i\in Ci}\{\text{Uncertainty}(j)i - \text{Uncertainty}(j)i\}\}}{\sum_{j=1}^{n}\{RII(j)i\}} \tag{11}$$

3.3 Case Study

The presented methodology is applied to the case study for more precise understanding. This study consists of a total of sixty-three construction projects of similar specifications and utility. It involves three valuation approaches: market approach method, cost approach method, and income approach method. Many more details of the case study are discussed in Table 1.

Data The data used for this study is obtained from [25]. The data comprises of estimated costs, actual costs, and uncertainties of 63 construction projects that comprise the 63 blocks of 40 buildings of GITAM (Deemed to be University), Visakhapatnam, Andhra Pradesh State, India.

Uncertainty percentage The percentage of the uncertainty of all projects for the market approach method, cost approach method, and income approach method is as given in Eqs. (12), (13), and (14), respectively. The percentage of uncertainties of all projects in three approaches are given in Table 2, and their variation is shown in Fig. 3.

$$\text{Uncertainty}(j)_i = \frac{\text{Actual Cost of project} - \text{Estimated cost by Market approach method}}{\text{Actual Cost of project}} \tag{12}$$

$$\text{Uncertainty}(j)_i = \frac{\text{Actual Cost of project} - \text{Estimated cost by Cost approach method}}{\text{Actual Cost of project}} \tag{13}$$

Table 2 Details of case study

S. No.	Project name	Valuation by cost approach method (₹)	Valuation by market approach method (₹)	Valuation by income approach method (₹)	Actual cost (₹)	Cost approach method uncertainty (%)	Market approach method uncertainty (%)	Income approach method uncertainty (%)
1	Block 1	349,274,640	317,522,400	402,930,626	366,738,372	4.76	13.42	−9.87
2	Block 2	531,950,629	488,028,100	616,882,383	505,353,098	−5.26	3.43	−22.07
3	Block 3	374,968,601	337,809,550	407,679,515	397,466,717	5.66	15.01	−2.57
4	Block 4	468,976,592	418,729,100	530,724,391	454,907,294	−3.09	7.95	−16.67
5	Block 5	588,009,792	539,458,525	683,505,265	635,050,576	7.41	15.05	−7.63
6	Block 6	606,478,752	561,554,400	713,259,484	582,219,602	−4.17	3.55	−22.51
7	Block 7	460,602,010	418,729,100	530,724,391	432,965,889	−6.38	3.29	−22.58
8	Block 8	166,007,448	153,710,600	186,666,648	172,647,746	3.85	10.97	−8.12
9	Block 9	20,440,443	18,752,700	22,772,664	19,827,230	−3.09	5.42	−14.86
10	Block 10	959,829,760	949,135,360	1,116,273,222	1,027,017,843	6.54	7.58	−8.69
11	Block 11	413,393,193	372,426,300	411,740,039	396,857,465	−4.17	6.16	−3.75
12	Block 12	252,008,540	235,522,000	259,071,456	259,568,796	2.91	9.26	0.19
13	Block 13	980,092,764	907,493,300	987,164,895	911,486,271	−7.53	0.44	−8.3
14	Block 14	38,163,516	35,012,400	38,350,372	37,400,246	−2.04	6.38	−2.54
15	Block 15	403,126,570	366,478,700	397,748,842	427,314,164	5.66	14.24	6.92
16	Block 16	406,791,357	366,478,700	390,661,374	382,383,876	−6.38	4.16	−2.16
17	Block 17	39,034,520	34,852,250	39,999,996	42,157,282	7.41	17.33	5.12
18	Block 18	143,695,605	129,455,500	139,439,986	148,006,473	2.91	12.53	5.79
19	Block 19	3,476,000	3,160,000	3,678,482	3,302,200	−5.26	4.31	−11.39
20	Block 20	1,282,712	1,176,800	1,863,497	1,359,675	5.66	13.45	−37.05

(continued)

Table 2 (continued)

S. No.	Project name	Valuation by cost approach method (₹)	Valuation by market approach method (₹)	Valuation by income approach method (₹)	Actual cost (₹)	Cost approach method uncertainty (%)	Market approach method uncertainty (%)	Income approach method uncertainty (%)
21	Block 21	210,004,920	194,449,000	220,694,422	224,705,264	6.54	13.46	1.78
22	Block 22	169,269,720	158,196,000	184,711,093	165,884,326	−2.04	4.63	−11.35
23	Block 23	1,581,963,818	1,464,781,313	1,487,399,851	1,613,603,094	1.96	9.22	7.82
24	Block 24	694,660,945	637,303,619	670,333,266	736,340,601	5.66	13.45	8.96
25	Block 25	61,162,200	55,602,000	63,772,769	58,104,090	−5.26	4.31	−9.76
26	Block 26	61,718,220	55,602,000	63,772,769	64,804,131	4.76	14.2	1.59
27	Block 27	62,274,240	55,602,000	63,772,769	66,010,694	5.66	15.77	3.39
28	Block 28	9,248,652	8,643,600	9,913,786	9,063,679	−2.04	4.63	−9.38
29	Block 29	1,862,352	1,724,400	1,977,802	1,974,093	5.66	12.65	−0.19
30	Block 30	1,463,652	1,342,800	1,540,127	1,566,108	6.54	14.26	1.66
31	Block 31	66,808,561	64,169,620	71,465,993	62,800,047	−6.38	−2.18	−13.8
32	Block 32	108,372,060	107,524,022	109,755,545	112,706,942	3.85	4.6	2.62
33	Block 33	109,552,999	107,891,550	110,882,878	113,935,119	3.85	5.3	2.68
34	Block 34	21,494,000	21,385,550	23,204,664	19,989,420	−7.53	−6.98	−16.08
35	Block 35	57,368,000	42,911,264	84,567,813	60,810,080	5.66	29.43	−39.07
36	Block 36	91,016,000	70,991,936	105,312,890	93,746,480	2.91	24.27	−12.34
37	Block 37	150,184,000	129,024,928	165,134,986	156,191,360	3.85	17.39	−5.73
38	Block 38	40,171,000	31,776,116	54,321,569	38,162,450	−5.26	16.73	−42.34
39	Block 39	18,192,000	14,480,832	26,684,531	18,919,680	3.85	23.46	−41.04
40	Block 40	1,315,000	1,030,960	1,432,664	1,393,900	5.66	26.04	−2.78

(continued)

Table 2 (continued)

S. No.	Project name	Valuation by cost approach method (₹)	Valuation by market approach method (₹)	Valuation by income approach method (₹)	Actual cost (₹)	Cost approach method uncertainty (%)	Market approach method uncertainty (%)	Income approach method uncertainty (%)
41	Block 41	30,280,800	24,466,886	36,478,950	27,555,528	−9.89	11.21	−32.38
42	Block 42	87,800,000	71,153,120	106,584,632	93,068,000	5.66	23.55	−14.52
43	Block 43	25,206,000	18,854,088	36,548,962	27,222,480	7.41	30.74	−34.26
44	Block 44	43,365,000	28,794,360	56,326,548	44,665,950	2.91	35.53	−26.11
45	Block 45	20,912,000	17,900,672	34,512,633	20,284,640	−3.09	11.75	−70.14
46	Block 46	64,782,000	43,015,248	74,463,212	68,021,100	4.76	36.76	−9.47
47	Block 47	45,372,000	38,838,432	51,133,456	46,279,440	1.96	16.08	−10.49
48	Block 48	29,376,000	25,145,856	41,136,456	27,319,680	−7.53	7.96	−50.57
49	Block 49	114,233,000	96,412,652	153,248,975	111,948,340	−2.04	13.88	−36.89
50	Block 50	573,350,400	511,428,556	739,805,415	607,751,424	5.66	15.85	−21.73
51	Block 51	175,200,000	158,380,800	226,064,042	185,712,000	5.66	14.72	−21.73
52	Block 52	88,136,000	81,790,208	113,723,633	93,424,160	5.66	12.45	−21.73
53	Block 53	122,155,200	110,428,300	140,106,028	114,825,888	−6.38	3.83	−22.02
54	Block 54	42,930,000	32,111,640	49,238,606	45,076,500	4.76	28.76	−9.23
55	Block 55	179,074,800	159,734,721	205,390,019	182,656,296	1.96	12.55	−12.45
56	Block 56	384,321,800	356,650,630	438,254,563	365,105,710	−5.26	2.32	−20.03
57	Block 57	37,601,850	33,992,072	43,429,069	39,857,961	5.66	14.72	−8.96
58	Block 58	51,611,000	47,895,008	58,384,394	55,739,880	7.41	14.07	−4.74
59	Block 59	61,87,13,100	57,41,65,756	70,65,66,773	60,01,51,707	−3.09	4.33	−17.73
60	Block 60	2,81,78,000	2,61,49,184	3,03,89,612	2,95,86,900	4.76	11.62	−2.71

(continued)

Table 2 (continued)

S. No.	Project name	Valuation by cost approach method (₹)	Valuation by market approach method (₹)	Valuation by income approach method (₹)	Actual cost (₹)	Cost approach method uncertainty (%)	Market approach method uncertainty (%)	Income approach method uncertainty (%)
61	Block 61	9,39,85,600	8,72,18,636	10,67,60,033	9,02,26,176	−4.17	3.33	−18.32
62	Block 62	6,95,17,900	6,45,12,611	7,86,41,383	7,43,84,153	6.54	13.27	−5.72
63	Block 63	3,21,36,000	2,98,22,208	5,10,34,730	3,37,42,800	4.76	11.62	−51.25

Note: For the Validation analysis, of the 63 above-detailed Construction Projects, the first 58 are treated as old or already finished construction projects and the rest of the 5; i.e., the last 5 (59 through 63) construction projects are treated as new or in the offing construction projects whose percentage uncertainty is treated as unknown

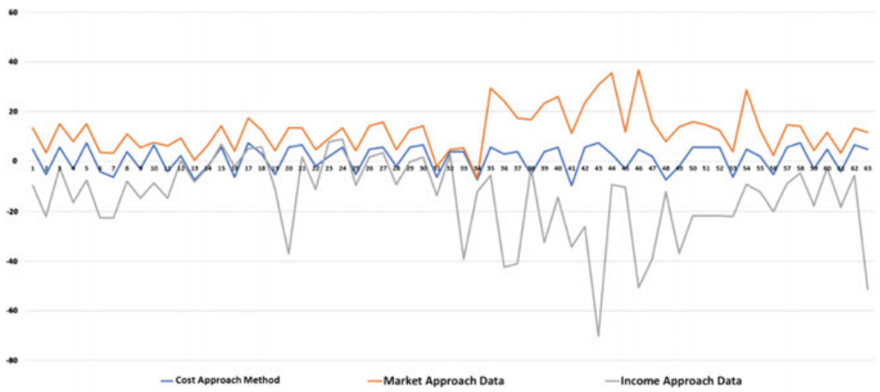

Fig. 3 Variation of uncertainties for all projects for all three valuation approaches

$$\text{Uncertainty}(j)_i = \frac{\begin{array}{c}\text{Actual Cost of project}-\\ \text{Estimated cost by Income approach method}\end{array}}{\text{Actual Cost of project}} \tag{14}$$

Simple Linear Regression. Simple linear regression is applied to percentage uncertainty of dataset (of the first 58 construction projects) for each valuation methodology. Linear regression equation for market approach method, cost approach method, and income approach method is given in Eqs. (15), (16), and (17), respectively, for prediction of uncertainty values of the proposed five projects.

$$y = \left(-8.866 \times 10^{-10}\right)x + 1.43e + 01 \tag{15}$$

$$y = \left(-9.5 \times 10^{-10}\right)x + 1.393 \tag{16}$$

$$y = (1.099e - 08)x - 1.616e + 01 \tag{17}$$

Project Cost Estimation. Project cost estimation of new or ongoing projects using three valuation methods, market approach method, cost approach method, and income approach method, is given Table 3.

Percentage Uncertainty prediction. Percentage uncertainty for new or ongoing projects (Projects 59 through 63) is calculated using simple linear regression. The predicted uncertainty for new or ongoing projects with all three valuation methodologies is given in Table 4.

K-Means Clustering of the 58 + 5 Construction Projects. The K-means clustering algorithm is applied for each valuation methodology separately for dataset consisting

Table 3 Project cost estimation of new or ongoing projects

S. No.	Description of building	Valuation by cost approach method (₹)	Valuation by market approach method (₹)	Valuation by income approach method (₹)
1	Block-59	618,713,100	574,165,756	706,566,774
2	Block-60	28,178,000	26,149,184	30,389,613
3	Block-61	93,985,600	87,218,636	106,760,034
4	Block-62	69,517,900	64,512,611	78,641,383
5	Block-63	32,136,000	29,822,208	51,034,730

Table 4 Predicted percentage of uncertainty

S. No.	Description of building	Predicted percentage of uncertainty		
		valuation by market approach method	Valuation by cost approach method	Valuation by income approach method
1	Block-59	9.209446	0.805226	−8.394831
2	Block-60	14.06816	1.366231	−15.82602
3	Block-61	13.52672	1.303714	−14.98671
4	Block-62	13.72803	1.326958	−15.29573
5	Block-63	14.0356	1.362471	−15.59913

of (58 already finished Construction Projects + 5 predicted construction projects for three methods of valuation.

Results of K-means clustering Analysis for Market approach method of Valuation data. K-means algorithm is applied to percentage of uncertainties calculated with market approach method of valuation with for all 58 + 5 projects in dataset. The elbow plot obtained from the k-means clustering algorithm is given in Fig. 4. Optimum

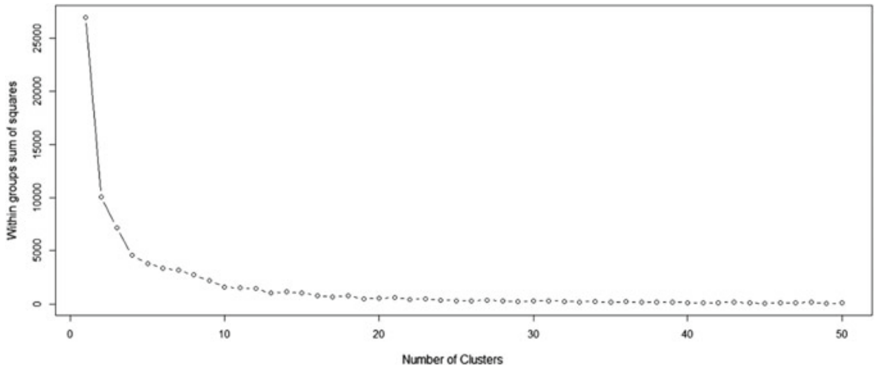

Fig. 4 Elbow plot for market approach method

Table 5 Cluster assignments for market approach method of valuation

Cluster number	Assigned project numbers
1	[29, 30, 32, 33]
2	[50, 51, 52, 53, 56]
3	[31, 34, 36]
4	[45]
5	[41, 43, 44, 49]
6	[11, 12, 13, 14, 16]
7	[2, 4, 6, 7, 9]
8	[60, 61, 62, 63]
9	[37, 40, 42, 46, 47]
10	[20]
11	[35, 38, 39, 48]
12	[21, 26, 27]
13	[19, 22, 25, 28]
14	[23, 24]
15	[1, 3, 5, 8, 10]
16	[54, 55, 57, 58, 59]
17	[15, 17, 18]

number of clusters considered from plot is 17. Clusters with their project assignments are represented in, and the silhouette plot is shown in Fig. 5 (Table 5).

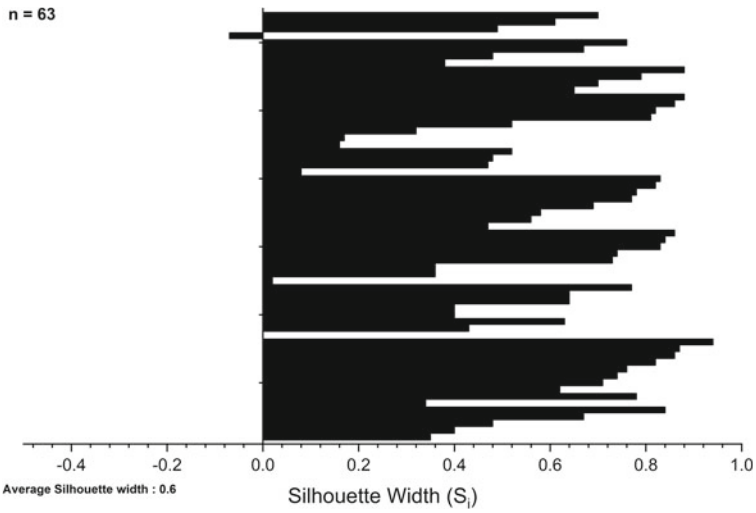

Fig. 5 Silhouette plot for market approach method

Results of K-means clustering Analysis for Cost Approach Method of Valuation data. K-means algorithm is applied to percentage of uncertainties by calculated cost approach method of valuation with for all 58 + 5 projects in dataset. The elbow plot obtained from the algorithm is given in Fig. 6. Optimum number of clusters considered from plot is 12. Clusters with their project assignments are represented in Table 6, and the silhouette plot is shown in Fig. 7.

Results of K-means clustering Analysis for Income Approach Method of Valuation data. K-means algorithm is applied to percentage of uncertainties calculated using income approach method of valuation with for all 58 + 5 projects in dataset. The elbow plot obtained from the algorithm is given in Fig. 8. Optimum number of clusters considered from plot is 12. Clusters with their project assignments are represented in Table 7, and the silhouette plot is shown in Fig. 9.

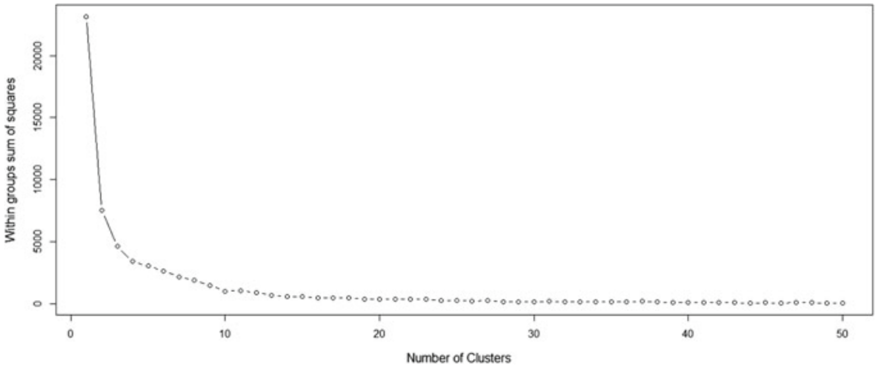

Fig. 6 Elbow plot for cost approach method of valuation

Table 6 Cluster assignments for cost approach method of valuation

Cluster number	Assigned project numbers
1	[45, 48, 49, 53, 56]
2	[2, 4, 6, 7, 9, 11]
3	[23, 24, 26, 27, 28, 29, 30]
4	[59, 60, 61, 62, 63]
5	[12, 15, 17, 18, 20, 21]
6	[50, 51, 52, 54, 55]
7	[32, 33, 35, 36, 37, 39]
8	[31, 34, 38, 41]
9	[57, 58]
10	[13, 14, 16, 19, 22, 25]
11	[1, 3, 5, 8, 10]
12	[40, 42, 43, 44, 46, 47]

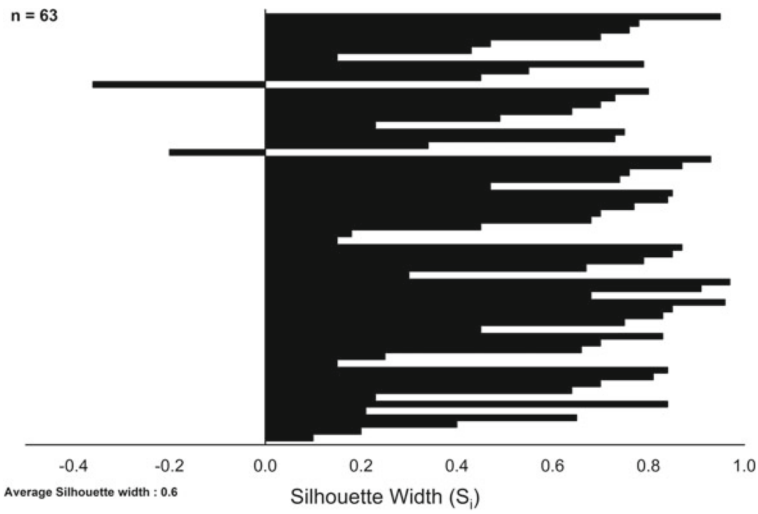

Fig. 7 Silhouette plot for cost approach method

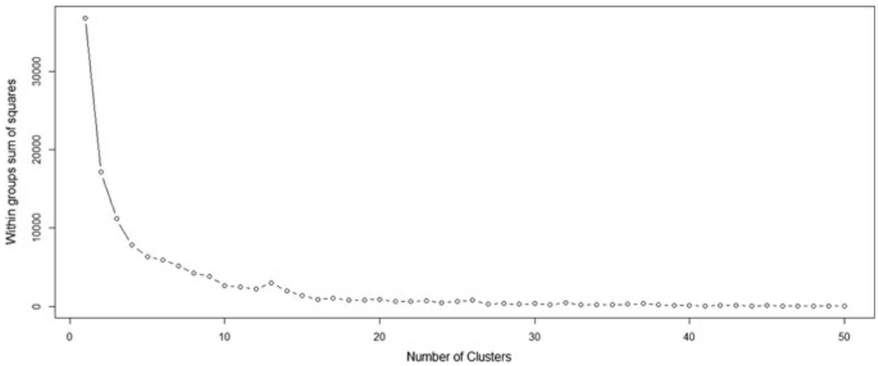

Fig. 8 Elbow plot for income approach method of valuation

Results of Cluster-Level Uncertainty for 5 New Projects. After application of K-means clustering algorithm to all valuation methodologies, cluster-level uncertainty for each new or ongoing project is to find out by using LBU and UBU equations. Calculated lower bound uncertainty and upper bound uncertainty for all new and ongoing projects by market approach method, cost approach method, and income approach method given in Tables 8, 9, and 10, respectively.

Results of Relative Importance Index (RII) for 5 New Projects. To ensemble results from all three valuation methods, RII needs to apply for upper and lower bound uncertainties for all new and ongoing projects. For new and ongoing projects,

Table 7 Cluster assignments for income approach method of valuation

Cluster number	Assigned project numbers
1	[55, 57, 58, 59, 60, 61, 62, 63]
2	[15, 17]
3	[31]
4	[8, 9, 10, 11, 12, 14]
5	[45, 47, 48, 49, 50, 51, 52]
6	[24, 26, 27]
7	[2, 4, 6, 7]
8	[13, 16, 19, 22]
9	[43, 44, 46, 54]
10	[18, 20, 21, 23]
11	[37, 38, 41]
12	[34]
13	[29, 30]
14	[1, 3, 5]
15	[35, 36, 39, 40, 42]
16	[53, 56]
17	[25, 28, 32, 33]

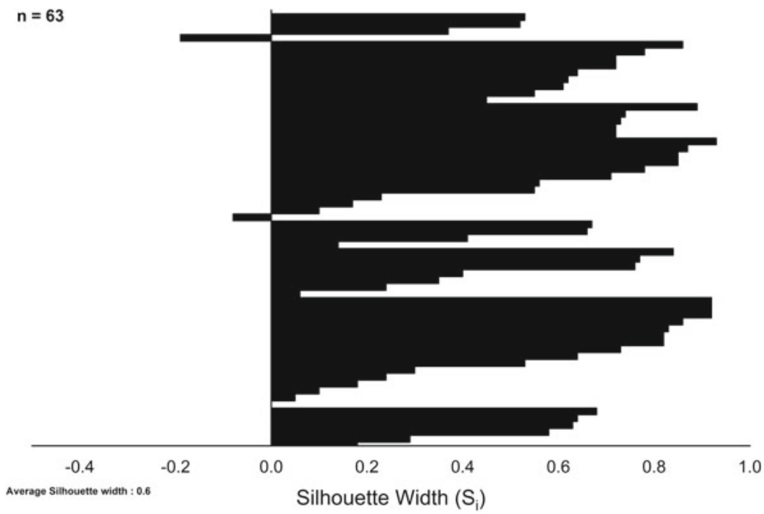

Fig. 9 Silhouette plot for income approach method

Table 8 Cluster-level uncertainties for market approach method (computed by way of prediction)

S. No.	Description of building	Cluster-level uncertainty for market approach method	
		LBU	UBU
1	Block-59	0	5.52
2	Block-60	4.86	0.66
3	Block-61	4.32	1.2
4	Block-62	4.52	1
5	Block-63	4.83	0.69

Table 9 Cluster-level uncertainty for cost approach method (computed by way of prediction)

S. No.	Description of building	Cluster-level uncertainty for cost approach method	
		LBU	UBU
1	Block-59	0	0.56
2	Block-60	0.56	0
3	Block-61	0.5	0.06
4	Block-62	0.52	0.04
5	Block-63	0.52	0

Table 10 Cluster-level uncertainty for income approach method (computed by way of prediction)

S. No.	Description of building	Cluster-level uncertainty for income approach method	
		LBU	UBU
1	Block-59	4.06	3.65
2	Block-60	0	1
3	Block-61	0.84	0.16
4	Block-62	0.53	0.47
5	Block-63	0.23	0.77

Table 11 RII values for lower bound uncertainty

S. No.	Description of building	Relative importance index for lower bound uncertainty		
		Market approach method	Cost approach method	Income approach method
1	Block-59	0	0	1
2	Block-60	1	0.1152	0
3	Block-61	1	0	0.0890
4	Block-62	1	0	0.0025
5	Block-63	1	0.0630	0

RII values lower bound uncertainty are shown in Table 11 and RII values upper bound uncertainty are shown in Table 12.

Results of Weighted Relative Importance Index (W-RII) for 5 New Projects. For new and ongoing projects, W-RII values lower bound uncertainty are shown in Table 13 and W-RII values upper bound uncertainty are shown in Table 14.

Computed Lower and Upper Bound Ensemble Uncertainties. After combining the results from cluster-level uncertainty and weighted relative importance indices, ensemble formulation is given in Table 15.

Table 12 RII values for upper bound uncertainty

S. No.	Description of building	Relative importance index for upper bound uncertainty		
		Market approach method	Cost approach method	Income approach method
1	Block-59	1	0	0.6229
2	Block-60	0.6666	0	1
3	Block-61	1	0	0.0877
4	Block-62	1	0	0.4479
5	Block-63	0.8961	0	1

Table 13 W-RII for lower bound uncertainty

S. No.	Description of building	Weighted relative importance index for lower bound uncertainty		
		Market approach method	Cost approach method	Income approach method
1	Block-59	0	0	1
2	Block-60	0.8966	0.1033	0
3	Block-61	0.9182	0	0.0817
4	Block-62	0.9975	0	0.0024
5	Block-63	0.9407	0.0593	0

Table 14 W-RII for upper bound uncertainty

S. No.	Description of building	Weighted relative importance index for upper bound uncertainty		
		Market approach method	Cost approach method	Income approach method
1	Block-59	0.6161	0	0.3838
2	Block-60	0.3975	0	0.6024
3	Block-61	0.9193	0	0.0806
4	Block-62	0.6906	0	0.3093
5	Block-63	0.4726	0	0.5273

Table 15 Ensemble uncertainties

S. No.	Description of building	Ensemble uncertainties (computed by way of prediction)	
		Lower bound	Upper bound
1	Block-59	4.06	4.80
2	Block-60	4.41	0.97
3	Block-61	4.03	1.11
4	Block-62	4.50	0.83
5	Block-63	4.57	0.73

Comparison for Validation

Considering Percentage Certainty as 100—Percentage Uncertainty, we compute the certainties for the actual case and the case of computation by way of prediction:

Percentage Error

Percentage Error = (Actual – Computed by way of Prediction)/Actual.

K-Means Clustering of the 63 Construction Projects. The K-means clustering algorithm is applied* for each valuation methodology separately for dataset consisting of all original 63 construction projects for three methods of valuation.

*As the change in variation of clustering assignments contributed by the K-means clustering is very negligible, we have considered the same clustering assignments (clustering vector) for this run of K-means clustering gotten previously by considering 58 old or already finished +5 in the offing construction projects whose percentage uncertainty is predicted. It should be understood that this is an approximation done to reduce the tediousness of labor involved. However, one can choose to run this algorithm again for the original considered complete set of 63 construction projects for their perfect clustering assignments from which one can compute their lower bound uncertainties and upper bound uncertainties of each construction project of concern.

We then find the cluster-level uncertainties for market approach method (actual) (Table 16).

Table 16 Cluster-level uncertainties for market approach method (actual)

S. No.	Description of building	Cluster-level uncertainty for market approach method	
		LBU (Actual)	UBU (Actual)
1	Block-59	1.08	10.5
2	Block-60	8.93	2.65
3	Block-61	0	11.58
4	Block-62	10.71	0.87
5	Block-63	8.93	2.65

Table 17 Cluster-level uncertainty for cost approach method (actual)

S. No.	Description of building	Cluster-level uncertainty for cost approach method	
		LBU (Actual)	UBU (Actual)
1	Block-59	2.01	0
2	Block-60	0	3.1
3	Block-61	1.01	1
4	Block-62	1.65	1.45
5	Block-63	0	3.1

Cluster-level uncertainty for cost approach method (actual) (Table 17), cluster-level uncertainty for income approach method (Actual) (Table 18), and ensemble uncertainties (actual) (Table 19) for each construction project of concern for all three methods of valuation.

In Table 20, we show the comparison between ensemble certainties (actual) and ensemble certainties (computed by way of prediction) for both lower bound certainty and upper bound certainty. In Table 21, we present the error between the lower bound ensemble certainties (actual) and lower bound ensemble certainties (computed by way of prediction). In Table 22, we present the error between the upper bound ensemble certainties (actual) and upper bound ensemble certainties (computed by way of prediction). From the error values, we can note that the authors proposed concept is validated to a good degree.

Table 18 Cluster-level uncertainty for income approach method (actual)

S. No.	Description of building	Cluster-level uncertainty for income approach method	
		LBU (Actual)	UBU (Actual)
1	Block-59	2.3	5.28
2	Block-60	6.52	0
3	Block-61	1.71	5.87
4	Block-62	3.51	3.01
5	Block-63	18.89	0.68

Table 19 Ensemble uncertainties (actual)

S. No.	Description of building	Ensemble uncertainties (actual)	
		Lower bound	Upper bound
1	Block-59	2.17	8.75
2	Block-60	7.91	2.89
3	Block-61	1.44	9.77
4	Block-62	9.48	2.67
5	Block-63	15.69	2.89

Table 20 Percentage error in certainty domain

S. No.	Description of building	Ensemble certainties (actual)		Ensemble certainties (computed by way of prediction)	
		LBC	UBC	LBC	UBC
1	Block-59	95.94	95.2	97.83	91.25
2	Block-60	95.59	99.03	92.09	97.11
3	Block-61	95.97	98.89	98.56	90.23
4	Block-62	95.5	99.17	90.52	97.33
5	Block-63	95.43	99.27	84.31	97.11

Table 21 Percentage error in certainty domain for lower bound certainty

S. No.	Description of building	Percentage error in certainty domain for lower bound certainty		
		LBC (actual)	LBC (computed by way of prediction)	Percentage error
1	Block-59	95.94	97.83	1.931923
2	Block-60	95.59	92.09	−3.80063
3	Block-61	95.97	98.56	2.627841
4	Block-62	95.5	90.52	−5.50155
5	Block-63	95.43	84.31	−13.1894

Table 22 Percentage error in certainty domain for upper bound certainty

S. No.	Description of building	Percentage error in certainty domain for upper bound certainty		
		UBC (Actual)	UBC (computed by way of prediction)	Percentage error
1	Block-59	95.2	91.25	−4.32877
2	Block-60	99.03	97.11	−1.97714
3	Block-61	98.89	90.23	−9.59769
4	Block-62	99.17	97.33	−1.89048
5	Block-63	99.27	97.11	−2.22428

4 Results and Discussion

For new and ongoing construction projects or projects with unknown uncertainty, we can use the group level or cluster-level uncertainty of a group of such similar construction projects completed in the past whose uncertainties are known. The group level or cluster-level uncertainty is further decomposed into a lower side uncertainty and an upper side uncertainty. The relative importance index justifiably ascribes relative importance to the uncertainties of all three valuation approaches.

The ensemble uncertainty combines the results of uncertainties of all three valuation approaches justifiably. The scheme is self-validating because some of the uncertainty points of the three approaches of valuation are themselves close to the derived ensemble uncertainty values gotten by this proposed scheme. Knowing this uncertainty helps us to prepare for additional costs if any and also be economical in case of negative uncertainty.

5 Conclusions

For engineering valuation of any construction project, it is essential to find the cluster-level uncertainty of the construction project, w.r.t to data instances of similar project types. This macro-level uncertainty captures uncertainty at a more generic concept level.

It is essential to quantify uncertainty for developing a stochastic cost model system that assists engineers and valuers in calculating rational contingencies for early estimates.

Engineering valuation may involve more than one kind of valuation approach, and one can use all these results via an ensembling scheme which again resorts to the use of the relative importance indices as detailed in the appropriate related section in this literature.

It is expected that the proposed strategy would assist the valuation of construction projects to play its rightful and necessary role as well as contribute to the cause of sustainable development, particularly in the developing countries.

The authors recommend that the state maintain a database of all construction projects uncertainties, as this kind of uncertainty analysis of a construction project helps us to get a more probable uncertainty value for any future construction project of concern.

This study helps avoid risks and uncertainty of financial institutions, financed in loans by ensuring accurate cost estimates which leads to optimal expenditure of funds.

6 Scope for Future Work

It can be noted that, if we were to consider construction projects of similar kind, like that of a mercantile project, a residential project, etc., category-wise and performing this analysis will give us a better more probable uncertainty of the construction project type of concern.

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Comparative Study of Time Optimization Algorithms for Traveling Salesman Problem

Devansh Messon, Divyam Verma, Mayank Rastogi, and Amit Singh

Abstract Brute-force-based solution using backtracking method of traveling salesman problem (TSP) algorithm which is an NP-hard problem is not improved in terms of space and time complexity. The algorithm is muddled to apply in graphs that contain a larger number of well-connected nodes. To handle this huge time complexity, approximation/divide and conquer methods, heuristic methods, and nature-inspired methods are applied. The use of a keen and numerical procedure speeds up the enhanced TSP by multiple times. In this paper, two approaches using the divide and conquer technique and nature-inspired algorithms like recursion with bitmasking and genetic algorithm, respectively, are applied to minimize the running time of the TSP algorithm, and their performance is also analyzed and compared on the different number of nodes.

Keywords TSP algorithm · Recursion with bitmasking · Nature-inspired algorithm · Brute-force · Time complexity · Comparitive analysis

1 Introduction

A wide application domain of traveling salesman problem (TSP) garnered much attention among researchers to analyze the performance of the various approaches available in the literature. Traveling salesman problem (TSP) states that on a given set of nodes and distance between each pair of nodes compute the shortest route that visits each city exactly once and returns to the starting point [1]. There is no polynomial time known solution to this date; hence, it is an NP-hard problem [2]. Algorithms with exponential time complexity are being used to solve the traveling salesman problem to date [3]. Purpose of TSP is to keep both the travel costs and the distance traveled as minimum as possible. TSP is utilized to track down the most efficient route for data to go between different nodes [4]. The TSP has several applications, such as planning, logistics, manufacture of microchips, and DNA sequencing. In

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these applications, the concept city represents, for example, customers, soldering points, or DNA fragments, and the concept distance represents traveling times or cost, or a similarity measure between DNA fragments [5].

2 Litrature Review: Exisiting TSP Solution Approaches

2.1 Brute-Force-Based Solution Using Backtracking Approach

The brute-force-based solution of TSP computes the cost of every possible route by generating all possible permutations of the vertices. After computing the cost of all permutations, the permutation with the minimum cost is the shortest route. The time complexity of this algorithm is O(n!) (where n is the number of nodes) which is much high; hence, there is a need to minimize the time complexity to some extent so that it can process bigger graphs in a lesser amount of time [6].

2.2 Recursion with Bitmasking

The time complexity of the brute-force-based solution of TSP is significantly improved by a strategy called recursion with bitmasking [7]. This method divides the problems into sub-problems by a recurrence relation and produces at most $\mathbf{n * 2^n}$ subsets of the absolute number of nodes and stores it in a bitmask and afterward it in the long run finds the shortest route by discovering the minimum cost among all cost [8]. The computation of each subset takes linear time. The time complexity of this algorithm is $\mathbf{O(n^2 * 2^n)}$, where n is the number of nodes.

2.3 Nature-Inspired Genetic Algorithm

The time complexity of recursion with the bitmasking algorithm is significantly improved by a nature-inspired algorithm known as the genetic algorithm. It works by generating random valid routes and then put these random routes in a population [9]. To improvise the fitness value of the routes in the population, the mutation is applied to it which leads to new routes and lesser fitness values of those routes [10, 11]. Many such routes are being generated, and the route with the minimum cost is chosen. A chromosome represents a TSP path containing cities. The fitness value of the chromosome is the cost of the whole path. A population contains a finite number of chromosomes. This finite number is the population size. Mutation of a chromosome is a process to generate a new child chromosome by swapping two cities in the parent chromosome [12]. When a mutation is performed, a new generation is defined. The number of generations is equal to the number of populations, which is done by performing mutation on chromosomes of a population [13]. The time complexity of this algorithm is **O(G * P * S)**, where *G* is the number of generations *P* is the population size, and *S* is the size of the chromosome [14].

3 Proposed Methodology

Existing literature shows various solution approaches to solve TSP efficiently. Over decades, several application domains of TSP have garnered the attention of researchers to reduce the computational complexity. Few solutions described below are demonstrated and implemented in this paper. The solution of TSP depends on the different parametric values, such as the size of the problem set, the complexity of the graph, and solution strategies applied. As a novelty, the paper presents various solution approaches for the effective solution of TSP in a large problem set. The contribution lies in terms of the result analysis demonstration and comparison of approaches, such as brute-force using backtracking, recursive bitmasking, and genetic algorithm against the variation in the problem size.

The paper is organized as follows. Section 2 presents the methodology of various solution approaches. The result validation and verification is discussed in Sect. 3. Finally, the conclusion of the future scope of the research conducted in this paper is highlighted.

3.1 Brute-Force-Based Solution Using Backtracking Approach

Exploration of solution space as a whole is a tedious task. However, when it comes to the problem domain like a graph, it becomes goes exponential in time complexity. Backtracking with pruning criterion addresses such solutions more efficiently. The following pseudo-code represents the solution methodology of the brute-force technique using the backtracking strategy:

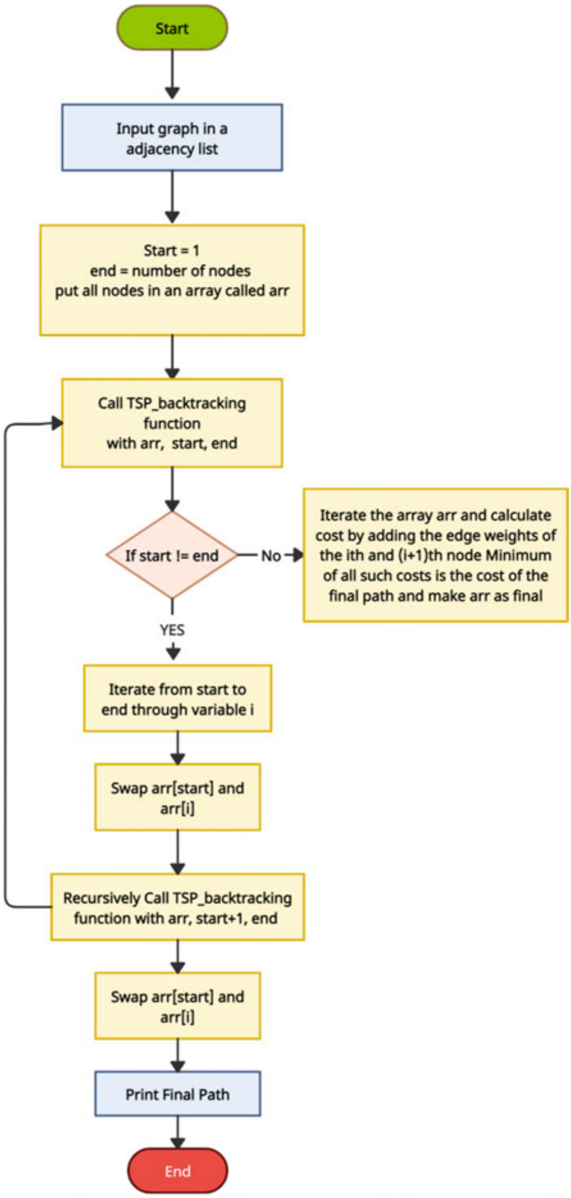


Fig. 1 Flowchart for brute-force-based solution using backtracking method

Algorithm:

1. Input the edges(e) between the nodes(n) and starting_point=1, cities[]=2,3,...,n
2. If (starting node = = ending node)
3. Calculate cost of the path by adding edge_weights
4. Optimal_cost = minimum (Optimal_cost, calculated_cost) and update optimal_path
5. LOOP from i=0 till n-1:
6. swap(cities[starting_point], cities[i])
7. starting_point = starting_point + 1 and goto step 3.
8. swap(cities[starting_point], cities[i])
9. Return optimal_cost, optimal_path.

3.2 Recursion with Bitmasking

In this approach, a bitmask of 0-based indexed is used for the naming of graph nodes ranges from 0 to $n - 1$. Bitmask represents a visited array, whereas bits of the bitmask represent nodes/cities. For example, bitmask 1010 represents the 1st and 3rd cities are not visited, yet whereas 2nd and 4th cities are visited. Equation 1 is used to compute the cost of a salesman while visiting the cities.

$$\text{cost}(S, i) = \text{dist}[i][j] + \text{cost}(\{S - i - 1\}, j) \tag{1}$$

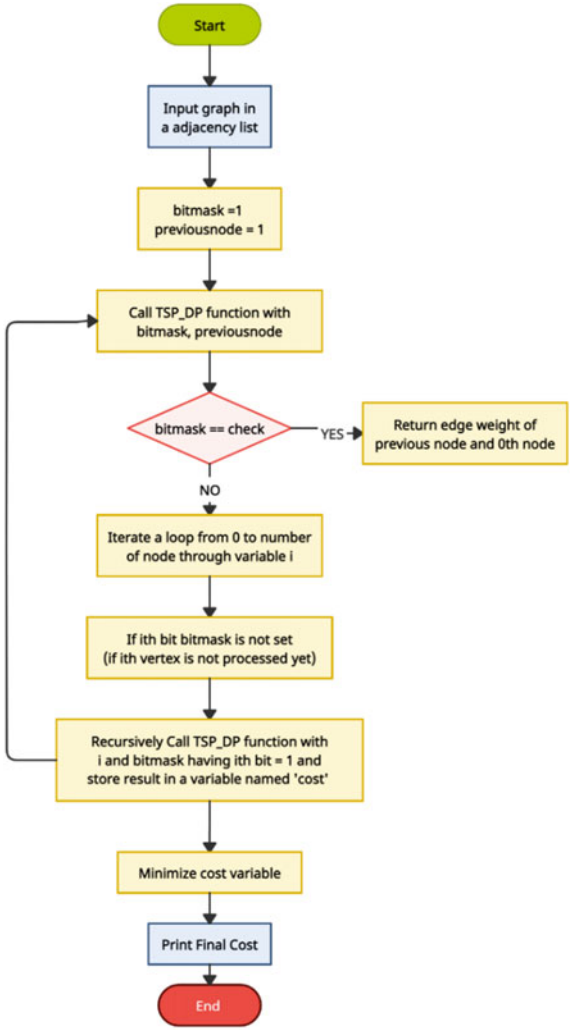
where S represents the set of all vertices and j belongs to S.

The logic behind recusion using bitmasking is shown below in the following algorithm.

Algorithm:

1. temp_bitmask = 0, ideal_bitmask = $2^n - 1$, previous_node = 0
2. If (temp_bitmask = = ideal_bitmask)
   return edge_weight(previous_node, 0)
3. LOOP from i=0 till number of nodes:
4. If (temp_bitmask BITWISE AND 2^i == 0):
5. temp_bitmask = temp_bitmask BITWISE OR 2^i
6. cost = edge_weight(previous node, i) + returning value (goto step 6)
7. Optimal_cost = minimum(Optimal_cost, cost)
8. return Optimal_cost.

Fig. 2 Flowchart of recursion with bitmasking



3.3 Genetic Algorithm

As discussed in the earlier section, GA is one of the evolutionary algorithms that work with mutation and crossover operations to converge the solution at global optima. In this paper, a fundamental GA with a single fitness is used to validate the proposed work. In each iteration, the population set members called for mutation process and based on the fitness, offsprings (new population) are selected for the new generation. The implemented GA is demonstrated through the following algorithm. The number of cities in the TSP problem is given as input to the GA along with population size and the number of iterations (generations). Based on the input values, the population set is initialized from steps 1 to 8. The improvement toward the global optima solution starts from step 9 onward, where the mutation operation and fitness evaluation are performed for the selection of the next-generation population set. This process iterates itself until the number of generations, and finally, the best solution is recorded.

Algorithm:

```
1.  input number_of_cities, population_size, number_of_generations.
2.  LOOP till population_size:
3.    Parent_Chromosome = Generate_chromosome()
4.    Parent_Fitness = Calculate_fitness_of_chromosome()
5.    If Parent_Fitness < Optimal_cost:
6.        Optimal_cost=Parent_Fitness
7.        Optimal_path=Parent_Chromosome
8.    Append Parent_Chromosome, Parent_Fitness in Initial_population
9.  LOOP till number_of_generations:
10.    LOOP till population_size(iterator i):
11.        Parent_Chromosome=Initial_populationchromosome[i]
12.        While true:
13.            Child_Chromosome = mutated_chromosome(Parent_Chromosome)
14.            Child_Fitness = Calculate_fitness_of_chromosome()
15.            If Child_Fitness < Optimal_cost:
16.                Optimal_cost=Child_Fitness
17.                Optimal_path=Child_chromosome
18.            If Child_Fitness < Parent_Fitness:
19.                Append Child_Chromosome in New_population
20.                Append Child_Fitness in New_population
21.                Break
22.            Else:
23.                Percentage_change_fitness=(Child_Fitness-Parent_Fitness)/100
24.                Probability=1/ e^Percentage_change_fitness
25.                If Probability > 0.50:
26.                    Append Child_chromosome in New_population
27.                    Append Child_Fitness in New_population
28.                    Break
29.    Copy contents of New_population to Initial_population
```

The above mentioned algorithm is represented in the form of a flowchart given in Fig. 3.

4 Performance Evaluation

The research work presented in this paper is implemented in ANSI C and executed over GCC compiler. The used platform is Windows 10 with an Intel i5 processor and 8 GB RAM.

The result is computed and demonstrated against the various solution approaches presented in the previous section. Further, the comparison among the solution

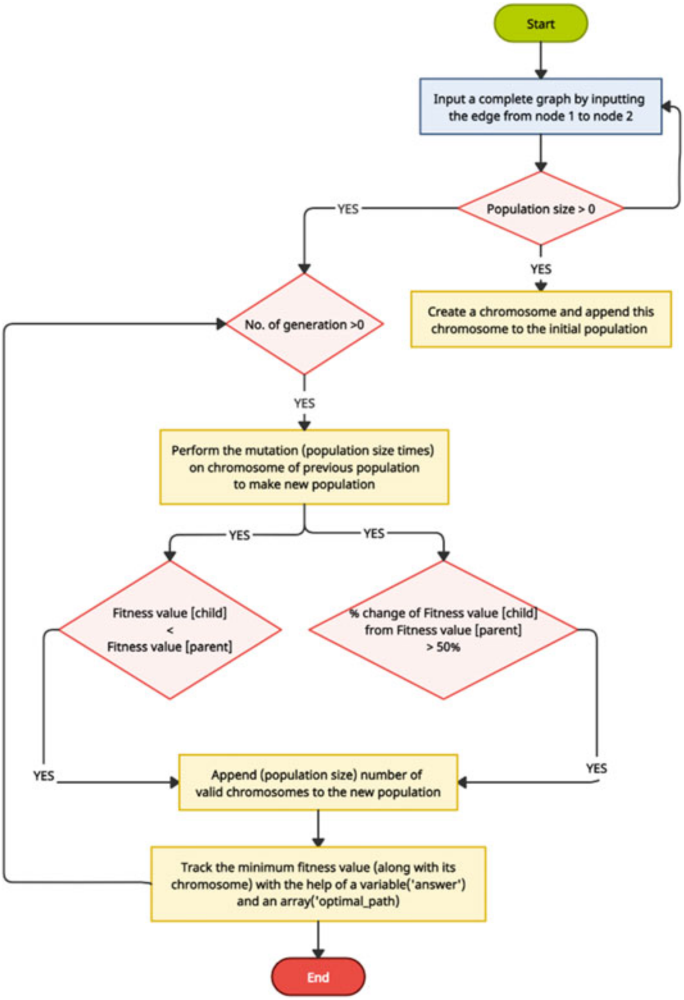


Fig. 3 Flowchart of natured-inspired genetic algorithm

approaches is based on the execution time (in milliseconds) taken to provide the solution of TSP. The analysis is examined on a different number of nodes in the graph (for a larger network) as shown in Table 1. The problem domain belongs to a fully connected graph in which N represents the number of nodes. In the case of a fully connected graph, the number of edges would be equivalent to:

$$\{N * (N - 1)\}/2 \tag{2}$$

There are five test cases considered during the experimentation. All the three proposed solution approaches are brute-force-based solution (BFB), recursion with

Table 1 Execution time (in milliseconds) of all proposed methods to solve TSP

Number of nodes	Test case	BFB	RBM	GA	D-point
10	Case 1	48	30	1	GA
11	Case 2	328	311	16	GA
12	Case 3	4050	3613	156	GA
13	Case 4	58,510	45,619	6136	GA
14	Case 5	Fail	1,462,645	380,400	GA

bitmasking (RBM), and genetic algorithm (GA) are analyzed over five test cases. The decision point is the algorithm with the best performance among all other algorithms based on the execution time.

4.1 Performance Analysis

In Table 1, as per the outcomes, GA has shown impressive performance as compared to RBM and BFB. GA is continually increasing in a normal pattern as the number of nodes growing.

The same can also be validated in Fig. 4. When it comes to BFB, it has shown the worst performance, and as the number of nodes increases from 13 to 14, the BFB fails to compute the TSP solution as also demonstrated in Table 1 and Fig. 5.

In the case of RBM, it is trying to optimize the TSP solution; however, it is not that efficient as compared to GA. Though RBM has shown an improvement over

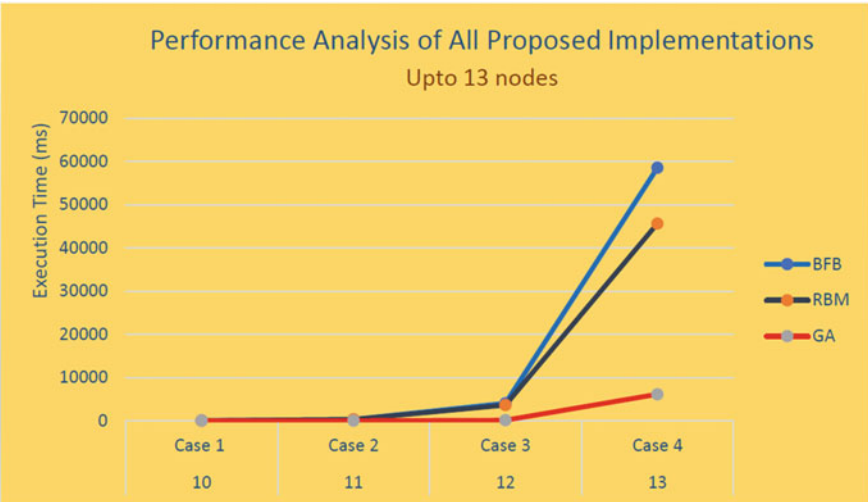


Fig. 4 Execution time analysis for BFB, RBM, and GA

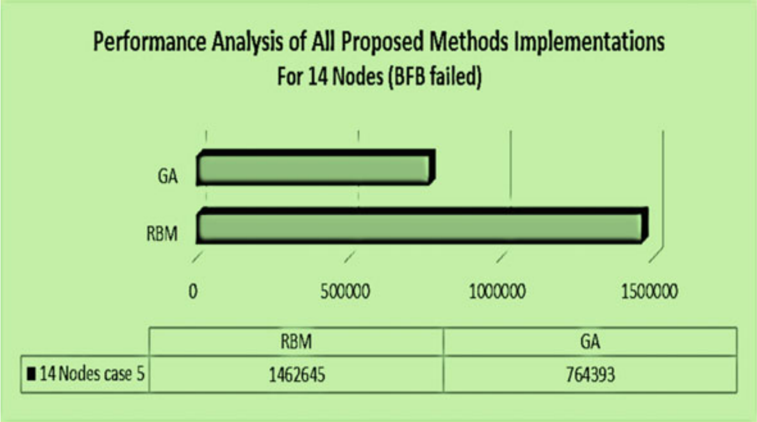


Fig. 5 Execution time analysis of BFB, RMB, and GA for network load of 14 nodes, where BFB failed

BFB in terms of execution time, the difference in time taken is very less and thus can be concluded more or less the same When it comes to a large number of nodes (i.e., cities), BFB is not able to perform the solution; however, RBM and GA find the optimal solution. The execution time taken by GA is approximately half of the time taken by RBM as shown in Fig. 5.

5 Conclusion and Future Scope

As shown in the performance evaluation section, the execution time of three different optimizations on similar test cases for the different problem domain sizes is varying. However, it is visible that the evolutionary-based genetic algorithm is performing much better than the other two. The GA is computationally efficient in terms of time complexity. Since the traveling salesman problem is an NP-hard problem, a graph containing 14 nodes is the highest number of nodes that the genetic algorithm processed easily unlike the brute-force method. As the problem domain size increases, the processing of the similar graph becomes hard for BFB and RBM, but the GA broke the user's patience to process a graph containing the number of nodes greater than 14. The two major deriving factors for the genetic algorithm's time complexity are the number of generations and the population size. There is no rule to wisely decide these two factors, instead of the multiple hit and trial. The accurate value of these two parameters may lead to a lesser execution time, and this is the main reason for the better performance of the genetic algorithm as compared to other algorithms.

The future scope of the research work presented is as follows:

1. The genetic algorithm may further be optimized by using the crossover operation after the mutation process. The multiple fitness criteria may also be applied for a better optimal solution.
2. Traveling salesman problem may be further optimized by another nature-inspired technique, such as artificial bee colony (ABC) and ant colony optimization (ACO). In these optimization techniques, artificial swarms start to travel from the origin city and take different routes to visit all cities [15, 16]. While traveling through the cities, they release a fluid called pheromone in the case of ants and dances in the case of bees. The path, which has the largest amount of pheromone, is the shortest one and is followed by the rest of the swarm population [17].
3. A polynomial time-based solution is not yet explored for TSP. Further, improvement can be explored with the higher-end systems. An improvement by other algorithms in terms of the running time is very less as on date.

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Automated Soil Moisture Detection with IoT for Smart Irrigation System

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Abstract The basic progress of any developing country can be observed by sounding technology of agriculture. In this paper, our goal is to maintain the flow of water, which is based on the moisture content in the soil. Watering the crop in the field, according to the moisture level is controlled by adjusting time interval through our system. The system uses DHT-11 and moisture sensor to monitor the humidity, temperature, and moisture level in the soil at a selected location. Our system will automatically cancel water flow process when the soil is moist enough with the help of IoT devices. When the soil dries down, the sensor lets the controller run its irrigation cycle. The sensor data collected from the sensors are updated constantly to the database server through Web technology and also to the cloud server. The data uploaded to the server can be accessed through the mobile application and also be used for various analytics. Daily, weekly, and monthly reports of water usage and other statistical information can also be generated through the application. The system can also be controlled using the mobile application. Whenever the moisture level goes beyond the critical level, an alert message is sent to the farmer's mobile application so that using his mobile application he can switch on the motor for watering the plants.

Keywords Soil moisture · Smart irrigation · IoT · SVM · Digital temperature · Humid sensor

1 Introduction

The quality of food is a very basic requirement for the surivival of every living being. This intends to develop high sound in agriculture technology so that sufficient amount of food may be served to every living being. But, geometrical growth of population

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cannot be easily controlled. Therefore, survival of the population depends only on technology in agriculture. Major natural resource 'water' requires to manage for proper tuning with soil moisture. The major natural resource that is under demand nowadays is water. Approximately, 70–80% water is consumed from the rivers and ground water collated from rain. But, due to sudden changes in climate conditions, availability of water is considerable accordingly the estimation of soil moisture for better crop productions. The information of soil moisture can determine the life and progress of overall global system since it decides the complete irrigation system, water management. More specifically, the content of soil moisture can determine crop quality which results human health and progress. Therefore, the research on soil moisture connects every phase of human life. Based on determining the soil content, the most important natural resource 'water' can be preserved. Avoiding the wastage of water and yielding of better crop become an interesting research problem while connecting with soil moisture. This idea is used to develop an automated IoT-based irrigation system. The framework of IoT remotely controls the devices and results in developing smart irrigation system.

The major challenges in this research are to deal with sudden changes in spatiotemporal data collected during different climate conditions and the drastic updates in population. Alternatively, the outcomes of the irrigation system are supposed to be cost-effective and easy to handle for every class of farmer. Therefore, the main challenges of unpredictable climate condition and population growth lead to develop an IoT irrigation system. Dealing with spatiotemporal data is a major issue of this research. We achieved satisfactory result in predicting the soil moisture. In this article, our objective is develop a plant irrigation system-based IoT devices.

2 Related Work

The importance of the interaction between land–atmosphere and terrestrial ecosystem can be easily originated from the major parameter 'soil moisture' of agriculture on earth's surface [1]. The achievements and study of high-quality content of soil moisture can be observed in several scientific process and important applications such developing smart city, weather forecasting, drought, flood prediction, and water resource engineering [2–4]. In current situation, the measurement of soil moisture includes various technologies such as tomography, cosmic ray neutrons, signals reflected from satellite, and ocean salinity [5, 6].

Understanding the serious requirements for protecting survival of the farmers, this is very important to develop some technology which can provide better solution in the diverse situations. Machine learning and IoT-based agriculture system with Raspberry Pi suggested better insights to improve the situation [7]. The effectively dynamic approach for monitoring the soil moisture is satellite remote sensing. Having high major uncertainties in spatiotemporal data, remote sensing methods are superimposed by situ sensors [8]. CROPCARE is a mobile vision-based sustainable crops disease detection system to ensure safety of farmer lives [9]. The application used convolution network based on super resolution approach (SRCNN). Their network was trained on MobileNet-V2 for making a decision system of disease matrix. Google clouds and IoT ensured the sustainability of CROPCARE.

Several existing methods presented in [10, 11] conclude that it requires to compromise with high economy of manpower to deal and process large amount of data. Utilizing multiple frameworks of SVM, fuzzy logic and machine learning and processing the thermal data opened new directions to accelerate the progress in determining the soil moisture [12]. The review report presented in [13] gives the salient features of machine learning that motivates the recent soil moisture estimation techniques. Alternatively, several popular research ensured that machine learning is not only mimic the idea generated in human brain but can be applicable with satisfactory performance of several multiple domains [14–17].

Due to geometrically increasing the population in several courtiers, the high economy is expanded to deal with major scarcity of water resources. On the other end, limited agriculture land converts the globe simple polluted from industrial hub. To overcome the issues, monitoring the agriculture farming requires soil moisture alert continuously for proper breeding of the plants. The IoT system proposed in [18] uses an esp8266 microcontroller and Losant sensor by developing a strong and secure cloud platform for determining the soil moisture.

3 Proposed Model

The proposed irrigation IoT model consists of three modules which are presented in linked flow diagram in Fig. 1. The first module 'DHT-11' a moving sensor is placed in the field of farming. The task of DHT-11 is to collect the information of humidity, temperature, and content of moisture. This information is sent to the cloud server. The components used for developing IoT irrigation system include the following:

- DHT-11—digital dynamic sensor for measuring humidity and temperature.
- YL69—sensor to measure information of moisture present in earth.
- ESP8266—a Wi-Fi module to connect the data with secured cloud server.

3.1 Digital Moving Sensor Data to Web Server

3.1.1 Digital Humid Temperature Sensor DHT-11

The DHT-11 is used to sense the data of temperature and digital humidity. After collecting the information from surrounding environment, the sensor generates digital metrics. By sensing the data, DHT-11 takes the interface of Arduino for generating instantons information. This sensor is best suitable and affordable for farmer at low cost and efficient performance.

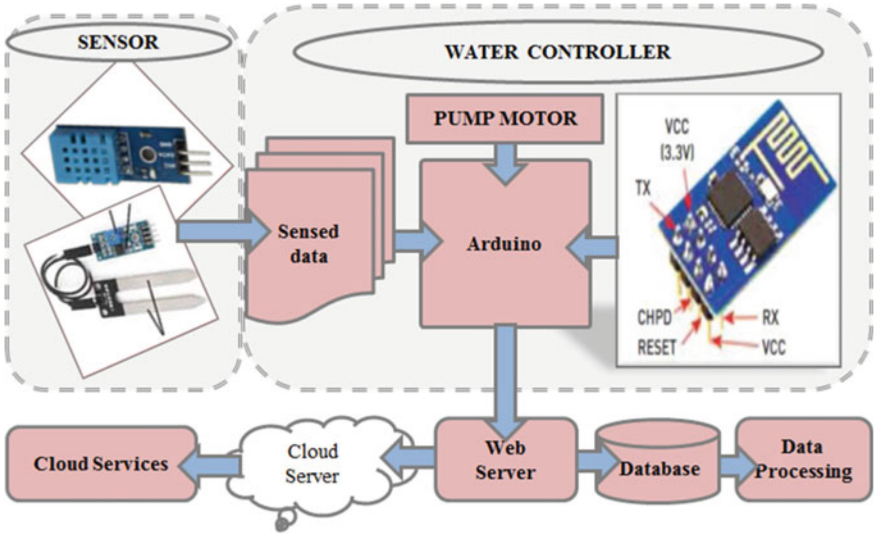

Fig. 1 Soil moisture detection IoT for irrigation system

3.1.2 YL69: Moisture Sensor

The moisture sensor (YL69) also known as hygrometers which usually responsible for checking the content of moisture present in soil. Therefore, YL69 sensor is useful to generate the moisture film from the water collected from the selected surface of ground. The sensor contains potentiometer for adjusting the sensitivity of D0, the digital output received from temperature sensor. There is inbuilt power LED, LM393comparator for generating LED output to process the data. The output of the sensor is adjusted accordingly the moisture content present in soil. Web technology provides the interface to process the digital content of soil moisture data received from YL69, and for dealing with security issues, the sensor data are also connected with cloud server environment.

3.1.3 ESP8266:Wi-Fi Module

ESP8266 is a Wi-Fi module which is required to program using AT command for connecting the module with Arduino device. The algorithmic steps for ESP8266 module to get connected with Arduino device are as follows:

- Connect VCC to the power supply with 3.3 V.
- RX: Pin-3 in Arduino devices adjusts the voltage supply.
- CH_PD: Enables the chip to keep the normal operation on 3.3 high 3.3 V.
- GND: Connect to ground.
- TX: Connect the Arduino digital to pin-2.

3.2 Automated System of Water Flow

This module is responsible to maintain the water flow fully automated in the developed soil moisture IoT system. The functioning of the module works on logical parameter by checking the moisture level in the soil. Whenever the contents of moisture in soil are calculated beyond the assumed level, then water starts pumping by the motor automatically. Further, the output of the sensor is updated accordingly to the level of contents of water present in the soil. This follows according to the folowing quality of soil:

- Wet: The output of voltage signal decreases.
- Dry: The output of voltage signal increases.

The content of water helps to determine the output of digital signal whether it is (D0) LOW or HIGH (D1). When the moisture value exceeds than the certain predefined threshold parametric value, the modules indicate the output as LOW; otherwise, it gives high output. A 12-pin DC voltage battery is used to supply the power in the motor. In case of the value of moisture signal is less than threshold value, the water pump is supposed to be automatic. There is an inbuilt mobile application in the system which is used to operate the soil moisture detection IoT from remote location. The failure in the automated system of water flow is indicated by sending an alert to the farmers. While the data are recorded via mobile application, the values of all the parameters such as humidity, temperature, and the content of moisture are displayed along with regular date and timings. In this case, ThingSpeak helps the users to see the all the updates in graphical formats. The smartness of the proposed system is achieved, while minimum duration of 10 min is taken to upload the data at server. ThingSpeak provides the concept of Internet of Things (IoT) platform in which the data can be collected and stored in cloud to maintain the system more secured. The ThingSpeak of IoT also provides facility for analysis and visualization. In the next step, the data collected from sensor can be sent to ThingSpeak from other hardware devices like Raspberry Pi, Arduino, and BeagleBone Black (BBB). In the next section, the results of the experiment of the proposed model have been discussed.

4 Experimental Settings and Results

For integrative soil moisture system, Wi-Fi ESP8266 module helps to update data read by the other sensors to store in database for every 10 min (ref. the propose model shown in Fig. 1). Finally, the database is updated by uploading data to the MySQL server. The uploading process is accomplished by using PHP. After that for securing, the date are sent to cloud server which is an IoT platform referred as ThingSpeak. Figure 2 shows the output sensed by sensor as a dry soil detected and output waveform on its Webpage (Fig. 3).

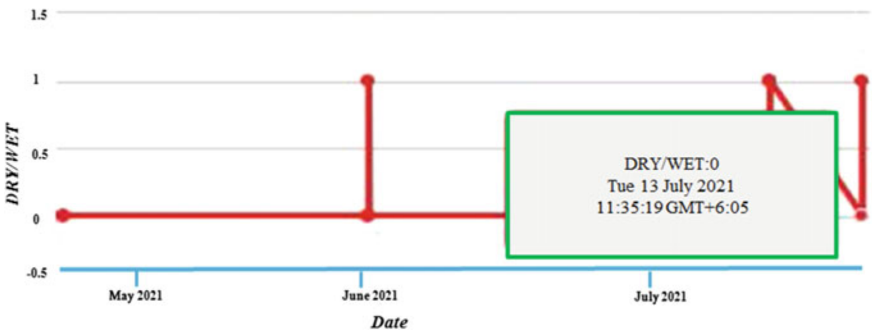

Fig. 2 Plant irrigation system sensed for dry cell

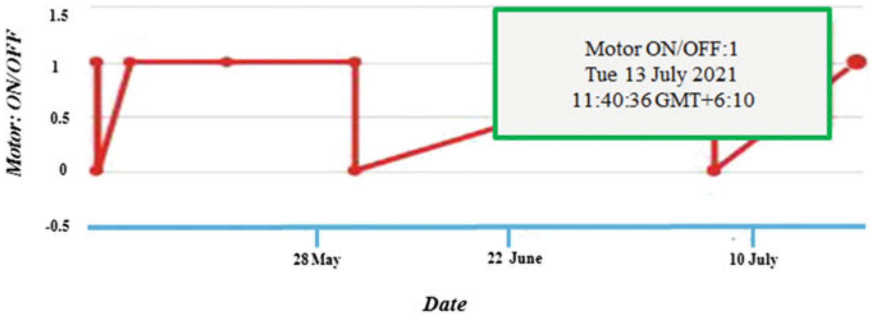

Fig. 3 Plant irrigation system sensed for turn ON motor

In Fig. 2, it is shown that if dry soil detected by dry/wet sensor, then the requirement of turn ON the motor is processed, and it indicates to flow the signal in IoT system.

The presented Fig. 4 shows that the output of the wet soil detected by sensor, and Fig. 5 shows that the soil contains moisture; therefore, it is not required the flow of water.

4.1 Limitations Against the Advantages

- In the all conventional soil moisture detection system, Zigbee module is used to establish the communication among all the sensors. This drawback is noticed as the range of Zigbee module limited to 100 m only.
- All the previous state-of-the-arts used robot to monitor the moisture and temperature parameters. This makes the system comically monotonous due to high cost.

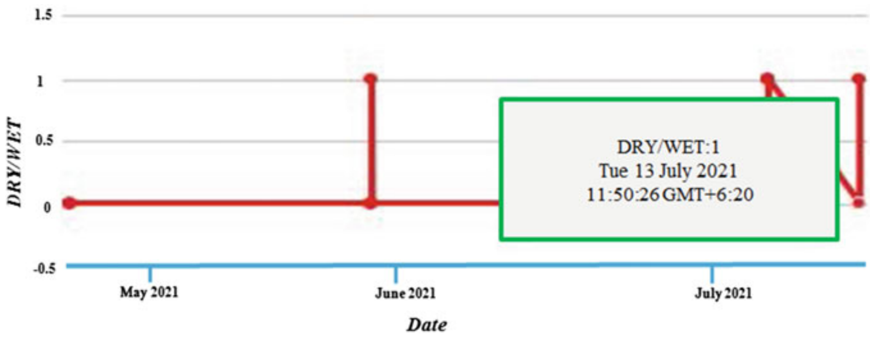

Fig. 4 Plant irrigation system sensed for wet cell

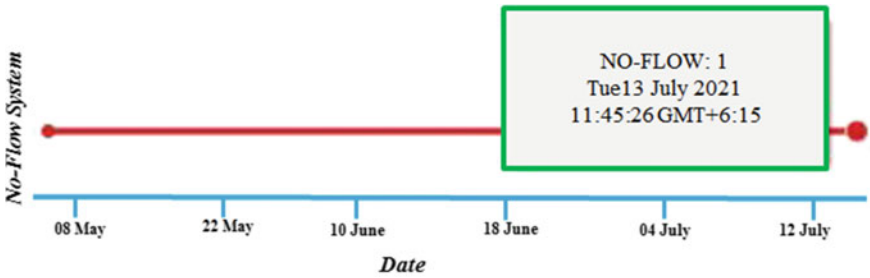

Fig. 5 Plant irrigation system sensed for turn OFF motor

- In our proposed soil moisture system, Wi-Fi module is used which make the communication smooth and faster. Our proposed model does not bother about the distance between farmhouse and workstation.

5 Conclusion and Future Recommendations

The research work implemented in this paper is concerned with multiple benefits, one of which is considered to save the unnecessarily waste of water. The parametric values of moisture, rainfall, humidity, and temperature are controlled using the various sensors as depicted in the proposed model. The condition for water pump to be automated is to maintain moisture value always less than the threshold value. For developing the smart android application, it is associated to send the information at cloud. This helps to save natural water for future generation. This helps to save natural water for future generation.

This research can be further expanded to develop such an applications which can efficiently recommend the selection of crops for particular type of soil and the quality of available water resources used for irrigation. On the basis of soil quality, the progress of producing qualitative seeds, organic products can be enhanced for yielding higher growth. This advancement of the research can indirectly impact the starvation problem of developing nations. Furthermore, recommendation system can be looked for developing farmer sentiments based on their expectation from the previous crops.

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A Comparative Performance Model of Machine Learning Classifiers on Time Series Prediction for Weather Forecasting

Sudhir Sharma, Kaushal Kishor Bhatt, Rimmy Chabra, and Nagender Aneja

Abstract Machine learning is a booming technical term in every domain of research. The majority of the technical concepts sounds to accomplish classification task in a real-life scenario. In the literature, the huge number of classification tools, it becomes very necessary to justify the performance of machine learning classifiers. This paper describes four classification techniques that are successfully applied for the prediction of the two most significant features for weather forecasting temperature and relative humidity (RH). A brief introduction of the proposed model with four prediction methodologies—ARMA, MLP, SVM and ELANFIS—follows the discriminate ideas that can create the space for such research. The techniques are then compared on a public data set containing the time series of the two parameters: temperature and relative humidity. As per the data statistics, the parameters are registered on an hourly basis and recorded over a field in an Italian city. An elaborating analysis of the results is performed to provide insights into the satisfactory performance of the models.

Keywords Time series prediction · Weather forecasting · Support vector machine (SVM) · Multi-layer perceptron (MLP)

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1 Introduction

Weather forecasting is one field which has emerged greatly in the past few years. It finds huge application in the lives of most people who look to plan their activities accordingly. Two of the most important parameters of weather prediction are temperature and RH which contain the majority of the information required for the prediction. The relevance of these features is evident from the fact that most forecasting stations provide the future values of only temperature and RH values. Thus, considering their practical application, temperature and RH data set is selected to test the four prediction models. Time series prediction (TSP) has a great demand in a number of fields which can be mainly attributed to its increasing importance in practical applications there. This has led to a lot of research in TSP [1], and as a result, various methods have evolved over the years. This paper deals with some of the popular techniques present in literature. The first model used is ARMA [16] which consists of two interlocked parts that operate simultaneously: first an autoregressive (AR) part and second a moving average (MA) part. The function of the first part is to regress the variable on its own lagged values, i.e. express the variable as a linear function of its own past values. The MA part performs the same role for the error term. It models the error term as a linear combination of various past values of itself. The second model used is artificial neural networks (ANNs) [7]-based multilayer perception (MLP). Their inherent capability of nonlinear modelling without any knowledge of statistics is the main reason for their popularity. Another powerful tool which has been employed is support vector machine (SVM). An amazing feature of SVM [6, 11] is that it only yields good classification results but also generalizes well to new data. The final method used for modelling is extreme learning adaptive neuro-fuzzy inference system (ELANFIS) [10] which represents a class of systems in which the learning potential of neural networks is combined with the expressiveness of the fuzzy logic and implemented using the time-saving approach of extreme learning.

The rest of the paper is organized as follows. Section 2 provides a brief overview of some of the prior works in this field. Section 3 describes the four models which have been compared over the acquired data set. It contains a brief introduction to the algorithms of those models. The next section illustrates the results of the time series prediction on the test data and provides a comparative discussion on the four aforementioned methods in terms of various errors. The last section concludes the paper with the inferences drawn from the analyses carried out.

2 Related Work

There has been a large body of work in the field of weather forecasting and modelling the time series of some of the primary metrics related to weather. Most of the research efforts in this domain have been to try and forecast different temperatures [4, 15, 19] such as minimum temperature, daily dew point temperature, ground temperature and indoor temperature in different parts of the world with the help of different input data variables. Some of them look to perform spectral analysis of climate indices [4], while others use infrared sounder observations [2] to make their predictions. There are other research works that look to model and predict other metrics such as humidity [2, 14, 18], or global solar radiation [17], or reference evapotranspiration [15]. The popular classification techniques used in their work have been considered major state of the arts in the comparative studies of machine learning domain. They used variants of the SVM such as LS-SVM and fuzzy LS-SVM, extreme learning machine, ELANFIS, different modifications of ANNs and other adaptive neuro-fuzzy inference systems.

3 Proposed Work

3.1 Auto-regressive Moving Average (ARMA)

The theory presented in [16] states that any linear stationary process can be modelled as follows:

$$Y_t = \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \cdots + \alpha_m Y_{t-m} + \epsilon_t - \beta_1 \epsilon_{t-1} - \beta_2 \epsilon_{t-2} - \cdots - \beta_n \epsilon_{t-n} \tag{1}$$

where Y_t is the processed output of the forecasting system, Y_{t-i} are uncorrelated input variables, α and β are model coefficients, and ϵ_{t-j} is random error term associated with the forecasting process [8].

Input variables are basically past values of the same process; this means to say the system works on feedback policy. The total number of nonzero terms to be included in the model and the value of the model coefficients are determined in the following algorithmic steps:

1. Calculate the auto-correlation function (ACF) and partial auto-correlation (PACF) [13] for the process.
2. Try to match the above estimated functions with ACFs and PACFs of standard theoretical functions available. Some of the standard theoretical models are AR(1), AR(2), MA(1), MA(2), ARMA(1, 1), etc. Here (m, n) indicates number of input variables and random error terms used.
3. Take the best matching model. Thus, the number of terms in series has been determined.
4. To determine the coefficients α and β, we equate estimated ACF to theoretical ACF. This will give us one equation corresponding to each coefficient. Determine the coefficients from the equations.

After the successful follow-up of the mentioned algorithmic steps, the proposed model is ready to predict the time series values.

3.2 Multi-layer Perceptron (MLP)

Perceptrons are analogous to neurons in human brain. A network of more than one layer of neurons is MLP [13]. MLP learns from the experience obtained by analysing input data. The processed features from input data are fed to the network, based on which the desired model is learnt in adaptive fashion. In most of the practical time series, the past and the future values are highly correlated. Thus, the MLP can be trained on some selective time lagged samples of the same time series for which the prediction is to be done. The number of lags to be used for a prediction is decided from ACF and PACF plots of data with different time lags. Those time lags, at which ACF and PACF values are above a predecided threshold, are taken for prediction. Input samples to be considered are determined accordingly, and MLP is trained on that data.

3.3 Support Vector Machine (SVM)

SVM is one of the most recent forecasting methods with its foundation in statistical learning. It is based on the principle of structural risk minimization (SRM). The input and output format is same as in MLP, only the training method is different. Training SVM [6] involves optimization of a quadratic cost function. We can increase the performance of our SVM by transforming input data to higher dimension. We have used LIBSVM library [3] for prediction using SVM.

3.4 Extreme Learning Adaptive Neuro-Fuzzy Inference System (ELANIS)

Adaptive neuro-fuzzy inference system (ANFIS) [10] is a very popular learning algorithm derived from a combination of two of the most basic learning architectures. It leverages the capability of the fuzzy inference systems to store knowledge and unites it with the power of neural networks to adapt resulting in a much more powerful learning system. The initial parameters of the fuzzy inference system are trained using back propagation which makes ANFIS highly dependent on learning through gradient-based methods. This leads to slower training and thus more cost computationally. With the idea of making the training of the network faster, Hunag introduced the extreme learning machine (ELM) [9] which modifies the learning method in a traditional single-layer feed forward neural network. In order to learn, ELM looks to find a solution for the weights from the hidden layer to the output layer after randomly projecting the input variables. It uses Moore–Penrose pseudo-inverse to find a solution that is not only minimum norm but also minimum error. Extreme learning ANFIS (ELANFIS) is a hybrid of ANFIS and ELM. It combines the fast learning method of ELM with the architecture of ANFIS to tune the parameters of a Sugeno-type fuzzy system. ELANFIS involves computing the consequent parameters with the help of pseudo-inverse method as in ELM while the premise parameters are assumed randomly.

4 Results and Discussion

The hourly data of Temperature and RH is obtained from the UCI repository [5]: Air Quality Data Set. This data was recorded by a multi-sensor device deployed on the field in an Italian city from November 2004 to April 2005. This provided a data set of 10,000 instances. However, only the first 2200 values were utilized for further processing because of the constraint of computation time. The first 2000 points have been used for training, including parameter calculation, and the rest 200 for testing in all the models. The prediction results for the same have been discussed ahead. It is clear from the plots that only two lags are significant for prediction, namely 1 and 4. Hence, out of the various ARMA models, the one which gave the best results is AR(2) which involves only the α coefficients and not the β coefficients. The values of the parameters α_1 and α_2 are obtained for lags 1 and 4, respectively, which are 0.77 and 0.32. Figure 1a shows the prediction results for instances 2001–2200 of the temperature data using the above model. Figure 1b shows the same results but for humidity data. The results from the MLP model are illustrated in Fig. 2 which contain the results when first four lags, i.e. previous four values of the time series, were randomly chosen for prediction of temperature and RH, respectively. Again, Fig. 2a, b shows the same results by choosing only first and fourth lags with marked improvement in accuracy.

The prediction using SVM is shown ahead in Fig. 3 which shows the result for temperature when last seven values were taken as input data for predicting the eighth value. The number of lags was chosen randomly. Figure 3a, b demonstrates the same with lags chosen as 1 and 4 specifically. This resulted in better prediction, as is evident from the figures, with the same argument as above. Figure 4 contains the result obtained using ELANFIS which are the best so far in terms of error. This can be mainly attributed to the capabilities of fuzzy logic combined with the learning ability of a neural network together in an inference system. This combination yields a very powerful tool for time series prediction as is proven in Fig. 4a containing the temperature prediction and Fig. 4b containing the RH forecasting result (Tables 1 and 2).

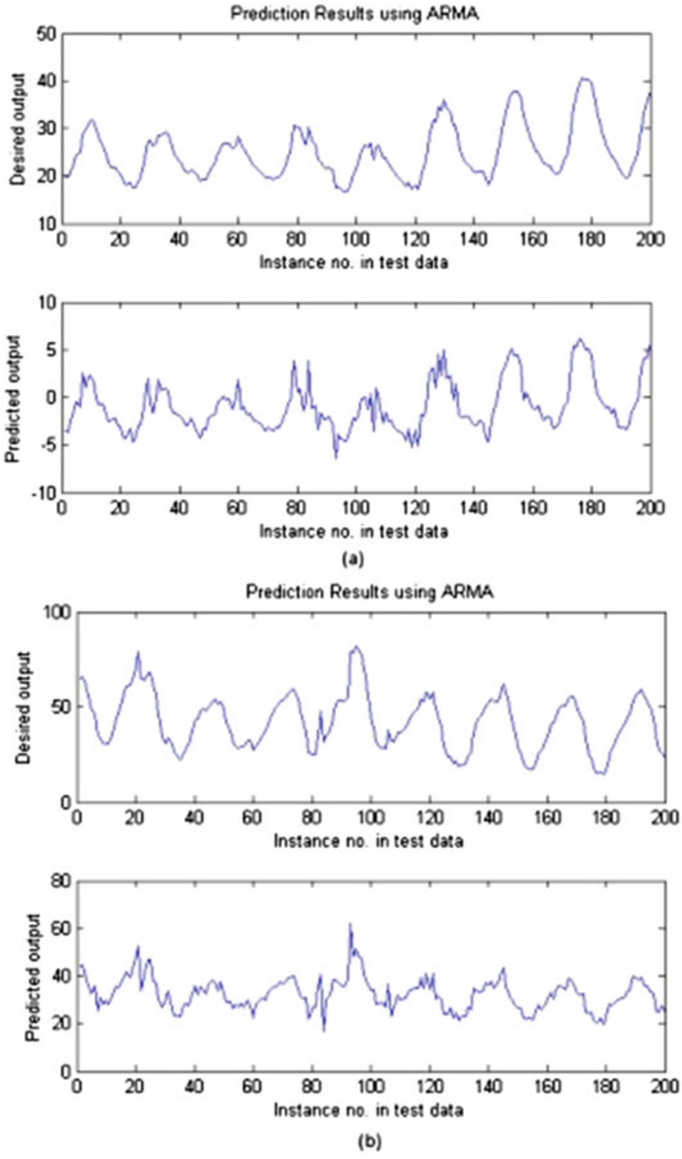

Fig. 1 Prediction results using ARMA model for **a** temperature, **b** RH

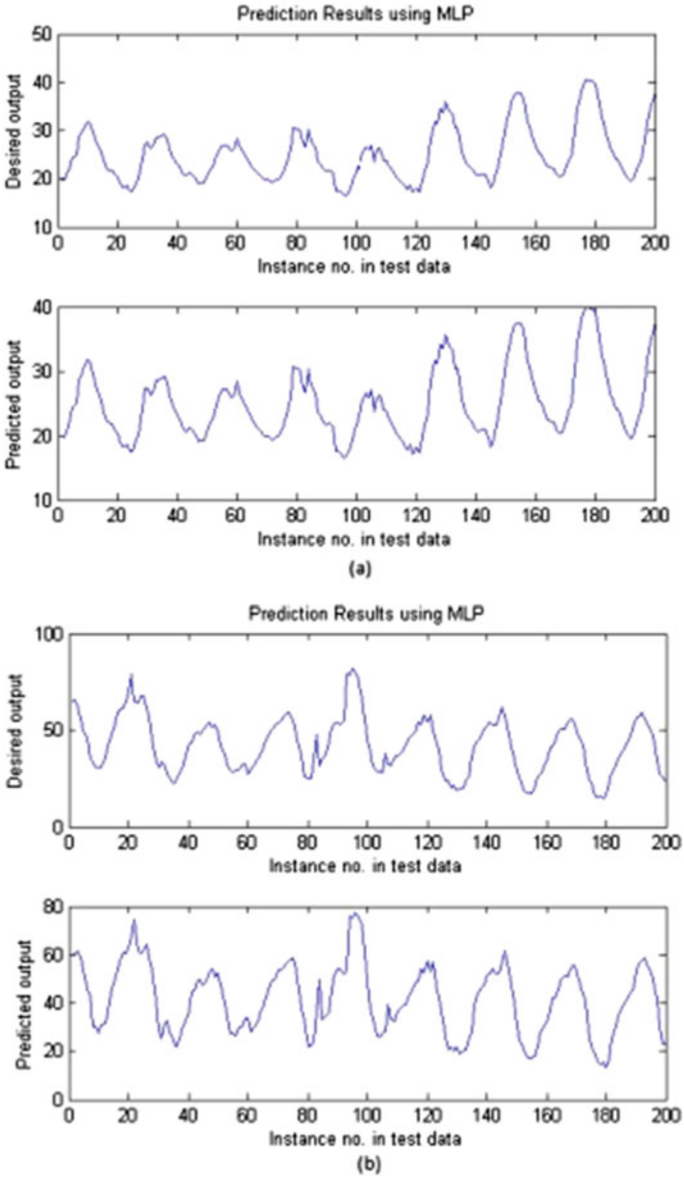

Fig. 2 Prediction results using MLP with first and fourth lags for **a** temperature, **b** RH

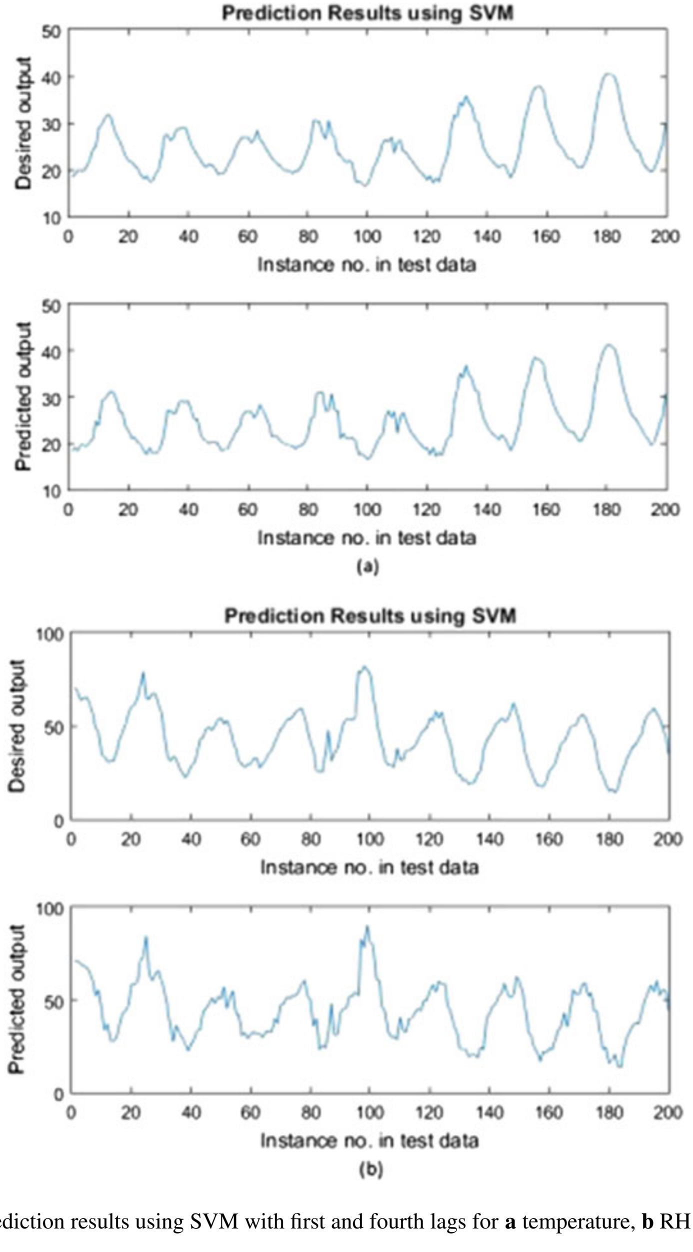

Fig. 3 Prediction results using SVM with first and fourth lags for **a** temperature, **b** RH

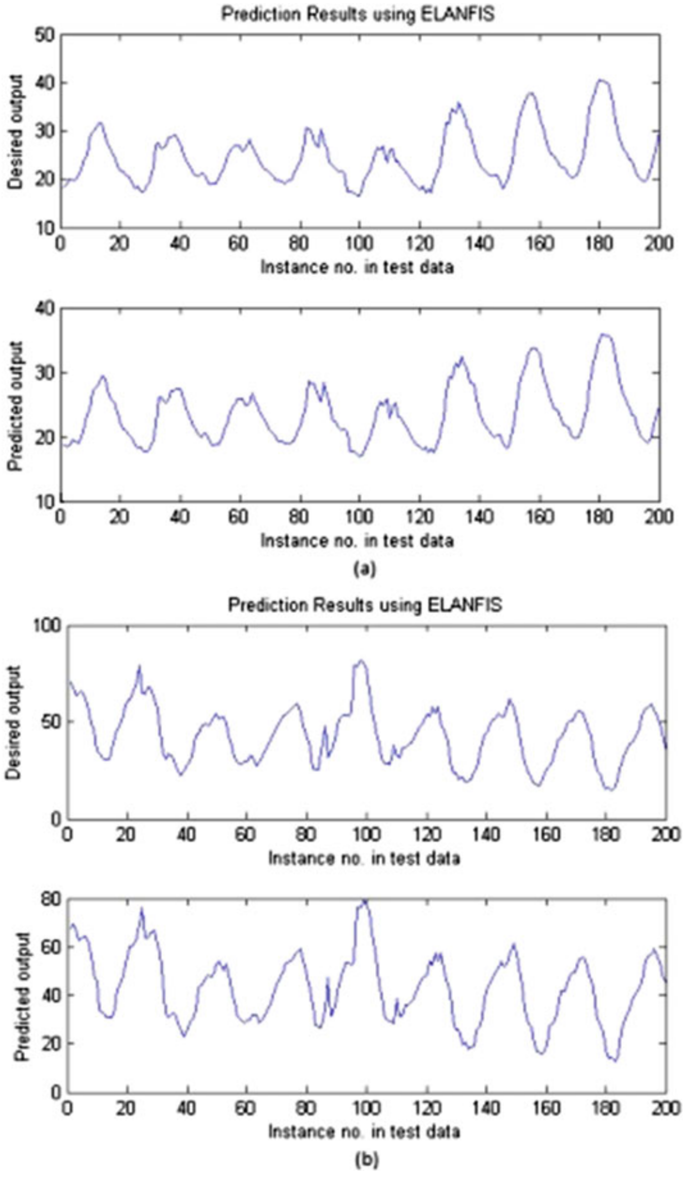

Fig. 4 Prediction results using ELANFIS with first and fourth lags for **a** temperature, **b** RH

Table 1 Comparison of the four classification models over three types of error for temperature

	ARMA	MLP	SVM	ELANFIS
RMSE	25.03	0.70	13.01	0.20
MAE	27.92	0.69	8.79	0.31
MAP	0.37	0.07	0.23	0.003

Table 2 Comparison of the four classification models over three types of error for humidity

	ARMA	MLP	SVM	ELANFIS
RMSE	19.58	4.44	6.39	1.63
MAE	23.96	5.02	5.86	2.39
MAP	0.38	0.12	0.16	0.09

5 Conclusion and Future Recommendations

The paper successfully achieves the objective of providing a comparative study amongst the four popular time series prediction models. The models were trained and tested on small and separate subsets of the complete data set acquired from UCI repository. Temperature and relative humidity were chosen for data selection because of their practical application in weather forecasting. Three different types of errors were evaluated to convincingly prove the superiority of some methods over others. The prediction results along with the original time series were also plotted for better visualization of the prediction accuracy.

The future recommendation of this work is looked for developing a better classifier which may effectively tune with deep data analytics [12] of spatiotemporal data statistics on several parameters such as snow, solar radiation soil moisture and different atmospheric pressure.

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GP-MSJF: An Improved Load Balancing Generalized Priority-Based Modified SJF Scheduling in Cloud Computing

Neeraj Kumar Gupta, Arundhati Walia, and Aditi Sharma

Abstract In today's research of multidisciplinary environment, heterogeneous devices are connected to meet the performance by solving the popular real-life applications like IoT for developing a cyber-physical system, smart healthcare and agriculture, etc. Such a heterogeneous system is risky to maintain its regularities in terms of scheduling the resources for better optimal throughputs. In this paper, we target to develop an optimal resource scheduling system in the cloud environment. More specifically, the improved load balancing algorithms are developed which give optimal allocation of the resources requested by the virtual machine. In the proposed algorithmic approach, the major efforts are to focus on developing an optimal load balancing system for allocating various tasks to virtual machines. The popular scheduling algorithm in a multitasking environment, the Round-Robin algorithm, allocates the task to VM on FCFS basis. In this paper, generalized priority-based modified shortest job first (MSJF), a premier load balancing algorithm is joint which resulted in a scheme that is effectively suitable for resource optimization and reduces the makespan at a large scale. We further presented the important objective of the load balancing technique via showing the difference between makespan and resources allocation by implementing RR, FCFS and MSJF. To optimize the allocation of available resources among the task with different requests, the proposed system satisfactorily reduces makespan and deactivates idea resources.

Keywords Cloud computing · Resource utilization · Virtual machine · Shortest job first · Support vector machine (SVM)

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1 Introduction

The load balancing technique is the most popular basic building block of a cloud computing system. The algorithmic part of these problems targets to achieve homogeneous load distribution among all the available virtual machines. The computational efficiency of each virtual machine must be responsible to design a distribution function for processing power according to the MIPS values required to execute the tasks. In this work, one of the important objectives is to distinguish the different load balancing techniques such as Round-Robin (RR), first-come first-serve (FCFS) and shortest job first (SJF) along with their advanced versions. After that, the optimized resource allocation and improved makespan values schemes are developed. The importance of load balancing is closely related to the popular paradigm of hosting and delivery of optimized resources over the cloud network. The advancement of load balancing research can accelerate high-performance processing and storage technologies for successful remote location services. At the outcomes end, this research can be considered a strong backbone of several automated real-life systems. Therefore, the requirement of such a system becomes a serious issue to consider when multiple resources and services are available with a significant impact on their security and privacy. The access of a particular cloud system of any specific domain like medical science, social media and academic instructions can be a dangerous overhead to blast the system. Therefore, better load balancing approaches are the necessities of the modern system to restrain the heterogeneous services and resources at a single platform. The important role and technical innovation in cloud computing research are shown in Fig. 1.

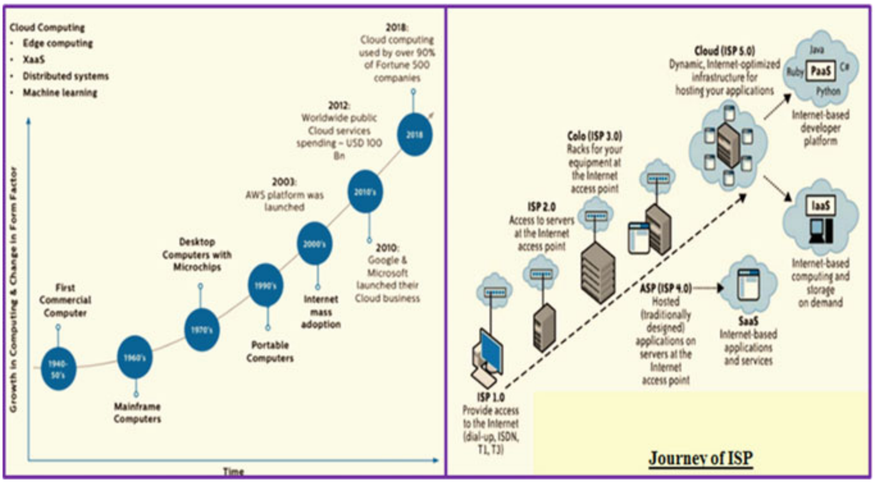

Fig. 1 Rapid techno evolution mainframe to cloud and beyond

Load balancing can likewise be accomplished through the product either by utilizing a working framework or as an extra application. Programming-based burden adjusting is easy to convey and has the exhibition like that of equipment-based burden adjusting. Some product-based burden offsetting incorporates those packs with Microsoft purplish-blue or Linux and extra, for example, PM intermediary. Load balancer deals with the traffic stream between different workers who require the resources and parallel modes. Load balancer is set between the worker and the customer and appropriates the heap among the accessible workers relying on the calculation of the load balanced. Load balancing does not just improve the reaction season of cloud applications. In addition, it guarantees the ideal use of the assets.

1.1 Load Balancing Factors

The task of load balancing ensures a metric that is responsible to check the optimality of the algorithms in terms of improved makespan, optimum resources allocation and least overhead in-device communication. Some important load balancing measures to analyse the load balancing algorithms are throughputs, response time, adaption to failure, overhead and resource utilization with better scalability. The basic architecture of load balancing system is explained in the form of tree depicting the parameters and nodes required to develop the load balancing system in Fig. 2.

1.2 Challenges in Load Balancing

The space of the cloud is composed of a large number of secured resources. It is always noticeable that the organization and allocation of these resources in specified format and protocols are the high responsibility of the cloud administrator. Therefore, it becomes necessary to assume a set problem and corresponding optimal strategies before diving deep into load balancing techniques. The very hard difficulties in load

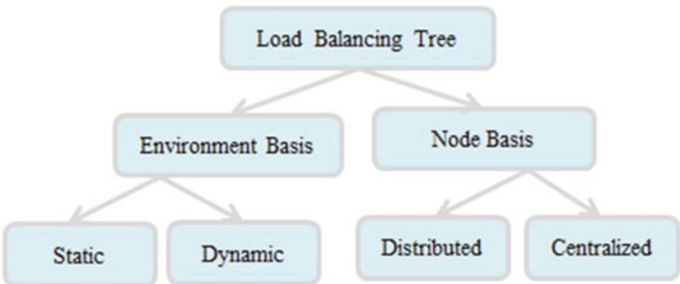

Fig. 2 Basic architecture of load balancing tree.

balancing sound for loads among the devices connected over the network. Almost all the load balancing techniques focus on reducing response time, high makespan, achieving better availability and scalability, etc. All the devices virtually connected over the cloud network may have various classes of parameters such as bandwidth, storage and memory and processing capabilities. According to the research presented in [11] on heterogeneous cloud structure, different combinations of the parameters lead homogeneous virtual machines to heterogeneous virtual machines (HVM). The response time and privilege are maintained, and accordingly the precedence of constraints is defined based on the requirements of all users. One of the hot challenges in load balancing is to meet all the requirements of each user connected over the cloud network. In dealing with big data over the cloud [12], there is always a little trade-off between performance metrics and user's satisfaction based on hard and soft execution time requests. This concludes that all these random requirements from users lead to a demand for improving response time and optimal utilization resources. Various load balancing techniques for a huge number of tasks and corresponding execution time words under very complex algorithms. Hence, extra processing overhead is generated for communication and monitoring ends of each task.

2 Related Work

The rapid growth in recent state of the arts shows that the task of resource scheduling in the cloud computing environment has great significance in several multidisciplinary applications of the research. To receive the optimal solutions to the load balancing problem, the researchers are heavily encouraged to provide solutions while multiple tasks and multiples devices are interconnected. The majority of the research work focused on optimization which can influence the scheduling in terms of makespan, QoS and waiting time, etc. [6]. Although very little research work is explored to deal with priorities of the tasks and allocation of VM in the scheduling process, The task of scheduling is interesting to play a very important role as much as difficult to find satisfactory solutions for all users. All the leading research on cloud computing impacts to provide high performance for throughput in multiple resource sharing networks. In [2], a multi-class technique for better load balancing is proposed in a heterogeneous computing environment for the users having different priorities. For developing such a load balancing system, uniform and random distributions approaches are adopted. Instruction length [2] is also an important concept to develop a priority-based load balancing system. The experimental workflow is designed using a sigma control system and ensured a significant improvement in execution time and makespan. An optimal scheduling model based on admission control priorities provides an efficient load balancing system by considering the time spent in the ready queue. The system can satisfy the framework of QoS for achieving high throughput. In [5], a task-oriented scheme is considered for resource allocation. For ranking the available resources, the pairwise-competitive matrix is developed. In this matrix, the ranking of resources is done according to the bandwidth and compile time along with the reliability measures of the tasks. The weight of the tasks allocated to the virtual machine is calculated with AHP technique. In the study of basic load balancing techniques, Round-Robin is very very simple and most commonly scheduling. For developing scheduling systems in clouds, RR algorithm sets its chunk time for providing managing multitasking. In [5], an analytic model on RR scheduling is presented. The main shorting of RR algorithm is to ignore the processing power of VM and the length of the task. This concludes that RR is a better candidate to be dealt with random sampling. In the case of another popular load balancing technique refereed as SJF, the tasks are sequenced based on MIPS values required to process by machine. In [4], it is ensured that SJF gives better resource utilization and makespan values to process the tasks. Few authors stated that many times the highest computational power can be assigned to the task which may be sufficiently processed with the lowest MIPS values [10]. Alternatively, optimization techniques also play a crucial role in developing a load balancing system in which the resource allocation time may be minimized with maximum throughput [7, 8, 10]. In our research, we focus on priority-based optimization scheduling in the cloud computing domain.

3 Proposed Work

3.1 Generalized Priority

Some fixed attributes are utilized in load balancing technique to assign priority to the given VM for particular task. The basic function of GP is to decide the required processing power of VM and corresponding length of all the tasks. Millions of instruction per second (MIPS) as an attribute of VM is responsible to assign the priority [13]. This means higher MIPS values correspond to the higher priority of the task. The shortcoming of GP is noticed in starvation while several tasks with lower priority have to wait in ready queue. For implementing GP, we used cloud simulator.

3.2 Task Assignment to Virtual Machine: (MSJF and GP)

Improving the value of makespan of the allocated virtual machine helps in optimizing the utilization of resources. The failures SJF scheduling requires to develop a new system may provide optimum resource utilization with improve makespan. Motivated from the fact discussed in [3], energy-aware load balancing system is developed. In general for the task with highest length, resource utilization is quite difficult to manage. To overcome the issues with resource management, modified resource utilization scheme is developed. The proposed scheme is satisfactorily optimal and referred as modified shortest job first (MSJF). In MSJ, the queue of all tasks is sorted accordingly and the length of each tasks which arranges the computational time of the tasks in non-decreasing fashion. Similarly, virtual machine with different MIPS values is also sorted. One different group is created to contain the VMs having MIPS values less than the average. Similarly, another group contains the VMs of higher MIPS values. Therefore, all the VMs are categorized into two groups of less and higher processing power. The key concept of algorithm adheres that the tasks having higher length than average are assigned to the virtual machine which has higher computational power [12]. This means the longest jobs are assigned to the fastest virtual machines. In very few cases, the only shorting of this scheme is noticed while the tasks of least length are assigned to the VM with higher computational power. In this way, the proposed load balancing technique improves the makespan values significantly. From the experiments, it is observed the tasks are assigned very evenly with higher range variation in the capacity of virtual machine. For receiving the highest improvement in MSJF, another load technique 'GP' is fused. The performance of the joint algorithm is improved because of assigning the priority value to each task and corresponding VM assigned based on the length and computational power of VM, respectively. In general, highest MIPS values and highest length task are most priority candidates to suit the load balancing algorithm. In this way, many important factors like makespan, response time and throughput are efficiently improved [1]. The algorithm of proposed system as shown in Fig. 3 shows the details of the proposed algorithm used to implement modified SJF with generalized priority.

The algorithm checks two conditions for allocation of VM: one is MIPS of VM which is below the average of all VMs and then assign task from the group

Algorithm: Modified Shortest Job First (MSJF) with Generalized Priority (GP): [MSJF+GP]

1. Consider heterogonous resources attributes for initiating the cloud computing system
2. Cloudlets: A random length cloud task is created.
3. Arrange the tasks in Cloudlets in non-decreasing sequence.
4. Sort all VMs in non-decreasing order of processing power i.e. MIPS.
5. Divide all virtual machines containing the all the Cloudlets two group based on MIPS. i.e. Processing Power less than or greater than average MIPS.
6. Compute average length of the tasks assigned in each group.
7. Classify the tasks again having the length below average and above average.
8. Assign the priority count to all the tasks and arrange them in decreasing order of the length.
9. Assign the task having highest priority to virtual machine from each of the group.
10. Finish all tasks for above steps.
11. Compute make-span and engaged total response time

Fig. 3 Algorithm: generalized priority for modified SJF accordingly. Another condition is tested for the length of the task below average or not, then group of task is decided according to the low or high processing power than the average power.

4 Results and Discussion

To implement the new hypothesis of MSJF and GP, we utilized CloudSim which is a core simulation engine. It is a robust stretchy framework of Java-based simulators which contains the libraries required to simulate in cloud environments. The policies of CloudSim can adopt by methods described in [9]. The characteristic of CloudSim permits the users to update several components like the power of VM, length of tasks in cloudlets for improving the system architecture. The components of CloudSim framework include the region of devices, datacentre, host, service booker, and VM allocation, etc. The configuration of the virtual machine includes four virtual machines VM-0, VM-1, VM-2, VM-3 and VM-4 each of which having the storage of 10,000 Mb, bandwidth 1000 Mb, memory 512 Mb and MIPS values from 1000 to 6000. On assignment of the task to the particular virtual machine, time logs are generated containing the details of ID of cloudlet and VM along with the corresponding starting time, finishing time and executing of each task. These details are helpful to compute makespan time. Table 1 below shows the makespan time for algorithms on a particular virtual machine. In total, 50 tasks are accomplished on each virtual machine.

From the observations of the experiments developed related to state-of-the-arts profiles from different researchers, it is noticed that load balancing with SJF is a highly suitable candidate when the length of the tasks lies in a very small interval. Such tasks are easier to allocate best-suited VMs having similar power. In case, the length of the task covers a large interval, SJF load balancing generates a higher makespan which finally creates an indefinite wait or starvation problem. Alternatively, it is also noted MSJF is the best suitable candidate when the length of tasks and VMs can be represented in terms of millions of instructions per second (MIPS). The outstanding contribution of this research comes into light when jointly generalized priority (GP) and MSJF schedule the longest task on the fastest virtual machine. This results in the processing of every task in exactly desired timespan and performance achieved can be seen in Fig. 4. From the experiments, it is deduced that Round-Robin load balancing has the same impact while MSJ and GP are scheduled on the same virtual machine with the same power. MSJF + GP implementation results in the same performance as RR if VMs are having the same processing power.

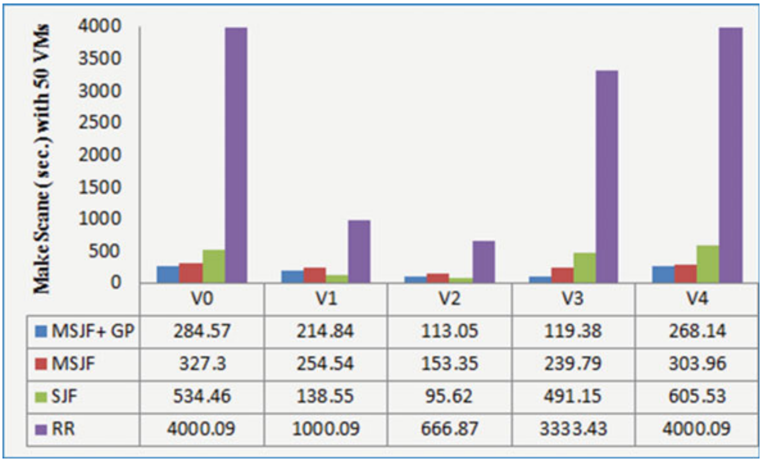

Fig. 4 Performance of load balancing model: makespan comparison for Round-Robin, shortest job first, modified shortest job first and generalized priority (MSJF + GP: proposed algorithms)

Table 1 Makespan: time measured from start of the first task till finishing of the last task on the 50 VM for computation makespan with MSJF and GP

Makespan (50 tasks)	VM-0	VM-1	VM-2	VM-3	VM-4
RR	4000.09	1000.09	666.87	3333.43	4000.09
SJF	534.46	138.55	95.62	491.15	605.53
MSJF	327.30	254.54	153.35	239.79	303.96
GP-MSJF	284.57	214.84	113.05	199.38	268.14

5 Conclusion and Future Recommendations

The important concept of load balancing in the popular domain like cloud computing shows its significance in addressing and improving the cloud users' experience to utilize the resources. The state of the arts in load balancing are very rich as being a research domain of many old decades. This is necessary to notice many of them avoid addressing the severe issues in load balancing with resource scheduling in the cloud environment. The objective of load balancing is to develop a cloud model which is based on optimized settings of the parameters used to develop the model. The important parameters include makespan, an available response time of machine to users and resources optimization, etc. The optimization approach depends on various users requirements. Therefore, the varieties of parameters in load balancing create huge scope in this research. From the experiment performed, it can be seen that RR and FCFS algorithms are considered as very usual scheduling for load balancing. Instead of optimal utilization of the resources, these algorithms provide a better response to interact with users according to their demands. The efficiency of resource optimization with SJF is far better than Round-Robin scheduling. The drawback with shortest job first fails to give accurate makespan, whereas resource utilization significantly improved. Many more alternative parameters to schedule the load balancing in a challenging insured cloud environment may be considered. The future recommendation in load balancing must ensure security issues with multiple parameters used for scheduling.

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An Approach to Convert Compound Document Image to Editable Replica

Anand Gupta and Devendra Tiwari

Abstract Various OCR techniques are available to extract text from the image, although these techniques fail to recreate the original document regarding its layout and text formatting. The document image contains components like text, tables, and pictures that pose challenges in extracting them separately and placing them at their correct positions. The said need and challenges are addressed in this paper by proposing a methodology that constructs a suitable feature vector. It extracts the components (text, tables, pictures) from a compound document image which contains multiple text blocks, pictures, and/or table components, for reconstructing the document in an editable format (LaTeX). The strength of the feature vector relies on the clarity of the source image. Robustness and accuracy of the editable reconstruction of a compound document are measured by analysis of feature vector.

Keywords Compound document image · Document image analysis · Editable replica

1 Introduction

A compound document image refers to the image of a document containing one or more text blocks, pictures, and/or table components. The image may have been obtained by scanning the document or captured through a camera, or created artificially. Today, the ubiquity of scanners, cameras, and other such image acquisition devices have led to the digitization of more and more such documents. Educational institutions, hospitals, and many other organizations often possess large databases of such digitized documents. This widespread access to electronically stored images

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has led to a growing interest in fields of identifying, analyzing, and/or modifying the various components (text, pictures, tables) of a compound document image.

1.1 Literature Survey

In our survey, it is found that the research conducted till now can be classified broadly into two major areas:

(1) Classification and indexing of documents based on components.

(2) Extraction of identified components, i.e., text, pictures, or tables.

Classification and indexing of documents: Research work concerned with the identification of components in compound document images and classifying and indexing based are grouped and analyzed. An architecture [5] that is relevant to the above example for classification of images has been designed using open-source methodologies and is presented. Thereafter, a system [1] for the analysis of the graphical information in a document for its classification has been presented. Furthermore, a processing pipeline [8] that automatically converts a set of scanned page images into an e-book in the popular PDF format has been built. This solves a part of the problem in the mentioned scenario; however, the final document is not editable. Also, several methods have been proposed for detecting tables. In 2010, an algorithm [15] which can be used with varying layouts in documents has been developed. In 2013, a novel method [12] which identifies the column and row line separators of tables have been published. Then, in 2014, an algorithm [11] using local thresholds for word space and line height to locate and detect all categories of tables from scanned document images has been proposed. The process of identifying images from documents is a challenging task. In recent works, [16] has given an approach to localization of text from a natural scene using features and text awareness scores. In 2020 [3], BinMakhashwn et al. have used geometric features on the historical documents for indexing and document analysis.

Extraction of identified components: Following research focuses on the extraction of one (or more) of the different components of the document. Extraction of the different identified components involves methodologies or algorithms differing in space and time complexity. Some of these algorithms are as follows. An algorithm [14] for extracting tables using conditional random fields of the tabular component in documents as in the above case scenario has been presented. Also, a novel method [7] for detecting all types of table format from single column image document has been presented. A novel learning-based framework [2] to identify tables from scanned document images using a fixed point model has been proposed. In order to handle different languages, a fast, language-independent (English and Tamil), skilled technique [6] for table structure detection and its content extraction based on morphological operation, connected components, and labeling have been presented. Several methods have been used for text extraction in documents. Also, a novel method [10] using morphological techniques for recognizing text from documents as in the proposed example has been presented. Then, a method [4] for localizing and recognizing text in complex images and videos has been presented. A method for detecting text from documents made from comic images has been presented in [17]. Majumdar et al. [13] have given a method to obtain high-resolution document image to achieve high OCR performance. Xi et al. in [19] have proposed an approach for layout analysis by the mean of edge information augmented as input channel. [18] Vyas et al. have used image features and background features to identify the most prominent image with the help of SVM.

1.2 Challenges

In the first area, while the components have been identified independently by different researchers, no work has been reported that is able to identify all these components together. Even though the work in the second area is able to extract the components separately, the reconstruction of the document in an editable form has not been achieved. In this paper, the authors focus on providing a methodology to recognize the textual, pictorial, and tabular components from the document image and reconstruct it in such a manner that the original formatting of text and positioning of the components of the documents are retained, and the final document is in an editable format.

Contributions: The contributions incorporated in the paper are as follows:

- A dynamic feature vector is proposed that characterizes the positioning of the three components (tables, text, images) of the document image and the text formatting. Hence, for each compound document image, we construct a dynamic feature vector that abstracts the layout and formatting of the document.
- The feature vector, constructed during the extraction phase, is used in the reconstruction of the editable document.

The rest of the paper has been organized into sections, which are described as follows: Sect. 2 presents the proposed methodology, and Sect. 3 presents results and experimentally demonstrates the robustness of the feature vector chosen and the methodology as a whole. Section 4 contains the concluding remarks.

2 Methodology

Five major steps are identified in the proposed methodology (Fig. 1) for converting a compound document image to an editable document. These are preprocessing, sep-

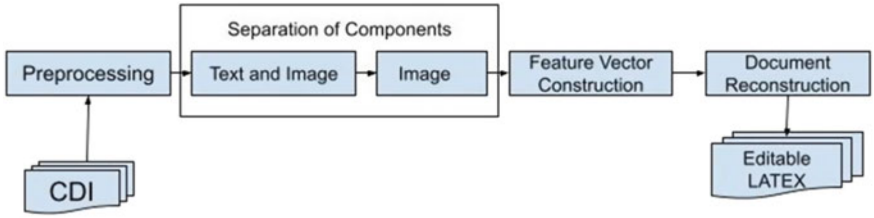


Fig. 1 Process flow of methodology

aration of text and images, separation of images, final text extraction, and document reconstruction.

2.1 Preprocessing

To get the document image in the desired form, image is converted to grayscale. These images carry only intensity information. Noise removal techniques are applied on the grayscale image that can remove noises such as Gaussian noise and salt and pepper noise. Other operations like skew correction when the page is not oriented correctly and sharpening of image when it is blurred may also be performed based on image acquisition requirement.

2.2 Separation of Text and Graphical Component

In this module, we extract the text, thus separating the text from the graphical components, i.e., tables and pictures. The steps followed are as follows:

Thresholding Thresholding methods replace each pixel in an image with a black pixel if the particular pixel value is less than some fixed threshold T or a white pixel if it is greater than that constant. Otsu s global thresholding method is found appropriate for this purpose.

Text extraction The text recognition algorithm applied over the image is based on the API functions of Tesseract. We run the OCR and create a .txt file containing each word read, the extracted text content, the font weight, the font point size, the font style, the font name, the left x-coordinate, and the bottom y-coordinate. All these pieces of information are essential for preserving the layout and formatting during the reconstruction phase.

Image matrix subtraction The image produced in the previous step image IM_2 is subtracted from the image after thresholding IM_1, i.e., every pixel that is black in that image is turned white in the image after thresholding to obtain the required image IM_3 that contains no text. Thus, the text and graphical components(tables and pictures) are segregated.

Algorithm 52.1 Matrix Subtraction

1: *for all i,j*
2: $i \leftarrow patlen$
3: **if** $pixel_{ij}(IM_2) == 0$ **then return** $pixel_{ij}(IM_3) = 1$
4: **else**$pixel_{ij}(IM_3) = pixel_{ij}(IM_1)$
5: **end if**

2.3 Separation of Graphical Component

- Perform morphological operation 'closing'on the grayscale image : In this step, an image containing only pictures(IM_4) is formed by applying the operation 'closing'to the grayscale image. The compound operation 'closing'is the 'dilation'of an image followed by an 'erosion'. The van Herk/Gil-Werman (vHGW) algorithm [9] is used for its efficient implementation. The operation 'closing'suppresses the dark details of an image, and hence, with our choice of a structuring element, the text and lines (whose thickness is less than the structuring element, which is generally the case) are suppressed. Hence, tables are also suppressed, leaving behind an image containing only pictures.
- Thresholding (in a specific manner): The image produced in the previous step is thresholded such that any pixel that is not white is turned black. The image so obtained is stored as IM_4.
- Bounding box creations: The images IM_4 and IM_5 contain only pictures and table structures, respectively. We now aim to isolate these pictures/tables by creating boxes around them. To achieve it, first, an algorithm to retrieve contours from these images has been used. Then rectangles are drawn that bound the required contours. It is done by approximating the curves (using the Douglas–Peucker algorithm) and then finding the minimal upright bounding rectangle for that point set along with their coordinates. Once we can obtain these bounding boxes, coordinates are used to separate all images, tables as separate images. Also, each picture and table's bottom-left coordinates, height, and width are stored in files named pictures .csv and tables .csv, respectively.

2.4 Final Text Extraction

In this module, the noisy text extracted in module 2 is filtered. Extracted text from any area where pictures or tables are present is deleted along with corresponding information. This step finally produces a file text format containing all information regarding the words read. Also, a file CSV file is created, which contains the font point size, the font style, the font name, the left x-coordinate, and the bottom y-coordinate of each word.

Algorithm 52.2 Text Extraction

```
for all i, j do
    for all pictures & tables as p do
        if xmin(word)>xmin(p) & ymin(word)>min(p) & xmax(word)<xmax(p) &
        ymax(word)<ymax(p) then
            delete(word)
            delete(word → info)
            Break
        end if
    end for
end for
```

2.5 Construction of Feature Vector

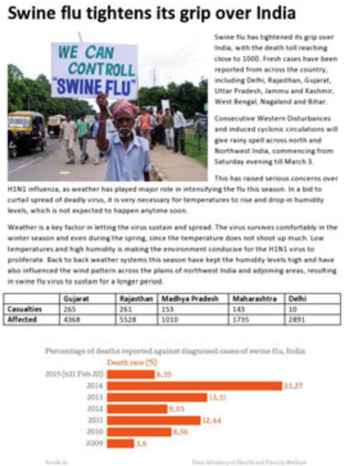
In the previous steps, we have created three files in CSV format for text, images, and tables. While CSE for text contains the formatting and positioning information for the text in the document, the latter two files contain the positioning information for the images(s) and table(s), respectively. All these together form the feature vector. This is a dynamic feature vector whose length depends on the document itself.

2.6 Creation of Editable LaTeX File

A method is developed which converts the information collected in feature vector into an editable LaTeX file. This method places all the component types into their respective places to create a replica.

3 Experiments and Results

In order to prove the robustness of the proposed method, we conducted experiments on all possible types of compound documents.



Swine flu tightens its grip over India

Swine flu has tightened its grip over India, with the death toll reaching close to 1000. Fresh cases have been reported from across the country, including Delhi, Rajasthan, Gujarat, Uttar Pradesh, Jammu and Kashmir, West Bengal, Nagaland and Bihar.

Consecutive Western Disturbances and induced cyclonic circulations will give rainy spell across north and Northwest India, commencing from Saturday evening till March 3.

This has raised serious concerns over H1N1 influenza, as weather has played major role in intensifying the flu this season. In a bid to curtail spread of deadly virus, it is very necessary for temperatures to rise and drop in humidity levels, which is not expected to happen anytime soon.

Weather is a key factor in letting the virus sustain and spread. The virus survives comfortably in the winter season and even during the spring, since the temperature does not shoot up much. Low temperatures and high humidity is making the environment conducive for the H1N1 virus to proliferate. Back to back weather systems this season have kept the humidity levels high and have also influenced the wind pattern across the plains of northwest India and adjoining areas, resulting in swine flu virus to sustain for a longer period.

	Gujarat	Rajasthan	Madhya Pradesh	Maharashtra	Delhi
Casualties	265	261	153	143	10
Affected	4368	5528	1010	1735	2891

(a) Compound image containing all three components i.e. text, picture and table

That young woman is also a reminder of how the most vulnerable in the state are still falling through the cracks of its prized social indices, of how the society discriminates against a poor Dalit woman who lived alone with her mother in a two-room dilapidated house on a strip of wasteland. All that stood between them and the men who reportedly and continuously harassed them was a frail door that would give away under force.

In India and Kerala — which prides itself that almost every house in the state (95%) has a toilet and that it has achieved almost 100% coverage in water supply — this mother and daughter lived with no well or toilet. They were barred from drawing water from a well in the neighbourhood and had to walk to a public tap a kilometre away. And to think that crime was what the daughter-mother duo were hell-bent on fighting: the 29-year-old was studying in the Government Law College, a daily-wage labourer, dreamed big for her younger child and eked out every paisa to make her a lawyer.

	Gujarat	Rajasthan	Madhya Pradesh	Maharashtra	Delhi
Casualties	265	261	153	143	10
Affected	4368	5528	1010	1735	2891

(b) Input test image

Individual components of the compound document image are extracted using the methodology explained in Sect. 2. As can be seen, the text is obtained in an editable format, and the rest of the graphics (images and tables) are extracted separately. These components are then combined to finally form a latex file which also contains the proper positions of these components. As the Image 2a shows, the data for the textual feature vector is stored in a text file which is then used for populating the

Table 1 Difference in percentage after creating editable document

Case	Text	Picture (s)	Table (s)	Diff (%)
1	0	0	1	0.00
2	0	1	0	0.00
3	0	1	1	0.00
4	1	0	0	13.01
5	1	0	1	4.05
6	1	1	0	6.70
7	1	1	1	3.46

vector. Taking different images as input corresponding to each of the above cases, we reconstruct the document and compare the accuracy of the proposed methodology by comparing an image of the final editable document and the original input image using a tool named ImageDiff. The results for the same are summarized in Table 1.

As can be seen in Table 1, for most of the cases, the percentage change is less than 5%, which proves that our methodology is robust and accurate with all the cases. Also, it is pretty logical to assume that the accuracy of the regenerated document will depend on the quality of the input image. The picture is skewed if it has been properly scanned or if the image is blurred or having low pixel density. All these are some of the factors that will impact the correctness of the final document.

4 Conclusion

This paper has successfully demonstrated a novel method for reconstructing a document in an editable form from its image. It extracts all the three components of compound images (tables/text/pictures) and places them in their original positions in a .TeX file (editable) in their exact original positions, whereas the commercially available tools, when converting an image to an editable form, distort the positioning of the document's components or layout. The methodology presented has been tested on documents containing all possible combinations of tables, pictures, and text with satisfactory accuracy; thus, it is robust. Effects of blurring and reduced pixel density on accuracy of editable document can be experimentally determined. There is an immense need to create digital and editable copies of ever-increasing documents for their safe storage and analysis in the digital age, and hence, the method proposed serves as an asset in this field. However, some other components exist in the documents/images that we take as input, such as margins, lines, but in this paper, we focus only on text, tables, and pictures. The authors hope to extend the methodology to incorporate the other possible components in compound document images in future work.

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An Energy Savings Approach Based on Data Mining by K-Means Clustering and R-Programming Framework

Vishal Goar, Manoj Kuri, Rituraj Soni, and Aditi Sharma

Abstract The entire world is dependent on corporate capacity. Whether it is at a household level or a corporate office, the basis must be sound. Corporate capacity deals with a huge amount of data, such as lighting, cooling, security alarms, and so on. Along these lines, manual interaction will devote a significant amount of time and effort to identifying faults and making critical decisions for something similar. This development employs an information mining method to forecast the framework's behavior and outcomes. This invention is also capable of dealing with the record's collection of experiences as well as the number of limits required in any setting. Following the recovery of data from all sensors, energy consumption is predicted using relapse-based approaches. Currently, all recovered data will be converted into a certain configuration, and then, desired provisions from that configuration will be picked. At this time, the model limits will be advanced, and then, the prediction will be completed using AI calculations. The k-implies grouping approach also perceives the pattern that will be obtained. Shortcomings will be detected after expectation and identification, and a quick exercise will be conducted to overcome the weakness. We used the most up-to-date R-programming components to carry out our plan.

Keywords Energy conservation · Data mining · K-means clustering · R-programming

1 Introduction

1.1 Information Mining

Information mining, also known as knowledge discovery in databases, is a breakthrough that allows academics, business analysts, and people to extract relevant facts

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from massive volumes of data (KDD) [1]. For this information finding, information cleaning, information combination, information choosing, information remodel, information mining, design assessment, and commonality show will all be critical.

1.2 Energy Conservation

Energy conservation, particularly in elevated structures or universities, is critical for our country, as well as for those structures and colleges that are located in warm climates. By using the bunching technique or designing the construction to minimize the exterior warmth, we may save around 10% to 15% of the energy. We can design a structure such that the number of lights used in that building is fewer when compared to a room that does not get as much light (dull room) [2].

Checking every single work is a time-consuming process if a large amount of corporate space becomes available. When it comes to energy usage, it is very difficult to get the wrong results physically after managing for a longer length of time. Another drawback of manual handling is that just the involved division worker will have a notion or knowledge of the framework, which they will tend to deal with. Everything will be a complete disaster if the individual changes, and it must be begun over from the beginning. It is quite tough to track the set of events in this manner since the workers may change. Not only the workers' but also segments such as the lighting in a specific area may have been changed previously, and if it shows any issue, the guarantee particulars, working voltage, and when it was changed, i.e., the entire history must be recorded and confirmed and broken down with records, so they can choose about the new changes that can be made to fix the issue.

The deficit in any foundation may be easily predicted with the results obtained by using relapse investigation k-implies bunching. The first goal is to use a robotized information mining technique to create an energy-efficient board structure [3]. This allows for rapid response for determining shortfalls through automated forecasting, reducing the computation time for factual border perception with remote systems administration.

1.3 K-Means Clustering

Unsupervised learning is a method of extracting information from data that lacks labels, groups, or categories. Based on the attributes given repeatedly, this technique will assign each data point to one of the K groups. We split the items into several clusters designated by the letter "K" in k-means clustering. If K = 2, for example, the items are divided into two clusters, c1 and c2. The attributes of all the objects are compared here, and the products with similar traits are grouped [4].

1.4 R-Programming

R-programming brings together several programming offices for data estimates, data management, and graphical representation of data. It provides a compelling approach for dealing with information and also allows the office to keep the data. It also provides a variety of alternative administrators for cluster processing, particularly in grids. It deals with the massive, consolidated, and integrated arrangement of modest equipment for data analysis [5]. We may address the information into a graphical structure for the analysis of information and also exhibit it on-screen or on printed copy using this method. It is a simple, well-constructed, and incredibly powerful programming language that combines circles, contingent proclamations, client-defined recursive capacity, and also provides information and yield offices.

1.5 K-Implies Clustering

Solo learning is a method of getting knowledge from material that does not include any markings, groups, or categories. This technique will transmit every piece of information pertinent to one of the K gatherings, relying on the properties offered several times. We divide items into distinct bunches denoted by the letter "K" in the k-implies grouping. For example, if $K = 2$, we divide the items into two groups, c1 and c2. The full qualities of the items are examined here, and the things with nearly identical provisions are grouped.

2 Literature Review

The author has simplified the symbol of tenant behavior in the paper [6] by using a standard or representative set of still and similar assumptions, ignoring the dynamics, stochastics, and variation of occupants' energy-related behavior in buildings. Large disparities between expected and measured true building energy performance result from the interpretation. The research proposes a paradigm for evaluating the impact of occupant behavior on ECM energy savings using building performance modeling. Occupant behavior has a little influence on energy savings in ECMs that are technology driven (the competitive savings differ by less than 2%) and have minimal engagement with the occupants. Occupant behavior has a large influence on vigor savings in ECMs with a lot of occupant engagement, such as the use of a zonal control variable refrigerant flow system and frequent ventilation (the relative savings differ by up to 20%).

In this paper [7], the author produced a theoretical overview of the energy awareness growing process based on the two models mentioned in this work. The theoretical framework is divided into nine phases: energy consciousness stimulation, transferable procedures, explication, comprehension, understanding, strengthening, short-term inspiration, obedience, and long-term commitment. According to the vigor awareness stimulus, workers may be motivated to assist an energy management program. Techniques or technologies that allow the stimulus to be successfully conveyed to the receiver are known as adaptation methods. Finally, the paper claims that authentications are required to confirm the conceptual framework's effectiveness and to identify areas for improvement.

According to [8], the majority of industrialized countries employ building energy strategies such as energy standards, legislation, and other steps to minimize building energy use. The status of developing countries in terms of applying and enforcing energy standards is either poorly documented or not documented at all. Furthermore, there is a shortage of trustworthy data, making it difficult to comprehend the fundamental differences that influence how energy policies are implemented in developing countries. The evolution of building energy legislation in emerging countries, as well as the consequences for energy conservation and competence, is addressed in this respect. The present state of building energy law in 60 developing countries throughout the world was studied through an online examination of building energy legislation. The study uncovered the present situation of building energy rules, including their implementation, development, and compliance. Simultaneously, the study suggests workable answers to the difficulties of implementing building energy laws in developing nations.

The author of this paper [9] presented a global k-means algorithm, which is an iterative clustering method that improves one cluster center at a time using a deterministic global search technique that consists of (variable N, which represents the size of the dataset used) implementations of the k-means algorithm starting at the appropriate exact position. They also recommend tweaks to the technique to minimize computing effort without sacrificing solution quality. They tested the proposed clustering algorithms on well-known datasets and compared them to the k-means algorithm with stochastic restarts.

The investigation done in this article about different clustering algorithms that have been suggested is covered in the paper [10] Author has presented the research done in this paper about different clustering algorithms that have been proposed. Among the various methods available, the k-means approach is a simple and rapid clustering strategy. They used the k-means algorithm to tackle the cluster number selection problem. The problem of cluster number selection is solved using the k-means technique. We may request that end users provide several clusters ahead of time, but this is not possible because each dataset requires domain expertise from the end user. There are several methods for estimating the number of clusters, including statistical indices, modification-based methods, information theoretic methods, and goodness-of-fit methods. Six approaches for calculating the appropriate number of clusters in a dataset are identified in the study.

The authors of this paper [11] discuss the original k-means strategy, which is computationally demanding and has a strong reliance on the beginning centroid to build excellent clusters. Many various strategies for increasing the performance of the k-means clustering algorithm are presented in the literature of this work. This paper proposes a way for increasing the algorithm's opportunism and efficiency, resulting in improved clustering with reduced complexity.

In his article [12], the author reviews the compensations and drawbacks of the aforementioned four methods in a K-value selection method, namely silhouette coefficient, gap statistic, canopy, and elbow method; the algorithm's virtual code is provided, and the normal dataset Iris is used for experimentation in the presented paper.

We saw in the article [13] that the author studied and demonstrated an energy benchmarking technique to give hotel categorization based on operational energy usage in terms of oil and electricity. The approach of organization generates clusters of hotels using the k-means method assessed using the silhouette plot (seasonal or yearly) and climatic settings, and a normalizing factor is added to the operational energy data to account for size, operation, and other variables. For the study, a sample of 90 hotels was selected, and using k-means clustering, well-defined clusters were generated for the overall sample, as well as for the sample separated into hotels that operate on an annual or periodic basis. Because energy consumption differs significantly across and within clusters, a range of energy consumption boards rather than a single value benchmark may be more suited for this type of facility.

Building automation and application control may benefit from a probabilistic management system with adaptive machine-building representations, according to an article [14]. The system used in this paper is based on machine learning and is adaptive, as it keeps an eye on the building model used in this paper and updates it frequently using Internet-based building operation information via an AI neural network via a nonlinear autoregressive endogenous structure. They use a variety of co-functions in the described system that can increase both internal thermal comfort and energy efficiency, which are normally at odds. They stated that this experiment was carried out at a lecture theater in Singapore, where the suggested predictive model was employed to manage the AC and mechanical aeration systems in two single-zone testbeds, a workplace, and the same theater to control performance. Each testbed that employs the suggested predictive model is compared to the original reactive control system, which is the thermostat at the current workplace and the lecture theater's building management system. They found that the proposed method decreases cooling thermal energy consumption by 58.5% and cooling electricity consumption in the lecture theater by 36.7% after comparing the present control system to the proposed predictive model described in this research. They discovered that the suggested predictive model effectively increases interior temperature, resulting in comfort in both testbeds. Importantly, they show that in comparison to a physical-based model, constructing a predictive model control system based on machine learning-based building dynamics might be highly useful in reducing model creation time to days, rather than months. Machine learning-based modeling may be restricted for model training due to a lack of building operational data, as predictive models require continuous data for control growth.

3 Present Work

The foundation sustains the corporate capacity, such as security, caution, energy utilization, medical services, cooling, ventilation, lighting, warmth, and so on, all of which must be continually evaluated and proper energy design supplied to the board structure. The board system can benefit from an effective energy arrangement thanks to the information mining computation. Information mining is similar to data engineering in that it is carried out by a person in a specific circumstance, on a specific dataset, with a specific goal in mind. This method is commonly used in text mining, Internet mining, sound/visual mining, pictographic information mining, and Web-based systems administration mining the use of programming is employed. Subcontracting information mining allows the entire project to be completed more quickly and at a lesser cost. Uncommon companies can also make use of modern technology to obtain information that would otherwise be impossible to obtain solely. Despite the plethora of material available on several levels, there is a paucity of expertise. The main goal is to study the data to identify essential facts that may be used to address a problem for company growth. There are several effective technologies and methods for mining data and eliminating more data from it. Sensors at various remote locations are used to detect and collect the source's factual limits. The data are subjected to a relapse-based evaluation approach, in which the data are first switched over. As a result of the large amount of data processed across numerous boundaries, the ideal component is retrieved. The AI computation is then created with model boundaries to create expectations. The example is viewed using K-implies grouping. It is a type of solo realization that is used for information that doesn't have a mark, information that doesn't have groups or classes. This computation will allocate each datum highlight to one of the K-gatherings based on the components provided repeatedly. We are isolating the articles into distinct bunches specified by the number "K" in the k-implies grouping. For example, if we declare $K = 2$, we are leaping the pieces into two separate bunches c1 and c2. There is a method for determining which result worth K in the given informative index is best. After that the defect will be investigated, and crucial work will be done to address any issues with the foundation.

4 Detailed Description of the System

The interaction stream chart from factual information to deficiency analysis is shown in Fig. 1. The finished aid necessary in the foundation in the running of any corporation premises is the foundation. Lighting structure's requirements, which include a variety of light settings and configurations for various areas within the building. It must also decide on the number of watts required for brightness. As a result, a remote sensor that can monitor the entire amount of light in the building is required [15]. Similarly, cooling, ventilation, and heating have similar factual information data

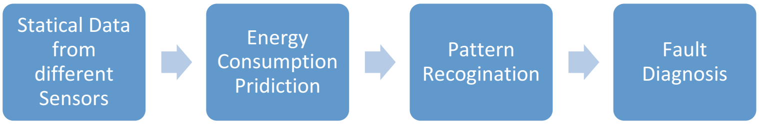

Fig. 1 Process flow diagram

that should be gathered. For example, it must monitor and notice the stickiness in the room, the environment condition around the room, materials in the area that can sense whether it is warm or cold, the temperature of the spot, and so on. It may also be overhauled to fit in the spot based on the data about being incorporated or secluded. By monitoring this with appropriate sensors and a historical backdrop of item records and details, it is possible to predict the item's life expectancy and make it simple to anticipate the deficit, repair it, or replace it at the appropriate moment. Medical care assistance, in particular, is essential in any business or foundational setting. Individuals who are staying or working must get their health checked. Pandemic illnesses are common in today's society, and while there is no cure for them for a set length of time, they are dangerous. As a result, there is consistently a need to screen the well-being status of individuals entering premises ordinarily by legitimate well-being screen sensors, with the information expected to be stored and consistently compared to the historical backdrop of information to avoid any pandemic situation. Another important need is the security and alarm system that is installed across the facility. This setup is developed to filter the individual entering and departing with their planning to avoid robbery and to enter only with the agreement. By transmitting relapse-based K-implies grouping for energy consumption expectation and example acknowledgment, energy arrangement may be managed by using all available data to predict the behavior of a system and the outcome. Defects can be identified, and appropriate action is taken to correct the problem in a short amount of time based on the results.

Figure 2 displays the relapse-based strategy's energy use projection. The information was gathered from a variety of sources in numerous locations, and it might be from any organization. In any case, the gathered data must be transformed into the needed format for calculation, i.e., data transformation must be completed. So, once we have gathered the data in various configurations, we will convert it over to the proper structure. Even though there is a lot of data, the best component must be picked,

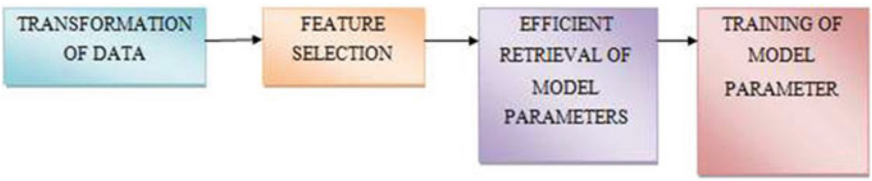

Fig. 2 Energy consumption prediction by regression-based method

and the limits must be shown. Assuming we are discussing the lighting requirements for a structure, we will first determine the quantity of lighting necessary, as well as the type of lighting we will use in which rooms. Following the gathering of essential information, we will now arrange all of the acquired data in the desired way. We currently have information in the desired arrangement; at that time, the boundaries that should be exhibited will be effectively retrieved. The AI computation is done to create the model boundaries so that forecasting may be done. This advancement is delivering information mining calculations on various data acquired constantly in the New Year. It forecasts how the frameworks will behave and what will happen as a result of the action. This invention is delivered to any development house pad or business office. Shortcomings may be examined, and measures are taken to correct the shortfall after the expectation and ID are completed using information mining calculations.

5 Methodology and Result

We successfully implemented the above approach using information mining, k-implies grouping, and R-programming to implement k-means bunching. We have taken a few readings from corporate buildings and are attempting to cope with the structure of corporate buildings by remembering to fulfill all of the building's requirements. As a result, we will start by gathering all of the relevant facts. Primer lighting structure's requirements, which are the many light settings and configurations required for better areas in the building. It is also necessary to decide on the number of watts required for radiance. As a result, a remote sensor is required to monitor the overall light assistance in the structure. Similarly, comparable factual information data for cooling, ventilation, and warming should be gathered [16]. For example, it must monitor and recognize clamminess in the room, environmental conditions around the room, and materials in the area that can retain warmth or cold, the temperature of the spot, and so on. It may also be overhauled to fit in the spot based on the data about being brought together or disengaged. As a result, we will only collect data on the number of lights required for a given corporate location. It will undoubtedly be difficult to preserve information physically, but we have gathered data to construct a dissipate plot using R-programming.

We have collected data from online sample data, such as how many high-watt lights are required in various areas, in Table 1, energy consumption in corporate premises. So, we gathered data to show that five offices, each with thirty high-watt lights, five low-watt lights, ten standard-watt lights, and twelve air conditioners. Meeting rooms, on the other hand, have ten high-watt lights, three low-watt lights, seven normal-watt lights, and eight air conditioners. As a result, we have data on all lights, whether they are high watt, low watt, regular watt, or air conditioners. We collected data from the above locations and then increased the number of lights and rooms to prepare our data so that we have a large amount of data. We will then differentiate that data based on their characteristics, divide the entire data into several

Table 1 Energy consumption in corporate premises

Office	High-watt lights	Low-watt lights	Normal-watt lights	A/C	No. of rooms
Work place	30	5	10	12	5
Meeting rooms	10	3	7	8	2
Pantry area	5	3	2	1	2
Dining area	8	4	5	5	1
Gym	7	3	4	4	1
Sports	7	4	3	5	1
Reception	4	1	2	2	1

clusters, and apply k-mean clustering before presenting our findings. We have created a chart in Fig. 3, no. of rooms vs. no. of lights, by collecting the lighting requirements for various types of rooms, especially corporate premises. With the help of R-programming, we created this chart, here is the code for something similar:

```
library(ggplot2) df <-data.frame(no._of_lights = c(18, 21, 22, 24, 26, 26, 27, 30, 32, 35, 34, 37, 38, 33, 31, 39, 40, 41, 42, 44, 46, 47, 48, 49, 54),
    no._of_rooms = c(10, 11, 22, 15, 12, 13, 14, 25, 28, 39, 37, 47, 33, 35, 40, 44, 27, 29, 20, 28, 21, 30, 31, 23, 24)
    ggplot (df, aes(x = no._of_lights, y = no._of_rooms)) + labs (title = "Lights needed for Office Premises", subtitle = "Calculate no. of groups") + geom_point()
```

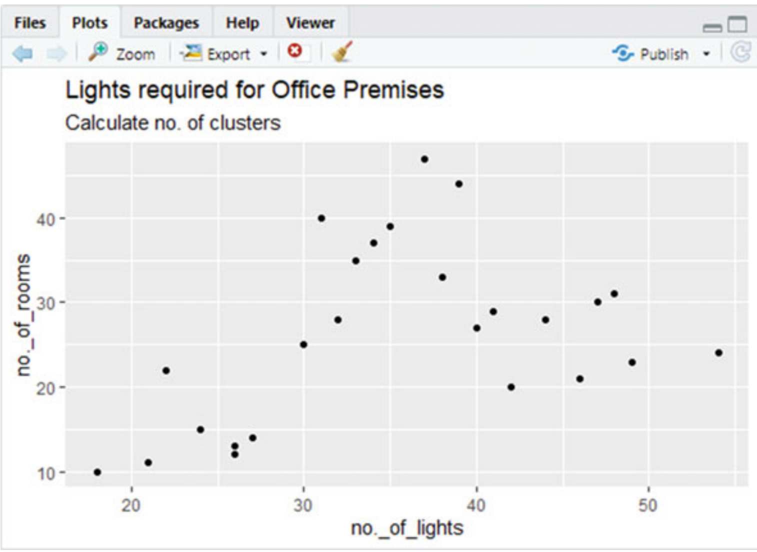

Fig. 3 No. of rooms versus no. of lights

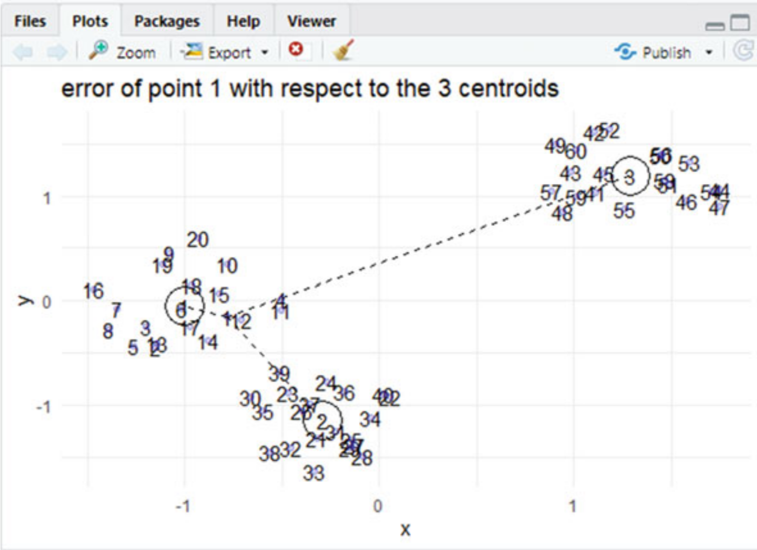

Fig. 4 Error of point concerning

Here is the chart, where every one of the lights needed for office premises is shown. By considering this chart, it is undeniably challenging to anticipate which sort of lights is required more in which kind of room as we can't separate the lights needed by their qualities. So, for that we need to make the bunches, so the lights which have same components will come in same group; then, at that point, it will be not difficult to figure out which kinds of light and the number of is needed in which sort of room. So, in this Fig. 4, error of point concerning the 3 centroids, we have shown that we will compute the separation from each highlight the centroid. Here, in the diagram, we have taken one point stamped 1, and afterward, we will ascertain the separation from direct 1 with deference toward every one of the three centroids, and then, we will conclude that this point named 1 will come in which class; then, at that point, we will point that point into the group whose distance is as contrast with different bunches the 3 centroids. Now, after calculating the distance of each point from the randomly generated centroids, we will bifurcate the entire data accordingly. In this Fig. 5, randomly generated centroids concerning the dataset, we have generated three centroids randomly; now, we will place them at their right position so that similar datasets will come under cluster accordingly. By using R-programming, we have generated this graph and represented the data with the help of the three basic colors: i. Presently, in the wake of ascertaining the distance of each point from the haphazardly produced centroids, we will bifurcate the whole information appropriately. In this Fig. 5, randomly created centroids concerning dataset, we have produced three centroids arbitrarily; presently, we will put them at their right position with the goal that informational collections which are comparable will go under bunch accordingly.

Fig. 5 Randomly generated centroids concerning the dataset

We have likewise taken haphazardly created groups in this figure and named them 1, 2, and 3; presently, we will reposition the area of arbitrarily introduced centroid to a lot nearer to the genuine centroid, from where the distance between each highlight the real-positioned centroid is lesser than prior. We will do this until we will get the genuine situation of the centroid where the distance between each mark of that dataset to their real centroid is limited.

In Fig. 6, actual centroids in the bunch concerning datasets, we have addressed our whole lights of the corporate premises into three groups, addressed by three essential tones, for example, red, blue, and green. Essentially, we will likewise keep up with the information of all the foundation needs like security alerts, energy utilization, medical services, cooling, ventilation, lighting, warming, and so forth. Manual help requires more representatives and necessities, separate gadgets, and a few computations that must be physically used to anticipate the activity of the framework. If there should be an occurrence of a colossal corporate premise, physically, checking every single usefulness will devour a ton of time, and extremely, challenging to oversee it some issue happens. Particularly, when comes to energy utilization, it is horrendous in getting wrong outcomes physically after controlling for a more extended period. Aside from this issue, it has some other issue as well that solitary concerned division worker will have a thought or the information on the foundation, and it very well may be taken care of by them. This included systems administration innovation, where some figuring techniques were embraced to work on the manual strategy. Yet, at the same time, considering the immense volume of information and dealing with ceaseless information from live sources is undeniably challenging to deal with. So, it is especially suggested for enormous corporate premises, emergency clinics, colleges, banks, and so on to change from this manual way to deal with this methodology referenced previously.

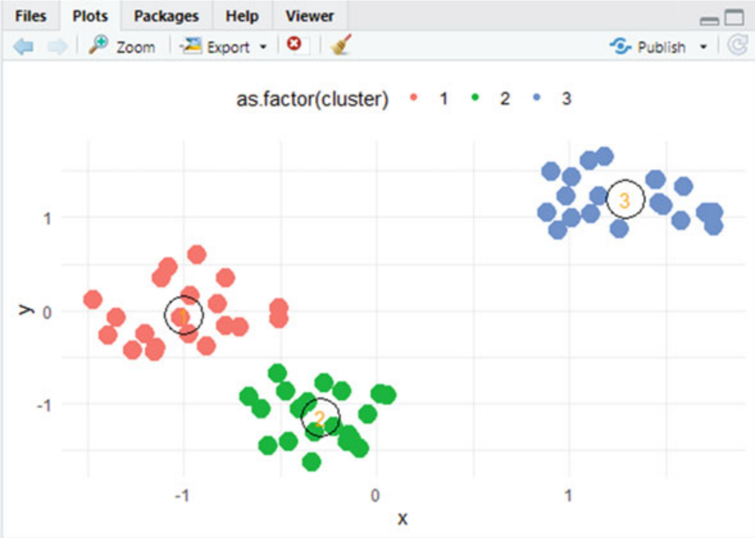

Fig. 6 Actual centroids in the cluster concerning datasets

6 Summary and Conclusion

An examination has been made by carrying out information mining K-implies grouping calculation to foresee shortcomings in any premises, regardless of whether it is an office or colleges or emergency clinics and so forth by utilizing relapse examination K-implies bunching; the flaw in any foundation can be effortlessly anticipated with the outcomes that are acquired. Average corporate capacity premises need to deal with data on security, alert, energy utilization, medical services, cooling, ventilation, lighting, warming, and so on in giving this gigantic volume of information; it is truly challenging to do a manual interaction, as it sets aside effort to anticipate the idea of flaw and make an essential move.

The principal point is to make an energy productive arrangement for the executive system utilizing a robotized information mining calculation. Information mining innovations have been utilized in this creation, where it can gage the conduct of a framework and anticipate the result of the activity. Furthermore, to deal with all the previous records and handle various boundaries in premises, this information mining innovation is exceptionally capable. By recovering data from every one of the sensors, the relapse-based strategy will anticipate how much energy that specific framework will devour. In this technique, we have right off the bat convert the information recovered into the necessary organization and afterward will choose the ideal components. Then, at that point, the model boundaries are advanced, and the AI calculation is prepared with the model to make forecasts. At the point, when someone did information science in a particular situation, on a particular information assortment, in light of a particular objective, then, at that point that would be like data mining. Text mining, Internet mining, sound and video mining, pictographic information mining, and Web-based systems administration mining are on the whole instances of this strategy.

The principal obligation is to contemplate the information to extricate significant realities that might be utilized to resolve an issue for corporate development. There are plenty of compelling apparatuses and approaches for mining information and separating more data from it. As there is a high volume of data registering various boundaries, the ideal element is recovered from them. Then, at that point, the AI calculation is prepared with model boundaries to make expectations. This calculation will iteratively dispense each datum highlight one of the K-gatherings which depends on the elements given. After the investigation of the current situations of energy preservation the board in the field of foundations, we feel that there are part changes are required which will help in shortcoming finding at beginning phase with the assistance of robotized information mining devices and calculations subsequently helping in decreasing the calculation time for a factual boundary.

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Effective Detection and Localization of the Text in Natural Scene Images Using Adaptive Kuwahara Filter

Rituraj Soni, Vishal Goar, and Manoj Kuri

Abstract The text matter present in the natural scene images imbibes facts and statistics about the concerned image. The text detected and located in the scene images finds applications in many domains like content retrieval, tourist navigation, etc. The real challenges in this domain are the surrounding elements and other noisy backgrounds present in the images. This paper attempts to detect and localize the text with the help of novel method that involves preprocessing the images using the adaptive Kuwahara filter and MSERs. Classifying the components in text and non-text is achieved with the assistance of classifiers using the MATLAB. Further, the texts are grouped into words with the help of the K-means clustering algorithm. The bounding box constructed for the localization of the text is evaluated with the DetEval tool. The experiments are performed using the training dataset of ICDAR 2013 and the testing dataset of the ICDAR 2011. The results obtained are better than the other state of the arts, concerning the F-measure, recall, and precision.

Keywords Born-digital scene images · Adaptive Kuwahara filter · Text localization and detection · MSERs

1 Introduction

The extraction of the information from the scene images has been a challenging task [1] for the last two decades. It is due to various challenges in font size, alignment, orientation, background, colors, and various non-text components. The extraction of the information solely depends on how perfectly the text is localized and detected in the scene images. The text knowledge from such scene images is applied in sign translation, license plate recognition, robot navigation, self-driving car assistance, tourist navigation, etc. The benchmark dataset available for such images is available in ICDAR 20032, ICDAR 2011 [2], and ICDAR 2013 [3]. These are widely used

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Fig. 1 Few samples of natural scene images [3]

datasets and competitions held on the text detection and localization theme through ICDAR.

The natural scene images are clicked using the mobile phone, cameras, and other handheld devices in natural conditions. These images contain notice boards, billboards, advertisement boards, and photos displayed on the public and private company buildings. Along with the text information, these images have an ample amount of non-text data. This non-text includes doors, windows, fencing, and other objects. Therefore, this non-text information always hinders the identification of textual objects accurately due to their resemblance with the similar text structure. The example of the natural scene images from the ICDAR benchmark dataset is displayed in Fig. 1. As shown in Fig. 1, the text contained in the pictures is of different shapes, sizes, colors, and lots of elements.

So, it is required to remove this non-text information to get the relevant text detected. Then localization of the text is done in terms of the bounding box around it. In this paper, the detection and localization of the relevant text are carried out using the MSER and adaptive Kuwahra filter [4]. Then classification is done with the help of the KNN selected using MATLAB [5] classifier learning application among the eight classifiers through experiment. Then the K-means shift clustering organizes all the detected texts in line, and the enclosing box is constructed on all sides of the detected text. The performance of the proposed method is evaluated using DetEval [6] tool, a benchmark and frequently used tool in this domain. The rest of the paper is organized as follows: Sect. 1 describes the introduction, Sect. 2 reviews the related work done, Sect. 3 demonstrates the proposed method, Sect. 4 describes the experiments and results, and Sect. 5 concludes the paper.

2 Literature Review

The researchers have explored the domain of text detection and localization in scene images during the last two decades. There are four primary methods [7]: edge based, connected component based, texture based, and stroked based. There are advantages and disadvantages associated with every technique. MSER is one of the approaches based on connected component methods used exclusively in this domain. Due to the limitations of the single mode, combinations of those as mentioned above are used to increase the accuracy. Thus, this section includes the previous work accomplished using different combinations of four methods.

Yu et al. [8] used the edge-based method and extracted text elements using morphological operators. It gives less accurate results on blurred images. The stroke-based methods [9, 10] are the best result-oriented methods but fail when the background is complex.

Guan and Chu [11] use a combination of MSER and SWT. The recall is less due to the blurriness of text due to which features are not extracted properly. Wu et al. [12] apply a color reduction scheme for extracting characters, and a learning machine groups the character. CNN is used for the classification of non-text and text elements which consumes a lot of time. Ghanei and Faez [13] apply the WMF-MSER approach, but it takes more time to smooth edges and is not suitable for the low contrast images. Baran et al. [14] use MSER and CC-based methods and remove non-text regions with only geometric rules. It gives low accuracy on ICDAR images.

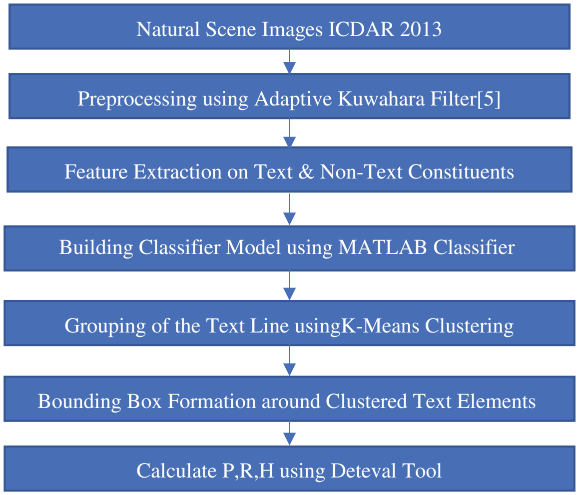
Jiang et al. [15] apply MSER with histogram equalization for low contrast images frequency tuned saliency and stroke width transform. Due to the histogram equalization, this method is slow and augments noise to the image. Mukhopadhyay et al. [16] used only 100 images with a one-class classifier and obtained less accurate results on ICDAR datasets. Chee et al. [17] propose a dataset and method polygon faster-RCNN, thus detecting text of different orientations. Liu et al. [18] discuss a technique that detects text from a synthetic dataset using a pre-trained model and unannotated dataset. Zhu et al. [19] demonstrate a method on MLT dataset using the complete border center information of the text and extract the text instances for semantic segmentation fails. Wang et al. [20] discuss a method based on deep learning to detect text using cross-model similarity.

Apart from the work discussed above, there are too many excellent works accomplished by researchers for the detection and localization of text with a deep learning approach. Still, a deep learning approach requires many high-end resources, an extensive training set, and high computation time. For traditional classifiers, the choice of classifiers is always a big question. The main contribution in this paper is to develop a modified MSER method using adaptive Kuwahara filter and to use a machine learning algorithm-based classifier for effective detection and localization of text in the ICDAR dataset. In the next section, the proposed methodology is discussed.

3 Proposed Methodology

This section introduces the proposed methodology for detecting and localization of the text constituents from the natural scene images. The benchmark dataset ICDAR 2013 is used for the same. The flowchart for the proposed method is shown in Fig. 2. The steps involved in the proposed process are as follows:

Fig. 2 Flowchart for the proposed methodology



- The images from the ICDAR dataset undergo the K-MSER method to remove the connected characters and text present in the images. It involves processing the image using edge smoothing adaptive Kuwahara filter before passing the images to the MSER [21] algorithm.
- The text-specific features are then extracted on the text and non-text components are available after applying the K-MSER.
- Further, then the classification is performed MATLAB classifier learning application.
- Then the K-means clustering is used for grouping the text components in line to form the word.
- The bounding boxes are created on these detected words.
- The DetEval tool is used to calculate the precision, recall, and F-measure of the proposed method with the help of the ground truth available for the images.

3.1 Preprocessing Using Adaptive Kuwahara Filter

Matas et al. [21] develop the concept of the MSERs for detecting the point of resemblance between the two images when viewed from different angles. This property helps in the field of object detection and recognition and image resemblance. There are extremal regions that do not change for an interval of thresholds in terms of intensity. Such blobs that remain stable are termed the maximum stable extremal regions (MSERs). Neumann et al. [22] applied this idea of MSER for the text region extraction, and after that, many improved versions were introduced to improve the original MSER. The MSERs are not efficient while detecting the connected characters, and thus accuracy of the method is affected by this trait of MSER. It gives fewer results on the blurred images.

The above-said problem for connected characters, which occurs due to the noise present in the images around the edges, can be solved using an edge smoothing filter. The pixels present around the edges are not part of the components but hinder detecting the text correctly. Thus, we apply adaptive Kuwahara filter for processing the edges for smoothness in our work. Krzysztof [4] presents the adaptive Kuwahara filter, which is efficient in noise reduction and, most importantly, does not blur the edges. This filter is performed by combining the adaptive median filter and the adaptive Kuwahara filter. The size of the window is adjusted using adaptive median filter.

On the other hand, the adaptive Kuwahara filter smooths the color intensity and removes the extra noise and maintains the edges. Thus, using the adaptive Kuwahara filter helps with the algorithm's automatic adjustment to each pixel in the given image. The natural images' text also has noisy pixels around the boundaries and thus needs smoothing before going for feature extraction and classification. It is required that edges should not get blurred in this process. Thus, the adaptive Kuwahara filter suits the current work's need, and therefore, we prefer to use it in our current work. The algorithm for preprocessing is as follows in algorithm K-MSER.

Algorithm K-MSER
Input: Image (I) from ICDAR 2013 Dataset
Output: Separated Connected Component (Possible Texts)
1: Transform I to I_i (Intensity Image).
2: Apply Adaptive Kuwahara Filter to I_i to obtain I_k image.
3: Normalized the gradient map values for I_k.
4: Get $I_{kd} = I_k + I_{kgvm}$, $I_{kb} = I_k - I_{kgvm}$
5. Apply MSER on I_{kd} and I_{kb} to get Output.

The algorithm K-MSER states that, firstly, the image is converted into the intensity image (I). Then adaptive Kuwahara filter is applied on this intensity channel image to obtain the smoothened image (I_k). Then, in the next step, the gradient value map of pixels (noise pixels) is calculated, and they are added and subtracted to get two sets of images (*Ikd*, *Ikb*). Further, the MSER is applied to these two images to obtain the possible text regions with adequately separated characters. The result of the algorithm is shown in Fig. 3. It is pretty evident that Fig. 3c has characters separated properly compared to Fig. 3b.

Although the text elements obtained from the K-MSER are separated, some non-text parts are always present. Such non-text can be removed by some heuristic rules [23] like aspect ratio (0.3–3) and occupation ratio (0–1).

3.2 Feature Extraction on Components

The text regions extracted using the K-MSER algorithm will now undergo a feature extraction process. The features or attributes of any object help in identifying it. In

Fig. 3 Result by K-MSER **a** original image, **b** original MSER [21], **c** K-MSER

computer vision, features carry vital importance, as machines cannot feel and see objects like humans do. So, it is needed to feed the machine with relevant inputs to the given object to be identified and thus recognized in the process. The text elements of the images have different features with respect to the non-text parts. Thus, the relevant features assist in selecting text. The text has different fonts, colors, sizes, shapes, and orientations. Therefore, in this paper, we propose to use a combination of three text-specific features.

(a) **Stroke width uniformity (SWU)**: The stroke width [23] of any text is one of its unique features. The stroke width of the text always remains uniform, and thus, it is one of the prominent features to identify between the text and non-text elements. The non-text elements do not have uniform text width due to their irregular structure. So, the stroke width obtained for the non-text details has many variations compared to the text elements. The stroke width uniformity for a given component can be defined in Eq. 1.

$$\mathrm{SWU}(T) = \frac{\sigma(\mathrm{SW})}{\mu(\mathrm{SW})} \tag{1}$$

where SW is the stroke width calculated as specified in [9].

(b) **Color discrepancy (CD)**: Color is one of the essential features of elements present in an image. The text elements embedded in the images have different colors as compared to their background. Therefore, this helps identify the text elements concerning the non-text aspects present in the images. Thus, the discrepancy in the color of the elements in the images is taken as one of the text-specific features. The color discrepancy is calculated by the Kullback–Libeler divergence [24]. It finds applications in information and probabilistic theory. The color discrepancy is obtained using KLD between probability distribution of the text and its background (color).

(c) **Occupy rate (OR)**: The text constituents present in the images have regular and uniform size and structure. But, on the other hand, the non-text constituents do not have such uniformity in the structure. Based on this structural property of these constituents, we prefer to apply to occupy rate as the third feature for the difference between text and non-text constituents. The occupy rate for any component is defined as in Eq. 2.

$$\mathrm{OR}(T) = \frac{\text{Convex Area}(T)}{\text{Bounding Box}(T)} \tag{2}$$

It can be defined as the ratio of the convex area of the component to the bounding box enclosing the given part.

The most important thing about the feature selection out of many features is that all three features are mutually exclusive and contribute to identifying any component as text or non-text. The SWU discriminates the components based on the uniformity of strokes present in them, and the CD determines based on a difference in the color of text and its background. Lastly, the occupy rate makes a difference based on the structural uniformity of the components.

Based on these features, a classification model is created to accurately classify text and non-text elements using the ICDAR 2013 dataset, discussed in the next section.

3.3 Training and Building Classifier Model

The classification process is to categorize the given inputs in terms of the labels assigned to classes. In the machine learning process era, classification is carried out with the help of various machine learning algorithms. The inevitable requirement for training and building the classifier model is the data on which training can be performed. The testing images are then tested on the trained model to calculate the accuracy for a specific work.

In this work, the training of the model is carried out using the ICDAR 2013 dataset. It contains 229 images having text with different types of fonts and background. This dataset includes ground truth information about every character present in the image. The total number of characters available in the ICDAR 2013 dataset is 4786. All the images of the ICDAR 2013 training set undergo the K-MSER algorithm (discussed in Sect. 3.1) and remove the information of the ground truth text characters. Therefore, with the non-text elements we are left with are 4594. So now, on these 4786 text components and 4549 non-text elements, the above-mentioned three features are calculated. So, the three features forming feature vector $F = \{\text{SWU, CD, OR}\}$, and we have two classes to be labeled text (1) and non-texts (0), $L = \{0, 1\}$.

Figures 4 and 5 display a few samples from the ICDAR 2013 dataset related to text and the non-text elements, respectively, obtained after applying K-MSER.

The classification problems are binary and multi-classification. The binary classification refers to labeling one out of two given classes, whereas it refers to one out of many classes in multi-classification. In this paper, we have a binary classification problem, in which the label is to give as text or non-text elements by the classification algorithm. We have chosen four classifiers for the purpose, and experiments

Fig. 4 Example of text elements

Fig. 5 Examples of non-text elements

are performed using MATLAB classifiers learner application. We have considered eight classifier-building classification models using the dataset and the three features. These are decision trees [25], K-nearest neighbor [26], Naïve Bayes [27], logistic regression [28], linear discriminant [29], quadratic discriminant [30], boosted trees [31], and SVM [32]. There can be two possibilities for an element present in the images: non-text and text. The following parameters for classification are used in the paper:

(a) True Positives (TP): Text is discovered as text.
(b) True Negative (TN): Non-text is discovered as non-text.
(c) False Positive (FP): Non-text is discovered as text.
(d) False Negative (FN) Text is discovered as non-text.

Therefore, the overall accuracy (A) of the classifiers is interpreted as mentioned in the equation

$$\text{Accuracy (A)} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}} \tag{3}$$

The accuracy calculated in Eq. 3 is used for the overall accuracy of the classifiers. The results obtained for building classifiers are discussed in Sect. 4.

3.4 Grouping in Text Lines Using K-Means Clustering

The classification process in the section mentioned above separates the non-text elements from the images, and thus, the image is left with the text elements. It is then required to cluster the text elements to form the words. The organization of the words into line is performed with assistance of the K-means clustering algorithm [33]. The best results are obtained at $k = 3$. Then the bounding box is created around the resultant text words. The ground truth of the available benchmark dataset is compared with the resultant bounding box with the help of the DetEval toolbox.

Figure 6 shows the overall work proposed in the paper. Figure 6a shows the original sample, and Fig. 6b shows the text and non-text regions obtained after applying K-MSER. Figure 6c shows the classified text detected in the image, and finally, Fig. 6d shows the bounding box created over the detected text, thus accomplishing the localization process (Fig. 7).

The results thus obtained in terms of the recall, precision, and F-measure are discussed in Sect. 4.

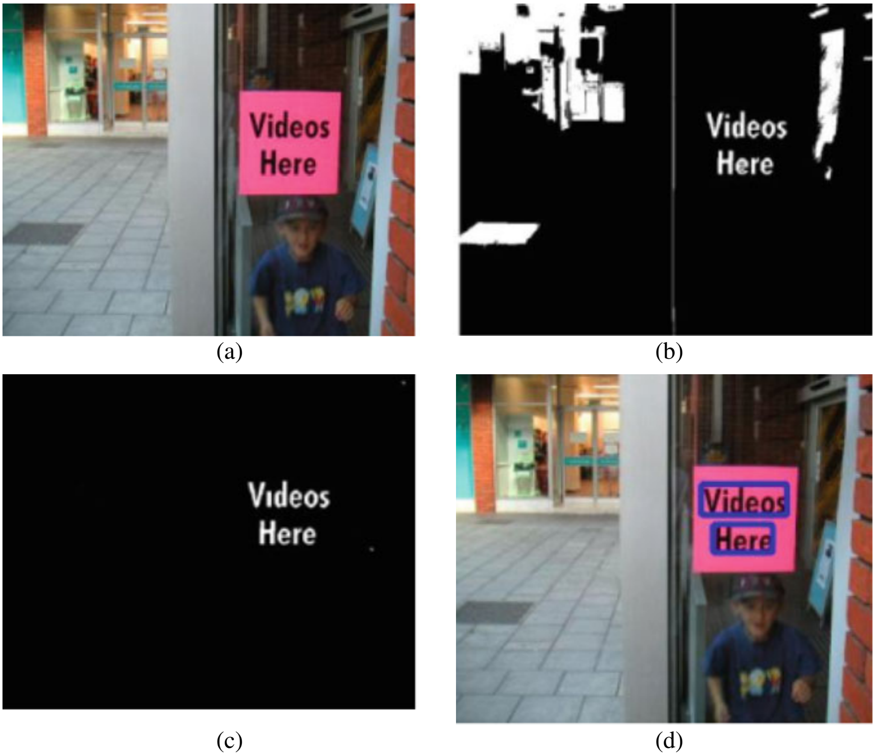


Fig. 6 Displaying the proposed work in terms of the images, **a** image from dataset, **b** K-MSER, **c** classification results, **d** localized text

Fig. 7 First row shows the result by MSER, and the second shows results by K-MSER

4 Experiments and Results

The experimental setup and the results obtained are discussed in the given section. The three texts mentioned above specific features are calculated on the 4786 text characters and 4549 non-text characters. There shall be two classes: text and non-text. So the feature vector (FV) and class label vector will be as follows:

$$\mathrm{FV} = \{\mathrm{SWU},\ \mathrm{CD}, \mathrm{OR}\}$$

$$L = \{1, 0\}$$

For building the classification model, we prefer to use MATLAB classification learner application for classification purposes. This application is a part of MATLAB, which trains the model to classify the data. There are many classifiers based on the supervised machine learning algorithms available in this application. The data can be explored, trained, validated, and assessed using this application, which is very easy to use and gives accurate results. The detailed experimental setup is displayed in Table 1.

(a) **Selection of the classifier**

The classifier selection is achieved with the help of MATLAB classifier learning application using feature vector and label. The tenfold cross-validation is used in the experiments to obtain accuracy in this paper. The feature vector is passed as an input to the eight classifiers, and the accuracy for the different classifiers is obtained. The results obtained are displayed in Table 2. It is evident from the table that the highest accuracy is obtained for the KNN classifier. KNN is very easy to implement. New data can be added to the training model, which will have no impact on the method's accuracy. Therefore, the accuracy obtained from KNN is highest using the feature vector consisting of three features due to the advantages mentioned above.

The Confusion matrix, which consists of the TP, TN, FP, FN, is used to make the ROC for the classifiers and is shown in Figs. 8 and 9. The ROC curve is also an

Table 1 Experimental details for building classification models

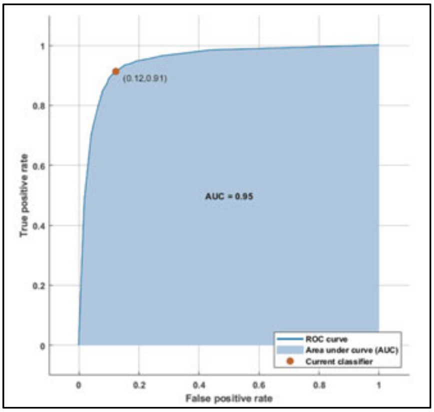
S. No	Particulars	Value/details
1	Classifier application	MATLAB learning application
2	Preprocessing	K-MSER
3	Cross-fold	10
4	Training dataset	ICDAR 2013 training set
5	Classifier	KNN
6	Text elements	4786
7	Non-text elements	4549
8	Grouping	K-means clustering
9	Testing dataset	ICDAR 2011, ICDAR 2013
10	DetEval	For determining P, R, H

Table 2 Classification accuracy obtained for four classifiers

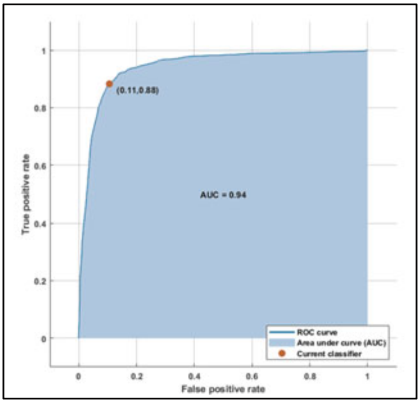
S. No	Classifiers	Text/non-text	Classification		A
			T	**NT**	
1	KNN	T	4199	587	89.5%
		NT	395	4154	
2	Decision tree	T	4278	508	88.9%
		NT	532	4017	
3	Linear discriminant	T	4180	606	79.3%
		NT	1325	3224	
4	Quadratic discriminant	T	4189	597	78.6%
		NT	1405	3144	
5	Logistic regression	T	4015	771	84%
		NT	719	3830	
6	Naïve Bayes	T	4174	612	88.6
		NT	449	4100	
7	SVM	T	3985	801	86.4
		NT	469	4080	
8	Boosted trees	T	4210	576	89.1
		NT	440	4109	

indicative measure of the best classifier based on the area occupied by the ROC. The area under the curve in the ROC curve is shown as best in the KNN cases, indicating that the KNN classifier is the best classifier among the rest eight chosen classifiers.

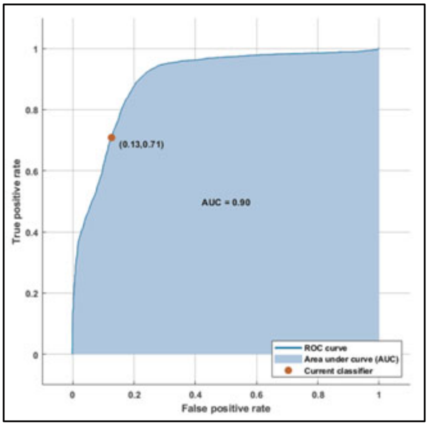
(b) **Results by K-MSER**: The original MSER and K-MSER results are displayed in Fig. 9. The original MSER gives inferior results on blurred and low contrast images. The use of the adaptive Kuwahara filter enhances the results as the



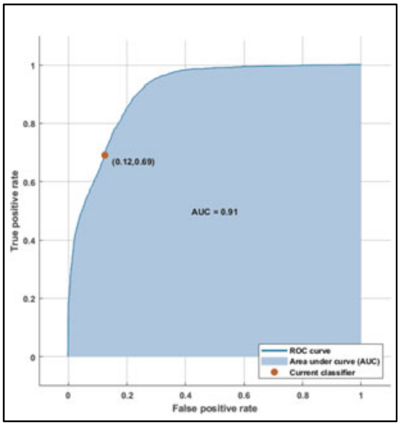
(a) KNN



(b) Decision Tree



(c) Linear Discriminant



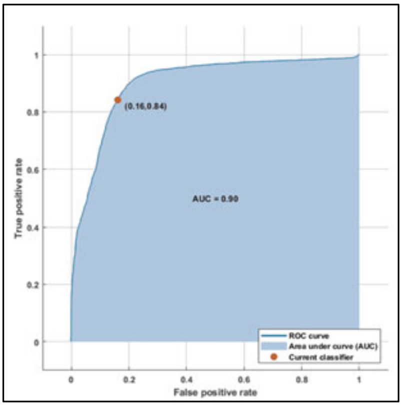
(d) Quadratic Discriminant

Fig. 8 ROC curves **a–d**

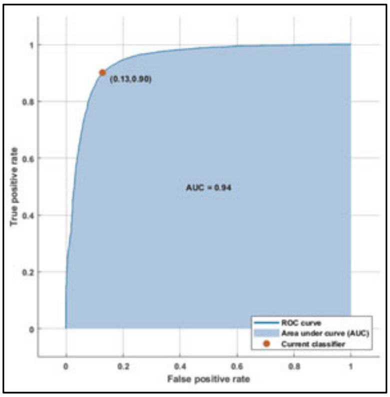
filter separates the interconnected components effectively. The components are adequately separated due to the edge smoothing properties of the filter. It also avoids creating blur in the edges of the images. Thus, it helps in increasing the recall of the detected text.

(c) **Detection and localization on ICDAR 2011 dataset**

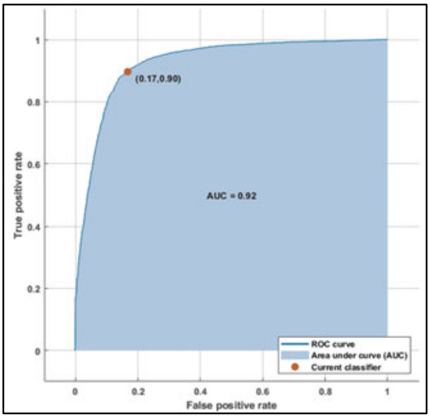
Our method is applied on the testing dataset of ICDAR 2011 (255 images). The result of a bounding box framed around the detected text is obtained using the DetEval tool, which matches the area of the detected text with the ground truth. The result is displayed in Table 3, in terms of precision (p), recall (r), and F-measure (harmonic mean of p and r) which indicates that our method is comparable with the other state-of-the-art method of recent years. It is due to the use of the K-MSER algorithm, which separates the character correctly, including three text-specific features, and



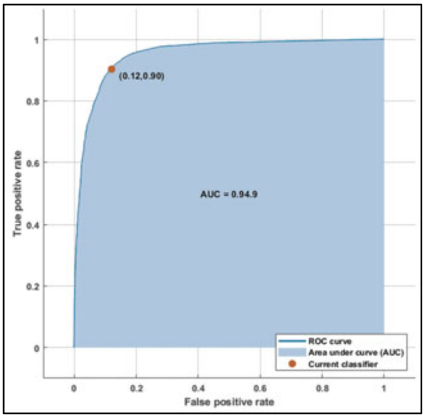
(e) Logistic Regression



(f) Decision Tree



(g) SVM



(h) Boosted Trees

Fig. 9 ROC curves **e–h**

Table 3 Comparative localization result on ICDA 2011 dataset

Methods	Year	F	P	R
Proposed method	2021	0.77	0.83	0.73
Alnefaie [34]	2020	0.83	0.85	0.81
Wang et al. [35]	2018	0.77	0.85	0.70
Baran [14]	2018	0.63	0.60	0.67
Jiang et al. [15]	2018	0.71	0.78	0.66
Joan and Vali [36]	2017	0.67	0.71	0.65
Ghanei and Faiz [13]	2017	0.74	0.77	0.72
Feng et al. [37]	2016	0.75	0.80	0.71

Fig. 10 Detection and localization results by proposed method

Fig. 11 Failure by our proposed method

the KNN as the classifier to separate the text and non-texts accurately. The method [34] involves the use of deep learning; therefore, it has better results with respect to proposed method.

The results obtained by the proposed method are shown in Fig. 9, which shows that the bounding box is framed properly on the detected and achieves the localization. There are few images which contains text and not detected by our method are displayed in Fig. 10 since texts are either too fancy or mixed with the background (Fig. 11).

5 Conclusion

The present paper aims to achieve an efficient method for detection and localization with respect to the text in the domain of scene images. We propose to use the K-MSER algorithm that includes an adaptive Kuwahara filter for the process of edge smoothing. This smoothing process increases the recall rate of the method by separating the characters correctly. Further, we propose to use the combination of three different features to retain the text elements and separate the non-text elements with the help of the KNN classifier. The KNN classifier is chosen from eight different classifiers based on the highest accuracy obtained among the rest eight. After that, the robust K-means clustering algorithm is preferred for clustering the words in groups. The value of F-measure, precision, and recall obtained by DetEval shows the effectiveness of the proposed method. The shortcoming of the approach is that the used Kuwahara filter creates artifacts in the images that hinder the detection process in a few cases. The future work involves using the RCNN and other deep learning models for the detection and localization processes.

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Classification of Breast Cancer Histopathology Images Using EfficientNet Architectures

Aditi Kajala and Sandeep Jaiswal

Abstract In women, breast cancer is one of the common diseases found worldwide. A pathologist confirms it by observing cancerous tissues in histopathology images. Due to a lack of pathologists, the manual process of diagnosis is a time taking process and may lead to delay in prognosis and treatment of the disease. Delay in treatment may cause to affect mortality due to the disease. Computer-aided diagnosis methods can assist pathologists and reduce the time of diagnosis. The goal of this work is to apply different EfficientNet architectures for the classification of breast cancer using histopathology images. EfficientNet architectures (B0–B7) models are used to classify histopathology images of breast cancer. The accuracy of all models is evaluated on breast histopathology image dataset a publically available. EfficientNet-B2 achieved validation accuracy and validation loss and AUC score of 0.875, 0.2945, and 0.95, respectively. Among all EfficientNet architectures, it has been shown that the EfficientNet-B2 model classification performance is better. EfficientNet-B6, -B7 faced overfitting which can be reduced by applying some techniques.

Keywords Breast cancer · CNN · EfficientNet · Transfer learning · Breast Cancer Histopathology Images

1 Introduction

Breast cancer is an abnormal growth of breast tissues that may cause a lump, and it is the most common cause of death in women in India as well as across the globe [1]. According to the recently released study GLOBOCAN2020, female breast cancer has surpassed lung cancer as the most often diagnosed cancer, with 2.3 million new cases (11.7%) reported globally [2]. Female breast cancer cases in India may increase from 13.9 lakh to 15.7 lakh in five years (2020–2025). Therefore, it is an urgent need for the development of an efficient and more accurate automated method to diagnose the disease. At an early stage, the detection and, therefore, survival of

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breast cancer are considerably higher than those of the middle and last stages [3, 4]. The diagnosis of breast cancer in histopathology images is complex and required an expert medical professional. The conventional diagnostic methods are more prone to human error because of manual systems and time consuming. Therefore, computer-based automatic diagnostic methods will be helpful for accurate and fast diagnosis of cancer [5, 6]. The detection of cancer cases with the existing manual system may cause false diagnoses due to the limited expert persons and huge data. Although double reading can improve the accuracy, it needs more human resources. Recent advancements in technology make it possible that a computer can assist an expert to reduce the time taken in the detection of cancer [7]. Authors [8] concluded that artificial intelligence (AI) supported system can improve the detection of cancer without requiring additional reading time. Traditional machine learning algorithms [9, 10] are used to develop an automated diagnosis system using handcrafted features and low-level patterns based on pixel distributions. Such a system can be trained with a huge amount of data, and then it can be used to classify the images which were not presented to the algorithm. But to apply such algorithms, one expert is required to apply the handcrafted filters for extracting the hidden patterns in the images, and also there is a possibility of error. The involvement of deep learning algorithms in digital image classification, on the other hand, allows the doctor and specialist a second opinion because deep learning algorithms learned hidden features during training of the model [10]. Using such methods, the diagnosis can be done in less time without human intervention. Authors [11] put a special emphasis on convolutional neural networks (CNN) methods for breast cancer classification. The diagnostic capabilities of deep learning algorithms are approaching the levels of human expertise. So computer-aided detection and diagnosis (CAD) paradigm tool may be shifted from the second opinion to a more collaborative utility tool [12].

In the present study, the authors want to compare various efficient CNN models for the classification of breast cancer in histopathology images for better accuracy and improved diagnosis. The study is organized as follows: Sect. 2 explains the literature survey. Section 3 describes the methods and techniques used in the study, Sect. 4 shows the results and discussion, and Sect. 5 describes the conclusion and future scope of the presented research.

2 Previous Work

From the previous studies, it has been found that significant efforts have been put into the diagnosis of breast cancer from histopathology images. Breast cancer is classified into two categories: benign and malignant. Malignant cancers are more dangerous than benign. Early diagnosis of this cancer can reduce the chance of death. As per scientific published studies, computer-aided diagnostic methods show impressive results. Before the era of deep learning algorithms, the researchers used to apply traditional machine learning algorithms such as support vector machine (SVM), random forest (RF), K-means algorithm, artificial neural network (ANN), and Naïve Bayes algorithm (NB) to analyze the labeled data to extract important features, and then based on the values of these features, the algorithm may be tested for new data. But getting this labeled data with domain experts was an important and difficult constraint. Recent advancements in deep learning algorithms make it possible to apply raw images directly for getting features. Later these features are used to classify them into specific classes without expert knowledge [13]. Hidden patterns inside the images are first recognized, and then the classification of images could be done [14]. Computer-based diagnostic methods are reaching the human expertise levels with deep learning algorithms [15].

2.1 Transfer Learning

Transfer learning is the learning of a new concept from the previous similar concept that was learned earlier. This made it possible to fine-tune pre-trained models on top layers only and avoid training from scratch. Using histopathology images, breast cancer had been classified in the literature using transfer learning. Table 1 shows the summary of a few recent works in the literature.

3 Methodology

This section presents the methodology used in this study. Figure 1 depicts the class balancing. Since the dataset was imbalanced, first training and testing data were taken by applying class balancing. The workflow of the approach is shown in Fig. 2. Four epochs were performed in the training phase, and then each model was tested. The performance of each model is measured by computing the accuracy, precision, recall, and $F1$-score.

3.1 Dataset

The dataset used in the study was publically available Breast Cancer Histopathology Images [19]. It consisted of 162 whole mount slide images of breast cancer specimens scanned at 40x. 277,636 patches of size 50×50 which were extracted from the slides. Among patches, 198,738 patches belonged to negative invasive ductal carcinoma (IDC), and 78,838 patches were from positive IDC. Figures 3 and 4 show sample healthy and cancerous sample images.

Table 1 Summary of breast cancer classification using pre-trained CNN models in the literature

S. No	Refs. No	Year	CNN model	Methods/techniques used	Dataset used	Results achieved
1	[9]	2020	InceptionV4 with residual connection	Transfer learning with data augmentation	ICIAR-2018	For binary classification 93.7% accuracy
2	[16]	2020	DenseNet-121 with SENet	Images were enhanced with CNN	Breast Cancer Histopathological (BreakHis)	Patient recognition rate (PRR) and image recognition rate (IRR) were compared
3	[15]	2020	U-Net with CNN models as backbone	Background removal from histopathology images with U-Net	The Cancer Genoum Atlas (TCGA)	EfficientNet-B3 proved the best backbone topology
4	[17]	2020	EfficientNet-B3, ResNet50 DenseNet-121	Random center cropping and attention with feature fusion	Rectified Patch Camelyon (RPCam)	EfficientNet-B3 achieved 97.3% of test accuracy
5	[18]	2020	EfficientNet-B6	EfficientNet-B6 combinations of few activation functions and optimizers	Patch Camelyon (PCam)	EfficientNet-B6—97.94% accuracy with rectified Adam optimizer and Mish activation function
6	[5]	2021	EfficientNet-B0–B6	Stain normalization techniques (Reinhard and Macenko) with EfficientNet architectures were compared	ICIAR-2018	EfficientNet-B2 produced 98.33% accuracy using Reinhard and 96.67% accuracy using Macenko stain normalization

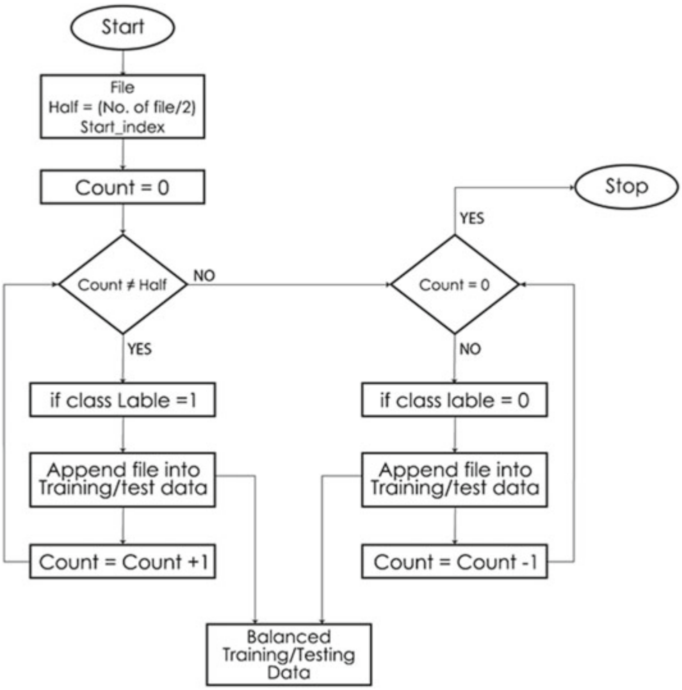
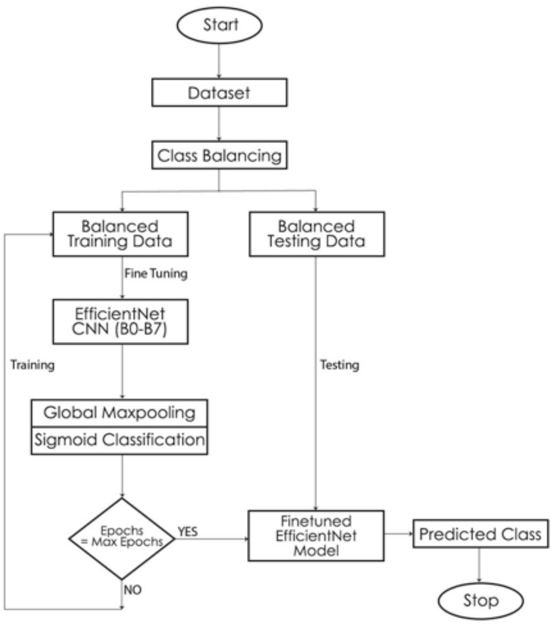


Fig. 1 Class balancing of dataset

Fig. 2 The workflow of approach



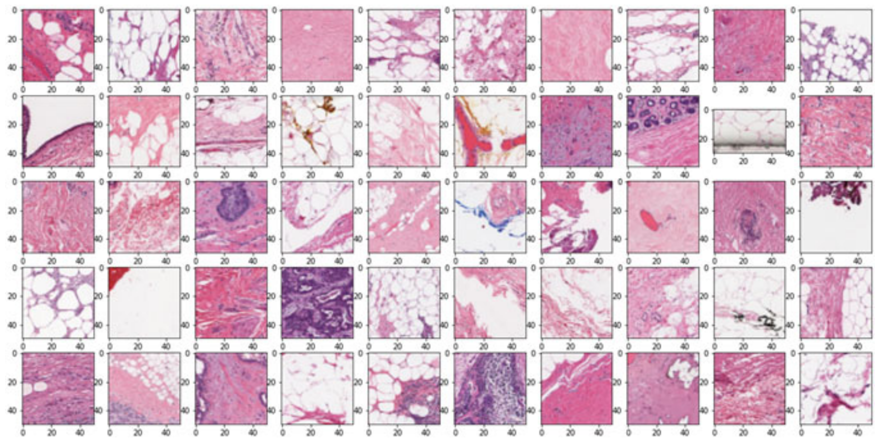


Fig. 3 Sample of healthy patches of the used dataset

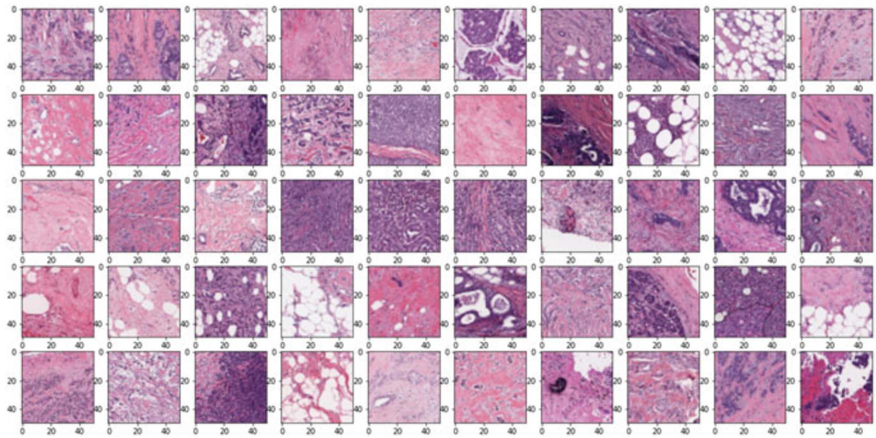


Fig. 4 Sample cancerous patches of the used dataset

3.2 Class Balancing

The performance of any model is decided by the dataset used in the study. If the dataset does not consist of an equal number of samples of each class, then the result of the model may not represent the actual scenario of each class. Since the data that is used in the study consisted of an unequal number of samples of both classes, therefore, class balancing was applied to get balanced training and testing data from the dataset. The effect of class balancing can be seen in Fig. 5. Figure 6 which show the samples of training and testing data after class balancing.

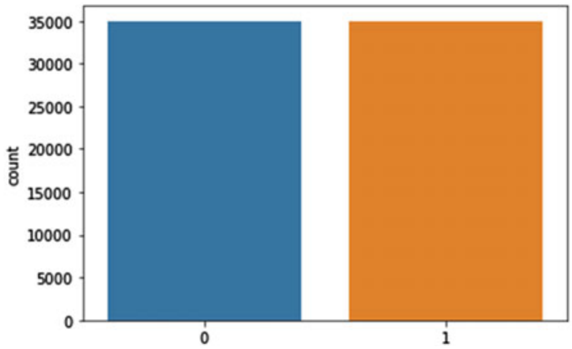


Fig. 5 Training data after class balancing

3.3 EfficientNet Architectures

Generally, the efficiency of a deep learning model can be increased initially by increasing the width, depth, and resolution. This is called the scaling of the model. After the extent of such scaling, the number of parameters may exceed a limit which may decrease the efficiency of the model. EfficientNet architectures [20] consist of a family of eight networks (B0–B7) that work on a compound scaling. It applies to scale gradually based on user-defined coefficient using grid search. The architectures of EfficientNet consisted of a combination of various modules [21]. Every model consisted of a stem module, seven blocks, and a final layer module. Each block is made of different sub-blocks that are combinations of three modules. The numbers of sub-blocks present increased from EfficientNet-B0 to EfficientNet-B7. The details of these modules, blocks, and sub-blocks are shown in Figs. 7 and 8.

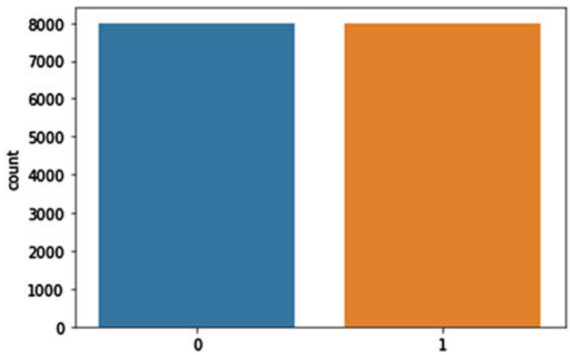


Fig. 6 Testing data after class balancing

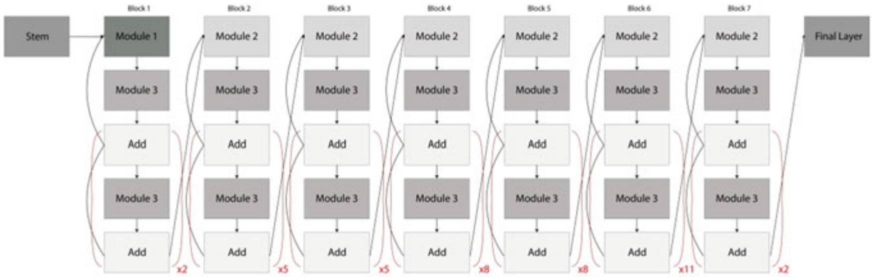


Fig. 7 Blocks and sub-blocks of EfficientNet-B7 architecture, xi represents the repetition of the block *i* times

3.4 Experimental Setting

The flow diagrams shown in Fig. 1 represent the process of breast cancer images classification. Class balancing was applied to reduce the difference between the sample of both classes. The models are implemented based on Keras framework and TensorFlow framework as back end using Python (3.7.10). EfficientNet models (B0–B7) were imported using Keras library. The application of transfer learning with freeze layers of pre-trained CNN models and arrangement of top layers are shown in Fig. 6. Each CNN model was extended with global max pooling, and a classification layer with a sigmoid activation function was applied. Batch size of 64 and data augmentation applied for training. All the pre-trained models were applied with Adam optimizer at a learning rate of 10–3. The binary cross-entropy function is used to compute the loss of classification. Checkpoints were used during each experiment so that the best accuracy value was saved while training continued. All the experiments were performed using the Kaggle kernel on GPU VM with the specification as follows:

GPU: Nvidia Tesla P100,
GPU memory: 16 GB,
GPU memory clock: 1.32 GHz and
Performance: 9.3 TFLOPS.

4 Result and Discussion

4.1 Evaluation Criteria

The performance of a model can be measured through different metrics. Accuracy, precision, recall, and $F1$-score are computed and compared for each model to measure the performance of models. These values can be computed from the confusion matrix

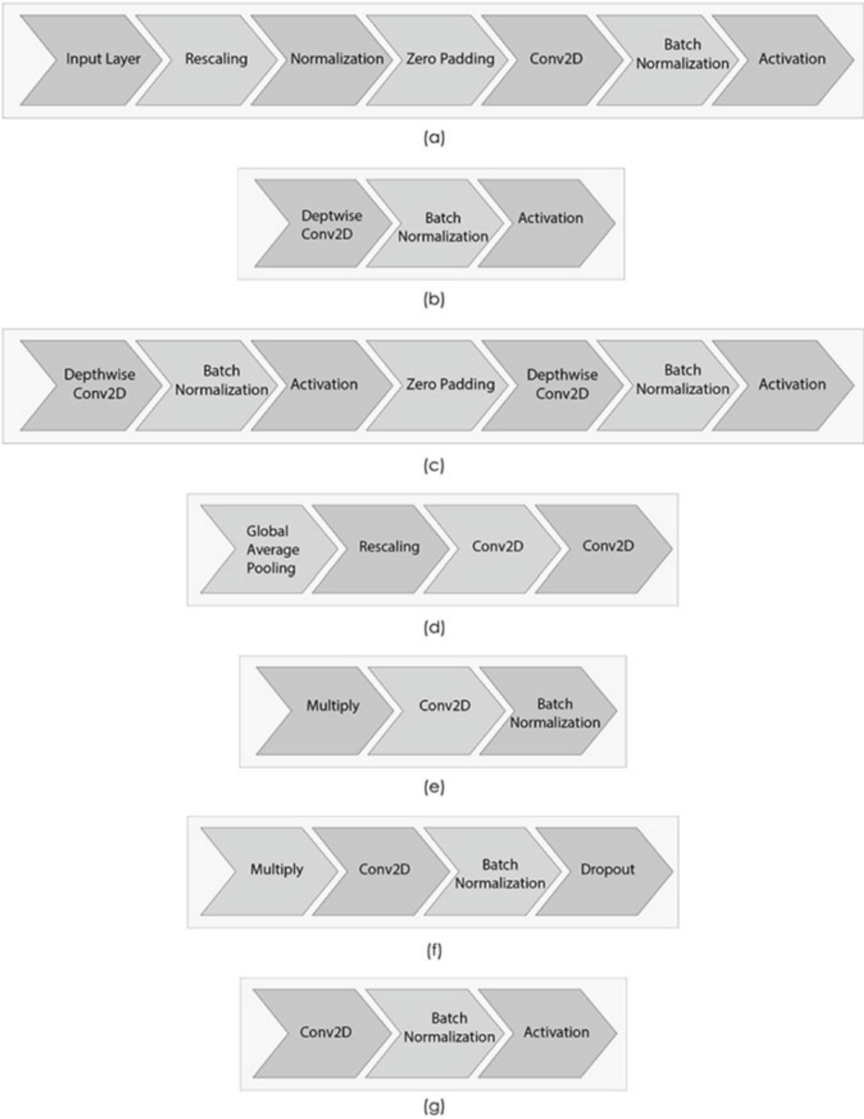


Fig. 8 Modules of the family of EfficientNet architectures **a** stem, **b** final layer, **c** module 2, **d** module 3, **e** module 4, **f** module 5, **g** module 1

using the expressions written as in Eqs. (1–4). The confusion matrix of any classification model consists of the number of records that are classified correctly and incorrectly in terms of True positives (TP), true negatives (TN), false positives (FP), and false negatives (FN).

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}} \tag{1}$$

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}} \tag{2}$$

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}} \tag{3}$$

$$F1\text{-score} = \frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \tag{4}$$

where accuracy represents the overall correctness of prediction, the precision value for each class represents the ratio of correct prediction with the total prediction, the recall for each class shows the ratio of correct prediction with the actual total samples of the same class, and $F1$-score gives the harmonic mean of precision and recall. Depending on the number of samples of each class available in the datasets, these metrics can be used to compare the performance of any model.

4.2 Experimental Results

Table 2 provides the models' validation accuracy, validation loss, AUC score, precision, recall, and $F1$-score for each model with the dataset. It can also be observed that EfficientNet-B1 and EfficientNet-B2 achieve better results among all architectures. Among all EfficientNets architectures, EfficientNet–B2 performs better achieving an AUC score of 0.95. EfficientNetB6 and EfficientNetB7 faced overfitting and took more training time. They also did not classify the images so correctly as compared with EfficientNetB2.

4.3 Discussion

The malignancy of breast cancer can be confirmed by a pathologist observing the patterns in the histopathology images. Since the availability of pathologists is limited, the results of diagnosis for a patient can be delayed if only such manual processes [9] are applied. But with the recent advancements in artificial intelligence and deep learning methods, [22] have been applied for medical image processing and analysis. These methods involve CNN, recurrent neural network (RNN), and auto-encoder, etc. Artificial intelligence techniques [22] made it possible to improve diagnosis efficiency. Although, applying a deep learning method needs a high computing speed and a large amount of data. With the development of a graphical processing unit (GPU), the computing speed and time can be reduced. Using transfer learning, the processing

Table 2 Comparison of EfficientNet architectures (B0–B7)

EfficientNet	Validation accuracy	Validation loss	AUC score	Precision		Recall		$F1$-score	
				IDC (negative)	IDC (positive)	IDC (negative)	IDC (positive)	IDC (negative)	IDC (positive)
B0	0.8336	0.4290	0.90	0.79	0.84	0.86	0.77	0.82	0.81
B1	0.8542	0.3409	0.94	0.87	0.90	0.91	0.86	0.89	0.88
B2	**0.8749**	**0.2949**	**0.95**	**0.84**	**0.92**	**0.93**	**0.83**	**0.88**	**0.87**
B3	0.8144	0.4582	0.92	0.84	0.84	0.84	0.84	0.84	0.84
B4	0.5026	0.8359	0.93	0.82	0.90	0.91	0.80	0.86	0.85
B5	0.8492	0.3624	0.94	0.79	0.93	0.94	0.75	0.86	0.83
B6	0.8570	0.3674	0.94	0.83	0.91	0.92	0.82	0.87	0.86
B7	0.8603	0.3461	0.95	0.88	0.89	0.88	0.89	0.85	0.88

Table 3 Output of confusion matrices for EfficientNet-B0-B7

CNN model	Predicted class	Actual class		Predicted class	Actual class	
		0	1		0	1
B0	0	6854	1146	1	1821	6179
B1		7252	748		1107	6893
B2		**7410**	**590**		**1396**	**6604**
B3		6692	1308		1254	6746
B4		7273	727		1604	6396
B5		7532	468		2017	5983
B6		7350	650		1472	6528
B7		7155	845		994	7006

time of deep learning models also can be reduced. As per Grand challenge [5], EfficientNet architectures showed better performance than any previous CNN models. From Table 1, it is evident that EfficientNet architectures have been widely used for the classification of breast cancer from histopathology images. The performance of the models was evaluated using accuracy curve, loss curve, confusion matrix, and receiver operating characteristic curve (ROC). The outputs of confusion matrices of all eight models are given in Table 3. Figure 9 showed the ROC curves of all eight efficient models. From the graph and matrix, it is evident that the EfficientNet-B2 showed a better result. Table 3 showed the results of confusion matrices for eight models: EfficientNet-B0, -B1, -B2, -B3, -B4, -B5, -B6, and -B7 with the dataset. From the table, it can be seen that EfficientNet-B2, among all eight models, was able to classify more accurately the samples of IDC (negative) class, whereas EfficientNet-B7 classified more accurately the samples of IDC (positive class). It can also be seen that EfficientNet-B1 showed similar results as EfficientNet-B2. The graphs in Fig. 9 show the ROC curve for eight models. All eight models achieved an AUC score between 0.90 and 0.95. Among all, EfficientNet-B2 and -B7 achieved 0.95 AUC score, and EfficeintNetB0 achieved a 0.90 AUC score. EfficientNet-B5 and -B6 achieved the same AUC score of 0.94.

5 Conclusion and Future Scope

Family of EfficientNet architectures showed satisfactory results on the dataset in a small amount of training time. In the experiment, EfficientNet-B6, -B7 models have faced overfitting and store the weights from the end of the best epoch during training by early stopping. Although data augmentation was applied by image data generator, customized data augmentation techniques can be applied in the future to improve the results. Early stopping was used to avoid overfitting in the experiment, and other techniques such as regularization techniques can be applied to improve the results.

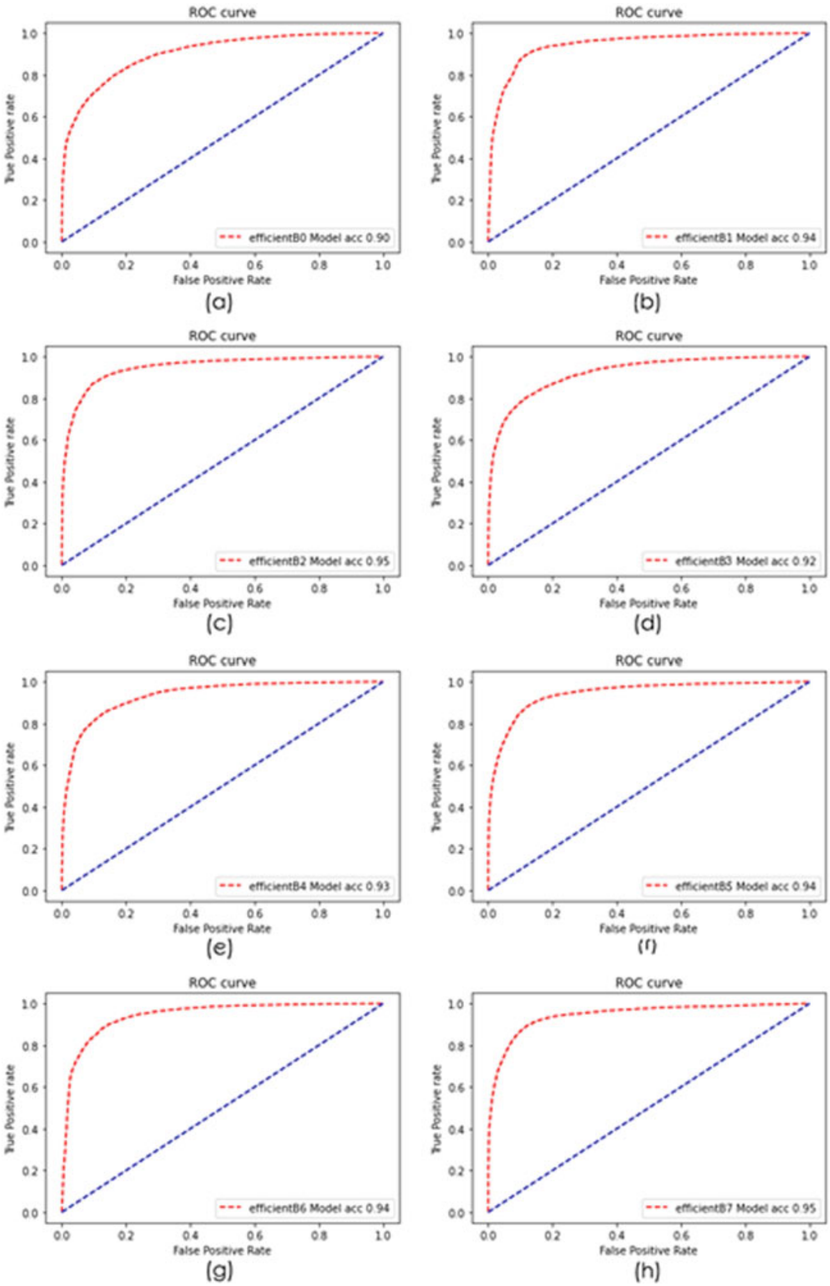


Fig. 9 ROC curve graphs: **a** EfficientNet-B0; **b** EfficientNet-B1; **c** EfficientNet-B2; **d** EfficientNet-B3; **e** EfficientNet-B4; **f** EfficientNet-B5; **g** EfficientNet-B6; **h** EfficientNet-B7

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