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Nikhil Marriwala
C. C. Tripathi
Shruti Jain
Dinesh Kumar *Editors*

Mobile Radio Communications and 5G Networks

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Preface

This conference provides a platform and aid to the researches involved in designing systems that permit the societal acceptance of ambient intelligence. The overall goal of this conference is to present the latest snapshot of the ongoing research as well as to shed further light on future directions in this space. This conference aims to serve for industry research professionals who are currently working in the field of academia research and research industry to improve the life span of the general public in the area of recent advances and upcoming technologies utilizing cellular systems, 2G/2.5G/3G/4G/5G and beyond, LTE, WiMAX, WMAN, and other emerging broadband wireless networks, WLAN, WPAN, and other homes/personal networking technologies, pervasive and wearable computing and networking, small cells and femtocell networks, wireless mesh networks, vehicular wireless networks, cognitive radio networks and their applications, wireless multimedia networks, green wireless networks, standardization activities of emerging wireless technologies, power management, signal processing, and energy conservation techniques. This conference will provide support to the researchers involved in designing decision support systems that will permit the societal acceptance of ambient intelligence. It presents the latest research being conducted on diverse topics in intelligent technologies to advance knowledge and applications in this rapidly evolving field. The conference is seen as a turning point in developing the quality of human life and performance in the future; therefore, it has been identified as the theme of the conference. Authors were invited to submit papers presenting novel technical studies as well as position and vision papers comprising hypothetical/speculative scenarios.

5G technology is a truly revolutionary paradigm shift, enabling multimedia communications between people and devices from any location. It also underpins exciting applications such as sensor networks, smart homes, telemedicine, and automated highways. This book will provide a comprehensive introduction to the underlying theory, design techniques, and analytical tools of 5G and wireless communications, focusing primarily on the core principles of wireless system design. The book will begin with an overview of wireless systems and standards. The characteristics of the wireless channel are then described, including their fundamental capacity limits. Various modulation, coding, and signal processing schemes are then discussed in detail, including state-of-the-art adaptive modulation, multicarrier, spread spectrum, and multiple antenna techniques. The book will be a valuable reference for engineers in the wireless industry. This book will be extremely valuable not only to graduate students pursuing research in wireless systems but also to engineering professionals who have the task of designing and developing future 5G wireless technologies.

For the proper review of each manuscript, every received manuscript was first checked for plagiarism, and then the manuscript was sent to three reviewers. In this process, the committee members were involved, and the whole process was monitored and coordinated by General Chair. The Technical Program Committee involved senior academicians and researchers from various reputed institutes. The members were from India as well as abroad. The technical program mainly involves the review of the paper. The conference has had an acceptance ratio of **18.9%**.

An overwhelming response was received from the researchers, academicians, and industry from all over the globe. The papers were received from pan-India with places such as **Punjab, Himachal, Uttar Pradesh, Maharashtra, Tamil Nadu, Chhattisgarh, Telangana, Rajasthan, Uttarakhand, Kerala, Odisha, Rajasthan, Uttar Pradesh, Delhi, J&K,** and **Andhra Pradesh**. The authors from premium institutes IITs, NITs, Central Universities, NSIT, PU, and many other reputed institutes participated in the conference.

Organizers of MRCN-2022 are thankful to University Institute of Engineering and Technology, Kurukshetra University, Kurukshetra (UIET, KUK), which was established by Kurukshetra University in 2004 to develop as a "Centre of Excellence" and offer quality technical education and to undertake research in Engineering and Technology for providing the necessary resources to organize such a mega event. UIET, KUK under the dynamic leadership of **Prof. (Dr.) Som Nath Sachdeva**, Honorable Vice-Chancellor, Kurukshetra University, Kurukshetra, and **Prof. (Dr.) Sunil Dhingra**, Director UIET, KUK, has established itself as a role model for Engineering and Technology Education not only for the State of Haryana but for the world over to meet the challenges of the twenty-first century.

The editors would like to express their sincere gratitude to Patron of the Conference MRCN-2022 **Prof. (Dr.) Som Nath Sachdeva**, Honorable Vice-Chancellor, Kurukshetra University, Kurukshetra; **Prof. (Dr.) Sunil Dhingra**, Director UIET, KUK, Dean, Engineering and Technology Kurukshetra University, Kurukshetra, and Convener of the Conference; **Prof. (Dr.) Dinesh Kant Kumar**, Professor at RMIT University, Melbourne; **Prof. (Dr.) Carol Fung**, Concordia University, Canada, Special Guest at the conference; **Dr. Utkarsh Srivastava**, Western Michigan University, USA; **Prof. S. Jagannathan**, Rutledge-Emerson Distinguished Professor of Electrical and Computer Engineering, Missouri University of Science and Technology, USA; **Dr. Vijay Garg**, Co-Coordinator of MRCN-2022, all General Chairs, Plenary Speakers, Invited Keynote Speakers, Reviewers, Technical Program Committee Members, International Advisory Committee Members, and Local Organizing, Committee Members of MRCN-2022, without whose support, the quality and standards of the conference could not be maintained. Special thanks to the Springer and its team for this valuable publication. Over and above, we would like

to express our deepest sense of gratitude to UIET, Kurukshetra University, Kurukshetra, for hosting this conference. We are thankful to **All India Council for Technical Education (AICTE)** for sponsoring the International conference MRCN-2022 event.

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Dr. Shruti Jain is an Associate Dean (Innovation) and Professor in the Department of Electronics and Communication Engineering at the Jaypee University of Information Technology, Waknaghat, Himachal Pradesh, India. She has received her Doctor of Science (D.Sc.) in Electronics and Communication Engineering. She has teaching experience of around 18 years. She has filed eight patents, of which one has been granted and five are published. She has published more than 24 book chapters, and 125 research papers in reputed indexed journals and in international conferences. She has also published 14 books. She has completed two government-sponsored projects. She has guided 07 Ph.D. students and now has 04 registered students. She has also guided 11 M.Tech. scholars and more than 97 B.Tech. undergrads. She has organized 09 conferences of IEEE and Springer as Conference General Chair. Her research interests are Image and Signal Processing, Soft Computing, Internet-of-Things, Pattern Recognition, Bio-inspired Computing, and Computer-Aided Design of FPGA and VLSI circuits. She is a senior member of IEEE, Executive member of IEEE Delhi Section, life member and Executive member of the Biomedical Engineering Society of India, and a member of IAENG. She is a member of the Editorial Board of many reputed journals. She is also a reviewer of many journals and a member of TPC of different conferences. She was awarded by Nation Builder Award in 2018–19 and enlisted in 2% scientist of world rankings of 2021 published by Elsevier, data compiled by Stanford University.

Prof. Dinesh Kumar completed B.Tech. from IIT Madras and Ph.D. from IIT Delhi and is Professor at RMIT University, Melbourne, Australia. He has published over 400 papers, authored 5 books, and is on a range of Australian and international committees for Biomedical Engineering. His passion is for affordable diagnostics and making a difference for his students. His work has been cited over 7400 times, and he has also had multiple successes with technology translation. He is Member of Therapeutics Goods Administration (TGA), Ministry of Health (Australia) for medical devices. He is also on the editorial boards for IEEE Transactions of Neural Systems and Rehabilitation Engineering and Biomedical Signals and Controls. He has been Chair of large number of conferences and given over 50 keynote speeches.

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Android Malwares with Their Characteristics and Threats

Tejpal Sharma and Dhavleesh Rattan

Abstract Android smartphones have a big share in global market in comparison as it is open-source architecture, high usage and popularity in the community of developers. In general, smartphone becomes a persistent gadget in individual's life because it is used for various purposes such as office applications, gaming, Internet and vehicle guidance-based services along with basic services like calling and messages. With the high usage of android smartphones and its association with monetary benefits, it has made its point of attraction for attackers. As a result of this, it leads toward the exponential growth in android malware apps. This study has mainly focused upon android platform and aims toward the systematic characterization of existing android malwares. The study includes the types of malwares in android operating system along with characteristics. It also covers the activities that are performed by the malwares. Moreover, case studies of few recently discovered malwares are discussed in detail with their working and threats. This study will help the researchers to obtain the knowledge regarding android malwares and their threats caused to devices. It will help the society to become aware about the malwares that will keep them away from these types of apps.

Keywords Mobile apps · Android malware · Mobile security · Cybersecurity · Malware family · Virus · Timeline

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1 Introduction

1.1 Introduction and Motivation

Nowadays, the usage of smartphones is growing day by day. People use it for various types of daily activities such as calling, SMS, banking, shopping, education and gaming. This high usage of smartphones highlights it in the world of technology which attracts the people to create new apps. But malware authors have also focused to create new malwares or malicious applications for these smartphones. These malwares may be the clone on popular applications, fake applications, advertisement pop-ups, etc. [1, 2].

Motivation:

- The usage of android smartphones is very high as compared to others operating systems, and malwares are also growing rapidly. 72% of the total smartphones are using android operating system [2, 3].
- It is the need of time to make the people aware about the android malwares and their characteristics, so that its adverse effect can be reduced [4, 5].

1.2 Introduction to Android

Android is an operating system that is used in various daily use gadgets like mobile phones, smart watches, TVs, etc. It is an operating system developed by Google and based on Linux kernel. As shown in Fig. 1, android framework is divided into four layers: Linux kernel, libraries, application framework and applications. Linux kernel contains essential hardware drivers such as keypad, Wi-Fi, camera, display, Bluetooth and USB. After Linux kernel, there are libraries that include set of code libraries and Dalvik virtual machine for the execution of code. Next is application manager which provides higher-level services such as view system, notification manager, activity manager, resource manager and content provider. Application is the top layer in the architecture that contains the application to be installed on the device for use [1, 2, 6].

1.3 Usage of Android

Android is the fast-growing operating system, as per report in the year 2021, 72% of total mobile users are using android operating system and only 27 percent are using iOS Apple's operating system. It has been observed that from 2012 to 2019, the usage of android increased rapidly from 23 to 75%. But in these days, the usage

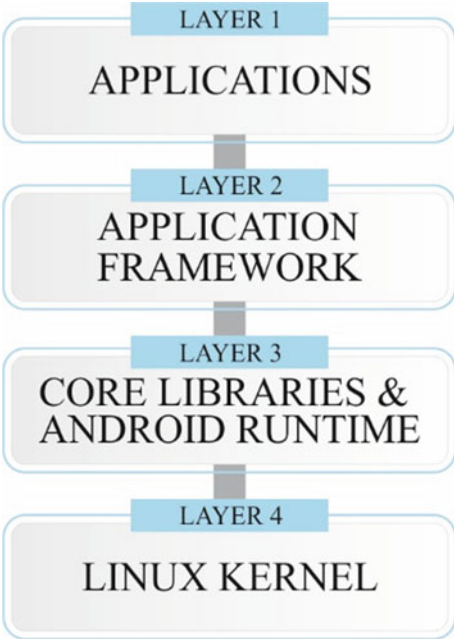

Fig. 1 Android framework

of android faced slight decrease and reached to 72%, users shifted to iOS, and there is increased iOS usage from 20 to 27% in 2021 [2, 5].

1.4 Malwares

Malware is the program or code that performs malfunctions on victim's device. It may harm designated device hardware or data stored on that device. Some malwares also retrieve data from network also. There are a number of methods to spread android malwares in the society. The following are main four approaches to spread malwares [7]:

- **Fake Applications**: These are the applications that are uploaded on Google Play Store on the name of some purposeful applications such as calculator, video editors and document scanners [2, 8].
- **Repackaged Applications**: These are the clone of popular applications that includes features of that application along with malicious code. These applications are spread through third-party application stores or directly transferred from phone to phone [9].
- **Bug Exploitation**: Some applications on Google Play Store have vulnerabilities. Malware authors find these types of applications and use them for malfunctions [10].

- **Remote Installation**: Google Play Store has some verification procedure that detects the applications and restricts the uploading of malicious applications and malwares. In these types of cases, malware authors try to install applications directly to the victim's phone using remote install method like sending download link through email or SMS [11, 12].

1.5 Malware Growth

As the android operating system is used by huge number of users, it led the malware authors to develop malwares to attack android devices. As per reports shown in Fig. 2, it has been observed that every year millions of new malwares are introducing to attack on android systems [3].

2 Related Work

Spreitzenbarth and Freiling [13], have mentioned about the characteristics of various malwares in the form of activities they perform on victim's device, i.e., gain root access, send and receive SMS, steal personal and device information, installation of malicious code on infected device, user location information, etc. It has also mentioned case studies of various malwares. Zhou and Jiang [4], have reported various malwares families and their characteristics. In this, they have reported 14 malware families having 1260 malwares from the period of 2010 to 2012. The process of installation and activation also explained in detail. Malware is installed by using four different methods like repackaging, malicious code in update of app, drive by downloading link through SMS or email, and stand-alone. Qamar et al. [14], have reported malwares from the period of 2000 to 2018. It includes malwares from various mobile operating systems such as android, windows, Symbian and iPhone.

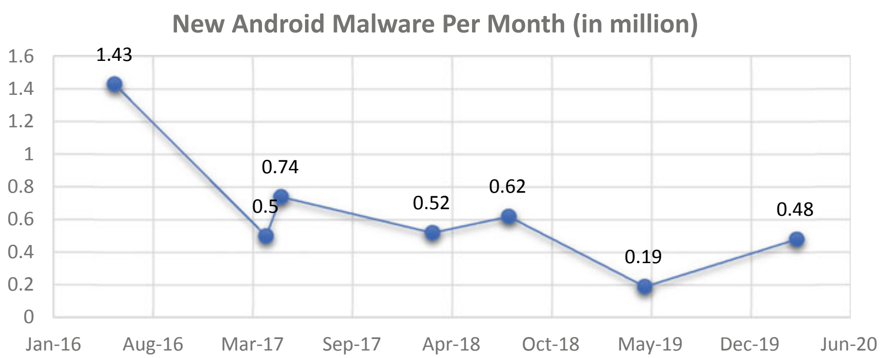

Fig. 2 New android malware per month

This study also includes the information about types of malwares and threats caused by malwares. Rahali et al. [15], developed a technique for malware detection based on deep learning. In this study, they have discussed about the datasets. Characteristics of various malware families are mentioned which shows how malwares attack on the device.

3 Work

3.1 Malware Types

There exist various types of malwares that attack on android systems. These malwares have various characteristics according to their activities that they perform on victim's device. Figure 3 shows types of malwares.

The following are malwares discovered in android systems:

- Trojan: Trojan is the type of malwares which install some backdoor code on attacked device and then use that to communicate with the device from remote station. When communication link is created, then that is used to steel information from device or new malicious code is installed in device to perform malicious activity. Various types of activities are performed like fetching banking details, access to SMS, steal personal information, fetching device information, etc. [16].
- Adware: These are the types of malwares which are used for monetary benefits in direct way or indirect way. Malfunction is added in various types of regular use applications and then that shows pop-ups of premium ads that pays money for clicks to the malware author directly as per number of clicks. These types of malwares are very popular and mostly used by attackers to make money [15].
- Root Exploit: Whenever someone got root access of android device, then that can change the settings of the device as per its convenient. It is based on any vulnerability in specific type of operating system. It is a difficult process, but it is performed by malwares author to access the root of operating system [17].

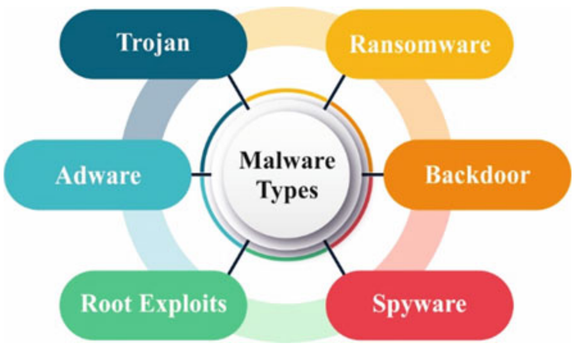

Fig. 3 Types of malwares

- Ransomware: Ransomware is malware that is used for monetary benefits. In this case, attackers take access of victim's important data and encrypt that data and ask for money from victim to decrypt that. The usage of ransomware has increased with the invention of cryptocurrency, because it is very easy for attackers to collect money anonymously from victim because they can easily hide their identity in crypto transactions [18].
- Backdoor: It is a type of malware which gets access of victim's device as a normal application and then downloads malicious code on device to apply malicious activities [7].

3.2 Malfunctions Performed By Malwares

There are a number of activities that are performed by malwares on attacked devices [4, 13]:

- Gain root access using vulnerabilities of operating system.
- Acquire information about hardware and software of device.
- Acquire personnel information of user.
- Access to SMS to get one-time password or send SMS to premium numbers.
- Install malicious code to victim's device
- Gather information of network where device is working.
- Collect the bank details of user.

3.3 Threats of Android Malwares

There are various types of threats that android malwares may cause to the android users. Some of the threats are mentioned below [7]:

- SMS and call to premium numbers: There are some kinds of malwares which are used to send SMS or call to premium numbers without consent of user. These types of SMS and calls are highly chargeable. This is used to make money from these calls and SMSs.
- Ransomware is used to make money from victims by taking access of their important data. This is the main threat in these days because attackers use digital currency for transactions to hide their identity.
- Spywares are used to get information from device silently without consent of device owner. In this, they may collect device information in the form of hardware and software used by the device such as processor, operating system, camera, Wi-Fi and Bluetooth. Moreover, it is also used to get personal information of user like name, address, contact information, government identification number, bank account numbers, etc.
- Use the system as bot to perform various activities, sometimes malware authors attack system with root exploit codes and that codes are used to access the root of

system through vulnerabilities of operating system. In this case, they gain access of root and use that system as a bot for various types of malfunctions.

- Advertisements are also popped on user device with any regular app such as video editor, calculator, document scanner and call recorders. Some malwares, called adware, are used for this purpose to show ad pop-ups on user screen and allow forcefully to click and watch those ads.

3.4 Case Studies

This section includes information about the details of some malwares which affected the society recently. Here we have included five case studies of popular malwares discovered in last year. These case studies contain history, working and threats of each malware.

3.4.1 AbstractEmu (Root Exploit) [19]

- **History**: On October 10, 2021, lookout threat laboratory researchers discovered an android malware that belongs to root exploit category. They named this as AbstractEmu because of its working on code abstraction and anti-emulation. Lookout threat laboratory has identified 19 similar applications at that time, and seven were related to root exploit. All the applications were uploaded on third-party app stores except one application named Lite Launcher that is uploaded on Google Play Store with 10,000 downloads.
- **Working**: This malware is one of the intelligent malwares because it uses code abstraction and the evasion techniques. It uses the anti-emulation techniques to escape from malware detection systems. It used the vulnerabilities of the android systems and then processed it to gain access. In this, they have picked the vulnerabilities from the year 2019 to 2020. They have used one of the exploit CVE-2020-0041. Another targeted exploit is CVE-2020-0069 which is vulnerability of Mediatek chips and used by a number of manufacturers. Exploit codes for CVE-2019-2215 and CVE-2020-0041 are also used to support more targets.
- **Steps**:
  - Check whether the targeted device is real or emulator.
  - Look for device system properties and installed applications.
  - Connect to the server using command except to receive the commands from JSON to execute.
  - Then it uses commands to transfer data to device information, model, version, phone number, network address and serial number.
- **Threats**:
  - It is used to extract user and device information by gaining root access.
  - It also works as banking Trojan, because it also steals bank credentials.

- It has gained access to allow various types of dangerous permissions without the consent of device user.

3.4.2 GriftHorse (Trojan) [20]

- **History**: GriftHourse malware is discovered by Zimperium zLabs on September 29, 2021, as a Trojan. It targeted about 10 million devices globally and stolen hundreds of million Euros. Instead of using phishing for premium service scam, here android app is used as Trojan for this scam. These applications are used to pay premium services from infected device without the owner consent. They have started the campaign from November 2020 and detected by Zimperium zLabs in September 2021 and intimated to Google. Then after verification, Google removed it from Play Store, but this is still available at third-party app stores. It affected millions of users around the world which includes 70 countries.
- **Working**:
  - It shows prize winning pop-up on user phone. It sends it multiple times to make the user to click, e.g., five times in an hour.
  - When user clicks on the pop-up, then it redirects to webpage.
  - Then it asks for mobile number verification and makes the user to add mobile number and other details.
  - After this, it performs activity that deducts money from user account.
- **Threats**:
  - Unexpected subscription of paid services and premium services without the knowledge of user. Sometimes the charging amount was around 36 Euros for monthly subscription.
  - It sends the pop-up on screen for fake prize that user has won, after sending pop-up multiple times, it gets click from user and asks for verification and makes them to send SMS or call to premium number that are highly chargeable.
  - It took benefit of small phone screen to make user to click on link and also targeted people of different countries in different way like using pop-ups related to local environment.

3.4.3 TangleBot (Root Exploit) [21]

- **History**: It is a SMS Trojan that attacked on targets from USA and Canada. It is used to obtain personal information and access applications from user mobile device. It is discovered by Cloudmark Threat analysis. It sends SMS to the victim reading COVID-19 rules regulations and asks them to register for third dose of vaccination. They use that trick to download the malware on victim's mobile device.

- **Working**: The working of this malware is very simple. It uses SMS to make the user to download malicious code in user device. It sends link through SMS, makes the user to download the code and then takes access of mobile functionalities.
- **Threats**:
  - It can make and block the call from mobile phone without user intervention.
  - It can send and receive SMS.
  - It can record audio and video by using camera and mic.
  - It can use the function of overlay by covering benign application with malicious content.

3.4.4 SharkBot (Banking Trojan) [22]

- **History**: It is a banking Trojan discovered by Cleafy Threat Intelligence team at the end of October 2021. Its characteristics did not match with any previous family, so it is named as a new family Sharkbot. It affected the people of UK, Italy and USA. The main goat of this malware is to use money transferring method by using automatic transaction systems (ATS). It used the methods to bypass the authentication system without verifying.
- **Working**:
  - It used automatic transaction systems for bypassing the authenticating process.
  - It fetches bank and card credentials using overlay functions by misleading the user.
  - It intercepts the SMS to fetch one-time passwords or personal identification numbers sent by banking systems.
  - It also collects the information using key log feature.
  - It obtains the remote access of android system to access services.
- **Threats**:
  - It uses automatic transaction systems and bypasses the authentication process to access the bank account to fetch money.
  - It performs overlay attack to add fake screen on legitimate bank application. It fetches bank details or card information by using these methods.

3.4.5 Joker [23, 24]

- **History**: Joker is the malware first discovered in 2017, and Google Play Store found 1700 infected applications in 2017. Now in September 2021, it has been observed that Joker has again infected 24 applications having 500 thousand downloads and earned millions of dollars money during this period. It is a malware which is used by attackers to make the users to subscribe paid services without user consent.

- **Working**:
  - User installs Joker Trojan in its device.
  - In starting, it works as benign application and then after sometime it constructs a payload for URL.
  - It sends query to server regarding that URL.
  - It then downloads the malicious code.
  - It installs that code on victim's device.
  - It connects to C&C server for further communication and fraud.
- **Threats**:
  - It performs paid subscriptions without user consent.
  - It steals user information and bank details and transfers that to server.

4 Synthesis of Study

This section has information about the activities that various malwares perform on infected device. As mentioned in Table 1, totally eight types of malfunctions are reported in table and mentioned according to the type of malware. As per the observation, most of the malwares are used to steal information from victim's device and install malicious code on it.

Inferences: As per the report of synthesis, the following are the inferences of this study:

- Overlay function is used by the latest malwares for getting banking and password details.

Table 1 Synthesis of malware studies

Malware category Malware Category	Activities Activities						
	Money making	Access to SMS	Block/delete/use phone apps and remotely use the phone	Gain root access	Install malicious code files	Network and GPS info	Steal personal info
Trojan		√			√		√
Adware	√				√	√	√
Root exploits				√	√		
Ransomware	√		√				√
Backdoor			√	√	√		
Spyware		√				√	√

- Anti-emulation techniques are used to mislead the detection systems. Malware systems check for emulator and installed application.
- Most of the malwares are working to get monetary benefits.

5 Conclusion

Malwares have become a big problem for society, there are number of malware detection and mitigation techniques that are being developed in these days, but still the malwares are growing day by day. So, the knowledge about malwares and their characteristics is the requirement of time to control these types of applications effectively. In this study, we have mentioned six types of android malwares with their characteristics. We have also discussed about malicious activities that malwares used to perform on victim's device. It has been noticed that stealing personal and device information is used by most of the malwares. Malwares usually try to gain access of root and then install code on user device to apply malfunction on it. We have reported various latest malware case studies from the end of 2021. It shows that most of the malwares have money making attention. They try to subscribe paid services from user's device without consent. Screen overlay technology is used by most of the malware authors to mislead the innocent users. In addition to it, anti-emulation is also used to evade the detection systems. In this, they use evasion methods to escape from malware detection system. This study will help the future researchers to gain knowledge about the malwares and their activities, and this may lead to develop effective and efficient malicious application detection system. In the future, we will focus to provide timeline of malwares with more characteristics.

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Design of a Novel Side Chaining Model for Improving the Performance of Security Aware E-Voting Applications

Hemlata Wamanrao Kohad, Sunil Kumar, and Asha Ambhaikar

Abstract Electronic voting (E-Voting) has been described as one of the most efficient methods of collecting consensus-based decisions about a particular entity. These systems are useful for a wide variety of application scales, which range from selecting candidates at small corporations to nationwide elections. But voting systems face inherent security and quality of service (QoS) issues, which limits their public-domain deployments. Due to many sources of vulnerability, such as mutability, poor traceability, reduced trust levels, and centralized computing design, these systems are susceptible to attack by hackers and other adversaries. The usage of blockchain-based computing models, in which each set of votes is translated into a transaction, and these transactions are kept inside smart contracts, can be used to tackle these problems. These smart contracts are turned into blocks and kept in a decentralized blockchain database for storage. This database uses an improved unidirectional linked list, where each block is connected to the next block via a unique hash value. Due to the uniqueness of connecting hashes, this model exhibits immutability, which is one of the main reasons for its use in e-Voting systems. Secondly, hashes are generated using a decentralized mining mechanism, due to which the blockchain database is stored on multiple nodes, and is resilient against denial of service (DoS), Sybil, masquerading, and other server-based attacks. Similarly, the blockchain model also possesses transparency, and traceability, which makes it an ideal candidate for e-Voting systems. But the delay of voting increases exponentially w.r.t. the number of transactions, which is due to the fact that the addition of each block requires mining nodes to generate a new unique hash, which requires scanning of the entire blockchain. This limits the scalability of the blockchain model, which makes it unusable for larger-scale networks. In order to remove this drawback, a novel sidechaining mechanism is proposed in this text, wherein sidechains are created and managed using a firefly optimization model, which uses a number of parties and cast votes per party parameters. Due to this dynamic model for sidechain creation and management, the

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proposed method is capable of reducing transaction delay by 28% when compared with a single blockchain, and 16% when compared with static sidechain methods. Additionally, the model was tested on medium to large-scale e-Voting applications, and it was discovered that, when compared to other cutting edge models, it is capable of improving throughput by 8% and reducing storage cost by 18%. The proposed sidechain paradigm can be used for a wide range of e-Voting application deployments as a result of these benefits.

Keywords Blockchain · Sidechain · e-Voting · Machine learning · Delay · Storage · Throughput

1 Introduction

Blockchain is quickly becoming one of the most useful technologies for e-Voting due to its traceability, transparency, high-trustability, immutability, and distributed performance characteristics. While designing a blockchain-based e-Voting system (BES), design of a wide variety of layers is involved. These layers include, but are not limited to, storage layer, auditing layer, aggregation layer, administration layer, election management layer, etc. Figure 1 shows a typical BES model that allows for the visualization of these elements and their internal data flow.

The model initiates with election preparation services, wherein voter list, party list, election rules, etc. are decided. This information is given to an administration

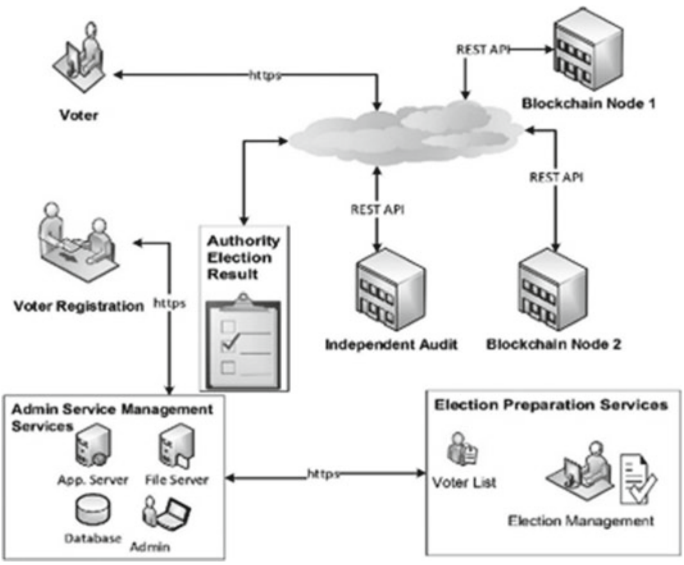

Fig. 1 Typical blockchain-based e-voting model

module, where details about file server, database, administrator, application server, etc. are stored. These layers are synchronized using Governmental authorities, and election-specific rules are enforced. Based on these rules, the e-voting process is started, and voters are requested to cast their votes using smart phones, and other e-Platforms. Each set of votes is added to a smart contract, and these contracts are stored on multiple blockchain nodes [1]. The following actions are carried out while adding a block to the blockchain: The block is encrypted using high-efficiency encryption techniques like elliptic curve cryptography (ECC) Each block is hashed using a secure hashing algorithm (SHA) Before adding a block, it is checked for uniqueness, wherein the block hash is compared with hashes of already stored blocks. Based on these components, the following delay equation is modeled,

$$\mathrm{New}_{\mathrm{delay}} = N * \left(\mathrm{Read}_{\mathrm{delay}} + \mathrm{Hash}_{\mathrm{delay}} + \mathrm{Check}_{\mathrm{delay}}\right) + \mathrm{Write}_{\mathrm{delay}} \quad (1)$$

where N represents a number of blocks already present in the chain, while New, Read, Hash, Check, and Write represents delay for adding a new block, delay for reading old blocks, hashing delay, delay for comparing current block with other blocks, and delay for writing the block to the blockchain. It can be shown from Eq. 1 that as the number of blocks grows, so does the time required to add a new block to the blockchain. It has been noted that the delay for adding blocks using distributed blockchain (DB) [2], consortium blockchain [3], or smart contracts [4] follows a roughly exponential curve in relation to the number of blocks. Thus, various techniques are proposed for reducing this delay, which includes side chain creation, increasing block length, etc. The next section reviews these techniques and discusses their intricacies, benefits, drawbacks, and potential applications in further research. The design of the suggested firefly-based side chain creation and management paradigm, which aids in enhancing the functionality of E-Voting systems, is then presented. In Sect. 4, the suggested model is tested, validated, and contrasted with several state-of-the-art methods across a range of applications. This essay concludes with some thought-provoking remarks on the suggested model and offers a number of suggestions for improvements to increase its capacity for real-time performance.

2 Literature Review

For e-Voting with side chains, a wide range of system models are put out, and each of these models is used for a specific user scale. For instance, to increase the scalability of e-Voting systems, the work in [5, 6] suggests trust-enhanced blockchain and access control-based blockchain. Similar to this, the work in [7] suggests many uses for an Oracle-based open-source decentralized blockchain that can be utilized to boost performance. This performance is measured in terms of quality of service (QoS) parameters including transaction delay, memory requirement, and throughput. Blockchain are further used for flying ad-hoc networks [8], corporate security systems [9], and industrial IoT [10] for solving multiple security and performance issues. All these models are equally applicable for e-Voting and are used while designing and optimizing block structures. Methods like delegated proof of stake (DPoS) [11], privacy preservation using smart contracts [12], Proof-of-Quality-Factor (PoQF) [13], and dynamic topology-aware blockchains [14] are further proposed by researchers for multiple application security. These models also find their usage in e-Voting via the reduction in delay and improvement in node-level scalability. In [15–17], a use case for these models is presented, in which a Blockchain-Assisted Certificateless Key Agreement Protocol is suggested for Internet of Vehicle (IoV) based voting scenarios, Secure Software-Defined Industrial Network voting scenarios, and Consensus Managed Reputation and Contract Theory-based IoV voting scenarios. By eliminating topological dependence, these protocols help to increase QoS and scalability performance.

Due to an increase in blockchain length, existing models adapt to side chaining, wherein the main blockchain is divided into multiple subparts, and each subpart is managed independently for secure communications. The work in [18–21] proposes such models, wherein researchers have discussed usage of Reputation-Based Coalition Formation, Streamlined Consensus models, Traffic Classification Services, and Trust Model for Malicious Node classification using side chains. These models assist in selecting side chaining as an alternative to single chained blockchains, which improves transaction speed while reducing dependency on singular chains. Based on this observation, the work in [22] proposes an Ethereum Smart Contracts-based E-Voting model, which reduces voting delay, and improves the efficiency of vote counting by storing multiple votes on a single block structure. A high trust model that uses Adjusted Blockchain Technology for trust (ABTT)-based voting is proposed in [23], wherein miner nodes are selected depending upon their location and computational efficiency. Similar models are put out in [24–26], where researchers talk about using IoT-based E-Voting systems, the privacy-preserving automatic voting tally mechanism (PriScore or PS), and Anti-Quantum E-Voting with an integrated Audit Function. These models are highly scalable, and reduce E-Voting complexity via truly distributed computing models. Based on these observations, a novel dual Genetic Algorithm (GA)-based model for the next section of this paper proposes side chain-based E-Voting. As seen in Sect. 4 of this text, where performance evaluation in terms of transaction delay, throughput, and storage capacity is exhibited for various scaling situations, this model is assessed on a wide variety of applications and compared with various state-of-the-art methodologies.

3 Proposed Novel Side Chaining Model for Improving Performance of Security-Aware E-Voting Applications

According to the literature review, the majority of current blockchain solutions for electronic voting are either not scalable or perform worse in terms of quality of service

(QoS) when compared to non-blockchain alternatives. Some side chain implementations are proposed for this purpose, but their complexity increases with respect to increase in E-Voting data. In order to design a highly scalable E-Voting system with lower complexity, this section discusses a novel side chaining model that is able to create and manage side chains depending upon the number of cast votes. Figure 2 shows the suggested model and specifics of how it operates internally, as well as how side chains are created and managed. The current blockchain is observed to be reviewed for each new request, and either new sidechains are created or old ones are updated.

Thus, two different Genetic Algorithm models are required for managing the blockchains. The Genetic Algorithm (GA) is designed for new sidechain creation, in order to optimize sidechain length, and the number of votes stored per chain uses the original blockchain and divides it into multiple parts. The proposed GA model employs the following steps to function:

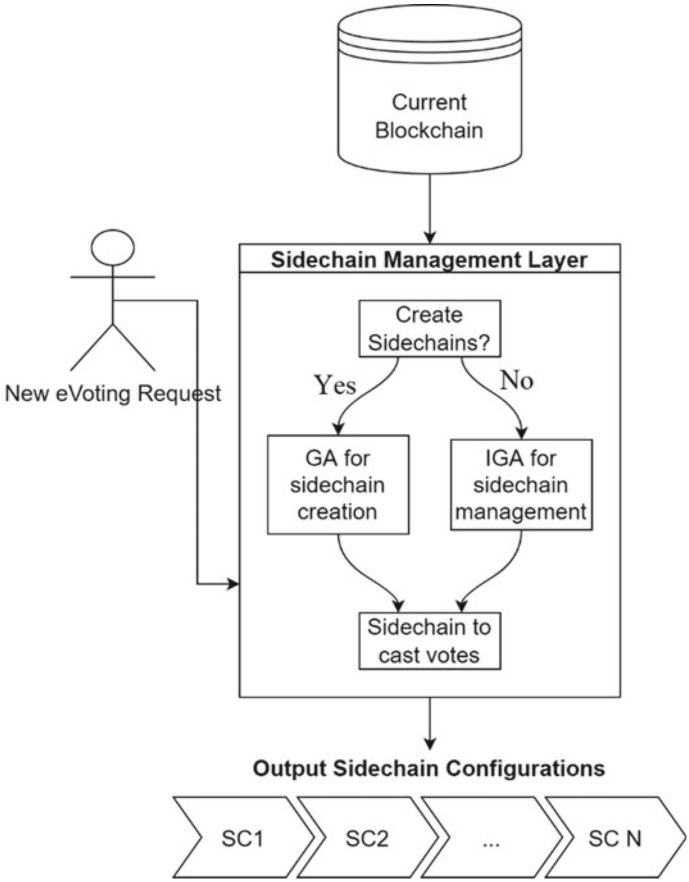

Fig. 2 Overall structure of the suggested model

Initialize GA parameters

Number of iterations (N_i)
Number of solutions (N_s)
Learning rate (L_r)
Voting time limit (max DV)
The blockchain's maximum length (max BL)

Mark each answer as "to be modified."
For each of the 1 to N_s solutions, from 1 through N_i iterations.
Go to the next solution if the first one is marked as "not to be modified."
Otherwise, create a new answer using the procedures below.
Using Eq. 2, divide the current blockchain into n random, unequal-sized chunks (Fig. 2).

$$n = \mathrm{random}\left(\max_{\mathrm{BL}} * L_\mathrm{r}, \max_{\mathrm{BL}}\right) \tag{2}$$

Number of blocks (NB) in each part is estimated using Eq. 3,

$$\mathrm{NB} = \mathrm{random}\left(\frac{\max_{\mathrm{BL}}}{n}, B_{\mathrm{REM}}\right) \tag{3}$$

where B_{REM} represents number of blocks remaining to be allocated in sidechains. Select a random chain r out of these sidechains, and cast a dummy vote into this chain.

While adding a vote, estimate its voting delay using Eq. 4,

$$\mathrm{DV} = \left(D_{\mathrm{read}_r} + D_{\mathrm{check}_r} + D_{\mathrm{hash}_r}\right) * \mathrm{NB}_r + D_{\mathrm{write}_r} \tag{4}$$

where DV, D_{read_r}, D_{check_r}, D_{hash_r}, NB_r, and D_{write_r} represents voting delay, delay to read one block from current chain, delay to compare hashes of one block from current chain, delay to hash the current block, number of blocks in current chain, and delay to write a block to the current chain, respectively.

Accept this solution, only if $\mathrm{DV} < \max_{\mathrm{DV}}$.

Else, again split the blockchain into multiple parts, and regenerate a new solution.

If, $N_\mathrm{s} * N_\mathrm{i}$ combinations have been evaluated, and solution is not found, then create a new sidechain and cast all votes into this sidechain.

Evaluate fitness for this solution using Eq. 5,

$$f = \mathrm{DV} * \frac{n}{\mathrm{BL}^2} * \frac{\sum_{i=1}^{r} \mathrm{NB}_i}{r} \tag{5}$$

where r represents number of sidechains created by this solution.

Repeat this method for each solution, and then use Eq. 6 to estimate fitness threshold.

$$f_{\mathrm{th}} = \frac{\sum_{i=1}^{N_{\mathrm{s}}} f_i * L_{\mathrm{r}}}{N_{\mathrm{s}}} \tag{6}$$

where fitness exceeds the threshold, mark all solutions as “to be mutated,” and “not to be altered.” Choose the solution with the lowest fitness value after all iterations, and estimate the following parameters: (N_{SC}) Number of sidechains produced Each sidechain’s total number of votes ($N_{V_{\mathrm{SC}}}$)

Selected sidechain for casting the vote ($\mathrm{Sel}_{\mathrm{SC}}$)

Cast current vote into this sidechain, and use the given configuration for casting future votes. While casting these votes, check DV levels, and if DV $>$ $\max_{\mathrm{DV}}$, then a new sidechain must be selected or created. The following Iterative Genetic Algorithm (IGA) model is triggered to carry out this task: establishing IGA parameters.

Number of iterations (N_{i})
Number of solutions (N_{s})
Learning rate (L_{r})
Voting time limit (Max DV)

Mark each answer as “to be modified.”

From 1 through N_{i} iterations, for each of the 1 to N_{s} solutions go to the next solution if the first one is marked “not to be modified.” Otherwise, create a new solution using the procedures below.

Select a random chain r out of the current sidechains, and cast a dummy vote into this chain.

- While adding a vote, estimate its voting delay using Eq. 4,
- Accept this solution, only if DV $<$ $\max_{\mathrm{DV}}$
- Else, select a new sidechain for casting the vote.
- If, N_{s} combinations have been evaluated, and solution is not found, then create a new sidechain and cast all votes into this sidechain.
- Evaluate fitness for this solution using Eq. 5.
- Carry out this procedure for each solution, and then use Eq. 6 to get the fitness threshold.
- Mark all solutions where fitness exceeds threshold as “to be mutated,” and mark other solutions as “not to be mutated.”
- Select the sidchain with the lowest fitness value after all iterations, and estimate the following parameters:
- Sidechain number ($\mathrm{Num}_{\mathrm{SC}}$)
- Number of votes in current sidechain ($N_{V_{\mathrm{CSC}}}$)

Cast current vote into selected sidechain, and use the given configuration for casting future votes. Repeat the process if DV $>$ $\max_{\mathrm{DV}}$, which assists in formation of newer sidechains. Based on this process, a wide variety of sidechains with different sizes, and different votes per chain can be created. These sidechains are tested on numerous e-Voting applications, and the results are tallied in terms of transaction delay, throughput, and storage expense. In the following section of this article, it is described how the proposed model stacks up against alternative techniques based on these parameters.

4 Results Analysis and Comparison

Different optimization methods are used for sidechain creation and maintenance in the proposed dual GA architecture. The proposed sidechain concept was put to the test in a variety of e-Voting scenarios to gauge its effectiveness, including

- Small-scale e-Voting, which is used to form consensus for less than 5 parties.
- Moderate-scale e-Voting, which is used to form consensus for less than 10 parties.
- Large-scale e-Voting, which is used to form consensus for more than 10 parties (Fig. 3).

Based on these scenarios, smart contracts were deployed using Ethereum blockchain in Solidity. Each scenario was evaluated terms of transaction delay (TD), throughput (Th), and storage cost (S). These values were estimated for the proposed model by varying number of votes casted by users, and were compared with DB [2], ABTT [23], and PS [25] for validating its performance. For small-scale voting application, number of votes casted were varied between 200 and 2000, and 5 participating candidates were considered during evaluation. Based on these parameters, transaction delay was estimated (Fig. 4).

The suggested model was found to be 15% quicker than DB [2], 8% faster than ABTT [23], and 26% faster than PS [25] for small-scale voting applications due to the usage of numerous GA models that are customized to reduce transaction delay. Similarly, the throughput (measured in Megabits per second, or Mbps), which represents the number of blocks mined in a unit of time, was seen for each of these models in Fig. 5.

The suggested model was found to be 61% quicker than DB [2], 9% faster than ABTT [23], and 28% faster than PS [25] for small-scale voting applications due to the usage of numerous GA models that are tweaked to optimize sidechain length. The storage cost (in Megabits or Mb), which represents the average number of blocks stored per chain, was similarly displayed for each of these models in Fig. 6.

The proposed model was observed to be 80% better than DB [2], 15% better than ABTT [23], and 40% better than PS [25] for small-scale voting applications in terms of storage cost due to the use of multiple GA models that are tuned to optimize sidechain length and number of blocks per sidechain. These benefits enable the suggested methodology to be implemented in small-scale e-Voting systems.

Similarly, for the moderate-scale voting application scenario, number of votes casted were varied between 8000 and 100 k, and 10 participating candidates were considered during evaluation. Based on these parameters, transaction delay was shown in Fig. 7.

The suggested model was found to be 25% faster than PS [25], 26% faster than ABTT [23], and 18% faster than DB [2] for intermediate scale voting applications

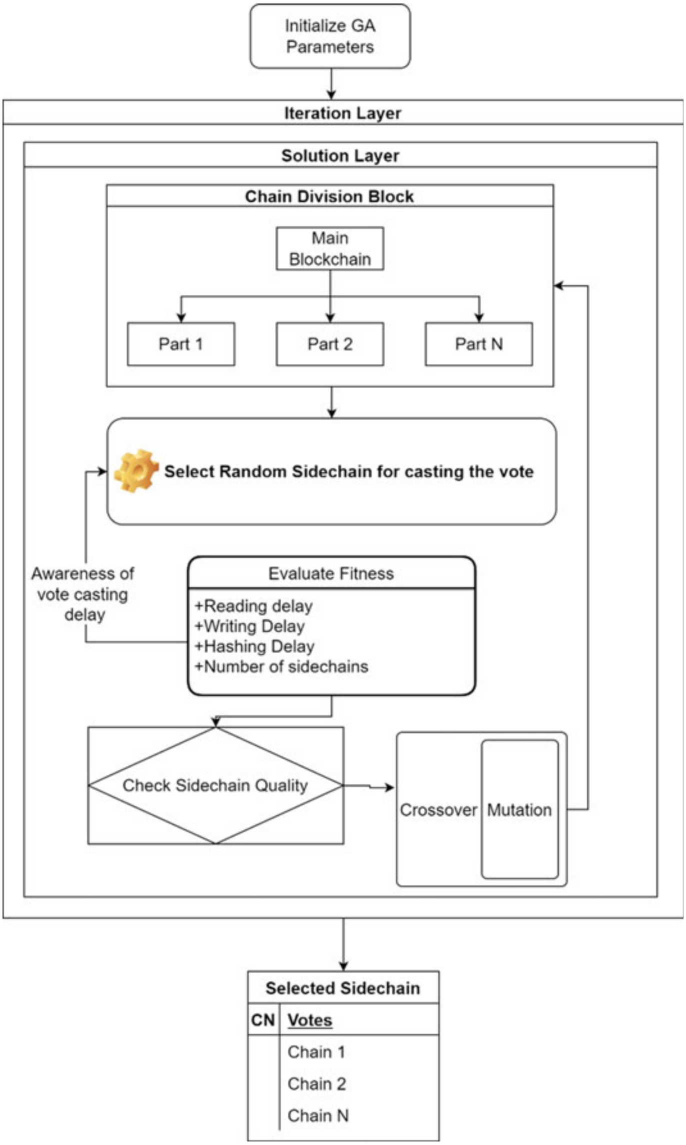

Fig. 3 Flow of the designed sidechain creation and management genetic algorithm (GA) model

due to the usage of numerous GA models that are optimized to reduce transaction delay. Similar to this, Fig. 8's throughput (in Megabits per second or Mbps), which represents the number of blocks mined per unit time, was displayed for each of these models.

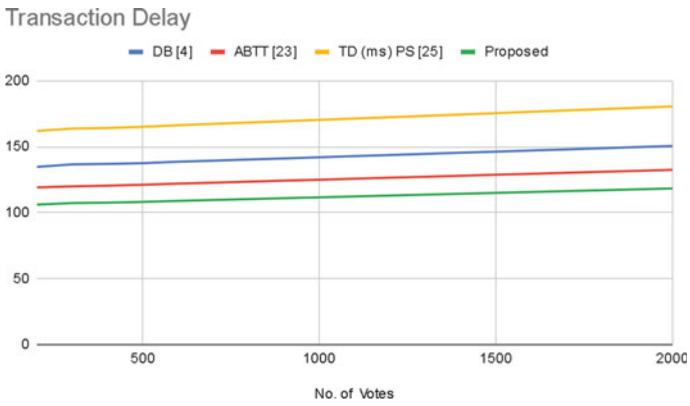

Fig. 4 Transaction delay performance for different algorithms on small-scale voting applications

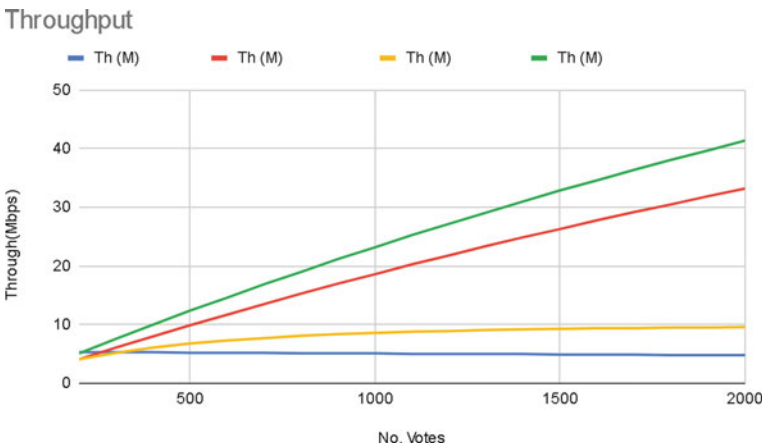

Fig. 5 Throughput performance for different algorithms on small-scale voting applications

The suggested model was found to be 20% faster than DB [2], 6% faster than ABTT [23], and 19% faster than PS [25] for moderate-scale voting applications due to the usage of numerous GA models that are tweaked to optimize sidechain length. For each of these models, the storage cost (in Megabits or Mb), which reflects the average number of blocks stored per chain, is presented in Fig. 9.

In terms of storage cost, the suggested model was found to be 20% better than DB [2], roughly the same as ABTT [23], and 10% better than PS [25] due to the usage of various GA models that are modified to optimize sidechain length & number of blocks per sidechain. These benefits make the suggested model suitable for deployment in any intermediate scale e-Voting application.

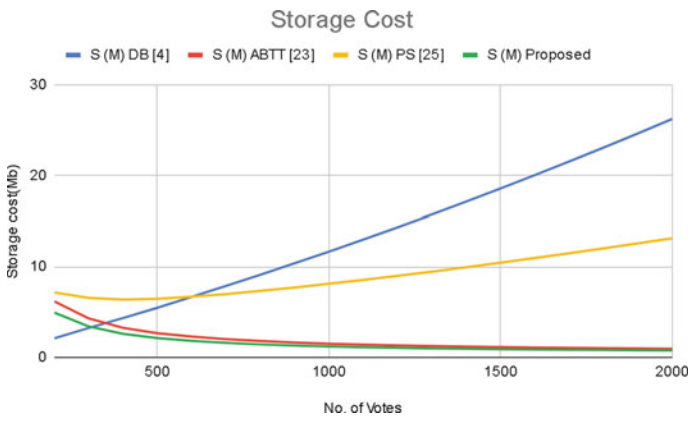

Fig. 6 Storage cost for different algorithms on small-scale voting applications

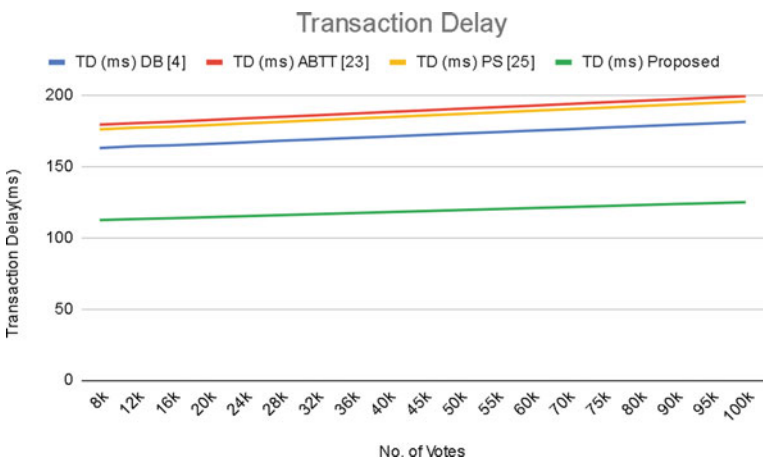

Fig. 7 Transaction delay performance for different algorithms on moderate-scale voting applications

Similarly, for the large-scale voting application scenario, number of votes casted were varied between 500 k and 20 M, and 45 participating candidates were considered during evaluation. Based on these parameters, transaction delay is shown in Fig. 10.

The suggested model was found to be 18% quicker than DB [2], 16% faster than ABTT [23], and 10% faster than PS [25] for large-scale voting applications due to the usage of numerous GA models that are customized to reduce transaction delay. For each of these models, the throughput (measured in Megabits per second, or Mbps), which represents the number of blocks mined per unit time, is displayed in Fig. 11.

Due to use of multiple GA models, which are tuned to optimize sidechain length, the proposed model was observed to have16% better throughput than DB [2], 25%

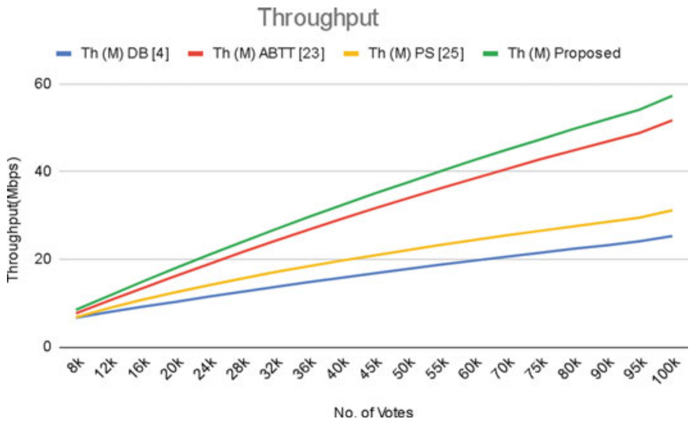

Fig. 8 Throughput performance for different algorithms on moderate-scale voting applications

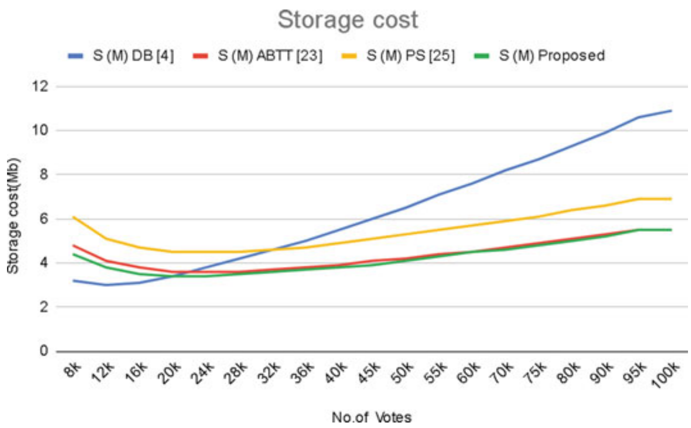

Fig. 9 Storage cost for different algorithms on moderate-scale voting applications

better throughput than ABTT [23], and 26% better throughput than PS [25] for large-scale voting applications. Similarly, the storage cost (in Megabits or Mb), which indicates average number of blocks stored per chain, for each of these models is shown in Fig. 12.

The proposed model was observed to be 25% better than DB [2], 10% better than ABTT [23], and 8% better than PS [25] for large-scale voting applications in terms of storage cost due to the use of multiple GA models that are tuned to optimize sidechain length and number of blocks per sidechain. These benefits make the suggested approach suitable for use in any form of extensive e-Voting application. The usage of multiple GA models for sidechain construction and maintenance causes the suggested model to be seen as being superior than a number of state-of-the-art techniques. These models enable the sidechain management technique to be

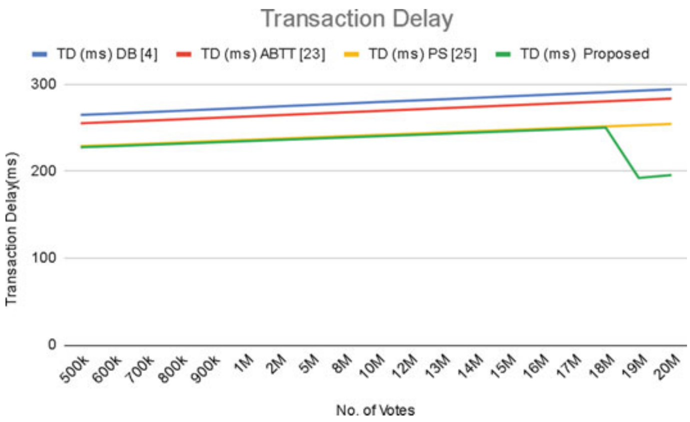

Fig. 10 Transaction delay performance for different algorithms on large-scale voting applications

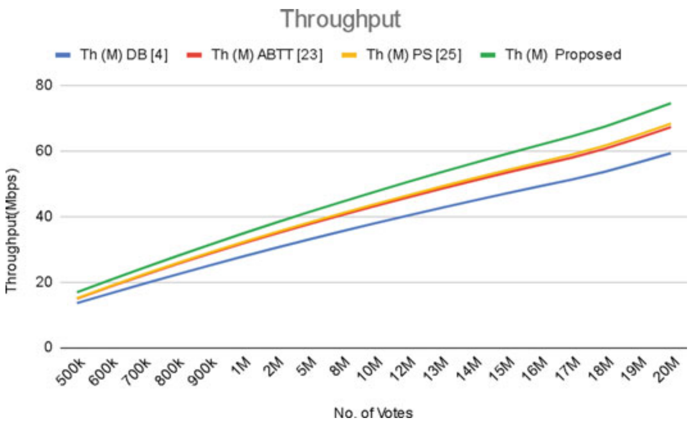

Fig. 11 Throughput performance for different algorithms on large-scale voting applications

presented to choose configurations that decrease transaction time and increase e-Voting throughput. As a result, the suggested model can be used for small, medium, and large-scale e-Voting systems.

5 Conclusion and Future Scope

The suggested concept combines two separate types of gas to create and manage sidechains. The sidechain creation GA is capable of selecting optimum sidechain lengths, and main blockchain divisions, which are optimized for improving transaction speed. The created sidechains are managed using another GA method, which

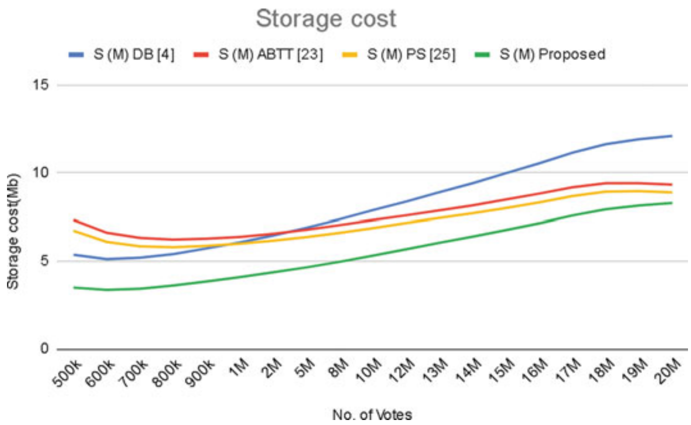

Fig. 12 Storage cost for different algorithms on large-scale voting applications

assists in optimal creation and usage of existing sidechain configuration model. Both the GA models utilize transaction delay, and sidechain lengths in order to improve e-Voting performance for small, medium, and large-scale deployments. As a result, it was found that the proposed model was 15% faster than DB [2], 8% faster than ABTT [23], and 26% faster than PS [25] for small-scale voting applications, 18% faster than DB [2], 26% faster than ABTT [23], and 25% faster than PS [25] for medium-scale voting applications, and 18% faster than DB [2], 16% faster than ABTT [23], and 10% faster than PS [25] for large-scale. For small-scale voting applications, the suggested model was found to be 61% faster than DB [2], 9% faster than ABTT [23], and 28% faster than PS [25], while for moderate-scale voting, it was shown to be 20% faster than DB [2], 6% faster than ABTT [23], and 19% faster than PS [25]. For large-scale voting applications, the throughput was 26% higher than PS [25], 25% higher than ABTT [23], and 16% higher than DB [2]. Similar findings were reached regarding the cost of storage, which makes the suggested approach highly scalable and applicable to a variety of e-Voting systems. Future evaluations of the suggested methodology for more blockchain applications will help determine its versatility. The performance of the proposed model can be further enhanced by applying deep learning techniques like reinforcement learning and Q-learning, which will help in optimizing sidechain parameters through reward-based learning mechanisms, accelerating transaction performance, and further improving throughput for a variety of side chain applications.

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Optimized Activation Function-Based SAR Ship Detection

Vishal Gupta, Monish Gupta, and Nikhil Marriwala

Abstract The task of recognizing or locating an object or group of objects in an image or video sequence is the focus of object recognition in the field of computer vision. It's a problem of matching models from a database with image luminance data representations of those models. The paper presents the novel method for the detection of vessels in complex environments. The present work is inspired by cuckoo search algorithm which was used to optimize the results. Otsu thresholding method was used to binarize the object image and then adaptive cuckoo search algorithm was applied for the detection of vessels in an optimized manner. In this work, we are comparing the proposed results with existing accuracy and time with other methods. The proposed method gives a better accuracy (97.8%) and processing time (3.67 s) as compared to other previous methods used.

Keywords Image processing · Support vector machine · Object detection · Ships detections · Otsu thresholding · Cuckoo algorithm

1 Introduction

The expanded danger of theft, observation is a flat out must on freight ships going in these hazardous regions. While radar frameworks have been widely utilized in sea conditions, these for the most part require enormous, metallic targets. Current privateers favor little, quick unbending inflatable boats that are principally non-metallic and consequently hard to identify While the answer for this would appear to be the utilization of manual location utilizing devoted group individuals ready, the modest number present at some random time makes this unworkable. Not at all like people that develop drained, robotized video reconnaissance frameworks can continually screen camera feeds and monitor various objects of interest around the boat. Following and checking human and other dubious movement adrift is a hot subject that is building up some decent momentum. For vessels observing, marine and

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beach front administration, and unlawful fishing observation, transport recognition from far off is the basic factor to detect pictures. Programmed recognition of sea protests particularly vessels (ships) is a significant angle in satellite picture handling and oceanic observation frameworks [1]. This is significant for keeping up with the insurance and traffic light of seagoing vessels. It's essential point is to perceive potential privateer dangers quickly. The ships are in danger in inshore as well as on shore. There is no defined bounding border in the coastal areas that why even in harbor environment the vessels are vulnerable to attacks. The navigational authorities however issued guidelines for the installation of automatic tracking systems in the ships, but they are limited to certain type of big and commercial ships only. The hostile ships and the small boats which are usually responsible for the pirate attacks are not installed with such type of surveillance devices. Therefore, in the proposed approach, we have introduced a learning method which depending on the training dataset can detect the presence of early attack system. The model is equipped with 3 layers of convolutional layers and two pooling layers have been introduced. The convolution of the image matrix is obtained by single stride with the matched filter.

The paper is structured as follows. In Sect. 2, we present a review of related works, while Sect. 3 describes the materials and methods used in the design process. Section 4 discusses the results, and Sect. 5 concludes the paper.

2 Related Works

This section presents a review of related works performed on ship/vessel detection. A vessel recognition system based on Sentinel-2 multispectral images and a spectral library of ship signatures was proposed by the authors in [2]. Hundreds of thousands of ships at sea were uniquely distinguished using spectral or other signatures from optical satellite images. The wavelet transform and multi-resolution analysis were used by the authors in [3] to analyze multi-scale discontinuities in SAR images and thus detect ship targets in a noisy environment. Authors in [4] proposed a collection of algorithms for automatically detecting spikes associated with vessels and evaluating the sharpness of spike features. A spike detection algorithm is used to produce a list of candidate boat detections. The height of the spikes is measured in a second algorithm, which is used to rule out iono-spheric energetic particle detections and rate boat detections as strong or weak. The nominee spikes are then screened to rule out features like land and gas flares. Furthermore, a validation study revealed that the automated algorithm had a detection rate of 99.3% accuracy. In [5], the authors developed a method for detecting and classifying small fishing boats on 5 m resolution SPOT 5 imagery using genetic algorithms and neural networks. Authors in [6] compared the relative improvement in ship detection efficiency of polarimetric SAR to that of single-channel SAR. Given the long history and continuing interest, there is a substantial amount of literature on ship detection algorithms. Authors in [7] presented a method for detecting and tracking ships using video streams from established port and river monitoring systems. The results show that the proposed solution is usable; however, in the presence of ship wakes or exceptionally bad weather conditions, some minor issues were discovered. Furthermore, despite the fact that undetected vessels are often visible to the naked eye, automatic analysis of SAR images can be difficult due to speckle and the reduced dimensions of the targets compared to the sensor spatial resolution. To tackle some of these challenges, in this paper, we propose a novel approach for detecting vessels in complex environments using cuckoo search algorithm. This algorithm was used to optimize the results and the object image was binarized using the Otsu thresholding process, and then an adaptive cuckoo search algorithm was used to detect vessels in an optimized manner.

The authors in [2] examine that such procedure is level set division which advances a shape to objects of interest in a given picture. This strategy functions admirably yet gives mistaken division results when an objective article is adulterated in the picture. This paper additionally centers around the chance of considering in earlier information on a boat's shape into level set division to further develop results, an idea that is neglected in sea observation issue. It is shown that the created video global positioning framework beats level set-based frameworks that don't use earlier shape information, functioning admirably even where these frameworks fizzle.

3 Materials and Methods

The proposed work depends on detecting a vessel from a given SAR image. In the wake of performing customary image pre-processing techniques, utilizing histogram separation technique is utilized to eliminate dot commotions from given SAR images. Streamlining the object to be recognized is important because of the vessels trademark, size, and expanded connection among other features. Numerous calculations were performed to choose all the more firmly connected component vectors of the image from a given element vector subset which aids the accuracy and precision of proposed detection model. The proposed model uses a versatile cuckoo inquiry advanced model which is dissimilar to other models as we introduce a numerical model to cuckoo search calculations. The relationship starts with cuckoos laying eggs in various species' homes. The Cuckoo Search (CS) algorithm is a biologically inspired algorithm based on cuckoo bird brood reproduction [8]. Each cuckoo chooses a nest at random and lays one egg inside, according to the CS algorithm. The best, most egg-producing nests will be passed on to the next generation. In this case, the host cuckoo must decide whether to discard the egg or leave the nest and start a new one elsewhere [9–20]. In view of this egg laying approach, advanced territory can be acquired [21–34]. A one-dimensional improvement cluster is formed to determine the vessels current position. The mathematical representation is given as follows:

The amount suitability rate for the current position is calculated using the profit function evaluation process and is expressed as

$$H_i = (E_1, E_2, E_3, \ldots, E_N) \tag{1}$$

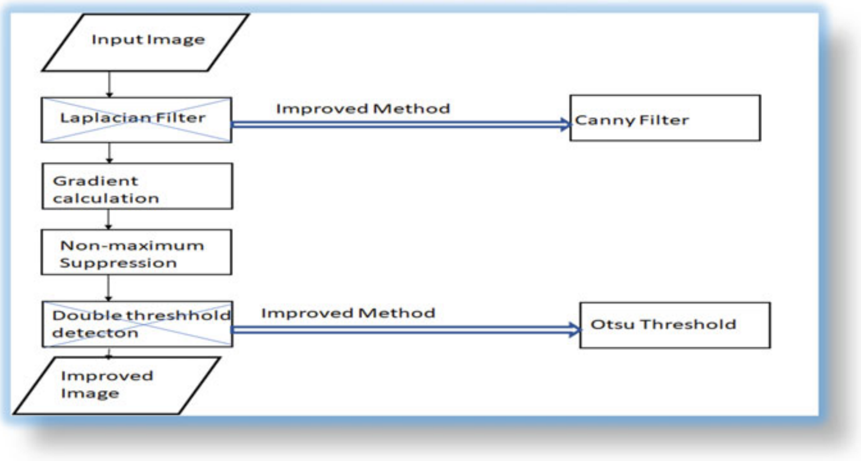


Fig. 1 Proposed flow chart

where H_i is the probability of occurrence of N values, and E_1, E_2, …, E_N are the individual happening events.

The suitability rate for the current position is calculated using the benefit feature assessment method described in Eq. (2.)

$$P = F_{\mathrm{p}}(H_i) = F_{\mathrm{p}}(E_1, E_2, E_3, \ldots, E_N) \tag{2}$$

where $P = F_p$ is the profit function which needs to be maximized in order to obtain the optimized value.

The cost function is considered in order to optimize the benefit function, and the maximum and minimum values for random eggs are defined in order to perform iteration on different levels. The maximum values are determined using the egg-laying radius as well as the i_{low} and i_{High} lower and upper limits. The proposed cuckoo search (CS) algorithm is presented in Fig. 1.

3.1 Dataset Description

The dataset from the below mentioned reference source taken: https://github.com/avaapm/marveldataset2016andwww.shipspotting.com.

Table 1 System's configuration

Processing unit	Dual core-i7
RAM memory	8 GB
HDD	500 GB
Software versions	MATLAB R2018a, Python
Applications used	Image Processing, CV

3.2 Computing Environment and Specification

The proposed methods' performance was simulated on a workstation with the following system configuration presented in Table 1.

The proposed method uses Otsu method which is used as a thresholding method in the preprocessing steps of image binarization. The Otsu method is one of the thresholding methods that is commonly used in a number of fields. The two-dimensional (2D) Otsu method outperforms the one-dimensional (1D) Otsu method in segmenting images with low signal-to-noise ratio (SNR). As a pre-processing stage, the Otsu threshold method is used to remove noise and binarize the image. The large objects from the background are separated using the Optimal Otsu thresholding method. This indicates that the Otsu method is fine for thresholding a histogram with bimodal or multi-media distribution. In gray scale image thresholding, the task is to separate the foreground and background. The foreground usually contains the object to be tracked or processed, and the background is anything other than the specified object to be detected. For example, for Optical Character Recognition (OCR), binary operation is required for document segmentation. The thresholding method separates some pixels belonging to characters and other pixels belonging to white space. In the proposed work, the cuckoo optimization was performed after Otsu thresholding method was applied.

4 Simulation Results and Discussion

For the experimentation, we used color images ((RGB) images) for testing. But we have trained our network with grey images by converting RGB images to grey images and then we applied Otsu thresholding method before applying the proposed adaptive cuckoo algorithm for optimization of the method. The reason to use gray images is that the size of the single gray image feature matrix is 25600×1, while that of the RGB image is $25{,}600 \times 3$. This was done to reduce the size of the training database. In the testing phase, we obtain our feature vector by using the following steps: Otsu thresholding method is applied on each component, i.e., RGB components of the color image separately. Then we apply cuckoo algorithm as mentioned, on each component separately and getting a vector of size $25{,}600 \times 1$ from each component. So now our test feature matrix for each image is of size $25{,}600 \times 3$. Figure 2 shows the activation layer. Few sample images are shown in the Figs. 3, 4, and 5. We have analyzed our study in terms of accuracy and running time. Figure 3 shows the results obtained for image preprocessing (Fig. 3a, the image, Fig. 3b the grayscale image, and Fig. 3c the binarized image). The results show that the proposed method performs better as compared to the previous methods. Similarly, Fig. 6 and 7, show the results for the detection of vessels and ships, respectively.

The performance evaluation performed show that the proposed CS algorithm outperformed other algorithms which were used to test its performance as presented in Table 2. The results with respect to accuracy and processing time are shown in Figs. 6 and 7, respectively.

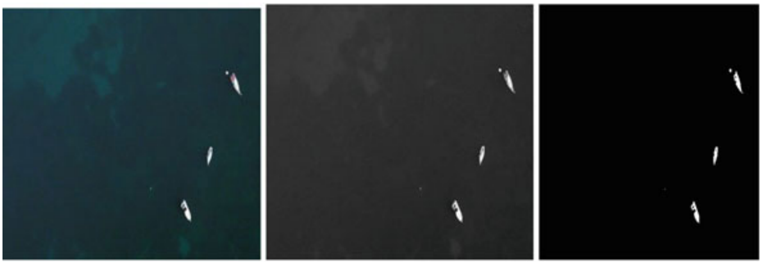
Fig. 2 Activation of layers

(a) (b) (c)

Fig. 3 **a** Input image RGB; **b** output image gray; **c** detected output image

(a) (b) (c)

Fig. 4 **a** Input image RGB; **b** output image gray; **c** detected output image



(a) (b) (c)

Fig. 5 **a** Input image RGB; **b** output image gray; **c** detected output image

5 Conclusion

Monitoring of vessels is an important aspect in the field of coastline area. The imagery satellite dataset represents the critical information about the ships. It is difficult to segregate and detect the vessels in the presence of water waves and other sea clutter. In our work, we have proposed a novel cuckoo search algorithm based on

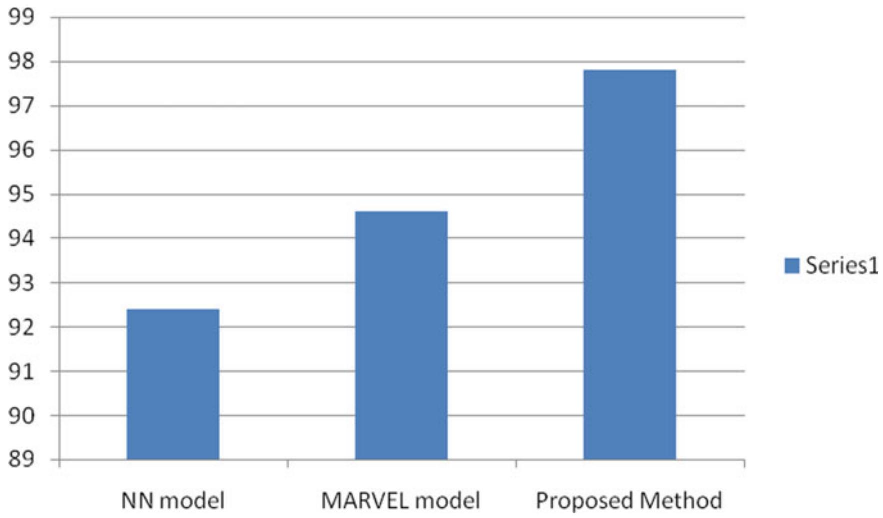


Fig. 6 Accuracy comparison of proposed model

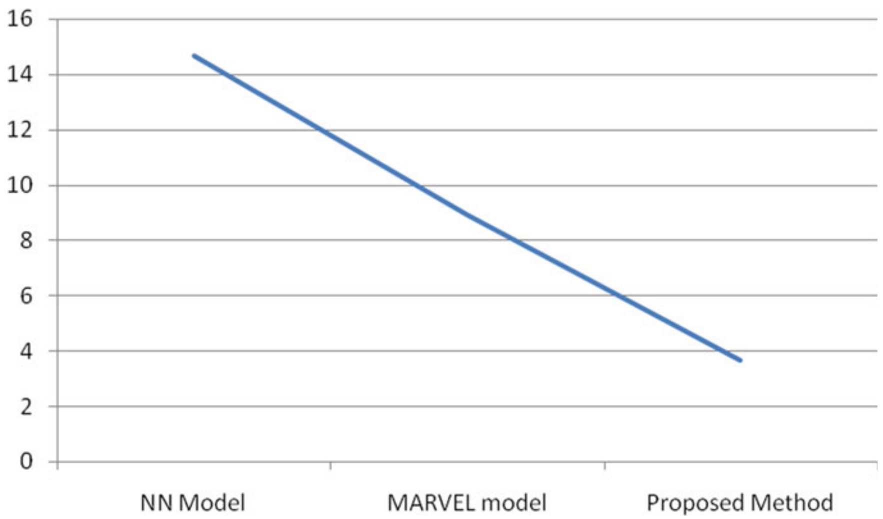


Fig. 7 Running time of proposed model

Table 2 Performance comparison of different models

Parameters	NN model	MARVEL model	Proposed adaptive Cuckoo search (CS) model
Accuracy (%)	92.4	94.6	97.8
Time (s)	14.67	8.91	3.67

the Otsu thresholding which helps in finding the desired object sets that is in our interest it is ships. The proposed method gives the results in terms of better accuracy and better computational complexity thereby reducing the computational time. We have compared the qualitative results with other previous methods and show the mathematical as well as graphical results which show the outperformance of previous methods. The future work may be expanded for the classification and tracking of ships using the Kalman filter.

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Elimination and Restoring Deduplicated Storage for Multilevel Integrated Approach with Cost Estimation

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Abstract Data handling is an important task in cloud computing because the data arrive at a high rate with a large volume. These data are stored in the cloud storage for consistent performance. Cloud offers services to the customer by allocating the virtual machine (VM) for requesting tasks. Cloud provider always satisfies the customer at anytime and anywhere manner. The services depend upon the resources at the data center through virtualization. Cloud follows the strategy called demand-based and pay-as-you-go basis. The customer must pay for the resource consumed using metering services. Customers store large volumes of data which occupies more space in storage. It leads to expensive problems for the customer because of excess payments paid to the cloud provider. This type of storage suffers a high volume with redundancy in the uploaded data. This problem is overcome by using the deduplication technique for keeping only one copy of data in the cloud storage. This achieves less storage, so the cost of services reduces drastically. The integrated data elimination with the cost estimation method has been introduced in this study to achieve better efficiency and availability. This process has been carried out by using two levels of elimination techniques such as local based and global based. This data are integrated into datasets without any redundancy in a data-centric manner. Integration of eliminated datasets is combined as a global level of elimination process by handling newly generated data. Finally, the data are stored in the cloud storage without any repetition in data.

Keywords Cloud · Virtual machines · Cost estimation · Data elimination · Data deduplication

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1 Introduction

The cost model of the cloud is least expensive than other existing models. Mammoth is a system used to manage the memory globally with a scheduling strategy for a large-scale dataset. It also addressed the problem of the traditional map reduction process because it is suitable for smaller sets of data. This model is only applied to the homogeneous task, but it is not suitable for multi-task. It only focuses on the request and response of the data from the user and provider, respectively. It cannot be used in the integrated model of both CPU based and data based [1]. Video storage and retrieval of real-time data suffer various issues in the distributed computing paradigm. Parallel computing has been introduced with high graphics processing unit (GPU) support, but it suffers the data storage and space constraints. Map-reduce programming model with cloud computing gives support to video processing. This approach is suitable for offline mode but not in real time with a massive amount of data [2].

Semantic-driven subtractive clustering method (SDSCM) is an integrated method of the existing clustering algorithm which is used to find accurate data in the data storage. It is not supported by the machine learning models and forecasting models for data prediction. This model analyzes the risk with minimal reduction, so an effective validated method is needed to improve the performance [3]. The remote sensing data maintained in the storage is a difficult process because various parameters rely on that image. The cloud-based model provides support for collecting, processing, and storing data with high-end servers. This model is not suitable for diverse remote sensing images with the respective type of data. It also stores and analyzes the image as a single. It can be addressed using distributed database with the decomposed image for achieving high performance during the retrieval process [4]. The latency and issues occur because of handling the improper distribution of the data across the task. The public cloud leads the performance problem due to excessive latency, so the private cloud can be replaced for sensitive data management in the cloud. Flex slot is a method that is used to address the issues like inference in the jobs and cluster maintenance process through slot management [5].

The main issue that needs to be addressed in big data is to detect and eliminate the duplication in the data without any bottleneck. This is handled by introducing the low overhead during the storage and backing up of the data. There are various features used in the system which does not provide a complete solution in the data deduplication process [6]. Security in the data deduplication process is a challenging task during the storage and access in the cloud. Data privacy and security can be handled and maintained properly without any problem. Recovering the key in the virtual machine (VM) and its boundary is a vital problem while interacting with the public cloud. The memory leakage issues occur during the hardware-based implementation, so they will be handled effectively [7]. HDFS is a data retrieval method to achieve a fast response time, but it suffers the block failure in the storage which will be addressed with novel methods [8]. Daphne is a framework that overcomes the utilization of resources, and the scheduling of jobs is addressed loosely coupled distributed priority-based scheduling process. It improves the throughput and performance of the data storage [9]. The existing issues are addressed by introducing an efficient integration model for data elimination during data storage and data aggregation during the data restoration process.

This chapter presents the duplicate elimination of customer data and restores the original data in the cloud with reduced cost. It also performs various levels which are identified during the interaction. Data are categorized as collected data, calculated data, and forecasting data. These data are used for duplicate elimination with respective local integration and produce a different set of eliminated data. These datasets are integrated and perform global redundancy elimination. The customer performs the data restoring process while downloading for their usage. The cost model supports the customer in maintaining the cost within the level. It is calculated based on the storage and VM cost. Comparison of various data is performed in an individual and integrated manner to achieve minimized cost over the cloud storage.

2 Problem Formulation

The redundant data are eliminated using the data deduplication process which keeps only one copy of the data. There are various methods available that are restricted to storage without knowing the type and purpose of the data [10]. It may cause data redundancy after the deduplication process. The data are analyzed and identified before the data are storage in the cloud [11]. The existing method follows only one cost model which is related to software-level implementation. It is not suitable for minimizing the cost during the data management process. The integrated cost model is needed to keep only one copy of data after processing takes place. A single level of elimination is not enough, so multiple stages of elimination are needed. The data restoring process is a difficult task. Hence, multilevel extraction and aggregation process is introduced. The cost model needs both cloud storage implementation level as well as virtual machine (VM) level. The proposed method addressed these issues by using an integrated cost model with data elimination and data aggregation method.

3 Architecture Diagram of Proposed Model

Deduplicated data are maintained at the cloud storage with multiple cloud service providers which follow the common standard to achieve high reliability. The data are collected from various sources and are not considered during the data storage which becomes expensive to the cloud user. The deduplicated data are analyzed and identified to the context of access and then categorize the data into different types such as collected data, calculated data, and forecasting data. The collected data are considered static data which are used only for storing purposes, i.e., the data remain the same. It is considered stored data as well as processed data. The data are processed by the cloud with high-end resources. Thus, produced data are stored in the cloud storage. Calculated data are categorized into temporary data and resultant data. Temporary data keep the sub-solutions that are not reflected in the final result whereas the resultant data hold the new value at the storage. Forecasting data are also classified into time series and interpolated data. The time series data decide the future prediction with null values. The interpolated data hold the new data without any null values. The local integration process is carried out based on its category. These types of data lead the redundancy, so they will be eliminated locally with high reliability. The eliminated data are integrated through a global integration process then eliminate those data again. There are two levels of the elimination process carried out to achieve high performance at cloud storage. The proposed method of integration process eliminates the redundancy of data without affecting the data privacy as shown in Fig. 1.

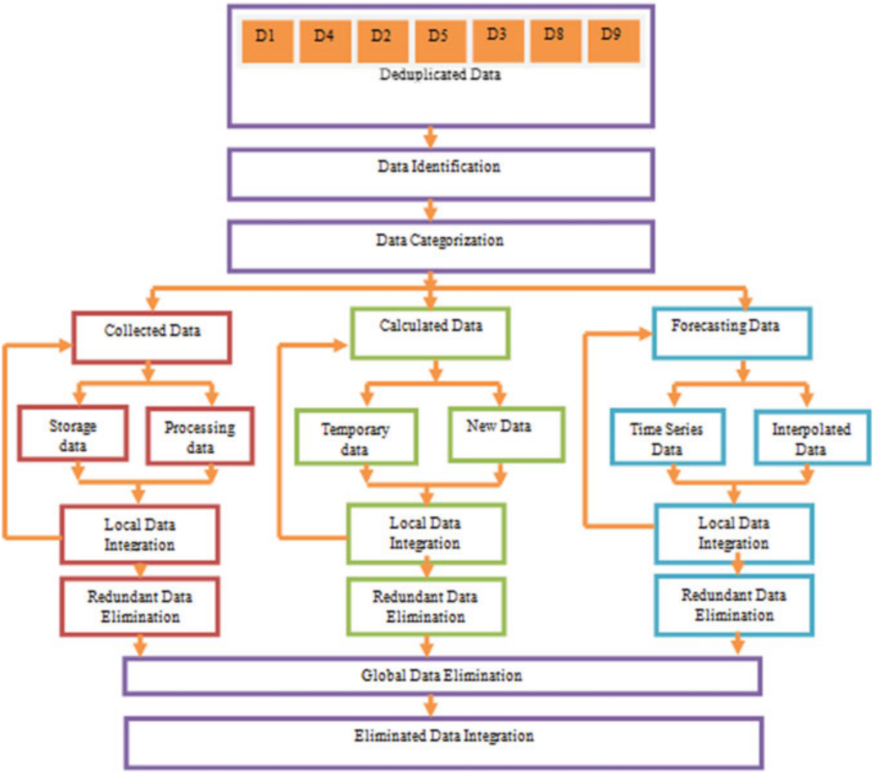

Fig. 1 Architecture of the proposed model

4 Data Restoring Process

The eliminated data are maintained in the cloud storage which will be accessed by the user through the cloud service provider [12]. The data restoring process restores the original data to the respective cloud provider without any loss and error in the customer data. This will be achieved by performing various stages of the data generation process with the respective standard. S is the integrated cloud storage with elimination during the global integration stage. It is restored as $S1$, $S2$, …, Sn with regeneration process called sub-storage, i.e., storage. These stages maintain the data for the cloud service providers; then, data are generated as $D1$, $D2$, …, Dn with S, i.e., i is the number of cloud service providers. These data are aggregated to the cloud service provider; then, the data are allocated to the user. The conceptual diagram of the data restoring process is shown in Fig. 2.

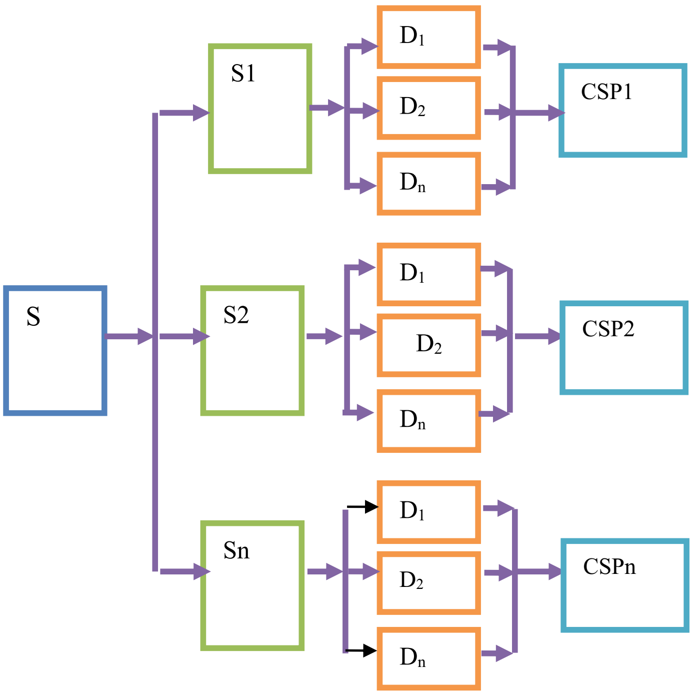

Fig. 2 Conceptual diagram of data restoring process

5 Algorithm

5.1 Algorithm for Integrated_Data_Elimination

Begin

Let DD be a Deduplicated Data;

Let DC be a Categorized Data;

L1: For each data in DC do

If data == collected_data then

Identify the type of access or operation;

If type == storage then

Collect the data for storage in the cloud;

Else if type == processing then

Processed the collected data for storage in the cloud;

Goto L1;

End

Else if data == Calculated_data then

Identify the type of access or operation;

If type == temporary then

Processed data never stored into the cloud;

Else if type == new then

Processed newly generated data stored into the cloud;

Goto L1;

End

Else if data == forecasting_data then

Identify the type of access or operation;

If type == time_series then

Times series data is stored into the cloud;

Else if type == interpolated then

Forecasting data is stored in the cloud;

Goto L1;

End

End;

Perform local integration for various data;

Eliminated the data based on its type;

Perform the global integration process for eliminated data;

Perform final resultant data elimination process;

End;

5.2 *Algorithm for Data_Restoring*

Begin

Let DE is the eliminated data in the cloud storage;

For each data in Cloud_Storage then

Identify the data from DE;

Categorized the data based on respective type;

If data == collected then

Restore the data to original data from sources;

Else if data == calculated then

Restore the data based on the application;

Else

Restore the data before the storage of the data;

End;

//The data are accessed and recovered by the cloud service provider;//

End

6 Cost Estimation Model

Cost is one of the metrics which is used to assess the deduplicated data at the cloud storage [10]. The cost models are maintained by the cloud service provider to minimize the overall cost during the cloud interaction [13]. The cost model of the collected data, calculated data, and forecasting data differs based on the operations and purpose of data usage. The cost model of the collected data remains constant because there are no changes in the data. The calculated data cost model is a combination of static and dynamic whereas the forecasting cost model is dynamic because the data are generated depends on the prior value. The design of the cost model is taken into the account with two main elements with various parameters, namely cloud storage and hardware element as virtual machine (VM) in the cloud. The parameter related to cloud storage brings better efficiency during the data restoration process. Cloud storage is attached to the VM in the cloud because every element in the cloud is virtualized and then offered as services, so the cloud storage is also a virtual element that is mapped to the corresponding user request. The cost estimation of the proposed model is represented in Eqs. (1–3).

$$\text{Cost Model} = \text{Storage}_{\text{Cost}} + \text{VM}_{\text{Cost}} \tag{1}$$

$$\text{Storage}_{\text{Cost}} = \text{Cost}_{\text{Types}} + \text{Cost}_{\text{Arrival}} + \text{Cost}_{\text{Process}} + \text{Cost}_{\text{Response}} \tag{2}$$

$$\text{VM}_{\text{Cost}} = \text{Cost}_{\text{VMAllocation}} + \text{Cost}_{\text{VMCreation}} + \text{Cost}_{\text{VMMapping}} + \text{Cost}_{\text{Availability}} \tag{3}$$

7 Result and Discussion

The data deduplication process has various types of data maintained at the storage in the cloud [11]. The data elimination process takes place on two levels, namely local elimination and global elimination [14]. The local elimination process is used to eliminate the duplicated data with specific types of data. At the same level, there are various elimination processes take place to keep reliable data. The global elimination process integrates all data which are eliminated during the local elimination stage. The final data are stored in the data storage in the cloud. During the recovery process, there are various processes carried out for providing exact data to the customer through a cloud service provider. The elimination process related to the data which are maintained in the files is considered for achieving maximum performance. The recovery process is compared with the necessary parameter for achieving high customer retention. The cost of the various elements in the cloud with storage is analyzed for better reliability. The main objective of the proposed method is to minimize the cost by considering hardware as well as software implementation using the respective model. The collected data over the data in the files with elimination are shown in Figs. 3 and 4, respectively.

The calculated data with temporary and newly generated types are compared with data elimination and integration as shown in Figs. 5 and 6, respectively.

The forecasting data with different types such as time series and interpolated data with detailed analysis and comparison are depicted in Fig. 7 and Fig. 8, respectively.

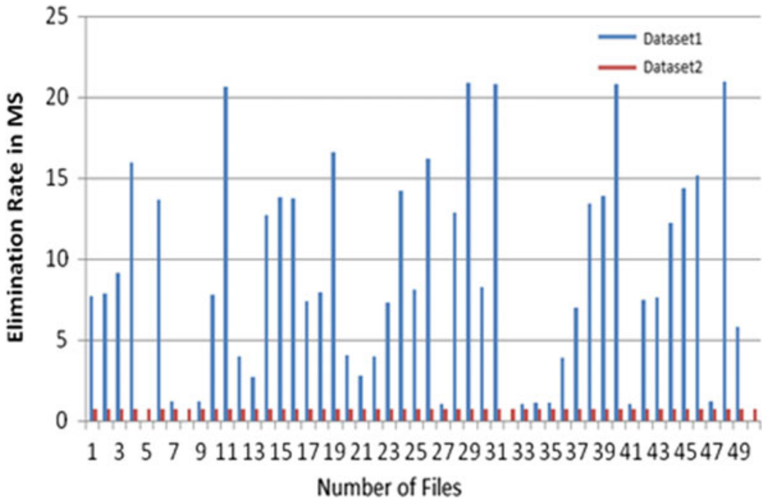

Fig. 3 Collected data versus data files

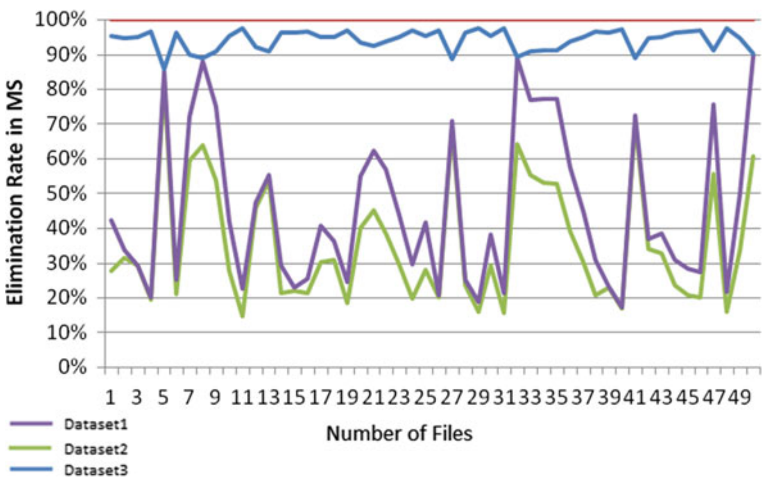

Fig. 4 Comparison of collected data elimination

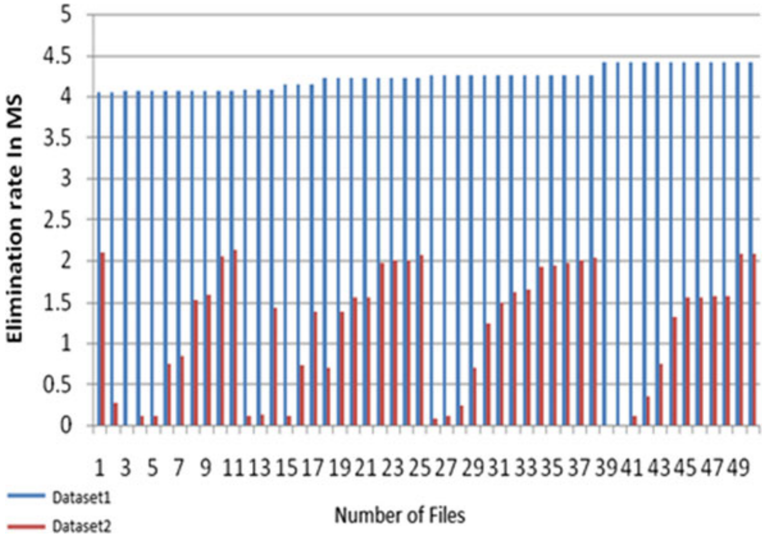

Fig. 5 Calculated data versus data files

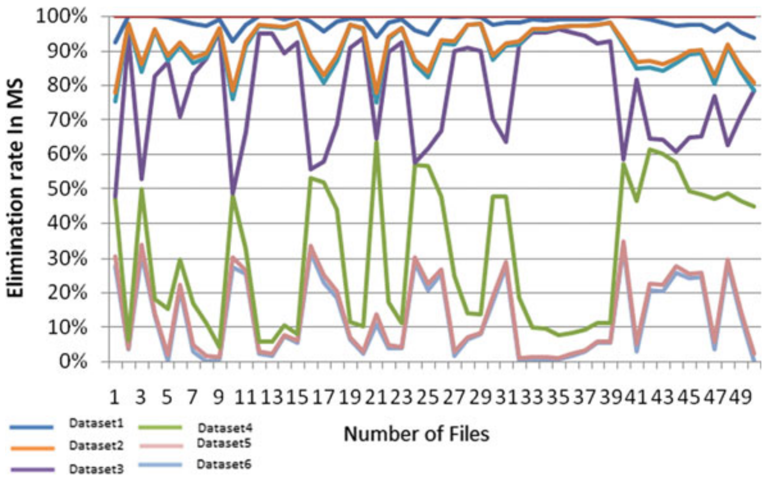

Fig. 6 Comparison of calculated data integration

All local eliminated data are integrated using global integration with the elimination process is represented in Figs. 9 and 10.

The overall cost estimation related to various components is assessed and analyzed to achieve the minimization process as shown in Fig. 11.

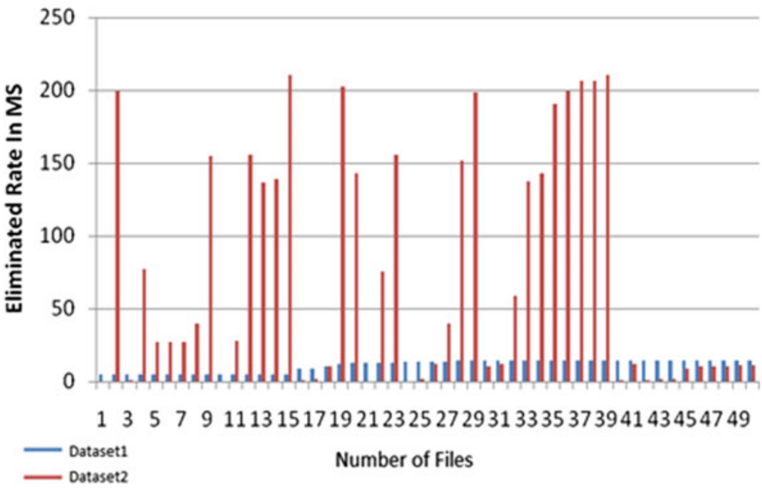

Fig. 7 Forecasting data versus data files

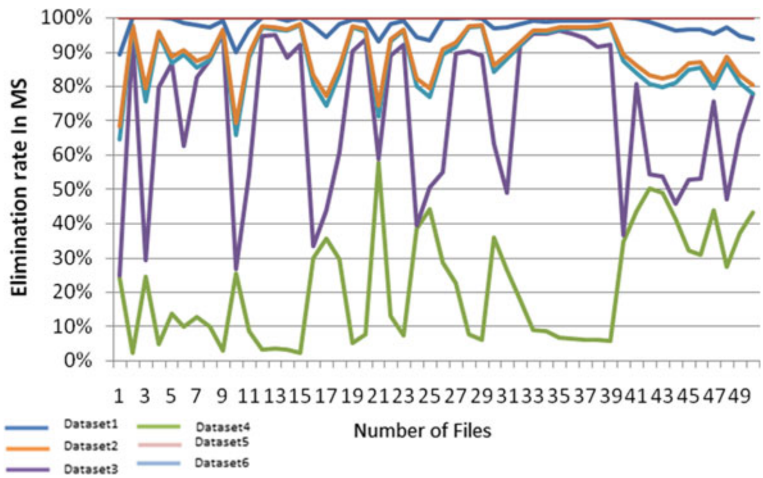

Fig. 8 Comparison of forecasting data integration

8 Summary

The cost estimation model has been developed for the data deduplication process with cloud storage. The objective of this model is to reduce the cost while interacting with cloud storage. Single-level data elimination and restoring operation does not provide a complete solution. This is addressed by using the multilevel method to solve cost estimation issues at various levels. Data elimination is done for reducing storage space by reducing duplicate data from the dataset. The algorithms are evaluated with

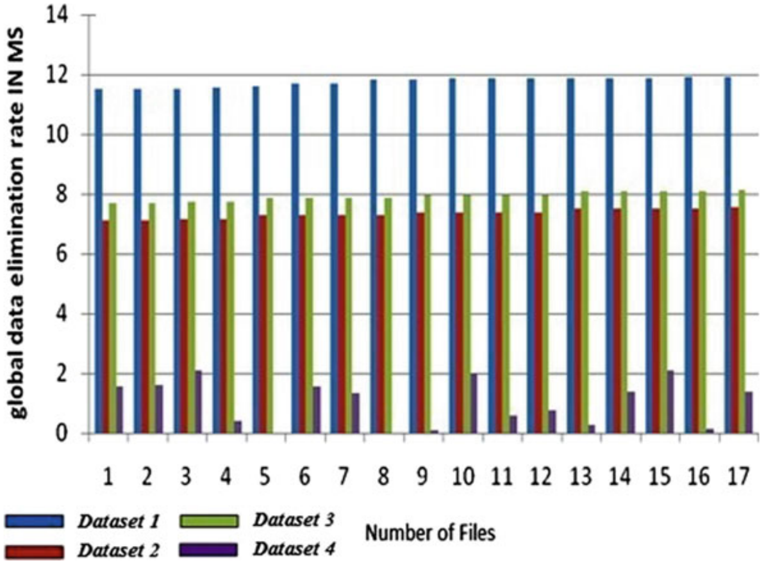

Fig. 9 Comparison of global data elimination

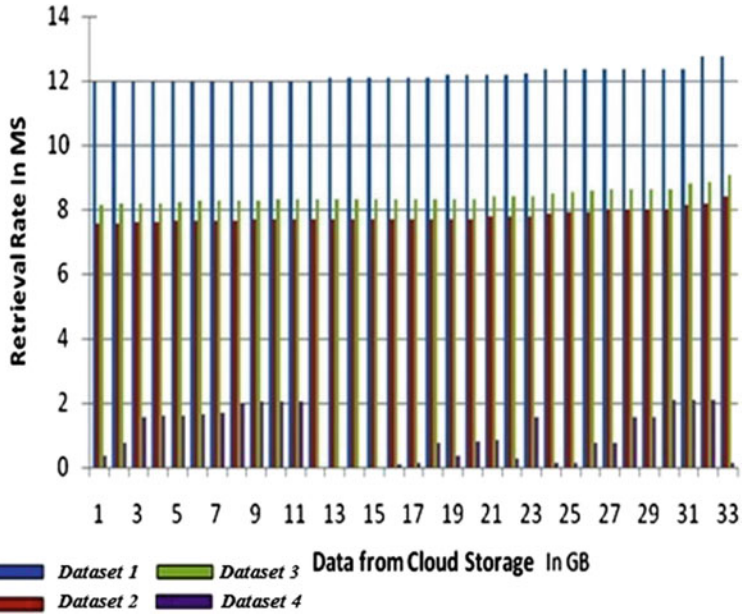

Fig. 10 Comparison of data retrieval

Fig. 11 Cost versus reliability

various dimensions to eliminate the cost management problem. The comparison of collected and calculated data is done for reducing duplicate data. The comparison of forecast data also takes place for performing the global data elimination process.

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DEEC Protocol with ACO-Based Cluster Head Selection in Wireless Sensor Network

Renu Jangra, Ankita Chhikara, Jyoti Saini, and Ramesh Kait

Abstract In wireless sensor networks (WSNs), the protocols for routing have a great effect in performance of network as network's lifetime, good energy organization, etc. These protocols are developed based on the different schemes like clustering, chaining and cost based. The WSN contains a large number of nodes which are sometimes difficult to manage. So, the best way is to make a cluster by combining various nodes, and this technique is known as clustering. By doing so, the energy exhaustion by nodes can be restricted. A node is nominated as cluster head (CH) to handle the communication amongst nodes and managing of nodes in the cluster. An ACO-based probability rule is used for choosing the CH amid the cluster nodes. The data are sent from cluster nodes to the CH; then, it further sends the relevant details to the base station (BS). ACO-DEEC: ant colony optimization-based distributed energy efficient clustering protocol is used for probability rule calculation for CH selection depending on the metrics, i.e. efficiency of the nodes and distance amongst nodes. The algorithm proposed enhances the parameters like energy consumption by cluster nodes, finding dead nodes in cluster and quantity of packets sent to the BS as compared with existing DEEC protocol.

Keywords ACO-DEEC · Ant Colony optimization · Cluster head · DEEC protocol · Wireless sensor network

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1 Introduction

The WSN comprises of sensor nodes. The sensor nodes have finite energy which effects the network persistence. There is a base stations (BSs) can be positioned on both: interior or exterior parts of the range of cluster nodes [1]. Various protocols of routing have been proposed to improve the persistence of the network, quantity of the data communicated to the BS and to decrease the risk of nodes to be dead too early and so on. These objectives are achieved by using cluster-based routing protocols. In clustering, a cluster is created by some nodes, and a CH is selected based on some given criteria, and remaining nodes are called cluster nodes [2]. CH and cluster nodes can transfer information directly to each other. The CH is responsible for applying data filtration and data aggregation on the data communicated from the member nodes to the BS, and then, it processes the sent data. The protocol distributed energy efficient clustering (DEEC) is one of the cluster-based protocols used for routing. In DEEC, the CH is the selected on the basis of the average energy and the node's remaining energy [3]. The node having high average and remaining energy has more possibility of being chosen as a CH. The routing protocols based on clusters recognize the process of selection of the CH and to identify the minimum path of commination between CH and BS, so data transmission can be energy efficient [4]. To find an appropriate cluster head, a biological inspired routing protocol based on clustering has been proposed. The wireless mode of transmission is considered less veracious and robust as compared to the wired communication medium. For its improvement, the societal model of insect swarm is taken into consideration for design basis of wireless networks [5]. To adopt bio-inspired criteria to design wireless network is in trend nowadays [6]. The main features of the routing algorithms based on swarms are that they are quiet understandable and adaptable to the topological switching [7]. The idea for this routing protocol is taken from ant colony's hunting nature for food in a particular manner. Here, an algorithm ant colony optimization-based distributed energy efficient clustering (ACO-DEEC) is proposed for calculating the probability law for choosing the CH depending upon the metrics, i.e. node's energy and distance between the nodes. As evaluated against to the DEEC protocol, the energy utilization by the nodes and quantity of packets to be sent to the BS has been improved; also, dead nodes are reduced by this proposed algorithm.

1.1 ACO-DEEC

In this paper, an algorithm is proposed in which ACO is applied on protocol named DEEC. This algorithm is specified as the name ACO-DEEC. In DEEC, based on the probability rule (the proportion of the node's remaining energy to network's average energy), CH is selected amongst network nodes. However, in ACO-DEEC, selection of CH is based on both the probability rule as well as on the parameters, i.e. node energy and the distance between node and BS. It is observed that maximum route amongst nodes consumes high energy and vice versa. The process involved in ACO-DEEC is that the next CH is selected by ants applying the rule1, and efficient node is selected by applying rule2.

Rule1: Locate an ant on the CH "i node" and next CH is selected as "j node" by Eqs. 1 and 2.

$$P = \frac{\text{Distance}_i * \alpha + \text{Phero}_i * \beta}{\sum_{i=0}^{N_i} (\text{Distance}_i * \alpha + \text{Phero}_i * \beta)} \tag{1}$$

where

P is the probability function. Phero_i is the pheromone value.

$$\text{Phero}_i = \frac{\tau^{a_{i,j}} * (\eta_i)^\beta}{\sum_{i=0}^{N_i} \left(\tau^{a_{i,j}} * (\eta_i)^\beta\right)} \tag{2}$$

where $\tau^{a_{i,j}}$ is the pheromone intensity, α and β are the controlling parameters, η_i is the heuristic information

$$\eta_i = \frac{1}{I_e - e}. \tag{3}$$

where I_e is the node's initial power and e is the node's remaining energy. Node having less power has minimum chances to be selected as a CH.

Rule2: At the time, the next CH is searched by ant, and then, the present pheromone value on that node is modified as stated by Eq. 4.

$$\tau_{i,j}(t+1) = (1-\rho)\tau_{i,j}(t) + \rho\Delta\tau_{i,j}(t) \tag{4}$$

where $\Delta\tau_{i,j}$ (t) is the modification value in pheromone and ρ forbids the additional pheromone to be produced in the experiment.

1.1.1 ACO-DEEC Algorithm

Start

1. Design a wireless sensor network and set initial parameters: number of rounds $r_{\max}$, number of nodes (n), starting probability (p), starting energy E_0, ρ, E_{amp}, E_{fs}, E_{RX} and $E_{\text{TX.}}$
2. Determine the average network energy.
3. Determine the probability rule of each node based on the node's power, distance between the particular node and BS.
4. Probability rule is determined using given formula:

$$P = \frac{\text{Distance}_i * \alpha + \text{Phero}_i * \beta}{\sum_{i=0}^{N_i} (\text{Distance}_i * \alpha + \text{Phero}_i * \beta)}$$

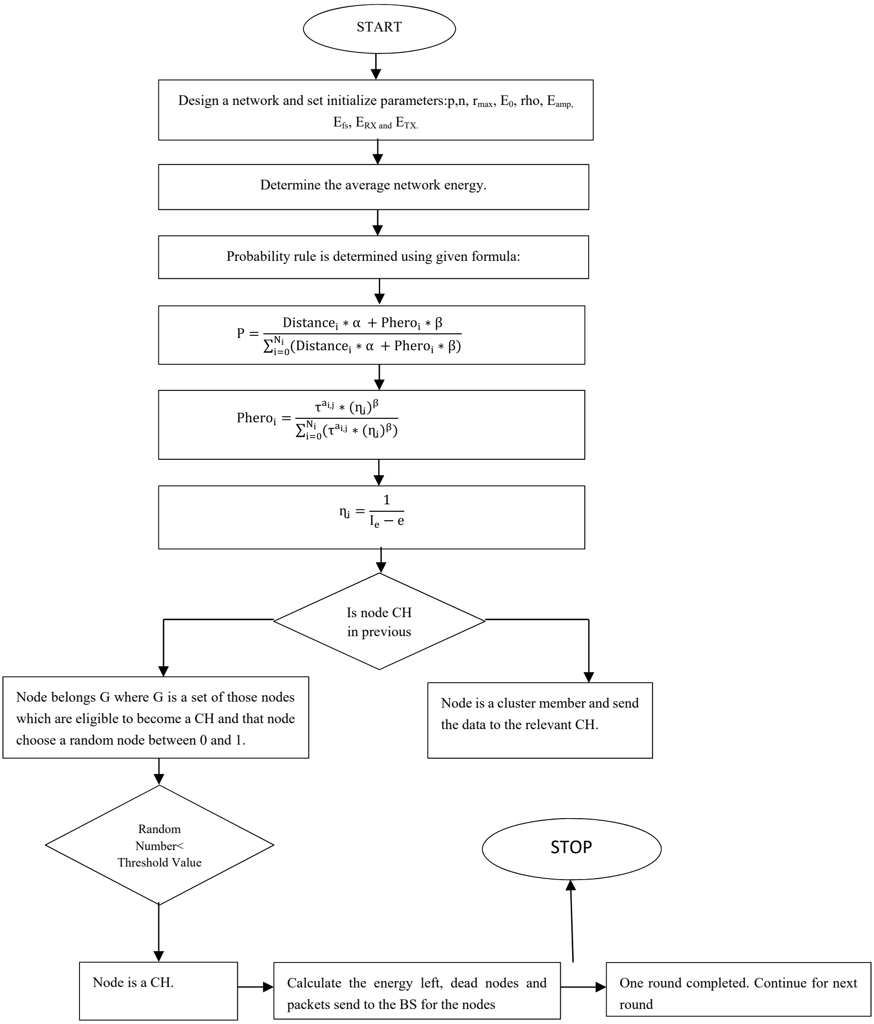
$$\text{Phero}_i = \frac{\tau^{a_{i,j}} * (\eta_i)^\beta}{\sum_{i=0}^{N_i} \left(\tau^{a_{i,j}} * (\eta_i)^\beta\right)}$$

$$\eta_i = \frac{1}{I_e - e}.$$

5. If in previous round a node is selected as CH, then that node becomes the part of group G (set of those nodes which are already selected as CH in previous rounds) and that particular CH node chooses a number ranging from 0 to 1 randomly, else same node merges into that cluster as a member. Then, data are transmitted to the CH related to that cluster.
6. If the CH chooses a random number having lesser value as compared to threshold value, the particular node becomes cluster head (CH) else becomes cluster member.
7. Compute the residual energy, quantity of nodes found dead and data packets transmitted to BS.
8. One round complete.

Stop

1.1.2 Flowchart of the Proposed Algorithm



2 Literature Survey

Saini and Sharma [8] proposed the E-DEEC algorithm having classifications of nodes as advanced, super and normal. The introduction of super node inserts the heterogeneity in the network which has more energy than the normal and advanced node. The simulation results of E-DEEC showed better performance than the SEP. The proposed algorithm extends strength and lifespan of the network.

Alla et al. [9] presented a protocol named as BCDEEC "Balanced and Centralized Distributed Energy-Efficient Clustering" algorithm for diversified WSN, in which they had suggested to prevent the node's average energy, the BS guarantee that the nodes having more energy could become a gateway and cluster head. The data transferred by cluster head from base station to gateway routing had reduced energy expenditure of CH and diminish the possibility of nodes that are malfunctioning. The experimental results illustrated BCDEEC was better than SEP and DEEC thus enhanced the life span of network, time interval of first node to be dead in the network.

Qureshi et al. [10] have compared the four protocols named distributed energy-efficient clustering "DEEC," Developed DEEC "DDEEC," Enhanced DEEC "EDEEC" and Threshold DEEC "TDEEC" with heterogeneous conditions having high to low level of heterogeneity. TDEEC and EDEEC performed better in all conditions, but stability period and life time were best in TDEEC.

Divya et al. [11] proposed the algorithm MDEEC that permits extra data to be transmitted between BS and CH in an exacting time gap than the existing DEEC. The simulation comparison between DEEC and MDEEC showed that MDEEC had less delay in data transmission and 15% increment in the transmission of messages. Hence, that made the network more energy efficient.

Bogouri et al. [12] presented an innovative technique ITDEEC that has been improved threshold distributed energy-efficient clustering protocol (TDEEC) by removing the nearer nodes (consumed more energy) to the BS in the process of clustering for diversified WSN. The experimental results of MATLAB illustrated that lifetime had increased by 46%, and data transmission was increased by 184% of the network in ITDEEC compared to the TDEEC.

WSN used large number of sensor nodes with limited resources capable of doing the task of computing and sensing. Yaeghoobi et al. [13] presented the pros and cons of routing protocols. They also found simulated results by comparing the protocols SEP, HEED, LEACH and DEEC. The result demonstrated that HEED was better than LEACH and SEP in mixed and homogenous environments.

Akbar et al. [14] developed two new protocols named as "AM-DisCNT" and "iAM-DisCNT." In first algorithm, nodes were deployed in circular fashion for uniform consumption of energy. In second algorithm, throughput was maximized by making the most use of both mobile and fixed base stations. The comparison demonstrated that AM-DisCNT and iAM-DisCNT increased sturdiness period by 32% and 48%, respectively, than LEACH and DEEC.

3 Experimental Results

The simulation environment has the network in (100 * 100) m^2 field and simulates using MATLAB. The comparisons are done with different parameter setting. In Fig. 1, the number of nodes is initialized as 100, and at different rounds, the energy left for a node is compared between DEEC and ACO-DEEC. In Fig. 2, the count of packets sent by CH to BS in DEEC and ACO-DEEC is compared with number of nodes is 100. In Fig. 3, the number of nodes again initialized as 100. The number of dead nodes is counted at different rounds and compared between DEEC and ACO-DEEC. In Fig. 4, the number of rounds is set to 100. The energy left for a sensor node is compared between DEEC and ACO-DEEC. In Fig. 5, the number of rounds is set to 100, and the packets sent by CH to BS in the network are compared between DEEC and ACO-DEEC. It has been found that in all comparisons, the results of ACO-DEEC are better than DEEC. ACO-DEEC has more energy left for communication. Hence, sensor nodes work for more time than sensor nodes of DEEC. Therefore, amplify the life span of the network. The sensor nodes in ACO-DEEC dead later than DEEC so the communication amongst nodes active for more time and, hence, increases the lifespan of network. More data transmitted to the BS means more data are passed to the BS. Hence, increases the efficiency of the network. The below graphs understand the concept more clearly.

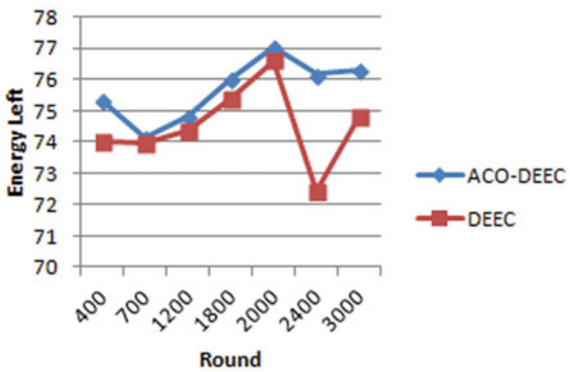


Fig. 1 Comparison of energy left at different rounds between DEEC and ACO-DEEC

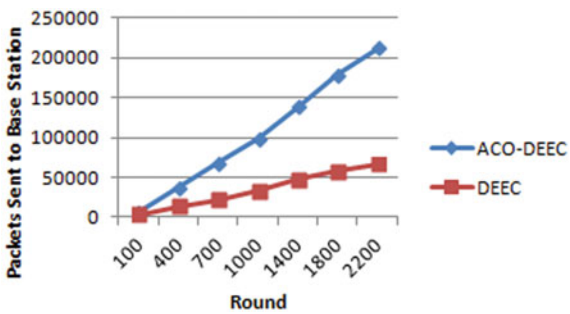


Fig. 2 Comparison of packets sent to BS at different rounds between DEEC and ACO-DEEC

Fig. 3 Comparison of dead nodes at different rounds between DEEC and ACO-DEEC

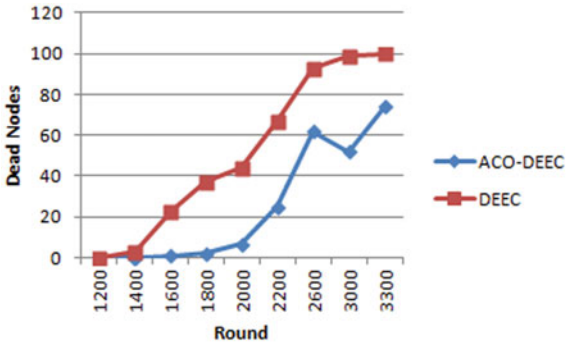


Fig. 4 Comparison of energy left at different nodes between DEEC and ACO-DEEC

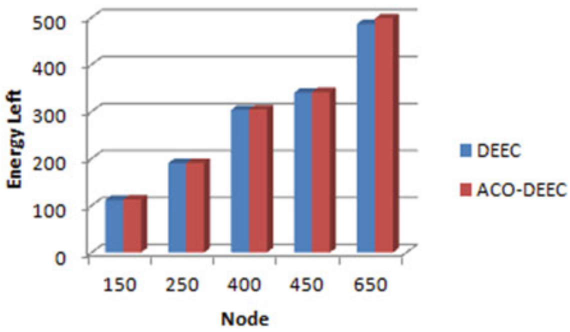
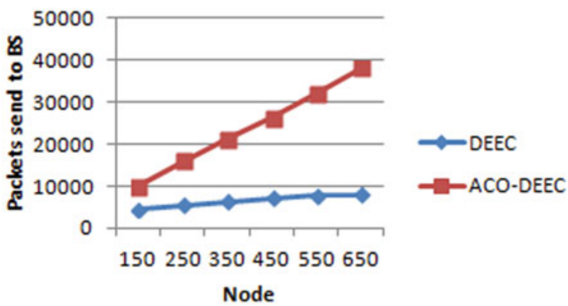


Fig. 5 Comparison of packets sent to BS at different nodes between DEEC and ACO-DEEC



4 Conclusion

A WSN routing protocol based on clustering has been used for preserving the sensor node's energy. Large networks are divided into clusters using routing protocols based on clusters, i.e. DEEC and ACO-DEEC. The proposed algorithm uses the ACO technique in probability rule for the cluster head selection. It has been concluded that ACO-DEEC performs better than DEEC. These two algorithms are compared using MATLAB simulation, and the experimental results are shown using graphs.

By using ACO-DEEC, the energy utilization by the nodes and data packets to be sent to the BS has been improved; also, number of dead nodes has been reduced. Hence, the working time of the network and the energy utilization has been improved.

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Effective Communication in NDN via Transient Popular Content Caching at Edge

Divya Gupta, Ankit Bansal, Shivani Wadhwa, and Kamal Deep Garg

Abstract The Named Data Networking (NDN) is a future Internet architecture to support content centric delivery. Among all the features offered by NDN communication such as effective network bandwidth utilization, name-based content routing, and so on, in-network caching plays a major role for achieving energy efficient content delivery. The caching of requested contents at network edge is incredible due to reduced content retrieval delay and network traffic a requester has to experience. Although, a number of caching strategies for content caching at edge exist in literature, still caching of popular contents with certain lifetime at edge network are less studied. Therefore, this paper proposes a novel idea for NDN node to take cache decision based on requested content popularity and its data lifetime. The data with the highest popularity and greater residual lifetime would be preferred for caching. The proposed approach has been evaluated in Icarus simulator for different performance metrics. The results retrieved from experimentation proved outstanding performance of the proposed approach over the existing state of art strategies.

Keywords Edge computing · Data caching · Energy efficiency · Content delivery

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1 Introduction

With the plethora of heterogeneous devices, the tremendous IoT data is generated each day. The traditional cloud based approach of information communication is not suitable nowadays due to huge network traffic produced by these device's data. The recent solutions suggested storing data at edge: location closer to the data generation location. The caching of content at edge is beneficial in terms of reduced content retrieval delay and effective network bandwidth utilization. The Named Data Networking (NDN) evolves as a strong candidate with its inbuilt in-network caching and name based content routing facilities. It enables distributed storage at edge based on each node's content caching decision.

Several edge caching techniques in NDN networks have been developed so far [1, 2]. The so far designed popularity-based caching strategies are quite efficient for applications related to non-real-time content delivery such as multimedia files and web pages. These methods overlook a unique feature of IoT content: its finite lifespan. In the literature, a few solutions for caching transient IoT content have also been proposed [3, 4]. They either target caching in resource-constrained edge devices, therefore accounting for energy efficiency, or discussed coordinated caching. This work proposed a simple yet effective caching policy which considers both IoT content popularity and its residual lifespan for storing content at edge in support to NDN network communication. Therefore, the following are the main contributions of this study:

- We propose a novel distributed edge caching strategy while considering both content popularity and lifetime. The decision on caching of content at each edge node in NDN network is autonomous. The content with high popularity and greater residual lifetime is preferred for caching.
- We investigate the performance of the proposed approach in Icarus- a python based simulator for measuring caching efficiency in NDN network. The results obtained from experimentation for different caching performance metrics such as cache hit ratio and content retrieval delay proved its advancement in comparison to various existing state of art caching schemes.

2 Related Work

The different works in the past have presented caching schemes either related to popularity-based caching or in terms of caching transient content.

- **Popularity-based caching schemes**

  Leave Copy Everywhere (LCE) with the Least Recently Utilized (LRU) replacement is the most basic caching method used in the NDN implementation. However, LCE wastes cache resources by caching content with high redundancy [5]. The probability caching (ProbCache) caches incoming content with some probability where value of p ranges from 0 to 1. The probCache reduced the cache redundancy in the network [6]. Another work in [7] proposed a caching scheme called most popular cache (MPC) to cache only popular contents on network caches. Here, the frequency of content requests exceeding the certain fixed threshold are considered as most popular. This do not require any coordination among NDN nodes for content caching decision. The works in [8] presented caching scheme based on node topological information such as betweenness centrality for caching decision. Similar to this, work in [9] presented collaborative caching scheme based on content popularity and betweenness centrality. The most popular contents are placed on the high centrality nodes for effective caching results. The caching based on co-operation and collaboration improves the caching efficiency as compared to the autonomous caching schemes.

- **Caching transient content**

  IoT contents exhibit certain lifetime ranging from few milliseconds to some days. The contents are invalid after its lifetime gets expired. For transient content routing, the lifespan of content is set in the lifetime field in the data packet, which eventually get checked at receiver node for its validation. Similarly, the data which exceeds its freshness period in the cache gets dropped from CS table. There are few works considering freshness of content for making caching decision in literature. For example, the pCASTING technique [4] in dynamically computes the caching probability by taking into account the freshness of content, the node's residual power, and the available cache space. Further, work in [3] presented caching transient content with popularity parameter consideration. However, the scheme exhibit high overhead due to lookup operation performed in all the nearby nodes for same content availability if any.

3 Caching Transient Popular Content (CTPC)

An edge-based NDN network where content routers are deployed in a tree topology and connected to the core network through a border router is our example scenario. Requesters are attached to the edge domain's leaf nodes and make request for contents being generated beyond the edge domain range (refer Fig. 1).

The number of available content in the network are represented as set $C = \{c1, c2, \ldots, cM\}$ for M number of total contents. Each content ci is composed of several data packets having same lifetime value (LT) provided by original IoT producer. The content demanded by requester from the available content set C is denoted as c_d. The parameters necessary for making cache decision in this study such as content popularity and content lifetime are periodically updated after fixed time interval T. Here, the value T is the shortest lifetime of the content from all contents in set C. Therefore, in each periodic time interval say T_{p}, the NDN router performs following computations:

- The total number of requests received for contents, $R_{\mathrm{total},p}$.

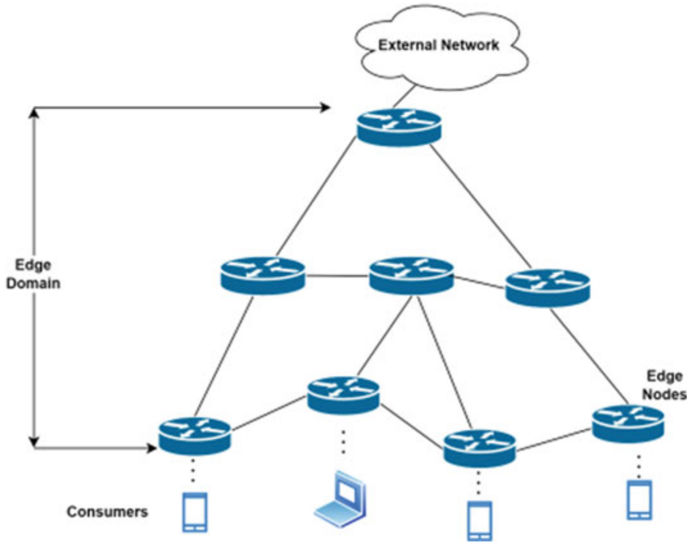


Fig. 1 An example scenario

- The total number of distinct requested contents, D_p.
- The number of requests received for each distinct content, $R_{\mathrm{cd},p}$.

After completion of T_{p}, the popularity of any requested content c_d at the NDN router is computed respectively using:

$$\mathrm{Pop}_{\mathrm{cd},p} = \frac{R_{\mathrm{cd},p}}{R_{\mathrm{total},p}} \tag{1}$$

Upon new time interval, all the counters are refreshed to make fresh calculations. Each data packet entry while traveling toward the consumer carries the name of requested content c_d, lifetime value $\mathrm{LT}_{\mathrm{cd},p}$, popularity value $\mathrm{Pop}_{\mathrm{cd},p}$, and the count of received requests during current time interval. The information about count of requested contents get stored in counter Table (CT). When the popularity of content or its lifetime becomes zero, the entry gets discarded from CT.

To distinguish between popular or non-popular contents and fresh or stale contents, the popularity threshold ($\mathrm{TH}_{\mathrm{pop}}$) and lifetime threshold ($\mathrm{TH}_{\mathrm{LT}}$) values are updated after each periodic time interval T_{p}. Hence, the popularity threshold and lifetime threshold after interval T_{p} are calculated using:

$$\mathrm{TH}_{\mathrm{pop},p} = (1-\alpha)\mathrm{TH}_{\mathrm{pop},p-1} + \alpha\overline{R_p} \tag{2}$$

where

$$\overline{R_p} = \frac{R_{\text{total},p}}{D_p} \tag{3}$$

$$\text{TH}_{\text{LT},p} = (1 - \alpha)\text{TH}_{\text{LT},p-1} + \alpha\overline{\text{LT}} \tag{4}$$

At the beginning of $T_{\text{p+1}}$, the packets received for requested content c_d having their popularity and lifetime value equal to or greater than $\text{TH}_{\text{pop},p}$ and $\text{TH}_{\text{LT},p}$ respectively will be considered popular with longer lifetime. Hence, such packets would be cached by content router and rest all not fulfilling the conditions would get discarded.

4 Performance Evaluation

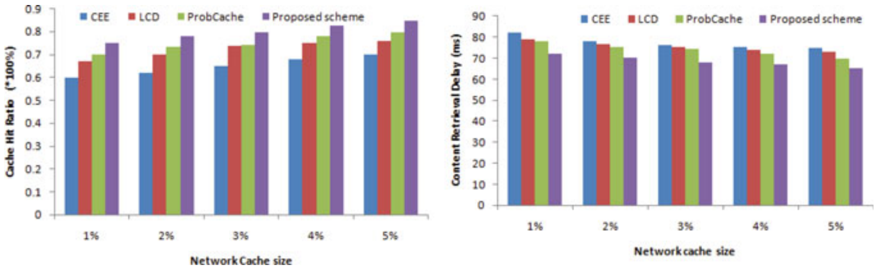
For the experimentation purpose, the performance of the proposed approach has been evaluated by conducting simulations in Icarus simulator. To build an NDN based edge network scenario, the tree topology with 5 servers and 45 content routers in the three levels have been configured. Initially, the network is warmed up with 3 * 10 * 5 content requests and caching in network is measured by considering 6 * 10 * 5 requests. The routers in the bottom level of tree topology act as edge nodes and are responsible for getting requests from the consumers. The number of generated requested follows a Poisson distribution. The content popularity follows a Zipfian distribution with skewness parameter β set to 0.6, 0.8, 1.0. The network cache varies in range from 1 to 5%. The following are the considered parameters for evaluating the caching efficiency of our proposed approach.

- Cache Hit Ratio (CHR): It is the ratio of number of requests served by an edge node to the total number of requests received at edge node.
- Content Retrieval Delay (CRD): It is the average delay encountered in getting the requested content by consumer.

The performance of the proposed approach has been compared against benchmark caching schemes such as Cache Everything Everywhere (CEE), Leave Copy Down (LCD), and Probability-based caching (ProbCache).

5 Results and Discussion

The cache hit ratio performance of all the considered caching schemes along with the proposed scheme has been illustrated in Fig. 2a. The results clearly depict outstanding performance of the proposed approach with gain of 14–25% in achieving high cache hit ratio with increasing cache size. CEE, unsurprisingly, has the worst performance by offering CHR of only 4% with increased cache size. LCD offers better performance than CEE due to the fact of caching at edge nodes only. ProbCache still has better performance than CEE and LCD due to considered popularity parameter for



(a) Cache Hit Ratio (b) Content Retrieval Delay

Fig. 2 Results for different cache size

caching. However, caching only based on popularity is not a good choice. Hence, the proposed approach based on both popularity and freshness has great impact on CHR performance.

Further, the results extracted for content retrieval delay (CRD) parameter for the considered strategies have been depicted in Fig. 2b. The proposed scheme outperformed other strategies in satisfying reduced delay for getting the requested content. However, the reason behind the worst performance of CEE for higher CRD value is increased cache redundancy and data elimination at the edge nodes.

6 Conclusion

This paper presents a simple yet effective caching strategy for storing contents at edge network. The proposed scheme makes caching decision based on content popularity and residual lifetime. Each node in edge NDN network is free to decide independently without any additional computational overhead. The conducted performance evaluation of the proposed scheme in Icarus simulator along with other three benchmark caching strategies have demonstrated its superiority over all other considered schemes for gaining high cache hit ratio and offering reduced average content access delay. Therefore, the proposed scheme is beneficial for both edge network and users with limited resource constraints. On the other hand, the offered reduced delay and high cache hit ratio enhances user's QoE with minimal energy utilization. We intend to extend the proposed work in the future to provide content placement at the edge that also reduces the operator's intra domain traffic transit expenses.

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Performance of HMRF-Based Unsupervised Segmentation and Random Walk Segmentation Algorithms for Gallbladder MRI

Koushik Chakraborty and Arunava De

Abstract This article represents performance of segmentation algorithm of an unsupervised image based on hidden Markov random field (HMRF) model and random walk segmentation algorithms for gallbladder MRI. Detection of lesions in human brain is an important task aimed at saving precious lives. The novelty of the method of segmentation is the use of random walk algorithm together with entropy maximization. We employ entropy maximization to automatically identify the seed points that are to be used in random walk algorithm. Detected early diseases can be healed by eliminating slices of human organs. Specific symptoms of the disease are missing, and the cancer remains undetected until it has spread to all the organs. Hidden Markov random field model is used to segment gallbladder lesions. Expert medical opinion is required to determine whether the lesions have cancer. Here, we analysis the performance of both the algorithm HMRF-based unsupervised segmentation and random walk segmentation.

Keywords Entropy maximization · Random walk · Wavelet mutation · Precision · Recall · Hidden Markov random field model

1 Introduction

Imaging techniques such as magnetic resonance imaging (MRI) are widely recommended to screen brain and spinal cord tumours. These tumours or lesions are detected only when a person visits a doctor with symptoms. The symptom of the people with brain and spinal cord tumour varies with age, the type of tumour and where it is located. It may be helpful if the lesions are detected and treated early. The symptoms of brain tumour may be headaches, seizures or changes in personality.

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Pressure in the skull may increase resulting in headaches, vomiting, sickness and confusion. Hence in modern medical science, emphasis is given on early detection of lesions so that precious life can be saved.

A random walk consists of succession of random steps. A molecule as it travels in liquid may show the property of random walk though in real world they may not truly be a random walk. Karl Pearson introduced the term random walk in the year 1905. Random walk algorithm finds use in numerous fields such as ecology, computer science, physics and many more. Random walks may be kind of Markov chain or process, but other complicated random walks are more interesting. Random walks may be in the plane, in graphs, in the line or it may be in groups. The random walk algorithm may used for segmentation purposes. An automated random walk algorithm is used for segmentation of MR image of brain.

To proper knowledge about disease and to measure its growth, we applied MRI. Human interference to identify the lesion border needs more time. It is also disposed to viewer inconsistency. Without using user intervene to properly segment the lesion, we need to make the system fully automatic.

Markov models show real findings for different of criteria. The applications of these models productivity will increase in the different fields. Problem of segmentation is effectively solved using hidden Markov model. The segmented image which is desired by us is hidden and may trail a case of a chain, tree or of a domain. Inverse problem in imaging for example noise removal may be done using HMMs.

2 Hidden Markov Random Field Model (HMRF)

Zhang et al. proposed hidden Markov model (HMM) to study and model images. Generative sequences can be modelled using HMM. Reproductive orders can be clarified using a primary process producing a sequence which can be observed.

HMM has used in different image processing applications and CAD apart from the NLP related tasks, e.g. phrase chunking, speech tagging and getting targeted information from given documents [1, 2].

The HMRF model is derived from HMM. A stochastic process which is generated by a Markov chain is called HMM. A sequence of observations of state sequence defines the Markov chain.

- **The broad steps involved while using image segmentation**
  - Magnetic resonance imaging is organized as an assembly of nodes that may resemble to pixels or group of pixels.
  - The nodes may be linked with hidden variables to define the intensity of the greyscale MR image.
  - Variables are used to make the joint probabilistic model.

- **Different Method for Entropy Maximization**
  - **Entropy maximization to get the probable seed points to be used in Random Walk algorithm**

    We used the random walker algorithm to achieve the above properties, and a practical approach to an interactive segmentation approach must bear the qualities of fast editing and computation.

The solution of sparse positive definite symmetric system of linear equations was used in random walk algorithm. The algorithm uses the previous solution for fast computing.

In this article, we propose to segment a multi-modal MR image. The MR image has a lesion in it. We use different seeds to label the different parts of brain MRI. Since the MR image is multi-modal and multi-threshold image, it has more than one threshold. Each threshold specifies a location of the MR image. The lesion has a specific threshold which is different from other thresholds in the image. Each threshold is a seed point and defines different regions of the human brain MRI by a user defined label. The random walker starts at an un-labelled pixel, and the probability of them reaching first to each of the N-seed points is calculated [3, 4].

Entropy maximization procedure is undertaken to identify the N-seed points of multi-modal MR image. The MR image has multiple thresholds (seed points) and each one pertaining to different regions/objects of the MR image of brain.

The grey level normalized histogram [*h(n)*] for MR image *f(x,y)* is defined as follows:

$$h(n) = f_n/N, \quad n = 0, 1, 2, \ldots, 255 \tag{1}$$

The grey level frequency n is defined as f_n. For multi-modal image, the total image is segregated into $(k + 1)$ zones at the grey level t_1, t_2, t_3, …, t_k. The zones are homogeneous in nature.

Shannon entropy is named after Claude Shannon who is also referred to as the father of Information Theory. Shannon entropy H is given by the formula

$$H(X, Y) = -\sum_i p_i \log_b p_i \tag{2}$$

where p_i is the probability when a pixel value i shows up in a given image.

The seed points (N-seed points) are found by maximizing the entropy of the histogram using hybrid particle swarm algorithm [5] as discussed in the subsequent paragraphs. The seed points are then used in random walk algorithm to get the segmented lesion region of the MRI of brain. Entropy maximization was applied on the basis function using hybrid particle swarm optimization using wavelet mutation operation (HPSOWM). The algorithm uses particle swarm optimization algorithm (PSO) together with wavelet mutation operation. The pseudo code of HPSO with wavelet mutation (WM) is given below [5, 6]:

Begin

$t \rightarrow 0$ // number of iteration
Initialize *X(t)* // swarm for iteration *t*
Evaluate fitness function *f(X(t))*
While (condition true) do
$t \rightarrow t + 1$
perform the process of PSO
perform WM
Reproduce a new *X(t)*
Evaluate fitness function *f(X(t))*
End

End

The wavelet mutation is a concept developed by [6]. It proposes that all the particles will mutate in the probability range $p_m = [0, 1]$. A random number is generated between the range 0 and 1 having the condition that if it is less than or equal to p_m mutation takes place otherwise not.

A randomly selected *i*th particle of the population and its *j*th element at *k*th iteration will mutate as per the following equation [5].

$$\left(N_{i,j}^{(k)}\right) = \begin{cases} N_{i,j}^{(k)} + \sigma \times \left(N_{j,\max} - N_{i,j}^{(k)}\right), & \text{if } \sigma > 0 \\ N_{i,j}^{(k)} + \sigma \times \left(N_{i,j}^{(k)} - N_{j,\min}\right), & \text{if } \sigma \leq 0 \end{cases} \quad (3)$$

where $\sigma = \psi_{a,0}(x) = \frac{1}{\sqrt{a}}\psi\left(\frac{x}{a}\right)$

The entropy maximization algorithm described here is used to generate the N-seed points for the random walk algorithm. Each seed point defines a user defined label on the image. The seed points correspond to different threshold for different regions of the image. From the above seed point, a particular seed point would correctly segment the lesion of the image [7, 8].

– **Segmentation Using Random Walk Algorithm**

  Random walk was initially formulated in computer vision and was used for texture discrimination, and it is used to segment the brain MR image.

The random walker algorithm was initially used to label a pixel as object and a background depending on the probability whether the pixel would reach background seed or a foreground seed. We have used a variation of the above model to correctly segment a lesion in an MR image [9].

For a single image, this algorithm is treated as a quadratic minimization problem. A 4-connected neighbourhood is assumed, and it is weighted according to the Gaussian function. The Gaussian function is normalized according to the Euclidean distances between different pixel intensities [10].

$$d_{ij} = \exp\left(-\beta \left\| \text{pixel}_i - \text{pixel}_j \right\|\right), \tag{4}$$

The Laplacian L is given by

$$L_{ij} = \begin{cases} \sum_k d_{ik} & \text{if } i = j \\ -d_{ij} & \text{if } i \neq j \text{ and } (i, j) \in \text{neighbourhood graph} \\ 0 & \text{otherwise} \end{cases} \tag{5}$$

MR image is a multi-threshold image. The N-seed points are used to label the multiple objects and the background. The lesion in the MR image is also labelled together with the other objects. The lesion has a different seed point as regards the rest of the image.

The probability of a random walker who starts from a pixel and arrives at different seed points is calculated. The image is then modelled as a graph, wherein the pixels are assumed as the nodes of the graph and edges are weighted according to the amplitude of the pixel value. The pixel is assigned a value of the label which has the highest chances to send a random walker [11, 12].

L is dominant in the diagonal and hence $L \geq 0$. A quadratic programme which is convex in nature can be developed.

$$\min_x = x^T L x \text{ subject to } x^{(s)} = k^{(s)} \tag{6}$$

$x^{(s)}$ = Values of N-seed points, $k^{(s)}$ = Known value of the seed, i.e. lesion, other objects and background. x^* is the probability that a pixel is assigned to the lesion.

- **Segmentation on a 4-connected graph of pixels using HMRF**

In the process of segment of an MR image into both labels, we use hidden Markov random field model. Pixel value 0 denotes the background, and pixel value 1 denotes the foreground of the image which is define by Boolean state space $x_i \in \{0, 1\}$.

Ising model is named after Ernst Ising, which was invented by Wilhelm Lenz [13, 14].

Single parameter $\omega = \{\gamma\}$ Ising model having origins in statistical physics is consider. The Boolean variables $x_i \in L$ and $x_i = \{0, 1\}$ constitute the state space (Figs. 1, 2, 3, 4 and 5).

3 Results and Discussions and Performance Comparison

PSO stagnates when it nears the optimal stage but it works fine in the earlier stages of the search process. It occurs when a particle's current position approaches the global best position. If the particle's inertia weight and velocity are non-zero, then it moves away from the global best. If the velocity is near to zero, then all the particles will stop moving at the moment they reach global best.

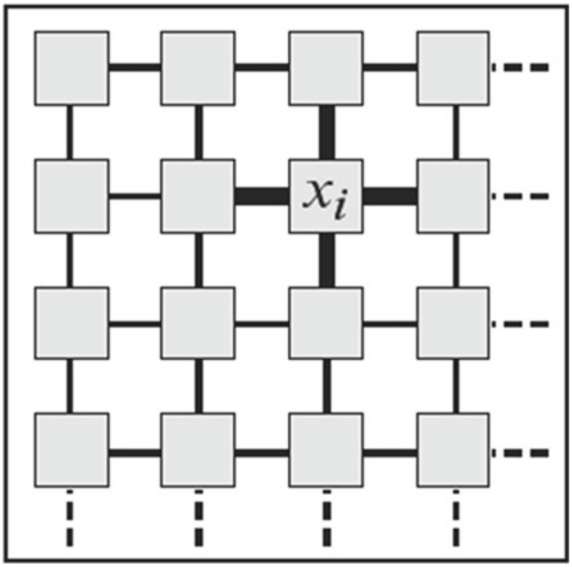

Fig. 1 Ising model cliques

Fig. 2 Gallbladder image no. 8 from dataset Fig. 9

Reference [15] proposed a hybrid PSO with the combination of a constant mutating space of genetic algorithm. Since in that approach, the mutating space is kept unchanged, and the permutation space of particles of the PSO is also unchanged.

HPSOWM overcomes stagnation by using a dynamic space of mutation which is large in the initial stage of search and small when it reaches the final stage of search

Fig. 3 Segmentation of gallbladder of Fig. 2

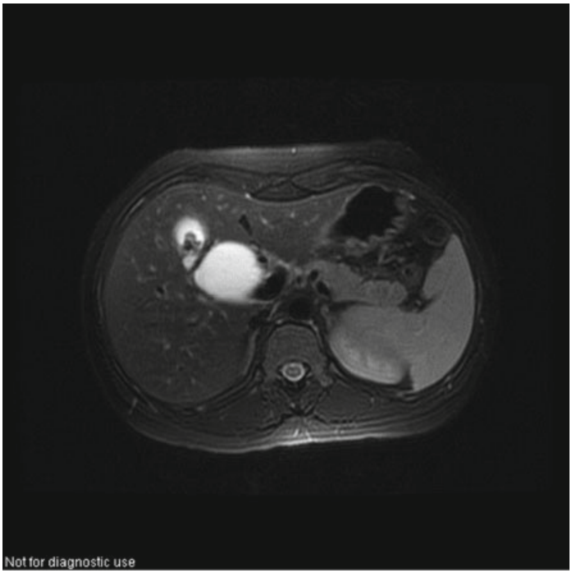

Fig. 4 Gallbladder image no. 9 from dataset Fig. 9

process by using the multi-resolution wavelet analysis [16]. Due to space constraints segmentation of a sample from the patient dataset, Fig. 8 is shown. The result of segmentation using random walk algorithm on Fig. 6 is depicted in Fig. 7.

Fig. 5 Segmentation of gallbladder of Fig. 4

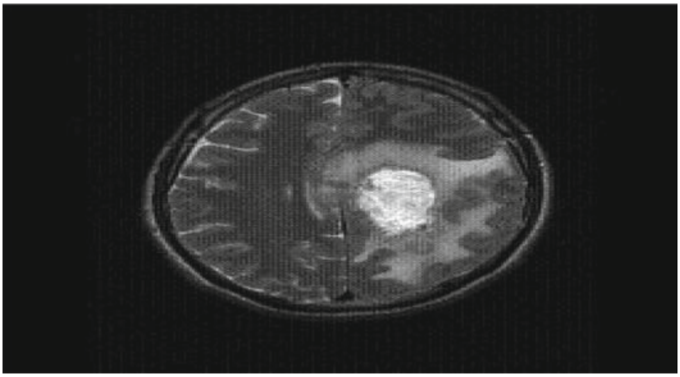

Fig. 6 MR in Axial-T2

The proposed algorithm using random walk was implemented on the patient dataset of Fig. 8. Precision and recall were used to calculate the segmentation accuracy. The segmentation accuracy is compared with [17]. Precision is the number of true positives divided by the number of images labelled as belonging to the positive class. Recall is the number of true positives divided by the images that belong to the positive class. The MR slices are marked relevant and non-relevant as depicted in Fig. 8. If the lesion is present, then it is relevant otherwise it is irrelevant.

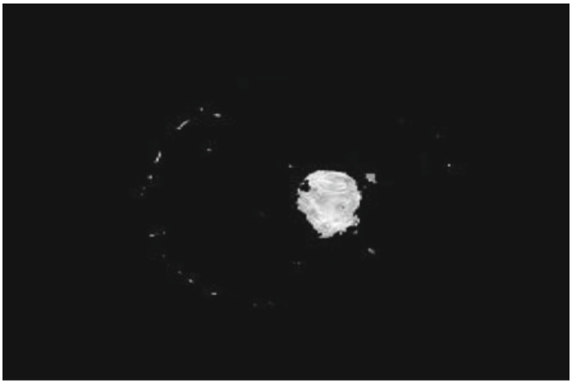

Fig. 7 Segmented image of Fig. 6

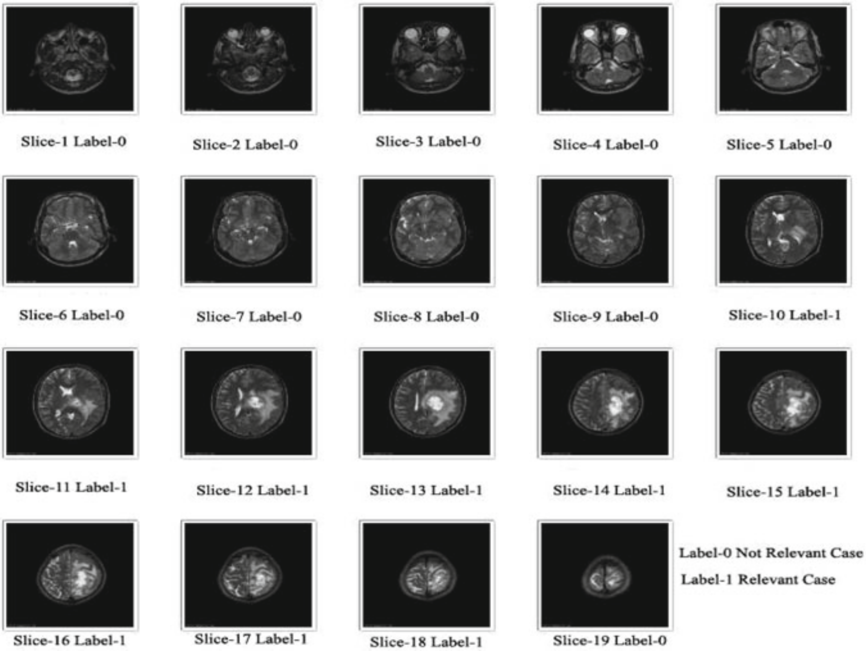

Fig. 8 Patient dataset 1

3.1 Segmentation Result Using Random Walk

TN/True Negative

Case was negative and projected negative.

Table 1 Evaluation of segmentation using random walk

Patient	Expert knowledge	Total cases		Projected negative	Projected positive
Dataset 1	Lesions may be present in some or all of the images	19	Negative case	9	1
			Positive case	1	8

TP/True Positive

Case was positive and projected positive.

FN/False Negative

Case was positive but projected negative.

FP/False Positive

Case was negative but projected positive.

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}}$$
$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}} \tag{7}$$

With entropy maximization using HPSOWM, the values for precision and recall [17] for Fig. 8 are 87.5% and 77.78%, respectively. In Table 1, with random walk algorithm for Fig. 8, precision and recall values are 88.89% and 88.89%, respectively.

Higher precision value means the algorithm gives more relevant results, whereas higher value of recall means it returned most of the relevant results. Hence, there is a considerable improvement in the segmentation result by using random walk algorithm.

3.2 Segmentation Result Using HMRF

The measurement for recall and precision is given in Table 2.

Table 2 Evaluation of segmentation using HMRF

	Expert knowledge	Total cases		Projected negative	Projected positive
No-1 patient dataset	Presence of lesions in some or all of the MRIs	22	Negative case	8	2
			Positive case	3	9

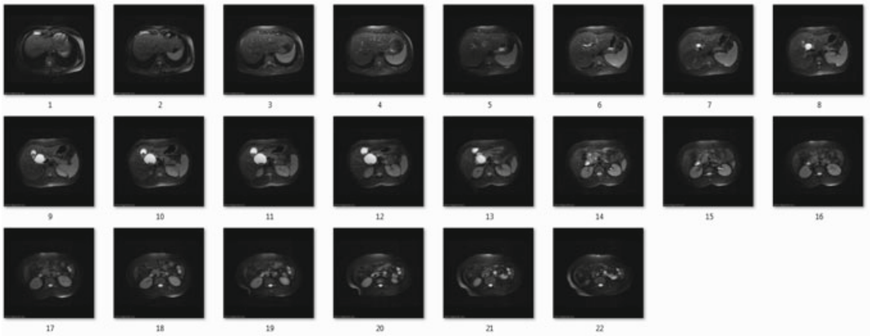

Fig. 9 Dataset of gallbladder images

TN/True Negative

Case was negative and projected negative.

TP/True Positive

Case was positive and projected positive.

FN/False Negative

Case was positive but projected negative.

FP/False Positive

Case was negative but projected positive.

In Fig. 9, recall is 75%, and precision is 81.82%

4 Conclusion

This article results an automatic method of segmentation of brain lesions using random walk algorithm. The method automates the process of selecting the object threshold (N-seed points) and thereby removing the need of user interaction as required in other existing algorithms. The results are compared with [17], and there is a considerable improvement in precision and recall as detailed in Tables 1 and 2. The unsupervised segmentation used in gallbladder lesions by us resulted in good segmentation accuracy when we used hidden Markov random field model. For other human organs, this technique can be appropriately useful for segmentation of lesions. By using suitable optimization techniques, we can improve the segmentation accuracy.

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Breast Cancer Detection Using Deep Learning

Bhavin Gami, Khushi Chauhan, and Brijeshkumar Y. Panchal

Abstract Breast cancer is a very common type of cancer found in women. Approximately, 43,000 deaths are recorded per annum worldwide due to breast cancer. With the advancement in medical technology, computer-aided detection and diagnosis (CAD) system is being used widely for the early detection of cancerous cells. Rapid development in deep learning has made the task of detecting cancerous cells accurate and trivial. In this paper, researcher used convolutional neural network (CNN) for classifying cancerous cells. CNN is a type of neural network which is extensively used for image processing, classification, and segmentation. The proposed system has achieved 82% accuracy by successfully classifying cancerous cells into benign and malignant which are the two common types of cancer cells found.

Keywords Histopathology · Benign/malignant · Classification · Deep learning · Receptive field · Convolution neural network

1 Introduction

Breast cancers are very life-threatening which are often shown up in women and rarely in men too. There are two types of breast cancer: benign and malignant. Benign tumors are not adverse. They are harmless and do not penetrate nearby tissues causing any damage to other organs. Malignant tumors consist of cancerous cells which have adverse effects on the body as they penetrate nearby tissues and in any part of the body too. Mammography is a technique for observing cancerous cells. To help radiologists and doctors successfully detect cancer, computer-assisted detection and diagnosis

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(CAD) software has been established and in clinical use meanwhile the 1990s. To boost the CAD system, deep learning is being used. For effective treatment of breast cancer, early detection is necessary. Various imaging techniques are used to detect cancer, including mammography, ultrasound, thermography, etc. Among the above, all imaging techniques mammography images are effectively used and give the best results of imaging for detecting breast cancers. Masses and microcalcifications (MCs) are two important early signs of the disease. The masses shown in figure A can be benign or malignant. There is a 30% possibility that the doctor cannot detect the signs of benign or malignant. In 1996, the researchers proposed a computer-assisted detection and diagnosis (CAD) system which can classify normal and abnormal mass using convolution neural networks (CNNs).

2 Literature Review

Research work was published in 2019 by Li Shen, Laurie R. Margolies, Joseph H. Rothstein, Eugene Fluder, Russell McBride, and Weiva Sieh in which they have worked on breast cancer detection using VGG16 (16 layers) and ResNet (50 layers) convolution neural networks and have done detailed comparison on their results. From the dataset of 2478 mammography images, two datasets were made, S1 and S10, where S1 had a set of patches centered on ROI, while the S10 consists of the whole mammogram. For ResNet, the highest patch classification accuracy was 0.87(AUC = 0.87) for S10 and was 0.85 highest for VGG16 in S10. The tests have shown that the dataset with no centered ROI and the pre-trained weights gives the best results [1].

Kalyani Wadka, Prashant Pathak, and Nikhil Wagh proposed an ANN model in 2019 that classified breast cancer and its performance analysis were done with an SVM classifier. They used a dataset of 5000 images which was pre-processed firstly. They have used various machine learning (KNN, SVM) and deep learning (ANN, CNN, Inception V3) algorithms and compared their confusion matrix's results. The accuracy of SVM and ANN was found to be higher (SVM-95%||ANN-99%) [2].

Shwetha K, Sindhu S, Spoorthi M, Chaithra D published a paper in 2019 in which they associated two models of CNN, InceptionV3, and MobileNet. They used two different datasets, the 1st dataset had 2 classes only, while the 2nd dataset consisted of 7 different classes. The data was pre-processed and trained with different models. The results concluded that Inception V3 (83%) gave better results than MobileNet (58%) model [3].

Saad Awadh Alanazi, M. M. Kamruzzaman, Md Nazrul Islam Sarker, Madallah Alruwaili, Yousef Alhwaiti, Nasser Alshammari, and Muhammad Hameed Siddiqi carried out research in 2021 in which they have trained machine learning models and deep learning models for breast cancer classification for and compared them. They have made 3 CNN models, one with 2 convolution layers, other two with 3 and 5 layered depth, respectively. The CNN model with 2 convolution layers (59%) was less accurate than the SVM model (78%), but by adding up the convolution layer, the model attained the highest accuracy of 87% [4].

Essam Rashed and M. Samir Abou El Seoud published a paper in 2019 through which researchers can conclude the importance of image segmentation in classification problems. Here, they have used well-known CNN O-Net architecture, i.e., two U-Net architecture (comprises of convolution and deconvolution layer). The dataset consisting of 6,671 mammograms images was used. The classification accuracy for microcalcification and masses is 94.31% and 95.01% [5].

Naresh Khuriwal and Nidhi Mishra proposed a CNN model in 2018 for breast cancer classification. The dataset consisted of 200 mammogram images which were pre-processed using watershed segmentation and texture segmentation. 12 features were extracted from the pre-processed image which was given as an input to the CNN model. The accuracy of the model was observed to be 98% [6].

Monika Tiwari, Praditi Shah, Rashi Bharuka, Reena Lokar published a paper in 2020 where they have worked on breast cancer classification using various machine learning (SVM, KNN, random forest) and deep learning models (ANN, CNN, RNN) and compared their results. They have used 30 extracted features from the 597 images as a dataset. The input features were pre-processed and passed to different models. They concluded that the deep learning algorithm ANN showed higher accuracy, i.e., 99.3% than any other deep learning or machine learning models [7]. F.A. Spanhol, L.S. Oliveira, C. Petitjean, C. and L. Heutte proposed a model in 2016 where they have used AlexNet CNN architecture for binary classification of cancerous cells in the breast. Firstly, the model was trained with LeNet architecture, but it provided indefinite results. Then, they worked on AlexNet architecture where they have compared two different patch extraction strategies at the convolution layer, i.e., sliding window and random extraction. They concluded that AlexNet provides better results than the class CNN, and the random extraction method of convolution comes out to be 89.4% accurate [8].

3 CNN Architecture Theory and Dataset Used

Among the various datasets available for the histopathology of breast cancer in this work, researchers have used the breast cancer histopathological image classification (BreakHis) dataset collected by P&D Laboratory, Brazil. It consists of 9019 samples of breast tumor tissues (mammography) of 82 patients with various magnifying ratios, i.e., 40×, 100×, 200×, and 400× zoom and have RGB color code scheme. From this 9019, 2480 are benign type tumors and 5429 malignant type tumors. Our dataset used only 1305 samples consisting of 407 benign samples and 898 malignant samples. Convolution neural network is a type of artificial neural network (ANN) widely used for image classification and processing which is specially designed to deal with pixel data. CNN comprises various layers which are not present in the classic neural network which gives the CNN architecture advantage of reducing the image in a specific way that it does not lose its features and is made easier to process [9]. These layers consist of artificial neurons. Neurons are responsible for the feature extraction in various layers available. When an image is specified as an participation to the CNN model, pixel patches of images are provided to the neurons which then detects features. The first layer detects the basic features of the image such as orientation and size. The obtained output then goes to a further layer, and higher-level features are extracted as the layer number increases. The figure shows different layers in CNN architecture [10]. The convolution layer is responsible for convolution which is a mathematical operation done between two signals which produce a new signal. In image processing, the image is convoluted by the kernel/filter by placing a kernel on each pixel of the image and getting a single-dimensional value for that particular receptive field. By this, researchers get a reduced image with extracted features. Talking about the pooling layer, it performs operations to minimize the dimensions of the input/extracted feature array which in turn minimizes the computation cost [11]. Max pooling and average pooling are the types of it. Similar to convolution, a kernel is placed on the input, and a single value is obtained for that particular part of the input. Based on the type of pooling, the value will be obtained. For max pooling, the maximum value in the overlapped part of the kernel and input will be the single value output for that part, and this happens for all the segments of input by placing the kernel one by one in each part. For average pooling, the average of the values in the overlapped part of input and kernel will be taken (Fig. 1).

The pooling layer also performs noise reduction in the inputs. The definite output of classification will be provided by the last fully connected layer that provides the probabilistic value in which neurons in the hidden layers are connected neurons. This fully connected layer easily classifies inputs with non-linearity. The input that is given to this fully linked layer is first flattened into a one-dimensional array by the flatten layer just before the fully connected layer. Training is done in various iterations over several epochs. The weight and bias are updated repeatedly for proper

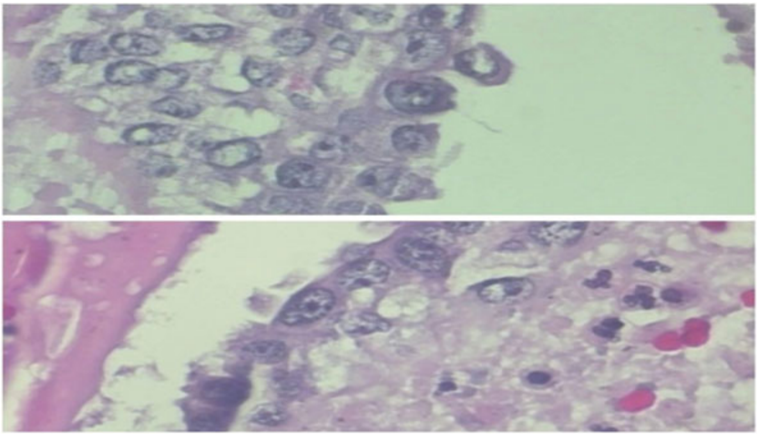


Fig. 1 Two malignant tumor cells from the dataset

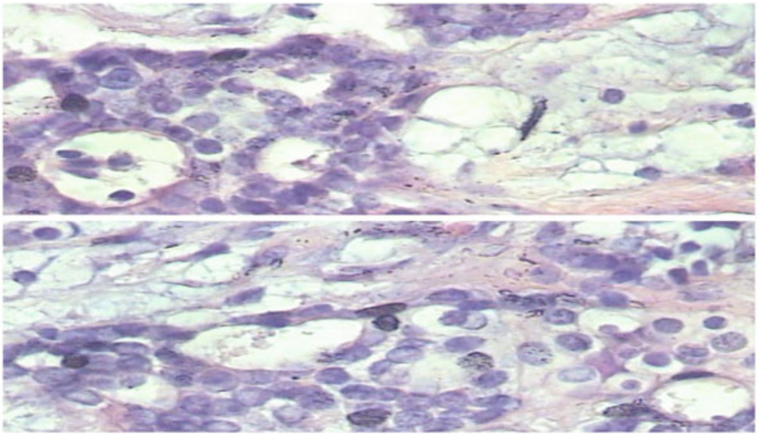


Fig. 2 Two benign tumor cell from the dataset

tuning of the model. There are various activation functions available that are used to produce output by taking weight and bias as input (Fig. 2).

4 Methodology

We have implemented CNN architecture implemented for image classification. Figure 3 shows the amount of layers present in our proposed model. There are 15 layers in our model from which there are 3 convolution layers, 3 max pooling layers, 3 dense (hidden) layers, 3 dropout layers, and one flatten layer. Figure 4 shows the flow of our proposed system. Firstly, researchers have resized and reshaped our data, i.e., images. Then, inputs were normalized from 0–255 to 0–1. The images after preprocessing are given as an input to the convolution layer which is the very first layer of the architecture. As discussed in the above background theory, convolution is used for feature extraction.

$$G[m,n] = (f * h)[m,n] \sum_j \sum_k h[j,k] f[m-j, n-k] \tag{1}$$

Equation 1 represents the convolution process in which f represents the input image, h represents the kernel or filter, (m, n) is the size of the input image, and (j, k) is the size of the filter.

Then, the output from this convolution passed to the max pool layer. All know that the pooling layer performs down sampling, so the dimension of output from the pooling layer will be given by this formula, $W_2 \times H_2 \times D_2$ where $W_2 = (W_1 - F)/S + 1$, $H_2 = (H_1 - F)/S + 1$, and $D_2 = D_1$ where F = filter size, S = stride, W_1, H_1, and D_1 are the dimension of input. Similarly, the features will be extracted

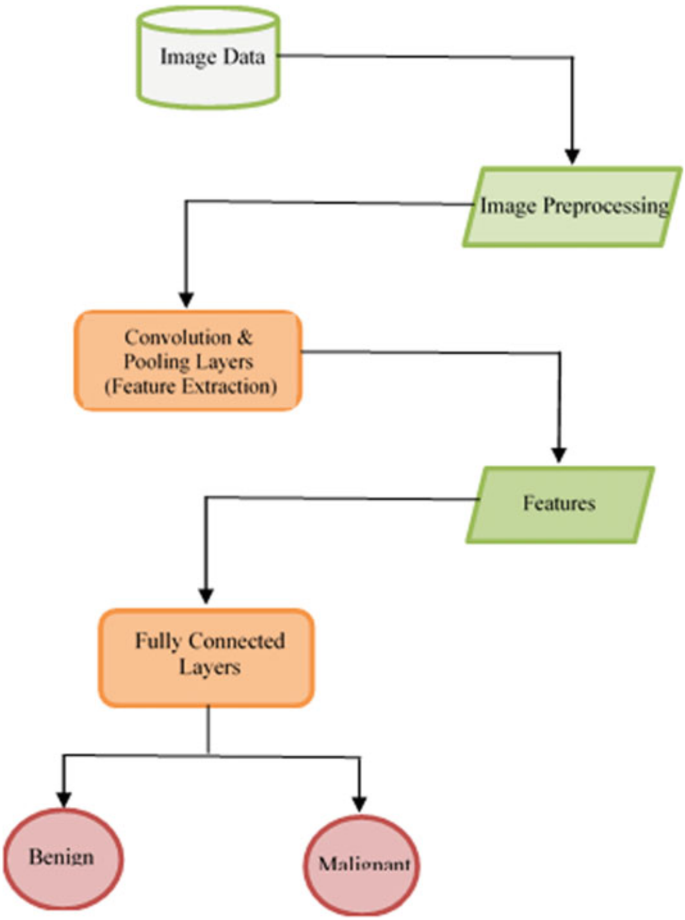


Fig. 3 System flowchart

as the inputs get to the higher-level layer as per Fig. 3. As observed in Fig. 3, the trainable parameters are increasing layer by layer which is nothing but the features extracted from the images. The features extracted from the convolution and pooling layer then are flattened into a 1D array and given as an input to the fully connected layer 1. The fully connected layer 1 and 2 consist of 64 neurons and use rectified linear unit (ReLU) activation function. ReLU activation function is widely used in deep learning models. It ranges from 0 to infinity.

The fully connected layer 3 has only 2 neurons and uses the softmax activation function which assigns probabilities (range [0–1]) to each class in a multi-class problem like the classification problem. Figure 5 shows the inner structure of a neuron. In our case, the inputs are the extracted features that are flattered in 1D-array. Respective weights are multiplied with the input, and bias is added to it which finally gives $\Sigma(x_i * W_i + b)$. Then, this value is passed in an activation function

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 92, 140, 32)	896
max_pooling2d (MaxPooling2D)	(None, 46, 70, 32)	0
conv2d_1 (Conv2D)	(None, 46, 70, 32)	9248
max_pooling2d_1 (MaxPooling2	(None, 23, 35, 32)	0
conv2d_2 (Conv2D)	(None, 23, 35, 64)	18496
max_pooling2d_2 (MaxPooling2	(None, 11, 17, 64)	0
dropout (Dropout)	(None, 11, 17, 64)	0
flatten (Flatten)	(None, 11968)	0
dropout_1 (Dropout)	(None, 11968)	0
dense (Dense)	(None, 64)	766016
dropout_2 (Dropout)	(None, 64)	0
dense_1 (Dense)	(None, 64)	4160
dropout_3 (Dropout)	(None, 64)	0
dense_2 (Dense)	(None, 2)	130

Fig. 4 CNN architecture in our system

which in our case is ReLU which gives output $Y = R(z) = \{z$ for $z > 0$ and 0 for $z \leq 0\}$. Finally, the fully connected layer floats over a value Y which shows the probability of having any one type of cancer benign (0) or malignant (1).

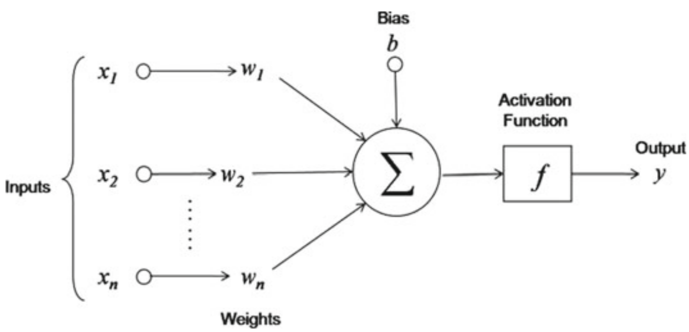
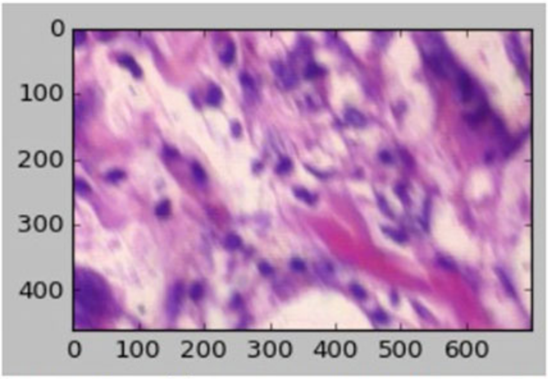


Fig. 5 Artificial neuron structure

```
path='/content/drive/MyDrive/data/malignant/SOB_
img = mpimg.imread(path)
plt.rcParams['figure.figsize']=4,4
imgplot = plt.imshow(img)
plt.show()
print(test_random(model,path))
```




```
MALIGNANT with Accuracy: 89.95195627212524%
```

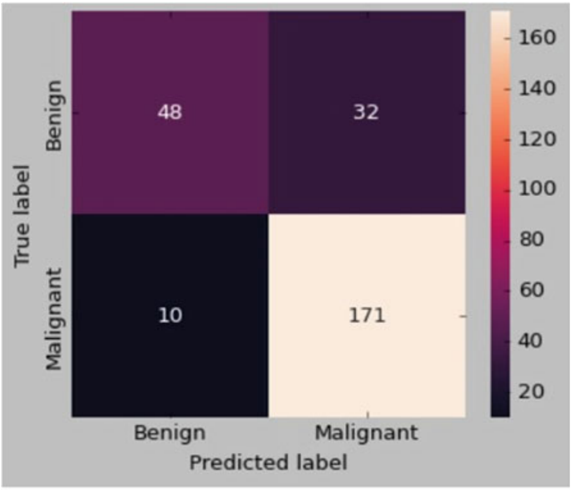
Fig. 6 Predicted value of randomly picked image

5 Output Discussion

As seen in Fig. 6, researchers are providing a random malignant image as the input to the model and it predicted it correctly as malignant with 87% accuracy. This model is 83% accurate as shown in Fig. 4. Researchers have used 5 epochs and kept the batch size 9 for training the model. They tuned the parameters like an epoch, batch size, no. of layers in the architecture, the activation function, and the no. of neurons while training the model. When researchers passed the validation data to the model, it achieved 82% accuracy which was the maximum of all after tuning the model by changing various parameters. Figure 7 displays the confusion matrix which displays the representation of predicted values and true values.

6 Graph Discussion

Figure 8 shows the graph of training_loss versus validation_loss. Here, the loss represents how far is the projected value from the actual value. The first graph train_loss versus validation loss represents how the loss function is declining with the rise no. of epochs. In the training of the model with the zeroth epoch, the loss was greater



CNN model Accuracy: 0.8390804597701149

Fig. 7 Confusion matrix

than 0.65 as shown in the graph. After validating the output with the true value, the model back propagates and tunes the weights and bias in the first epoch for better output.

As you can see in the graph, with the increase in an epoch, the loss is found to be less than 0.60 in the first epoch. With the increase in no. of epoch, the model will tune the weights and bias as per the requirement which will result in a decrease in the

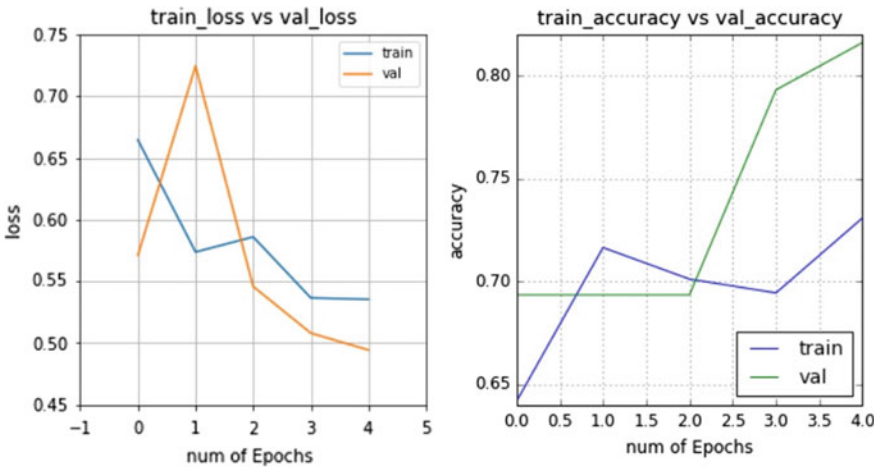


Fig. 8 Loss function graph

loss function. Similarly, the second graph shows training accuracy versus validation accuracy when the no. of epoch increases. The graphs represent that with the increase in the number of epochs, the loss decreases as we are predicting the values correctly.

7 Conclusion

Breast cancer detection using deep learning provides exceptional results while performing precisely and accurately with proper data, fine-tuning the model, and choosing the classification model. This artificial network is going to be way more helpful shortly as it will be saving lives in numerous ways. Detecting breast cancer is not just the single field where the neural network is serving. There are a lot more medical diagnoses where it is used. The early detection of such life-threatening diseases like breast cancer becomes an advancement in medical science as it will be saving numbers of lives. This is just a single model which researchers have implemented, there are various deep learning models providing almost 99% accuracy when provided a mammographic image.

8 Future Work

The model has achieved 82% accuracy while the classification of breast cancer. It uses approximately 35–40% of data available from the dataset. Shortly, researchers will be using all of the datasets as contribution to the model. Additionally, the model will be trained using various other CNN architectures for this full dataset such as ResNet5, VGG16, and more for the comparison, and researchers are thinking of using a classic machine learning classifier in place of the fully connected layer keeping the other layers of CNN as it is for feature extraction.

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Transferring Pre-trained Deep CNNs on Plantar Thermograms for Diabetic Foot Disease

Vikas Khullar, Raj Gaurang Tiwari, Ambuj Kumar Agarwal, and Mohit Angurala

Abstract Machine learning provides a plethora of approaches for tackling categorization problems, i.e., determining whether or not a data item belongs to a particular class. When the objective is to accurately classify new and unknown data, neural networks are frequently an excellent choice. The widespread availability of growing processing power, along with the development of more effective training algorithms, has enabled the application of deep learning principles. To provide superior learning solutions, deep architectures leverage recent breakthroughs in artificial intelligence and insights from cognitive neuroscience. Convolutional neural networks (CNNs) are a subclass of discriminative deep architectures that have demonstrated acceptable performance when processing 2D data with grid-like topologies, such as photos and videos. In this paper, we compare the performance of deep CNNs and machine learning for diabetic foot disease categorization. Diverse machine learning approaches were implemented for classification, viz., decision tree (DT), support vector machine (SVM), quadratic discriminant analysis (QDA), K-nearest neighbors (KNNs), AdaBoost (AB), Gaussian Naïve Bayes (GNA), logistic regression (LR), extra trees (ET), random forest (RF), histogram gradient boosting (HGB). Further, deep convolutional neural networks (CNNs) and transfer learning-based Inception ResNet V2 algorithms were used to analyze in the context of deep learning implementations. In this work, the classification of diabetic foot disease through plantar thermograms was conducted using deep learning implementations. The data

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augmentation is also done to address the paucity of data. Here, deep learning-based models with augmented dataset prove better outcomes.

Keywords Deep learning · Inception ResNet V2 · Machine learning · Pre-trained CNNs · Transfer learning · Object identification · Convolutional neural network

1 Introduction

Image classification is one of the important processes in digital image processing and analysis. Humans, with their inherent nature, visualize the scenes around them, understand the environment, and learn to classify objects. However, an automatic classification system using a computer complements the classification process. Image classification is performed by assigning a label to the image based on the attributes computed [1]. It can be carried out by classifying the images into either two classes or multiple classes (more than two classes). Image classification, in general, entails four steps: collection, preprocessing, extraction of features, and classification.

The machine learning algorithms are of present concern and have innovative around the different domains; however, ensemble learning algorithms give better in comparison with machine learning [2–4]. However, deep learning became the owner of the image domain. Machine learning is working where feature extraction is done manually, but in deep learning, features are selected automatically by deep learning architectures [5–8].

In machine learning, a convolutional neural network (CNN or ConvNet) is a sort of feed-forward network that closely resembles the pattern of the visual cortex in animals. A CNN's capacity to recognize spatial patterns in data makes it ideal for image categorization. The convolution operation in mathematics resembles the response of the individual neuron to the stimulus within the receptive field. In a traditional neural network, each layer takes a two-dimensional input, whereas in a CNN, each layer is a three-dimensional layer [9, 10]. It means that in CNN, besides the two dimensions—height and width—of the image, the third dimension, namely the depth of the image, is also taken into consideration. The depth of the image corresponds to the number of color channels like red, green, and blue channels. Each layer of the ConvNet converts the input volume to output volume in three dimensions with neuron activations. A CNN consists of several layers like convolutional layer, pooling layer, rectified linear unit (ReLU) layers, and fully connected layers. Different CNNs have evolved with variations in the dimensions of the input image, the number of layers, stacking of layers, and order of layers. A different model of deep learning such as ResNet-50 [11], GoogLeNet [12], Inception Net [13], and Inception ResNet [14, 15] extracts significant features from the pre-trained deep CNN model and provides better models. This network is created by assimilating the two utmost popular deep CNNs, ResNet [11], and Inception [13–15], but only batch-normalizing the standard layers rather than the summations. The residual modules are utilized to increase the number of Inception blocks [16].

The motivation of work is to provide deep learning intelligent detection system to identify diabetic foot disease through plantar thermograms with higher accuracy. In this paper, we focus to compare the existing machine learning algorithms with our proposed deep learning and augmented data based Inception ResNet V4 utilization for detection of foot diseases.

2 Literature Survey

In computer-based medicine, machine learning and deep learning techniques have been extensively utilizing [17–20]. Pattern recognition, categorization, autonomous control, and optimization have all been effectively implemented using computational intelligence algorithms (CI). ANN is the most well-known of the black-box techniques, with the vast majority of published research achieving an accuracy of 80% in diabetes prediction.

SVM, which is the utmost efficacious algorithm in both natal and medical datasets [21], is another option that has improved accuracy. This is because artificial neural network uses derivative-based algorithms to determine the weights, which have a sluggish convergence rate and frequently provide unsatisfactory results [22]. Deep learning is another wonderful methodology that has been gaining traction. We will now look at similar research that employs CI techniques to categorize diabetic feet in a variety of ways. Kavakiotis et al. [21] give an in-depth look at machine learning and data mining applications. After introducing a range of various types of diabetes and datasets, the paper investigates approaches such as ANN, logistic regression (LR), KNN, and random forest. SVM is the utmost effective and extensively used classification system. With independent component analysis (ICA) algorithms, the work in [23, 24] focuses on proficient data coding by eliminating input data redundancy. The data was gathered by putting the system to the test in the Pima dataset, where the SVM algorithm successfully categorized diabetics 98% of the time. Because ICA reduces the reliance on statistics in the acquired data, it improves the classifier's ability to determine appropriate class borders in CNN [25].

3 Materials and Method

3.1 Dataset Collection and Preprocessing

A dataset of thermal pictures (thermograms) of the plantar region has been used in this paper [26]. A total of 122 diabetic participants and 45 non-diabetic participants were included in the database. Figure 1 illustrates some examples of plantar thermograms used in this study.

Fig. 1 Plantar thermograms

3.2 Methodology

In this work, we applied machine learning techniques such as DT, SVM, QDA, KNN, AB, GNA, LR, ET, RF, and HGB on collected dataset and then on augmented dataset. In addition, deep convolutional neural network and transfer learning Inception ResNet v2 approach were deployed as depicted in Fig. 2.

Training. We explored whether a variety of pre-existing networks (e.g., Inception and others) can be clasped by a dataset that is drastically different from the data they were originally trained for (e.g., ImageNet).

Experiment Setup. Because CNNs require a three-dimensional tensor as input, this work utilized a patch-based labeling technique that is inherently aligned with CNNs. The thermal images were divided, each of which comprises definition for granular level, and the image center was labeled with a class. The CNN used in this experiment was ResNet Version 2. During training, the original deep architecture's parameters were kept.

Backpropagation is used to train CNNs by curtailing a cost function associated with the unidentified weights. The loss function is a weighted average of logarithmic

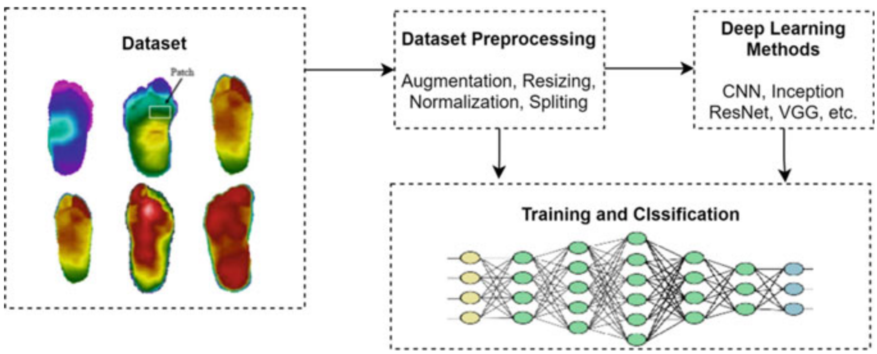

Fig. 2 Proposed approach

illustration of likelihood of categorizing each training image successfully throughout the whole training set. It is exemplified by the following:

$$L = -\frac{1}{|X|}\sum_{i}^{|X|}\ln(p(Y_i|X_i)) \tag{1}$$

X_i is the ith training picture with the matching label y_i, and $p(Y_i|\mathrm{X_i})$ is the likelihood value designating accurate classification of X_i. For minimizing the cost function, a conjoint training approach is stochastic gradient descent. The following formulas describe how to update the weights:

$$\gamma^t = \gamma^{\left\lfloor \frac{tN}{|x|} \right\rfloor} \tag{2}$$

$$V_l^{t+1} = \mu V_l^t - \gamma^t \alpha_1 \frac{\partial \hat{L}}{\partial W_l} \tag{3}$$

$$W_l^{t+1} = W_l^t + V_l^{t+1} \tag{4}$$

where

W_l^t weights of lth convolutional layer
V linear transformation
α_1 learning rate
μ momentum indicating preceding weight
γ scheduling rate
α learning rate.

Overall experimentation was conducted on the TensorFlow Keras platform through Python programming [27, 28].

4 Results

4.1 Machine Learning Algorithms Analysis

Table 1 included the initial comparisons on base and augmented data by applying machine learning and ensemble learning models. These outcomes were analyzed through parameters and attained 80% of accuracy with higher precision and recall.

Table 1 Machine learning with base data and augmented data

Algorithms	Accuracy		Precision		Recall		F1-score		MC		Kappa score	
	Base	Aug_Data	Base	Aug_Data	Base	Aug_Data	Base	Aug_Data	Base	Aug_Data	Base	Aug_Data
DT	0.65	0.48	0.60	0.44	0.65	0.44	0.59	0.44	0.25	-0.12	0.22	-0.12
SVM	0.80	0.63	0.40	0.32	0.50	0.50	0.44	0.39	0.00	0.00	0.00	0.00
QDA	0.61	0.61	0.55	0.59	0.58	0.59	0.54	0.59	0.13	0.19	0.11	0.18
KNN	0.62	0.63	0.51	0.58	0.52	0.56	0.51	0.55	0.03	0.14	0.03	0.13
AB	0.68	0.50	0.58	0.38	0.60	0.42	0.58	0.39	0.18	-0.20	0.17	-0.18
GNB	0.65	0.56	0.56	0.50	0.59	0.50	0.56	0.50	0.15	0.01	0.14	0.01
LR	0.58	0.60	0.46	0.55	0.45	0.55	0.45	0.54	-0.08	0.10	-0.08	0.09
RF	0.79	0.63	0.61	0.57	0.54	0.52	0.53	0.46	0.12	0.08	0.10	0.05
ET	0.77	0.58	0.57	0.39	0.53	0.47	0.52	0.39	0.09	-0.12	0.08	-0.07
VC	0.63	0.67	0.49	0.64	0.48	0.59	0.48	0.58	-0.03	0.22	-0.03	0.20
HGB	0.73	0.60	0.57	0.48	0.56	0.49	0.57	0.44	0.13	-0.03	0.13	-0.02

4.2 Deep Learning Algorithms Analysis

In this paper, better classification technique we tried to identify in terms of deep learning algorithms and comparison with machine learning algorithms. So CNN and Inception ResNet V2 were implemented and compared. Higher training and validation accuracy, i.e., 100 and 89%, were identified on base data. By training on the augmented dataset, the validation accuracy improved by 97 and 79%. By using augmented data in Inception ResNet V2 algorithms, it is identified better results in comparison with machine learning with/without augmentation, CNN with/without augmentation, and Inception ResNet V2 without augmentation (Fig. 3; Tables 2, 3 and 4).

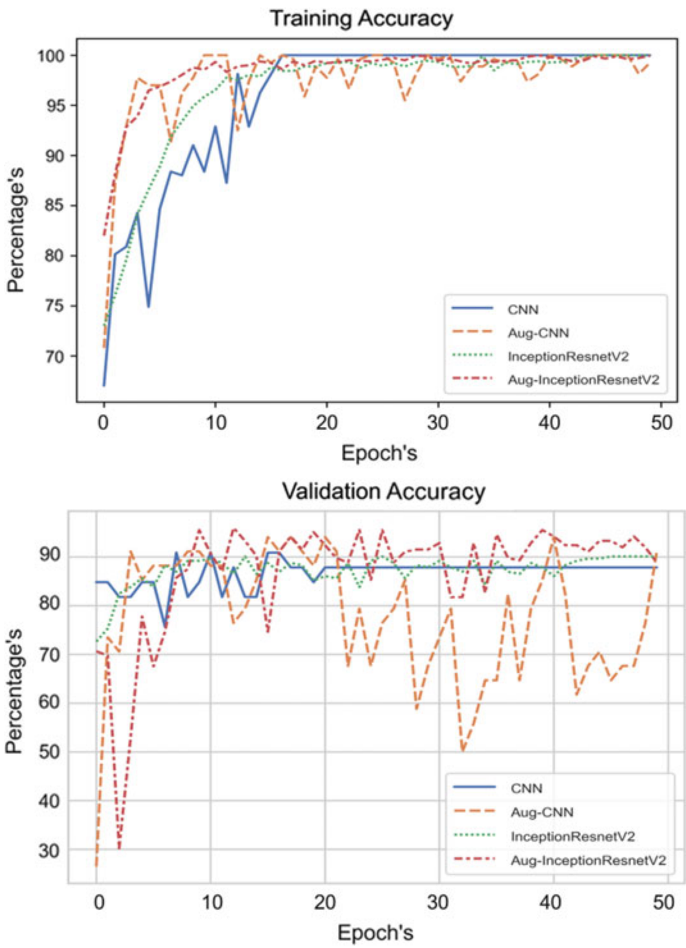

Fig. 3 Comparative analysis of training accuracy, validation accuracy, and area under curve

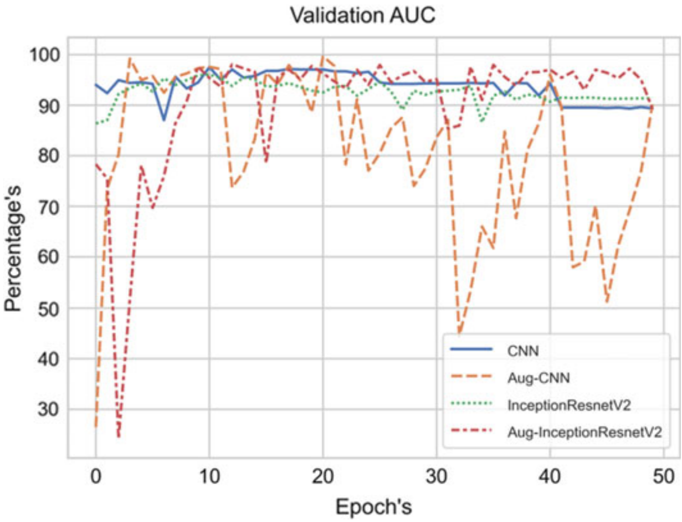

Fig. 3 (continued)

Table 2 Training accuracy

Epochs	CNN	Aug-CNN	IRV2	Aug-IRV2
1	0.67	0.71	0.73	0.82
10	0.93	1.00	0.97	0.99
20	1.00	0.98	0.99	0.99
30	1.00	1.00	0.99	0.99
40	1.00	1.00	0.99	1.00
50	1.00	0.99	1.00	0.99
60	1.00	1.00	1.00	1.00
70	1.00	1.00	1.00	1.00
80	1.00	0.99	1.00	1.00
90	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00

5 Conclusion

This work presents an evaluation of traditional classifiers like DT, SVM, QDA, KNN, AB, GNA, LR, ET, RF, and HGB and those of contemporary prominence like CNNs. The goal is to identify trends in diabetic patients' thermal pictures. After a feature extraction process, the results of the initial simulations employing classical classifiers were satisfactory. However, the deep learning implementations not only to enhance the results but also, in some situations, to eliminate the time-consuming work of

Table 3 Validation accuracy

Epochs	CNN	Aug-CNN	IRV2	Aug-IRV2
1	0.85	0.26	0.73	0.71
10	0.91	0.88	0.90	0.91
20	0.88	0.94	0.86	0.92
30	0.88	0.74	0.89	0.93
40	0.88	0.94	0.86	0.94
50	0.88	0.82	0.90	0.88
60	0.88	0.85	0.90	0.93
70	0.88	0.85	0.90	0.93
80	0.88	0.74	0.90	0.94
90	0.88	0.82	0.90	0.93
100	0.88	0.85	0.90	0.96

Table 4 Validation area under curve

Epochs	CNN	Aug-CNN	IRV2	Aug-IRV2
1	0.94	0.26	0.86	0.78
10	0.98	0.98	0.96	0.95
20	0.97	1.00	0.93	0.96
30	0.94	0.84	0.93	0.95
40	0.94	0.96	0.91	0.97
50	0.90	0.90	0.91	0.91
60	0.90	0.91	0.91	0.96
70	0.90	0.96	0.91	0.97
80	0.90	0.83	0.91	0.97
90	0.90	0.91	0.91	0.96
100	0.90	0.94	0.91	0.98

feature mining and segmentation of the preferred patterns. Outcomes gained with DL are superior and need less training time.

The results show that commonalities in the temperature distributions of the thermograms influenced consecutive classes. In this scenario, CNN and Inception ResNet V2 produce good results utilizing sensitivity, accuracy, and AUC values even in the most difficult classification cases.

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Sensory Nerve Conduction System with Non-invasive Glucose Monitoring Using Iot-Based Assessment

V. Vidya Lakshmi, S. Manju, S. A. Anushka, P. Aruna, R. Dharini Devi, and Katuru Gowthami

Abstract Health monitoring framework based on Internet of things (IoT) has been introduced as of late for improving the quality of medical care administrations. To control glycemia, patients analyzed with diabetes mellitus should screen their blood glucose levels frequently. Subsequently, they must play out a capillary test at least three times each day, also a laboratory tests few times each month. These principal strategies present trouble patients as they need to undergo the invasive method of pricking their fingers to figure the glucose level, yielding uneasiness and trouble. Further, patients affected by diabetes may have a possibility of damage in their nerve conduction system. An Internet of things (IoT)-based system for non-invasive blood glucose monitoring with a simultaneous nerve study system has been proposed in this paper. An Arduino controller with a sensor node is used for monitoring and data transferring to the cloud.

Keywords Nerve conduction · Non-invasive glucose monitoring · Glycemia

1 Introduction

Today, the Internet has turned out to be one of the indispensable components of our day-to-day lives. It varies with strategies of how each person lives, works, plays and learns. The Internet fills in as a key instrument for various functions like training, finance, business, ventures and amusements, social networking, purchasing and so on. Hence, IoT is the future of the Internet's new mega fashion. Imagining a world where a few objects will detect, impart and exchange data over an individual Internet protocol or public networks should be possible through IoT. The interconnected articles gather information at normal stretches, analyze and commence required activities, giving

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associate intelligent networks for examining, planning and decision-making. This is the Internet of things universe. IoT is commonly conceived of as connecting items to the Internet and executive those functions or remote watching. However, the meaning of IoT is making a splendid, imperceptible organization that may be recognized, controlled and programmed.

Specialists' facilities persistently require excellent organization. The database of every patient must be adequately useful. Likewise, there should be a chance for data avoidance. Similarly, the lenient data should additionally reinforce to be kept hidden in the event. Social insurance may be the larger concern, claiming various countries in the universe. Improving those patients who exist, especially in the more fragile pieces of the specific social order that join those older, genuinely handicapped and additionally, chronically sick patients may be the principal thought that will make progress.

IoT innovation utilizes brilliant detecting gadgets and the Internet to provide a powerful answer for the challenges confronted by organizations, public and private sector ventures and government associations around the world. The IoT developments have raised another world view in utilizing smart framework and wise gadgets to survey information for different utilizations. A fundamental IoT framework with summed up engineering is given in Fig. 1.

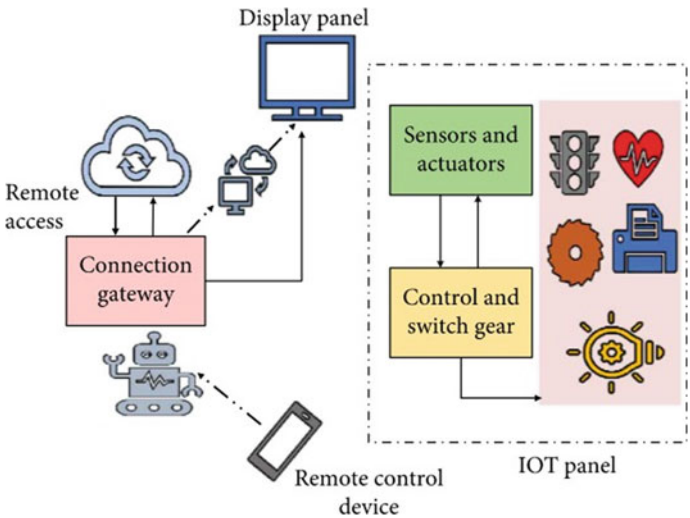

Fig. 1 IoT architecture

2 Literature Survey

To reduce inactivity and data usage, Arbi and Saffih suggested a fog-based system framework for health monitoring. He introduced a new load balancing scheme (LBS) to balance the load among fog hubs when the health monitoring system is distributed on a big scale [1].

Hussain and Lu et al. zeroed in on the recommendation of a fog driven remote, continuous, brilliant apparel and IoT-based structure for omnipresent well-being and wellness examination in a smart gym surrounding. The suggested system plans to support the well-being and wellness center dependent on body entrails, body development and well-being associated information. The system is relied upon to help competitors, coaches and doctors with the translation of various actual signs and raise alarms in the event of any well-being peril. Provided a strategy to gather and dissect practice explicit information which can be used to quantify practice power and its advantage to competitor's well-being and fill in as suggestion framework for impending competitors [2, 3].

Kuang and colleagues provided a workable solution for IoT-driven remote skin infection conclusion applications. The exam results can be separated into three folders. The primary file contains a sophisticated AI design that is supported by IoT-fog-cloud remote analyzing engineering with hardware models. The following file is an overview of the displays of AI models for skin disease identification [4].

Vidhya and Inbamani proposed a model framework for PPG checking utilizing Internet of things (IoT). PPG wave shapes are then displayed utilizing either Fourier or Gaussian strategy; the design boundaries subsequently acquired are really addressing the tested PPG Data. PPG information is caught by a reflectance-type PPG sensor with an inserted regulator throughout a deliberate time period [5].

Zholdas and Joy proposed a fast and productive E2E examining protocol for NB-IoTMDs depended on the RLNC technique to advance the examining time. The suggested approach can recuperate the greatest count of lost packets in a short second, subsequently limiting the quantity of retransmission [6, 7].

Bhat and Bhat mean to expand the program by coordinating apparel and inconspicuous sensors to screen patients having COVID infection. Further, coordinate machine learning algorithms to anticipate unsafe occasions and make a move quickly to amplify treatment adequacy [8].

Dasari used an electrical incitement on the back tibial nerve to quantify the somatosensory evoked potential (SEP). To work on the productivity of incitement, the expected field and current thickness appropriations deep down terminals were reproduced with a three-layer hypothetical design. To investigate the possible field of point charge, the mirror strategy was utilized. The possible field to one surface electric post was given by reconciliation of the field and the boost region. Super imposition of two unipolar fields determines the potential field conveyance of the bipolar terminals. At last, Laplace condition was used to determine the current thickness conveyance [9].

Guntha 2019 gives an on invasive way to deal with evaluating neuromuscular illnesses, including amyotrophic parallel sclerosis. To research this further, a gathering of solid grown-up rodents, a gathering of rodents fourteen days post sciatic crush and a gathering of creatures a half-year post crush went through EIM of the gastrocnemius–soleus complex [10].

Hebbale and colleagues portray introductory trials to decide the possibility of recording practically unmistakable neuro electric signals from the outer layer of the bunny's sciatic nerve. A sleeve cathode gathering was built; it composed of two balanced exhibits, each with four cords similarly dispersed throughout the circuit of the anode. The cathode gathering was put on the sciatic nerve adjacent to the popliteal fossa [11].

Santhosh Kumar, Hanumantappa and Chikkoppa concentrated on an exact hypoglossal nerve design is worked with heterogeneous conductivity in COMSOL. To boost the advantage of neural incitement, the electrode hypoglossal nerve interface (EHNI) impedance ought to be examined. The properties of the EHNI impedance in its two sections resistive and capacitance are given by their enactment results. The boundaries of the EHNI are related with the dimension of the cathode's affiliates. If the modest dimension of these affiliates is more, then the impedance will be high, and the capacitance will be low [12].

3 Proposed System

High glucose harms the nerves, and the nerves that are harmed might quit sending messages to various parts of the body. Nerve harm can cause medical conditions going from gentle deadness to torment that makes it difficult to do ordinary exercises. A big part surprisingly with diabetes has nerve harm.

The velocity at which electrochemical drive that spreads down a neural pathway is called nerve conduction velocity (NCV). The conduction of velocities is impacted by a broad bunch of variables including gender, age and distinctive restorative constraints and concentrates on think about unrivaled decisions of various neuropathies. Generally, conduction speed is unequivocal to each individual. Nerve inspirations are significantly move back diverged from the speed of electrical drive anyway fast appeared differently in relation to the speed of circulation system.

In this design, the feed in is attained from a minute electric stunner to spark the electric palpitation as shown in fig. A dual point electromyography (EMG) detector electrode will be bound to the hand of the case [13]. Grounded on the EMG signal attained from the detector, this signal will be intensified further fore sent to Arduino Uno. Arduino will perform analog-to-digital (ADC) conversion of intensified signal to the digital number to show the NCV output on the TV display. Support vector machine grounded machine literacy algorithm used to classify the inflexibility position of the cases.

3.1 Nerve Conduction Study (NCS)

A nerve conduction velocity (NCV) test is also called as nerve conduction study (NCS)—gage how quickly an electrical drive travels through the nerve. NCV can recognize any damage in the nerve conduction. During this test, the nerve is animated, typically with terminal patches joined to your skin.

EMG and nerve conduction studies are utilized to aid with diagnosing an assortment of muscle and nerve issues. An EMG test assists find with excursion assuming that muscles are reacting the right.

3.2 Pulse Rate Sensor

Pulse rate sensor is a ingenious plug-and-play heart rate detector for Arduino. The detector is affixed to the fingertip or earlobe of the subject and entrapments into Arduino. It also incorporates an open-source observing app that displays your pulse in a graph in real time.

The front part of the detector is concealed with a heart shape totem. This part makes contact with the skin. On the anterior, you see a small round hole, where the LED glows through from the reverse. There is a small square just under the LED, an ambient light detector quite like the one used in cell phones, laptops and tablets, to acclimate the display brilliance in various light conditions. The LED glows light into the earlobe or fingertip, and detector interprets the quantum of light that reflects back. By this method, it computes the heart rate. Their main parts are mounted on the other side of the sensor.

3.3 LM35 Temperature Sensor

LM35 is an analog direct temperature sensor. Its affair is proportionate to the temperature in degree Celsius. The working temperature of this sensor ranges from −55 °C to 150 °C. In response to every 0 °C rise or fall in temperature, the affair voltage varies by10 mV. It can be operated in 5 V as well as in 3.3 V force, and the stage by current is lower than 60 u A.

3.4 ESP8266-01

ESP8266 is commonly known as a Wi-Fi module; however, it is really a microcontroller. ESP8266 is a microcontroller created by Espressif Systems, an organization in Shanghai. It can perform Wi-Fi-based activities; hence, it is generally utilized as a Wi-Fi module (Fig. 2).

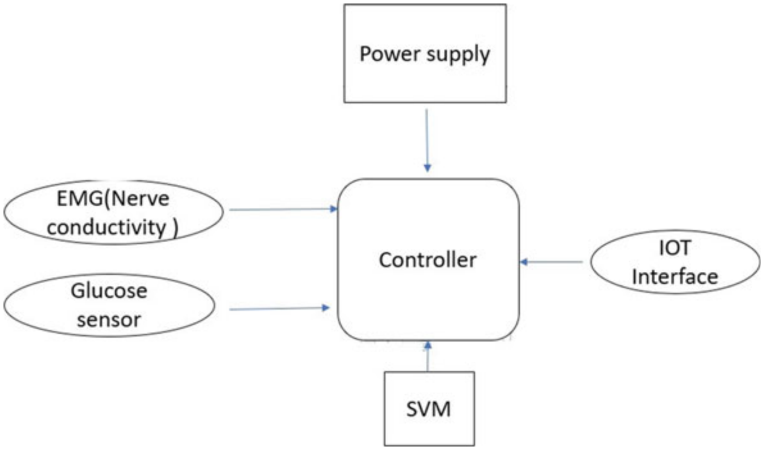

Fig. 2 Proposed system

4 Result and Discussion

The proposed framework is executed by utilizing Arduino regulator with glucose and nerve conductivity sensor module. Figure shows the general execution with ESP module as a server (Figs. 3, 4, 5 and 6).

Figure shows the conductivity plot noted from the IoT server. The relating information is put away in server for information mining reasons (Fig. 7).

Fig. 3 Overall system implementation

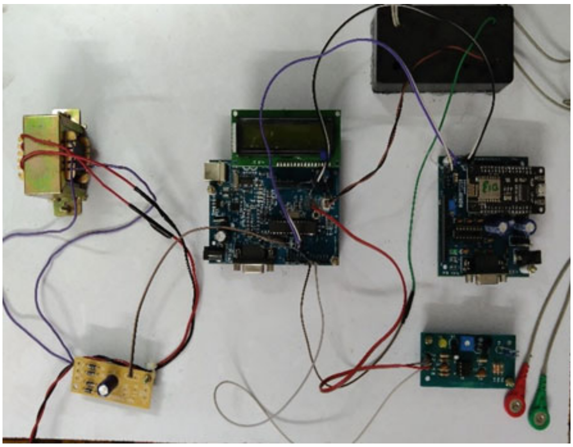

Fig. 4 Numerical display One

Fig. 5 Numerical display Two

5 Conclusion

Diabetes is a significant general health problem influencing in excess of 450 million individuals. Physiological and trial elements impact the precision of non-invasive glucose checking, and the above impacts should be defeated prior to supplanting the invasive strategy. The precision of glucose prediction is based on the relevant employment of machine learning strategies. Among the variety of utilizations empowered by the Internet of things (IoT), associated and smart medical care is an essential and significant one, also organized sensor, either worn on the subject's body or inserted in our living surrounding; create conceivable the association of enhanced data characteristics of our physical and psychological wellness. This work proposed an IoT empowered glucose and nerve conductivity observing system designed for efficient health monitoring.

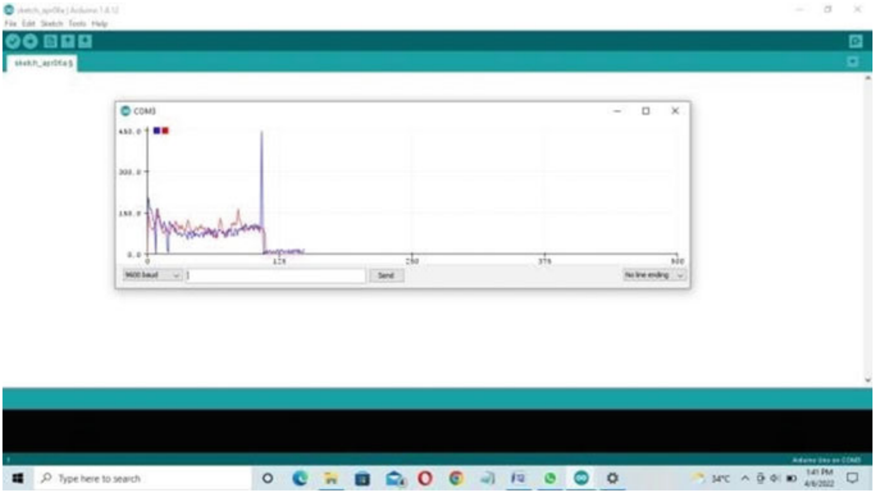

Fig. 6 Conductivity plot

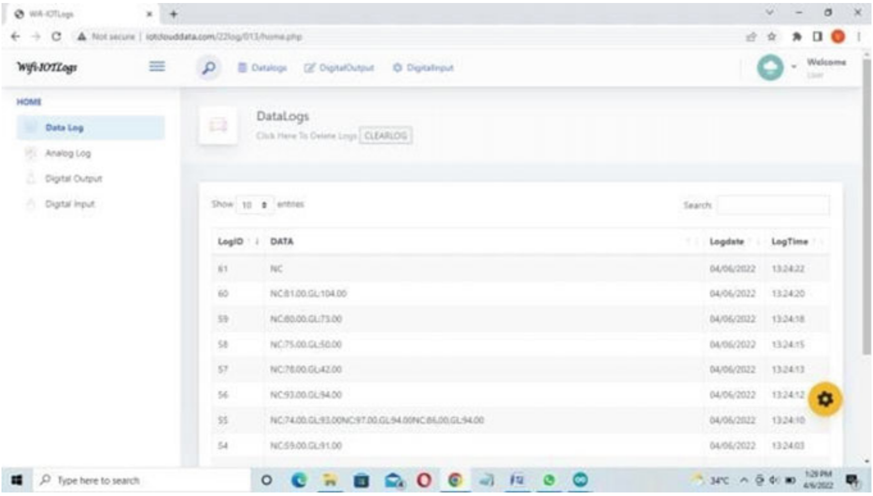

Fig. 7 Data log

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Detection and Classification of Waste for Segregation Based on Machine Learning

Pradnya Borkar and Krutika Channe

Abstract In the today's world, waste management is a prevalent problem and is increasingly growing with the growth in urbanization. In many nations, waste management is a crucial component of environment development. Enhancing management needs are usually recognized by officials in India like developing countries. Nevertheless, little effort is made to improve the situation and long-term changes. We know that 19.6% of the population of India is equivalent. A smart garbage management system is necessary with the development of intelligent cities throughout India. Since the quantity of waste grows every day. The best approach to dealing with this problem is essential, because the waste generated exceeds 2.5 billion tons. To enable the dumping sites to confirm that garbage is organized of appropriately, the waste must be sorted in a basic method. Waste sorting requires more staff and also takes more time. In numerous techniques, waste could be managed and sorted. Processing of image to analyze and categorize waste can be a highly effective way in the process of waste materials. This paper discusses the model based on MLP and Naïve Bayes for waste segregation. These also discuss the disadvantages and ways to overcome existing systems. The paper also presents a design for system for reducing physical effort and promotes automatic separation of waste.

Keywords Classification of waste · Waste separation · Image processing · Convolutional neural networks · Support vector machines

1 Introduction

Across the globe, millions of tons with almost one lakh of waste being produced daily in India. Nearly 90% of this waste is dumped into sites and bodies of water. This

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can have a significant environmental impact. To reduce the possibility of additional waste contamination and to increase the number of recycled goods, the waste must be sorted as quickly as feasible. With intelligent trash bins, it helps to sort waste at both local and wide scales automatically in this regard. Currently, it is manual work to recycle non-biodegradable waste.

To remove complex items of form from the current recycling process, various recycling facilities for waste recycling and incorporating broad philters with tools are needed. By minimizing waste and reducing waste sorting time, strengthening this extraction process would help to increase plant performance. Furthermore, as opposed to hand-made classification, this would improve classification precision, which will help both the atmosphere and the economy. The machine is fed a stream of photographs in a similar manner to how it is handled at waste plants. The picture distinguishes between related objects and categorizes each one separately. The image recognition algorithm is used to separate images into six groups. We can quickly distinguish recyclable objects using this method using only a single image.

Data mining is the practice of effectively using massive datasets to arrive at a reliable inference on proposed evidence based on detailed measurements and identify various trends correlated with the area of used datasets. Several methods can be used to achieve this, including analytics, artificial learning, pre-existing, custom-designed algorithms, and other tools. It is, therefore, possible to provide a valid interpretation of the evidence and effects, as well as their dependence and from the other facts that concern them. For image analysis, you can use knowledge discovery and other programs like OpenCV, MATLAB, and others.

The convolutional neural network (CNN) is a set of neural networks used jointly to process the entry and allocate logical weights to various parameters linked to data in terms of their value and effect on the performance for the data in question and other features. It was created to view data from various sources as the neural network could and to make decisions on the basis facts and criteria considered. Image processing approaches are very advantageous for CNN even though they can be extended to almost any information source while also delivering above-average precision for image detection and recognition.

2 Related Work

Currently, the waste is divided into different category by several machines [1]. There are few of them.

- Separator eddy current—This technique aims to separate different metallic components from garbage. It functions by employing an electromagnetic technique to separate trash into heavy metal and nonmetal groups.
- Sorting induction—The waste is conveyed to a production line equipped with a variety of sensors in this system. The sensor aids in the identification of various metal forms in waste. The sensors are connected to a quick-air jet mechanism that separates the metals that have been detected.

- Near-infrared sensors (NIR)—The reflectance characteristic employed in this method is the factor that is used to differentiate between them since different components have varied reflecting properties.
- X-ray technology—The thickness characteristics of materials materials are used to differentiate them in this scheme.

The methods mentioned above are effective on a local scale but ineffective on a large scale. These computers are extremely challenging to keep up with. All of these computers would have to be imported because of the daily waste produced. However, it would be extremely expensive to buy and maintain these computers. These techniques, particularly the manual approach, are frequently intrinsically wrong.

The study in [2] uses machine learning to detect garbage in photos in an effort to streamline this procedure. Support vector machines and deep learning with CNNs are two popular learning techniques that have been employed (SVMs). An input of a 256–256 colored png waste image is given in each algorithm, which divides garbage into the three primary categories such as plastic, paper, and metal. The accuracy given by two basic classifiers was compared in order to select the most appropriate one, and the Raspberry Pi 3's selection was used. Just the two neural networks are used by the author to calculate classification speed and apply the best models on the Raspberry Pi. The findings show that SVM had a 94.8% grading accuracy, while CNN had an 83% grading accuracy. SVM has demonstrated exceptional adaptability to a variety of waste categories. George E. Sakr et al. employed MATLAB 2016a for their SVM training and NVIDIA DIGITS for their CNN training. According to the author's examination, one disadvantage of the training sets was their small quantity of photos. The photos' 256×256 original resolution was reduced to 32×32 pixels for the images. This decline led to an increase in the problem of overfitting. On the Raspberry Pi 3(0.1 s), the final model utilized in this investigation executed fairly.

The AutoTrash Project [3] developed by a group of people, a sorting device that separates waste into compostable and recyclable components. The team constructed its own layer and utilized Google's TensorFlow algorithm to recognize the object. The Can is divided into several sections, and on the basis of item's classification, the spinning top can deposit it in the right portion location. Commodities will only be separated by auto trash into categories for recyclables to locate it. The approach uses convolutional neural networks to categorize and compostable, but recycling will benefit more from having more than two major categories.

Garbage spot [4] can also be identified with the help of smartphone. In [5], the author looked at the division of waste into six categories, including cardboard, metal, paper, and so on. Using a list, a compilation of over 400 images per group was done by hand. The classification mechanism promoting transforming functions like SIFT and CNN classifier was the frameworks used to categorize the input images into number of various groups. In this case, a network somewhat resembling AlexNet was implemented using an eleven-layer CNN architecture. Experiments demonstrate that the SVM is superior to the CNN in terms of effectiveness. Thirty percent of the entire data were used for testing, while the remaining seventy percent were used to train the mechanism. With a 30% training error, 63% accuracy was attained. Such categories were not included in the analysis to detect maximum precision because there were no ideal hyperparameters, demonstrating that the CNN lacked sufficient qualification.

The author [6] discusses the gray level co-event matrix (GLCM) technique for garbage identification and classification. GLCM and advanced contact mechanization have been combined to enhance the waste assembly process. Two GLAM parameters—scrolling and quantification—have been researched to determine the ideal parameter values in trash photographs. The suggested plan makes use of a range of networking technologies, including geographic information systems (GIS), RFID, and general packet radio systems, to address the current issues and make solid waste management easier (GPRS). Functionality is extracted using the GLCM and supplied into the multi-layer panel (MLP), and K-nearest neighbor (KNN) for waste sorting is used.

3 Classification of Images for Waste Segregation

(A) Classification Based on Shape

In [7], the researcher proposes a novel method for calculating the correlations between different types and recognizing the entity based on the results. The authors determine similarities in their sense by evaluating competitiveness throughout site that allows on the connection between the two shapes and then applying conformity to construct an alignment transformation. A subscript is allotted about each point as the type sense in order to resolve the symmetry issue. The remaining points are recorded in contrast to the reference point's type sense, which offers a clear point of differentiation. Two similar forms would have the same dimensional contexts for intensity values, eliminating interaction between them. The best transfiguration for synchronizing the two modalities is found using the point rivals.

Thin-plate splines that have been regularized provide maps for the transition. The amount of faults is used to calculate the difference between the types in a language that counts the alignment's weight. The problem of identifying the template shape gathered is known as recognition in a closest-neighbor grouping method. Results for contours, logos, numerals, and the COIL dataset are provided. This approach's ability to calculate shape similarity and competitiveness based on shape sensing is one of its most crucial features. This process is easy to understand and simple. As a result, point recording, shape recognition, and dimension matching are all improved since it provides exact descriptions for points. This experiment reveals diversity in several frequent visual shifts, such as significant 3D rotations of real-world models.

(B) Classification Based on Reflectance Properties

The author describes an undiscovered method [8] for categorizing surfaces in actual light that is unknown. Metal, plastic, and paper are the surfaces that are used. Their success serves as an example of what surfaces with random shape will produce.

The algorithm for reflectance estimations shows associations between the surface reflectance and the image data. The geographic distribution of ambient illumination is governed by statistical heterogeneity. The method for categorizing objects from monochrome photographs described in this study makes use of the reflecting characteristics present in real-world surfaces of any geometry.

(C) Classification Based on Material

The author uses the Bayesian approach to categorize things in accordance with material recognition [9]. By processing the image, objects are categorized into various material groups like glass, metal, cloth, and so on. Give the researchers a range of beginner and intermediate features so they can learn and complete different areas of information presentation, as it is difficult to identify fine, proper, and consistent characteristics that can distinguish material in different categories as compared to standard object recognition processes. This paper introduces an LDA model that uses a Bayesian framework to integrate various features to construct an optimal combination of characteristics.

This system has an identification rate of 44.6%, which was far higher than the 23.8% attained by the state of the art. A Bayesian network is utilized to acknowledge the components, together with a wide range of realistic values. The ALDA system has enhanced the identification rate of the suggested model. Compared to the cutting-edge model, this increased reliability and enhanced performance. The researchers have examined the contributions made by each function to the system's overall increase in efficiency. The first paradigm to see images in terms of their materialistic characteristics was this one.

(D) Classification Using CNN

Without a question, AlexNet is one of the most commonly used image recognition CNN models. The ImageNet large-scale visual reconnaissance challenge received accolades in 2012. AlexNet is mostly used because of its not as deep and reliable simple architecture. It is popular for its ability to manage huge databases as well.

The author [10] has been trained in a massive, deep neural network, divided into thousands of different classes by roughly a million high-resolution images. Compared to the previous iterations, error rates of 37.5 on top 1 and 17.0% on top 5 were found in the test findings. The neural network contained five convolutional layers and around 60,000,000 neurons. Some of these assisted with max pooling layers and 3 layers with a maximum of 1000 way. Researchers used a strategy called "dropout" to eliminate overfitting.

It is important to note that the effectiveness of the network is decreased when even one convolutional layer is removed. As a consequence, to achieve successful outcomes, the depth of the whole neural network is critical.

Fig. 1 Representative waste images

4 Dataset Collection

Recycling facilities often have to be sorted by hand in the current recycling process. The right way to recycle materials may also be mistaken for consumers. Using computer view, we may determine based on a photograph what recycling category a given object belongs to.

The technique uses a total of 50 trash items that are frequently found in the investigation's field. Paper, plastic, metal, and glass, as well as kitchen waste, are the five major types of recyclable waste. Books, magazines, cups, and packets are examples of paper products. Each category is made up of representative objects. These recycling groups include over 99% of all recycled content. Figure 1 depicts representative waste photographs.

5 Proposed Model for Segregation

The system focuses on waste material identification, sorting, and segregation. Waste that is disputed in the landfill is disposed of, creating additional health hazards. The system seeks to identify and classify waste autonomously, which requires minimum human intervention. All of this process of waste recognition depends on the objects' shape and size. The system is trained by means of a dataset using machine training methods called CNN. The system control will waste and isolate it automatically in order to decrease physical work. For waste management purposes, this may be a large-scale industry castoff. Figure 2 shows the proposed system. In order to eliminate noise, to improve image quality, image preprocessing technology is necessary. In order to limit the search for anomalies without undue influence from the background of the image, the pretreatment process is important before using an image processing algorithm. The main aim of this process is to delete and ready for further processing irrelevant and surplus parts in the background of the image. The function extraction process is performed. The extraction feature is a process of reducing attributes. Contrary to the choice of features, which determines the predictive significance of existing attributes, the extraction of the feature transforms the attributes. Feature extraction can also be used to improve supervised learning speed and efficiency. The system uses the GLCM (gray level matrix) algorithm for the extraction of feature elements. Create the data extracted and test file and perform data classification. The system uses the hybrid CNN + MLP algorithm for the classification of waste.

For digital image processing, CNN is commonly used. A neural network, or CNN, is a computer program that uses data to make decisions. As inputs, CDN normally takes pictures of the items being studied and categorizes them into different categories. The 3D quantities of CNN's neuron are one-of-a-kind in terms of their breadth, height, and width. The CNN also employs normalization layers, polling layers, completely linked layers, and convolutional layers. Only a small part of the neurons from the preceding layer connect to those in the fully convolutional layer. Multi-layer perceptron (MLP), one of the most well-known non-linear regression and classification deep learning structures, is often used for modeling and predestination.

A hybrid CNN + MLP framework was created to mimic a human sensor and intelligence system. The system is composed of a large number of interconnected subsystems, such as the image system, the central back-end classification system, and the central front-end classification system.

Figure 2 depicts the proposed system's three communicating subsystems and related elements. The arrows depict the workflow and the relationship between the machine and the user. The camera and sensors may be turned on to detect waste as

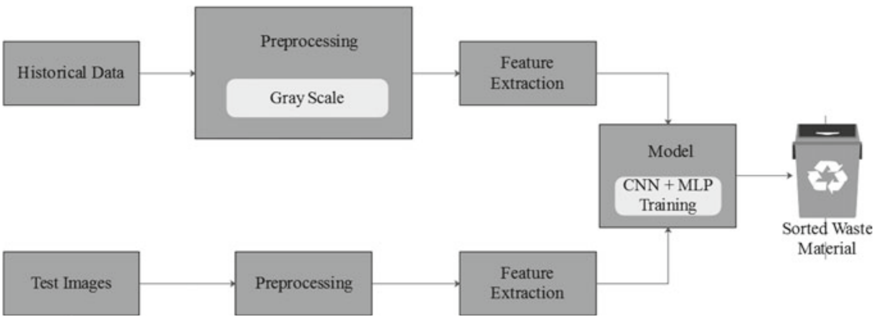

Fig. 2 Proposed system architecture

it enters the hybrid system. A camera takes a CNN-analyzed image as part of the imagery scheme. Simultaneously, the sensor system receives numerical data from objects.

The MLP method, which includes 22 CNN outputs and sensor numerical information, is used to achieve the ultimate performance. MLP can be trained independently of the CNN model in this regard, while the CNN model's weights and preferences are preserved. In reality, since CNN outputs are MLP inputs, these models can also provide binary classification results at the same time.

6 Mathematical Formulation

The mathematical formulation for the proposed system S can be represented as.

1. Initialize the system S with parameters as S = {IN,PRO,FE,T,CNN, M}
2. Input dataset IN = {in_1, in_2, in_3 …….. in_n} IN is the dataset and in_1, in_2, in_3 ……..in_n are the number of images 3. Preprocessing PRO = {pro1, pro2, pro3} pro1, pro2, pro3 shows the steps carried out during preprocessing pro1 be the input dataset reading pro2 be enhancement of input image pro3 be the removal of error from image 4. Feature extraction FE = {fe_1, fe_2, fe_3…f_n} fe_1, fe_2, fe_3…f_n are the features such as border, thickness, and color from the image 5. Training and testing file generation T = {T1, T2} T1 is training file, and T2 is testing file, these files contain various extracted feature values, while training file contains image of 0 and 1 6. Convolutional neural network CNN = {CN, RL, PO, FC, LS} Where CNN is algorithm consisting of various stages as CN is convolutional operation RL be the ReLU activation layer PO be the pooling layer FC be the full connection layer and LS be the loss function 7. Waste classification 8. W = {0, 1, 2, 3, 4, 5} W is the set of class having value 0 to 5 0 be the glass 1 be the paper 2 be the cardboard 3 be the plastic 4 be the metal 5 be the trash

7 Result Analysis

Naïve Bayes Classifier

Naïve Bayes classifier has been implemented on the said dataset for classification. The results obtained by Naïve Bayes classifier algorithm show the precision, recall F1-score, and support for each of the six classes, viz., 0–5. The macro avg precision for the NB algorithm comes out to be 0.52, whereas weighted avg is 0.59. Similarly, the macro avg and weighted avg for recall are 0.50 and 0.44, respectively. The macro avg for F1-score is 0.42, and weighted avg is 0.44. The overall accuracy of the algorithm is 0.44, i.e., 44%. The detailed classification report of the algorithm is shown in Table 1. The confusion matrix for the Naïve Bays algorithm is shown in Fig. 3. The result analysis for all the parameters for each class is sown in Figs. 4 and 5.

Multilevel Perceptron (MLP)

Multilevel perceptron classifier has been implemented on the said dataset for classification. The results obtained by multilevel perceptron classifier algorithm show the precision, recall, F1-score, and support for each of the six classes, viz., 0–5. The macro avg precision for the MLP algorithm comes out to be 0.78, whereas weighted avg is 0.83. Similarly, the macro avg and weighted avg for recall are 0.86 and 0.82, respectively. The macro avg for F1-score is 0.81, and weighted avg is 0.81. The overall accuracy of the algorithm is 0.82, i.e., 82%. The detailed classification report of the algorithm is shown in Table 2. The confusion matrix for the MLP algorithm is shown in Fig. 6. The result analysis for all the parameters for each class is shown in Figs. 7 and 8.

Table 1 Classification report for Naïve Bayes classifier

	Precision	Recall	F1-score	Support
0	0.37	0.86	0.52	44
1	0.57	0.34	0.43	58
2	0.57	0.32	0.41	37
3	0.81	0.33	0.46	80
4	0.58	0.3	0.39	47
5	0.21	0.82	0.33	17
Accuracy		0.44	283	
Macro avg	0.52	0.5	0.42	283
Weighted avg	0.59	0.44	0.44	283

Fig. 3 Confusion matrix for Naïve Bayes classifier

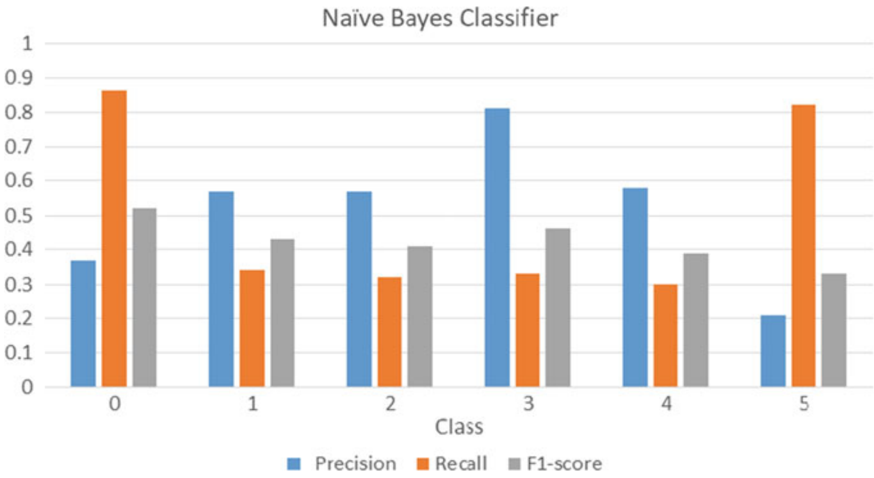

Fig. 4 Precision, recall, and F1-score for Naïve Bayes classifier

8 Conclusion

Many scientists and scientific enthusiasts have already researched and applied different waste treatment and disposal measures and methods. Many machines were also created to aid in the effective execution of this operation. To accomplish the goal, hardware components such as the Raspberry Pi and various algorithms were used. The computer scans object images in order to classify them. However, a significant limitation of both of these devices is that only images containing single objects

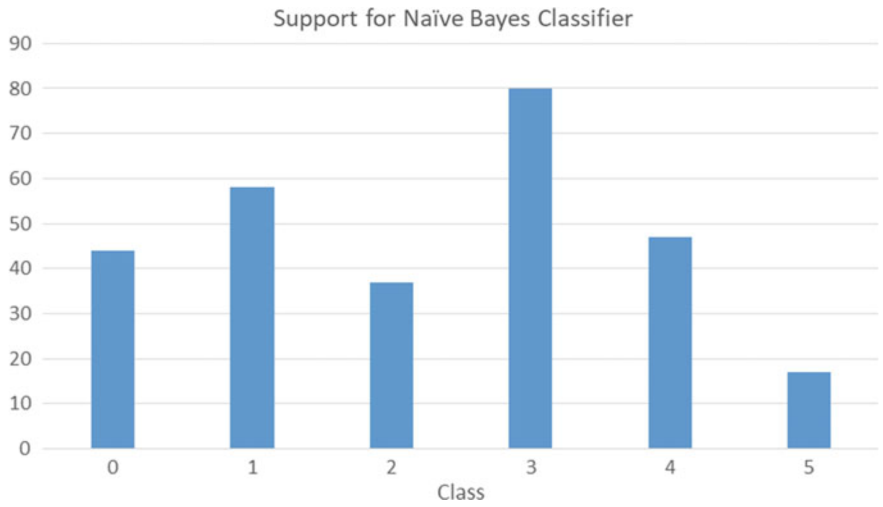

Fig. 5 Support for Naïve Bayes classifier

Table 2 Classification report for multilevel perceptron classifier

	Precision	Recall	F1-score	Support
0	0.92	0.98	0.95	47
1	0.7	0.84	0.77	64
2	0.82	0.97	0.89	38
3	0.85	0.88	0.86	83
4	0.91	0.62	0.74	89
5	0.5	0.83	0.62	12
Accuracy			0.82	353
Macro avg	0.78	0.86	0.81	353
Weighted avg	0.83	0.82	0.81	353

that must be identified and labeled operate with optimum precision. Convolution networks are thought to play an important role in object detection and classification and can be considered the first step in improving these approaches. Procedures and measures that take shape and scale of objects into account have since been created for their identification and classification, but they can only be used on objects that can be assumed to exist of a certain form or size that seems to be a little rough in terms of scrap or waste. Previously, the physical reflective properties of different materials, as well as their material classification, were used to propose methods for classifying photographs.

In order to calculate and assess the correctness and consistency of the implementations used to illustrate the value, execution, and kind of datasets utilized for the stated algorithm, various algorithms were also applied to the same datasets. Current

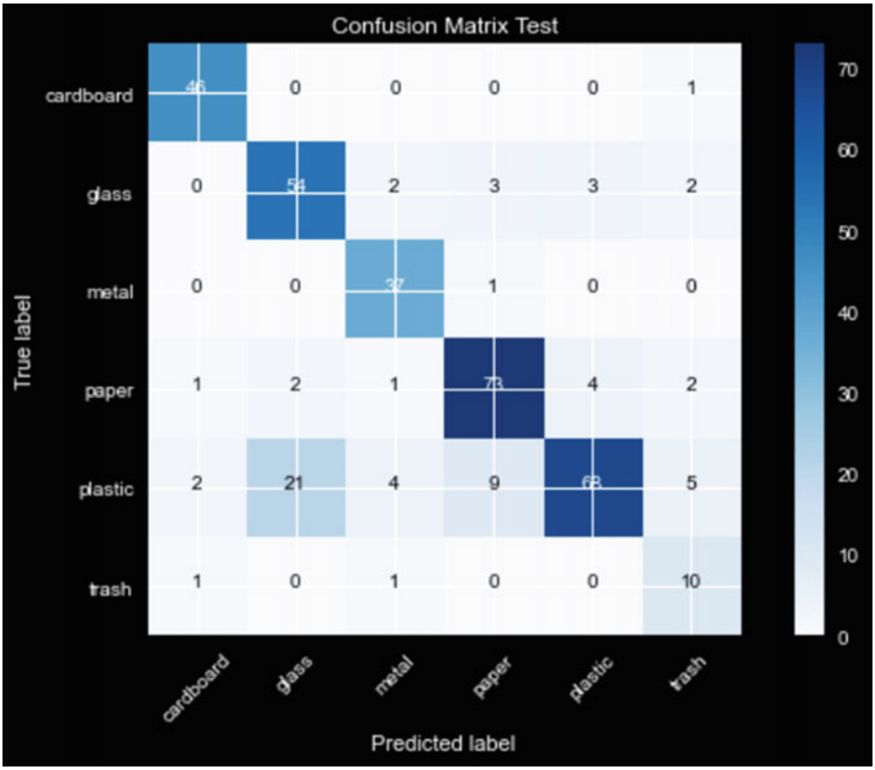

Fig. 6 Confusion matrix for multilevel perceptron classifier

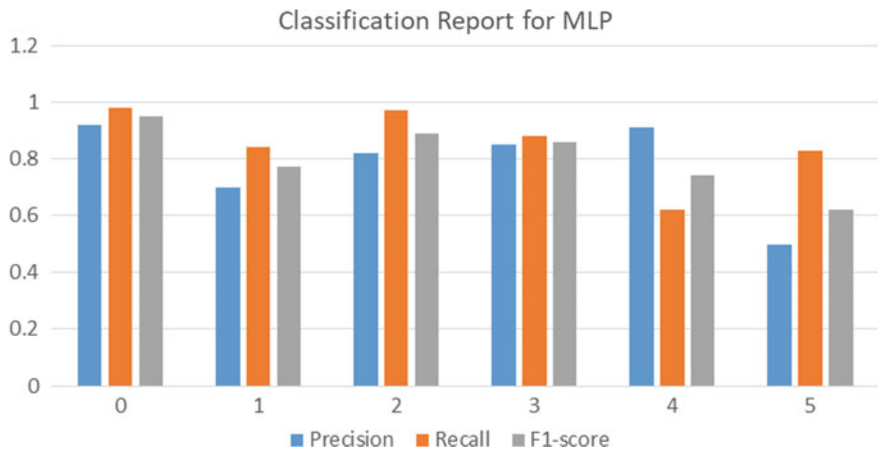

Fig. 7 Precision, recall, and F1-score for multilevel perceptron classifier

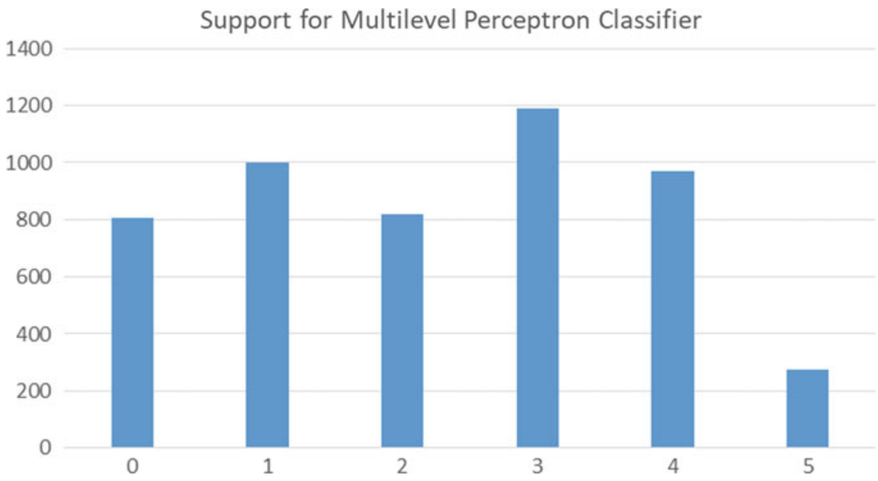

Fig. 8 Support for multilevel perceptron classifier

methods' primary flaw is that they frequently classify just one entity in an image. There would be millions of tons of unwanted accessible, and the operation would take a very long time because it would be quite difficult to collect any object from a waste pile and then find it. Multiple items must therefore be defined and isolated in a single image. The number of excess types that are closed is also greatly reduced in existing models. Wastes that can be recycled or composted are commonly graded. The recyclable materials include plastic, paper, and so on, each of which is recycled separately. As a result, classifying recyclable products from waste and waste into different categories will improve and simplify the recovery process.

Because of the exponential rise in computing and technology, the use of mobile devices has increased dramatically over the last decade. A smartphone, for example, has an estimated life cycle of around two years. The amount of electronic waste generated would skyrocket in the coming decades. Because each component is composed of a different substance and needs to be recycled in a unique way, recycling these parts would be incredibly challenging. It is therefore necessary to process electronic equipment efficiently and perform substantial repairs on it.

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Healthcare Framework for Privacy-Preserving Based on Hyperledger Fabric

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Abstract The healthcare business deals with overly sensitive information that should be handled with care. Names, social security numbers, insurance numbers, addresses, and medical history are all stored in Electronic Health Records (EHRs). Patients, healthcare professionals, medical insurance companies, and research institutes all value such personal information. Patients and healthcare providers, on the other hand, face substantial privacy and security risks as a result of the public dissemination of this extremely sensitive personal data. When health information is transferred, EHR management systems necessitate the use of effective technology. Medical record storage systems are frequently exposed to typical security attack vectors due to current management techniques. As a result, we anticipate the need for new solutions to solve the security and privacy issues that private data poses in healthcare applications. Decentralized, anonymous, and secure EHR handling is possible with healthcare-focused blockchain systems. The needs for privacy and interoperability in healthcare data exchange are examined in this research, and a blockchain-based solution is offered. We used private blockchain technology to examine their suitability for healthcare applications in this paper. The permissioned blockchain structure of Hyperledger Fabric is used in the article. The proposed approach may effectively preserve patient details while maintaining anonymity. The findings of this study show that blockchain technology may be used to promote privacy while also improving interoperability in healthcare information management.

Keywords Hyperledger fabric · Privacy · EHR · Blockchain · Security · Medical data · Healthcare

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1 Introduction

With the digitalization of medical records, there are increasingly more worries about the security and privacy of healthcare data. The infrastructure supporting healthcare applications and managing associated data in the healthcare industry, such as medical organizations and insurance firms, deals with extremely sensitive resources. These resources include EHRs, which contain sensitive personal information such as addresses, names, social security account numbers, health histories, and other information that should not be shared with the public. Personal data has, nevertheless, been the subject of a number of cyber-attacks on the internet. Many medical organizations have been cyber-attacked till date, resulting in the theft of millions of patient information. Due to a lack of technological awareness inside the healthcare business, it still appears to be an easy target for hackers. Indeed, several components of this platform need to be enhanced for privacy protection, like avoiding data loss, illegal access, and personal information leaks.

With the growing use of EHR, there is a pressing need to develop a scaled absolute, transparent, and safe solution to meet the aforementioned concerns. A cutting-edge method that is resistant to typical attack vectors might manage medical data in a decentralized fashion, avoiding the even a one chance of failure or assault. One of the most important drivers is to reach broad consensus among cooperating healthcare providers so that weak security and insider risks may be avoided or effectively addressed. Cloud-based technologies and other encryption approaches have been investigated by a number of healthcare facilities [1–3]. In recent times, blockchain has been hailed as one of the most capable options for addressing healthcare security concerns. Blockchain technology would allow various EHR systems to communicate with one another. It is more secure than the cloud since no one organization owns information, and it is very easy to set up. Blockchain is based on a distributed and decentralized computing architecture that prioritizes value and trust above information sharing. In healthcare, for example, it is recommended that documents such as diagnoses, prescriptions, and expenses, as well as all informed parties, be held on the blockchain. For greater safety management, the technology may also be utilized to track medical supplies and medicine information. Allowing the storage and exchange of medical information while permitting interoperability is an essential part of blockchain technology in the health information area. It has been suggested that the blockchain's anonymity function be utilized to secure patient identification information. Use of Smart Contracts and blockchain business frameworks have also enhanced the applicability of apps. This paper's key contribution is that it intends a healthcare data management architecture and method based on the Hyperledger Fabric blockchain ecosystem. The paper layout is laid out as follows: The background is discussed in Sect. 2. Section 3 delves into related work. The architecture and design are presented in Sect. 4. The implementation details are shown in Sect. 5. The conclusion is presented in Sect. 6.

2 Background

2.1 EHR

Electronic Health Records are used to keep the digital records of medical information about any patient. Electronic medical records are saved digitally that is maintained over time by a physician of the hospital. The EHR contain all of the required clinical data about that treatment of the patient and same is saved with a specific care, such as CT reports, past medical finding and report, vaccination information, laboratory findings, and any allergy from medicine about the patient. These real-time records are specific to the patient and these records are easily available to authorized individuals which may be a patient or a record.

EHRs may also be advantageous for obtaining healthcare data information 24 by 7 and from any location. This reduces the chances of repeat testing, treatment delays, and empowering patients and doctor to make right conclusion and decisions. EHRs have made direct connection between doctors and patients and are available anytime when it is required, therefore strengthening bonding between doctor and patient [4]. These data can be sent to other healthcare doctors or surgeon from other hospital for better second opinion, research, or study. They may be sent to other healthcare practitioners from other institutions for improved research and study in the sector. It changes and improves the traditional ways of storing patient medical records in black and white paper, which were likely be exposed to a number of dangers, for example natural catastrophes, theft, conflict, and illegal tampering. The information in EHRs may be retrieved automatically, and it improves the doctor's workflow. EHR supports various healthcare related activities directly or indirectly by numerous manner and user interfaces.

EHRs are extremely useful to the improvement of health care, by minimizing the prevalence of errors in documents and they have improved the excellence and transparency of healthcare engagement that has been grown up, and care coordination has also been improved. Because the data is readily available, it allows medical practitioners to make correct, quicker decisions and choosing better treatment to patients in minimum short time. However, as the information technology is growing rapidly, these digital health data have chances for being vulnerable to unauthorized hackers' attacks.

By using contemporary latest IT technology or hacking tools, these criminal persons may take access to patients' private information and can make alteration to their records or damage patients' data or utilize the data for their own advantage. Due to this, there has been an urgent need to safeguard patient healthcare information and health to avoid them from being hacked by cyber hackers. Nowadays, the technology based on cloud for collecting EHRs is insecure and be able to easily be hacked by expert hackers. The HER's are kept in the cloud and saved by utilizing the passwords that may be readily hacked or manipulated using social engineering.

So, there has been a pressing requirement in recent times to safeguard patient information and guard their privacy from hackers. Using a blockchain-based strategy for EHRs is an effective means of securely storing documents via a network.

2.2 Blockchain

Nakamoto created a decentralized peer-to-peer electronic payment system called Bitcoin, which used a novel technology called "Blockchain" to produce a rare, non-duplicatable money. The blockchain technology served as a distributed, immutable, and decentralized ledger.

A blockchain is a decentralized database, which means that no single entity has complete control over it or the ability to alter its contents [5]. Furthermore, the database is distributed, meaning that every node in the blockchain link has a complete replica of it. Only data updates and additions are permitted, and the consensus mechanism ensures that these restrictions are followed. The consensus protocol governs how data is added to the blockchain and guarantees that it is immutable. Most blockchains can be used to move money between accounts in the form of cryptocurrencies like Bitcoin, but some blockchains also enable Smart Contracts. Computer programs like Smart Contracts run according to a collection of pre-programmed protocol in a deterministic and tamper-proof way. When Smart Contracts are used in the blockchain, every node present in the network validates its work process and output. As a result, blockchain-based Smart Contracts are trustless, completely deterministic, and may operate as an autonomously connector between several parties. Smart Contracts may also be used to store data and ensure its integrity and validity. Permissionless blockchains allow anybody to join the network and function in a decentralized and trustless way. The network, historical data, and transactions are all under the jurisdiction of no single authority. Single point of failure is not possible, and every node in the network generally stores a whole history of all communications that have ever been broadcasted. Because every data ever saved on the blockchain is shared with every node, there is no way to keep personal information or interactions between participants private. Because every node has to be able to verify the validity of every transaction, permissionless blockchains require this openness. If a transaction conceals data, then it is not possible for each complete node to verify its integrity and accuracy of data content since the data required isn't available to the whole node. Due of the lack of anonymity, businesses such as IBM and Intel began developing permissioned blockchains. Permissioned blockchains keep track of nodes which are authorized and permit to link in the network and allocate responsibilities to certain available nodes. Unlike a permissionless blockchain, which distributes the permission to add to the blockchain among all nodes available in the network, only some nodes gather connections and generate the blockchain. As a result, permissioned blockchains restore a measure of confidence of the blockchain network. However, because every node in the network no longer needs to record and validate every single transaction, permissioned blockchains scale better than permissionless blockchains.

Permissioned blockchains also allow network participants to engage and transmit data privately and without the knowledge of other network participants. Hyperledger Fabric [6] is an open-source blockchain technology with a significant focus on security and identification. "Hyperledger Fabric presents a revolutionary architecture that selects where transactions are handled by execution computer code" (famous as chain code) written in JavaScript, Java, or Go with flow given below:

Execution Phase:

In order to launch a chain code function for interacting with the blockchain ledger, a clients' program transmits a transaction request to approving peers as indicated by the relative authorization strategy. The endorsement is returned to the client once the endorsers have successfully performed the chain code. The transaction is subsequently put together and authorized using credentials received from a Membership-Service-Provider that is a third party which manages each peer and validator identities inside an organization.

Ordering Phase:

The ordering service receives the built transactions from the client. Orderers are a group of nodes that effectively integrate several transactions to be performed into one single block add and then broadcast the ordered transactions to all other peer's node present in the given network.

Validation Phase:

Finally, every available peer validates received transactions against the authorization policy before updating the state of the local ledger. Hyperledger-Fabric, in particular, exhibits innovative security methods like data collections which are private, which enable only particular authorized parties to retrieve certain data. Peers utilize local state databases like CouchDB, MongoDB, and LevelDB to store data. Participants of Hyperledger Fabric can convert in to Docker containers. Containers are software units that encapsulate code of programming and dependencies in order to run the application effectively and reliably in a computer environment. Furthermore, because Docker has significant security features, applications are executed in a secluded and protected environment. On top of Hyperledger Fabric, a variety of technologies may be used to improve security and confidentiality. Idemix cryptographic protocol suite, for example, makes use of ZKP. Idemix is linked to identity certificates, which must be used by each participant to complete any and all actions on the ledger which is distributed in nature.

3 Related Work

Data storage, data protection, payment and sharing, data transactions, and prescription tracking are just a few uses of blockchain technology within the healthcare area that have been studied. The following are similar works: MedRec was built on Ethereum's Smart Contracts, used to link healthcare providers and allowed for the sharing of full and reliable medical history data across organizations [7]. "The Healthcare Data Gateway (HDG) joins a conventional database with a facility to accomplish private digital health records on the blockchain while assuring security and confidentiality via access control and secure multi-part computing" [8]. Therefore, combining blockchain with additional security technologies can improve patient privacy protection. It should be emphasized that those approaches for dealing with medical data ownership are based on the reality that data is totally under the control of the patient. To create a personal data management platform, Zyskind et al. merged blockchain and offchain storage [9] allowing users to manage access rights alleviated privacy issues. Because healthcare data is a type of private information, this study has some reference value. However, in other circumstances, the patient lacks sufficient medical expertise to handle the permissions, therefore allowing patients to control permissions which is entirely incorrect. Dubovitskaya et al. [10] proposed a cloud system which is scalable and preserving privacy of e-Health in which medical information is stored on both local and cloud-stored records, and information is encrypted by means of public-key cryptography and effectively disseminated using patient-defined mechanisms to retrieve the information. The potential for trustworthy cloud server providers to break secrecy by inferring personal data and information from the client's I.P. address is a shortcoming of this design. They may potentially use an inference attack to link a pseudonym to a patient. Roehrs et al. [11] divided information from personal health records (PHRs) into data blocks. The data storage appears to be centralized from a logical standpoint, but it is really dispersed across the connected devices. The researcher claims the suggested protocol, open PHR, is practicable extendable, and that it can be implemented by a wide range of organizations. The proposed architecture is portrayed in great aspect, but the model's feasibility is called into doubt. Furthermore, the authors stated that their technique is still weak in terms of security and privacy. With difference to an EHR, which is administered by a healthcare establishment, however PHR is controlled by the patient. EHRs and PHR are kept and transmitted electronically, and they may be compared in terms of performance and integration. To achieve access control, BBDS used encryption and digital signatures [12]. MeDShare is a blockchain-based sharing information platform for all providers of cloud that demonstrates privacy protection through access restriction and the tracing of infractions [13]. The viability of blockchain applications has risen with the rise of cloud computing, but security challenges have gotten increasingly difficult. Ancile employed Ethereum Smart Contracts for gain access to control and interoperability of electronic health data, focusing upon patient ownership rights and proposing the proxy re-encryption technique for remotely saving private keys [14]. FHIRChain presented an ideal architecture for securing and scaling medical data exchange in a blockchain context [15] that protected privacy by possessing private information offchain and swapping reference points on the chain. In mobile healthcare applications, Liang et al. presented a data-sharing architecture based on Hyperledger Fabric in which users control data sharing and access [16]. In William and Christian's proposal, patient-driven interoperability in health care is used to accomplish privacy [5]. The above study sought to maintain privacy using a patient-driven access control policy; however, it lacked answers for third-party security concerns. Furthermore, converting from the old approach to patient-driven access control is challenging since it surges the burden of data administration for healthcare personals without providing visible benefits. In 2019, Chen et al. presented a blockchain-centered EHR sharing system, arguing that blockchain should only be used as a trust mechanism in the healthcare data sharing process, and that privacy concerns should be handled entirely by a third party [17]. Med-Chain combines blockchain, digest chain, and a peer-to-peer system to solve proficiency challenges in exchanging different forms of healthcare data, while also addressing confidentiality concerns through information creation [18]. Doctors should also have authority over their diagnostic data, according to health chain [19]. These studies reveal that data security and privacy are mostly achieved in today's health IT systems by using several encryption mechanisms. A number of research planned to use private blockchain, such as the Hyperledger Fabric platform, to develop scalable healthcare data management systems in 2020. To provide appropriate scalability and data protection, PREHEALTH, which preserve privacy and is a very good EHR management system, employs Identity Mixer and Hyperledger Fabric [20]. Tanwar et al., suggested a Hyperledger-Fabric based EHR data sharing system and its accompanying examination conditions [21]. To minimize device failure, the Hyperledger blockchain has been proposed as a method for intensive medicine, particularly ICU data management [22]. The blockchain tree, which joins number of blockchains simultaneously to hold various type of data, is another way to improve security. The aforementioned experiments use blockchain to provide patients access control and monitor information consumption, mostly to solve privacy problems in healthcare data. These models take advantage of the data on the blockchain's transparency, traceability, and tamper proofing to overwhelm the limitations of conventional medical practitioner-driven information storage and exchange. If patient is controlling the healthcare data access then, it will efficiently safeguard confidentiality by stopping unauthorized access, based on the evidence of addressing the safety of information storage and communication. The preceding study, however, has significant flaws i.e., healthcare data ownership is complicated. Data ownership and economic worth are not covered by the law. The existing circumstance does not lend itself to the patient-driven data management strategy. The restriction is that most patients lack the competence to determine what information is shared with whom and when, potentially reducing the efficiency of healthcare delivery. The recommended measures have had no positive impact on the quality of healthcare services. Doctors talk to patients or suggest to health lab tests to know health past record in conventional face-to-face therapies. Allowing a doctor to look at a patient's medical records isn't always more efficient. On the other hand, needing access rights for each sort of data from each patient makes data collection more challenging for healthcare research institutes. For patients, deciding on every data request is also costly. The present frameworks do not take into account the legal and industry realities on data.

4 Architecture and Design

This paper proposes a better healthcare data sharing scheme that addresses medical practice's privacy concerns. During the analysis and treatment process, the healthcare information gathered by the doctor regarding a patient can aid in understanding the patient's history and determining treatment strategies. The major focus of this study is on information supplied by patients like x-rays, lab results, refer letters, medications, and further pertinent healthcare information. There are three steps to the process of creating, utilizing, and storing healthcare data.

(1) Generation of healthcare data
(2) Process data
(3) Access healthcare data

There are three key components to the Hyperledger network: (a) Participants; (b) Assets; and (c) Transactions. The system is made up of five primary components.

A. **The patient**:

Patients frequently receive rapid feedback on their medical records during diagnosis and therapy, and they must maintain them appropriately for later treatment. Patients have slight understanding in what way their healthcare information is utilized by healthcare providers after treatment, which has raised confidentiality issues. One of the significant tasks of the new system is for exposing the access interface for patients, and to measure data consumption. Patients will be able to store all of their medical data, as well as categorize, highlight, and examine their records. User issues of privacy are addressed by permitting patients to trace the use of their data and detect unauthorized access also. The address of visitors, their identity, organization data, and data retrieval time are all tied to each record. Patients can utilize this data usage as evidence to assist them safeguard their rights through legal procedures if they uncover unauthorized access.

B. **Medical service provider**:

Responsibility to gather, record, and maintain medical evidence, and to communicate and transfer specified data with others is with the doctor itself. The safety of data in the whole system is influenced not only by the competence of the physicians, but also by the types of permission given by the patients. Furthermore, the proposed plan offers them an easier data management solution by integrating current systems, allowing data to be transferred among multiple medical institutions without incurring additional fees. When a patient gives a permission to doctor for offering medical facilities to them, they receive authorization to utilize the patient's healthcare information in a reasonable manner.

C. **Data processing center**:

For the purpose of maintaining the ledger and Smart Contracts, virtual logical data processing center is very important node in a network. To achieve the functions of calling data, all apps must be connected to one of the nodes.

D. **Blockchain network**:

The blockchain is built on Hyperledger Fabric, which allows for a permissioned network in which all users should be approved. The healthcare information structure provides separation of various facilities in the blockchain networks based on the demands of users, like hospitals and insurance firms, via the channel. Channels can be made private, with just a limited number of members. The public key is used to create encryption certificates for companies, organizations, patients, and health personnel. To set the permissions for members, channels, and access authorization can all assist to efficiently manage privacy and secrecy problems. Furthermore, the blockchain may be used to store and share data assets; healthcare data is one such data asset that has yet to be fully established.

E. **Medical cloud**:

The actual healthcare data is split, kept in the cloud, and connected through blockchain, while the original data's access record is also saved on the blockchain. Both collaborate to make data access more traceable and scalable.

To obtain healthcare services, the user might exchange data with healthcare providers. When the system detects data sharing, an event will be produced to store the data access requests. Then this record is directed to the blockchain network, where it is transformed into a transaction through a series of processes. A block will be formed from a list of transactions, and validator nodes will authenticate the block in the blockchain network. The originality of the record can be kept after a number of procedures, and further authentication on the block and transaction connected to the record is possible. A record will be mirrored on the blockchain every time a medical data operation is performed. This guarantees that every action taken on a patient's medical record is traceable. Only registered providers are allowed to add additional valid blocks to the blockchain, as per the Fabric Access Control Layer. Smart Contracts finish the business logic for writing a patient's health information to blockchain and validating it using endorsement certificates (Fig. 1).

The following are the transactions that are carried out in the system:

A. **Create Medical Record**

The network would produce records as a result of this transaction. There are fields such as record ID, owner, and a detail of permitted patients and laboratories in it.

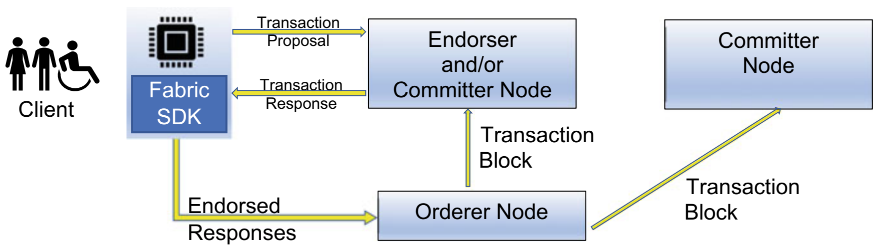

Fig. 1 Nodes in hyperledger fabric

It has areas for storing patient medical data such as health history, last discussion, consultation date, allergy, unsafe behaviors, and so on. The record's ID is exclusive to the record and is used to recognize it in the group.

B. **Grant Access**

The clinician will require access permission to the data in order to alter the records; only the authorized doctor would be able to fetch and read and write the medicinal records. This transaction is used to provide access.

C. **Revoke Access**

Once the clinician's requirement for access to a certain record has been met, the clinician will no longer have permission for that information. The clinician is now not able to read or change the saved data.

D. **Add Participant**

This transaction will be run each time when a node (new) is included in the system.

E. **Update Participant**

When data inside the participant's node is changed, this transaction runs.

F. **Update Asset**

It happens when we make changes to the medical records' information.

The transactions are mainly acts carried out on the network's asset, like inserting a member to the network, making a health record, recovering particular data from the network, alterations to the participant's information, and permitting or revoking access to clinicians or laboratories. An association among the two contributing nodes is needed for the execution of some of the transactions. For example, in order for a clinician to retrieve a patient's medical records, the patient's ID should be on the record of clinician's patients. In the system, the access control permissions are defined. These rules determine which participants have access to which resources and what level of access they have. This aids in limiting access to all of the system's resources. Only authorized users have access to certain records and can alter or view them.

5 Implementation

We took the following steps to set up this blockchain-based EHR network:

A. **Data collection**:

Patient's private data and medical health data, such as vital parameters, bad habits, past medical data, lab test, prescriptions, and other record gathered during a doctor's clinical diagnosis.

B. **Allocation of wallet**:

A space to set up a blockchain network and to store and track all the transaction in a separate area.

C. **Using Hyperledger Fabric and Composer to setup a blockchain network**:

To implement respective business network and initiate the same blockchain network on composer playground following wallet allocation.

D. **Creating nodes**:

To build a respective system model which will include design of various members/participating nodes in our blockchain network (Fig. 2).

E. **Medical record creation**:

We also design a framework for keeping patient-owned medical records (Fig. 3).

F. **Transaction creation**:

We generate the transactions that must be carried out based on the requirements, such as granting or robbing access from doctors or laboratories or identifying the permitted doctors or laboratories for a health record (Fig. 4).

Fig. 2 Create new participant

Fig. 3 Medical record creation

```
transaction CreateMedicalRecord{
  o String medicalHistory optional
  o String Allergies optional
  o String currentMedication optional
  o String lastConsultationWith optional
  o String lastConsultationDate optional
  o String activeHoursInAWeek optional
  o Boolean smoking optional
  --> Patient owner
}

@commit(false)
@returns(String)
transaction getUserType {
  o String email
}
```

Fig. 4 Transactions

```
transaction GrantAccess {
  --> Clinician authorisedToModify
  --> MedicalRecord medicalRecord
}

transaction revokeAccess{
  --> Clinician revokeThisClinician
  --> MedicalRecord medicalRecord
}

transaction GrantAccessToLab {
  --> Lab addThislab
  --> MedicalRecord medicalRecord
}

transaction revokeAccessFromLab{
  --> Lab revokeThisLab
  --> MedicalRecord medicalRecord
}
```

Fig. 5 Create new asset

G. **Node addition to the system**:

Lab node, medical record node, patient node, and clinician node that is owned by some patient, their instances are made using sample data collected. Network registered node validates the other nodes and before addition of node in the network public identifier is created (Figs. 5 and 6).

H. **Permissions provided to the user**:

This section specifies which participants have access to which system resources (medical records). Only participants with certain permissions (such as Read-only, Write, All, Transfer, and so on) have access to specific medical records data.

I. **Transaction execution**:

Various transactions are done based on the user's requirements, and data can also be fetched from the saved data collection if necessary. Following the completing transaction, a new medical record is created (Fig. 7).

6 Conclusion

EHR administration is critical now and will be for many years to come. EHRs include sensitive health information about individuals whose privacy must be maintained. Blockchain technology's non-changeable and traceable ledger distributed in nature

Fig. 6 Transaction submission

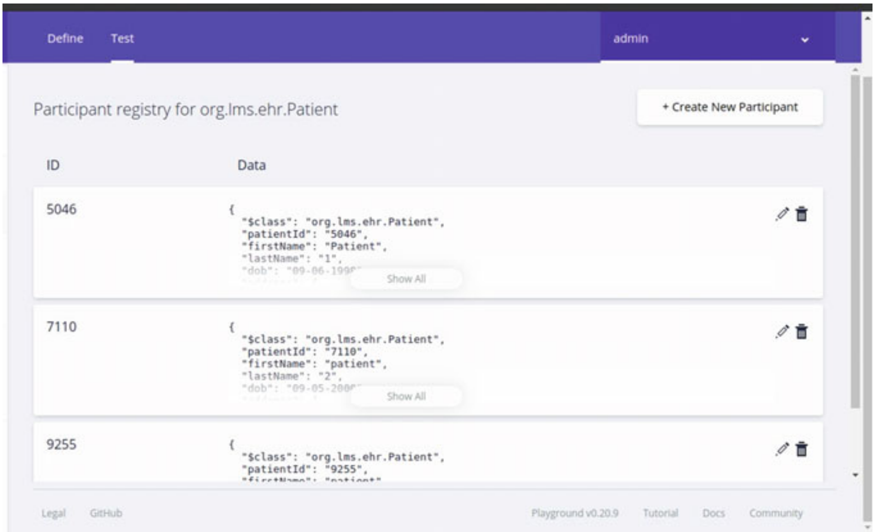

Fig. 7 Patients nodes

can help solve the healthcare industry's privacy and interoperability problems. The Hyperledger Fabric architecture, in particular, provides enterprise-grade blockchain application deployment and development components. This paper presents a hierarchical access control technique made possible by Fabric's privacy-preserving mechanism. We accomplish that blockchain technology is an advanced secure software technology for establishing EHR management system and, in the near future, it has the potential to aid in healthcare research and advancement.

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A Modified Approach for Accuracy Enhancement in Intruder Detection with Optimally Certain Features

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Abstract Mobile ad-hoc networks are vibrant and incessantly varying ad-hoc networks, so having centralized checking on the same is impossible. Vehicular ad-hoc network (VANET) is like mobile ad-hoc network (MANETs) where vehicles keep on interconnecting with adjacent cars and roadside units. Here in this paper, we use mobile ad-hoc networks, which combine various mobile nodes, which reduces interruption-however could not remove them. Intrusion detection in MANETs is an assignment associated with the machine learning area. In this paper, our primary focus is mainly on reducing features for achieving extreme precision and reducing the overhead time of machine learning algorithms. The interruption dataset is reserved from the customary dataset of named Network Security Laboratory-Knowledge Discovery and Data Mining (NSL-"KDD"). Here in this paper, the genetic algorithm (GA) is substituted by the gravitational search algorithm (GSA), which delivers the maximum precision and consumes significantly less time for training the model.

Keywords MANETS · IDS · VANET · "KDD"

1 Introduction

Mobile ad-hoc networks are vibrant and incessantly varying ad-hoc network, so it is impossible for obligating centralized monitoring on it. VANET is extremely vibrant in nature. Identifying the interloper in it is an inspiring undertaking. An interruption detection system (IDS) screens network circulation and frights the background or organization administrative. Intrusion detection system can similarly react

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to abnormal traffic by impeding the client or source Internet protocol address from getting to an organization [1].

A few surroundings (like the military-strategic activities) have exceptionally severe prerequisites on security, which make the sending of safety-related innovations fundamental. Like encryption and verification, interruption avoidance measures can be utilized in MANETs to lessen interruptions yet can't dispense with them. The ancient framework of safety research has shown that irrespective of the quantity of disruption avoidance procedures exploited, there are some fragile spots in the framework [1–3]. In an organization through high-sanctuary prerequisites, it is essential to convey interruption recognition procedures. The stunning contrasts between mobile ad-hoc networks and wired organizations make it unimportant for applying customary wired ID advances straightforwardly toward mobile ad-hoc networks. MANET doesn't have a decent framework. While the more significant part of the present wired IDSs, which depend on ongoing traffic parse, channel, organization, and investigation, generally screen the traffic at switches, switches, and entryways [4, 5].

Every node may utilize the fractional and limited correspondence exercises as the accessible review follows. MANET also has a few qualities, like disengaged activities, which sometimes exist in wired organizations. It is recommended that IDS of an alternate design be created to be relevant on the MANET stage.

Interruption detection in ad-hoc networks is the errand that can be identified with the AI field. The informational collection is accessible with NSL-"KDD" information for interruption discovery. The dataset comprises the history of gatecrashers, and its mathematical qualities. The dataset is exceptionally huge, so a dimensionality decrease must be performed to choose the most appropriate elements, which gives the most noteworthy exactness and consumes less time preparing the model [6, 7].

2 Dataset Depiction

The NSL-"KDD" [1] informational collection is an enhancement above the "KDD" "99" informational group. The NSS-"KDD" informative collection has 42 properties utilized in a detailed review. In NSS-"KDD", informational index copy occurrences were eliminated to dispose of one-sided grouping results. Numerous quantities of adaptations are accessible of this dataset, out of which 25% of the preparation information is utilized. Preparing information is recognized as "KDD" Train+_20% with an absolute no. of 125,978 examples. The test information is recognized as "KDD" Test+, and it has an aggregate of 22,545 samples. The quantity of characteristics in each is 42. With varieties in the number of occasions, various setups of the informational collection are accessible. Marked property 42 is the 'class' property which shows that the occurrence is an ordinary association example or an assault. Out of 43, 40 characteristics can be arranged into four distinct periods as talked about underneath [1]:

- Basic (B) Structures are the properties of discrete TCP associations.
- Content (C) highlights are the properties inside an association proposed by the space information.
- Traffic (T) highlights are the traits processed utilizing 2 s window.
- Host (H) highlights are the traits intended to evaluate assaults that continue for over 2 s.

3 The Selection of Optimized Features from Dataset

Forty-two characteristics are present in the dataset, and all examples either don't add to precision due to no. of zeros present in the property or not characterized standards in that. Likewise, specific properties which are non-applicable are additionally furnished with information that might diminish the precision. Therefore, we want to discover it and eliminate those who work on the precision [8]. Due to this reason, we depend on gravitational search algorithm (GSA), a worldwide meta-heuristic improvement technique dependent on the developments of planets in a circle. Every world draws in others with its gravitational power, and the power of fascination will be higher for which its mass is greater. Here, the group addresses the precision in interloper location for a specific arrangement of qualities. As far as time expands, the circle gets bigger, and gravitational steady, which has to be viewed as consistent as in condition 1.

$$(t) = G0e - \alpha t/T \tag{1}$$

"$G0$ and α are introduced toward the start and would be decreased by period of phase for controlling the precision of search". T is the absolute no. of emphases. These cycles are characterized by client and most extreme emphases changes from one application to another [9, 10]. Inside these emphases, the most extreme precision for a picked set of qualities should be achieved, and no more expansion in precision ought to be there. An immersion condition of precision in these cycles ought to be acquired, which implies the framework has accomplished and found the ideal arrangement of traits for which precision is most remarkable. GSA strategy does this assignment iteratively. Double digits address the places of specialists in GSA. The one address the characteristic is picked, and 0 lessons that trait is disposed of. A sum of 41 zero's and one's series address the specialist's positions [11]. In an emphasis, 20 specialists have 20 arrangements of zero's and one's series. We compute the precision for that multitude of twenty unique ascribes mixes utilizing the SVM (Support Vector Machine) characterization strategy, and a matrix is created for these 20 qualities [12, 13]. Every one of the specialist's positions is refreshed by the following conditions:

$$x\mathrm{di}id(t+1) = vid(t+1) + xid(t) \tag{2}$$

$$vid(t+1) = randixvid(t) + aid(t) \tag{3}$$

"Where

xid $(t+1)$: new agent's position for the subsequent iteration.
xid (t) is the current position.
vid $(t + 1)$ is the new velocity of program.
aid (t): the present hastening. It is further planned as":

$$aid(t) = Fid(t)(t) \tag{4}$$

Fid (t): the overall force acting on it agent calculated as:

$$Fid(t) = \sum randjFijd(t)\ j \in k\text{best} \tag{5}$$

Fijd (t) can be computed as:

$$Fid(t) = G(t) \cdot (Mpi(t) \times Mai(t)\ Rij(t) + \varepsilon) \cdot (xjd(t) - xid(t)) \tag{6}$$

(t) is the agent's mass which is normalized precision value for every agent. It is expressed as:

$$mi(t) = (t) - (t)\ \text{best}(t) - \text{worst}(t) \tag{7}$$

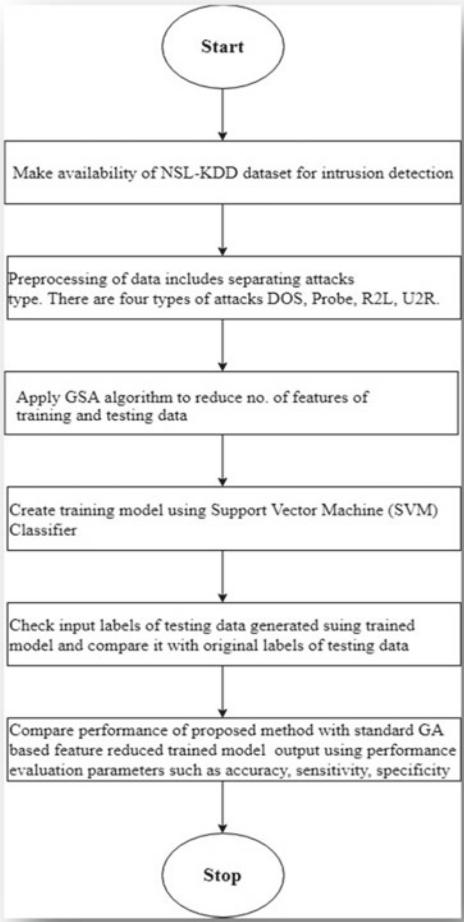
here (t) is the suitability rate of every agent.
w (t) is the lowest precision rate among all existent agents.
be (t) is the extreme precision value.

The new refreshed situation of each of the 20 specialists as in condition 3.2 is utilized to look at their precision. One more matrix is created, which stores the precision for that multitude of a new arrangement of traits. This interaction proceeds till all cycles are not wrapped up. At last, the most extreme precision ordered specialist's position is considered the ideal arrangement of characteristics. For these characteristics, just precision got deemed as most excellent precision [14, 15]. In this approach, it lessens the overhead in characterization and works on the phase and test precision. The complete layout of the work is displayed in Fig. 1. The entire channel for the work progress is shown in Fig. 1. Check yield names of testing information produced using the prepared model and contrast it with unique characters of testing information [16].

4 Results and Discussions

In this work, we have proposed a thorough report on GSA advancement calculation for highlight decrease for making a superior interruption identification framework

Fig. 1 Complete layout of work



(IDS). A ton of inherent capacities in MATLAB creates the utilization simpler and protects our chance to fabricate our code without any preparation to utilize that time in the issue arrangement of examination. The dataset contains 125,973 preparing's informational collection and 22,543 informational testing index with absolute 41 components having three emblematic provisions and yield is ordered as sorts of assaults. We applied GSA to decrease the no. of conditions from including the counter of preparing and test dataset. The SVM multi-class classifier preparing information is utilized to make a preparation model, and test information is tried for anticipated yield names utilizing this trained model. We have separated our outcomes into four cases relying on kind of assault. There are four significant sorts of assaults.

Case-I Denial of Service (DOS) Attack:

In this dataset, denial of service assault is additionally classified into 6 subtypes. We have analyzed the execution of GSA-based element decrease with GA-based element decrease (Fig. 2).

It has been seen that planned strategy is having more precision, precision, review, F-measure, affectability as well as particularity for DOS kind of assault. The accuracy and F-measure bend are displayed in Figs. 3 and 4

Case-2 User to Root (U2R) Attack (Fig. 5).

Case-3 Remote to User (R2U) Attack (Fig. 6).

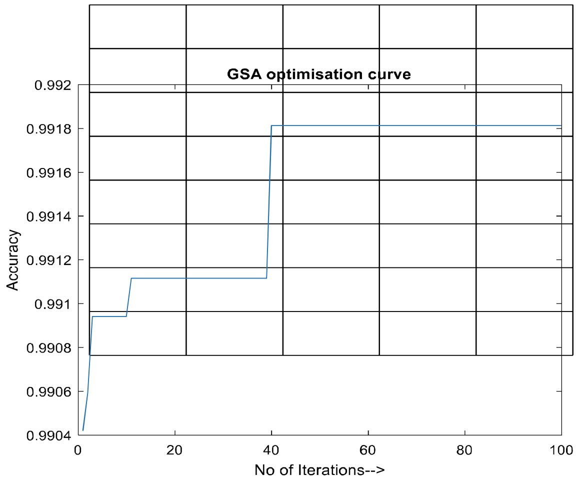


Fig. 2 Iteration curvature for DOS attack

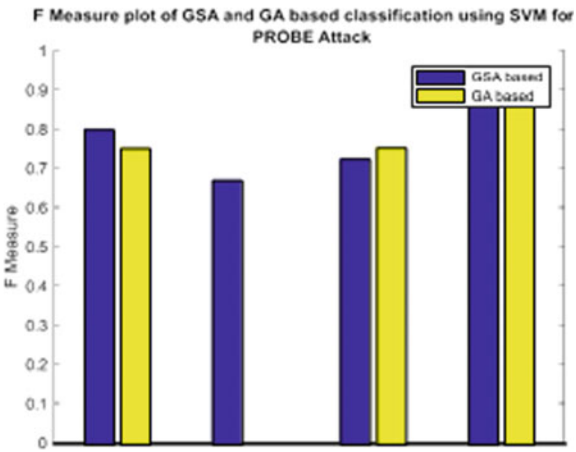


Fig. 3 Comparison of precision between genetic algorithm and gravitational search algorithm selected features for PROBE attack

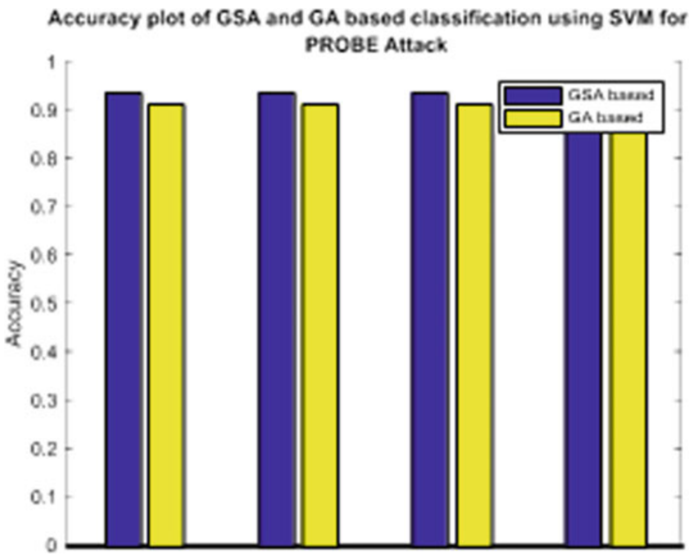


Fig. 4 F-measure comparison genetic algorithm and gravitational search algorithm selected features for PROBE attack

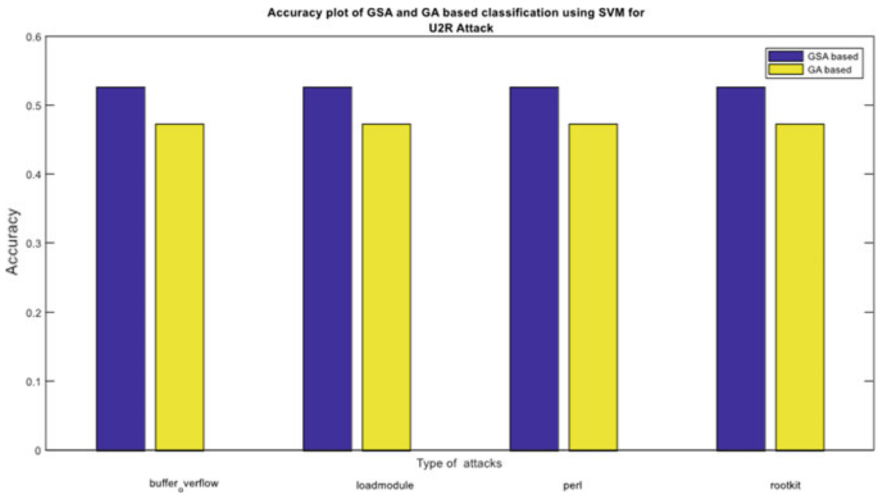


Fig. 5 Precision comparison for U2R attack

5 Conclusion

MANET gives well-being from the assaults. AI field shows the arrangement of this issue. And as we know that every node may utilize the fractional and limited correspondence exercises as the accessible review follows. MANET also has a few

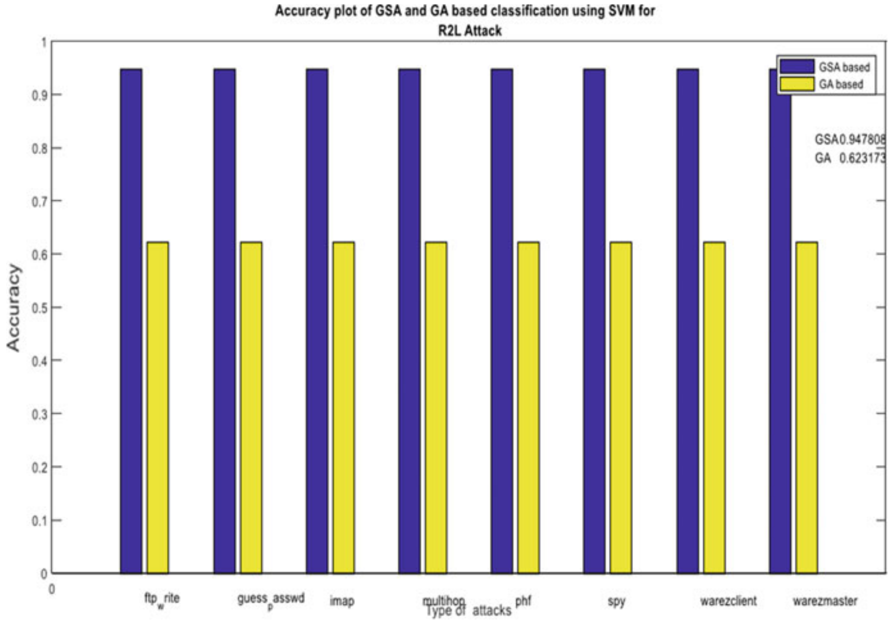


Fig. 6 Precision comparison for R2L attack

qualities, like disengaged activities, which sometimes exist in wired organizations. It is recommended that IDS of an alternate design be created to be relevant on the MANET stage. Our work utilized the public accessible NSL-" KDD" dataset, which is changed and sifted adaptation of the "KDD" cup dataset. The result gave extraordinary precision and devoured less time when contrasted with the past. GSA is utilized distinctly for those elements which participate in assault identification. The more seasoned one utilizes the Genetic algorithm; however, we utilize GSA, which results in 98% precision in these assaults. Gravitational search algorithm gives 54% more accuracy than the GA.

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An Ensemble (CNN-LSTM) Model for Severity Detection of Bacterial Blight Rice Disease

Shweta Lamba, Anupam Baliyan, Vinay Kukreja, and Ramamani Tripathy

Abstract The devastation of crops due to various ailments has become one of the biggest threats in the agriculture sector. The necessity of early diagnosis and preventive measures can limit the effect of the disease on overall yield. To predict the condition of the plant, the disease severity is estimated based on the affected area of the leaf. This paper proposed 4-score disease severity classification architecture with the integration of Convolutional Neural Network (CNN), and Long Short-Term Memory (LSTM). CNN has made significant breakthroughs in extracting the feature from an image. The input of convolutional layers is inputted to the LSTM layer. The result analysis shows a promising improvement in the classification performance by including LSTM layers after Convolutional layers in the proposed model. The proposed classification approach is evaluated using a dataset consisting of 1856 images of bacterial blight disease. The images are collected from st, standard online repositories. The accuracy of the classifier is significantly higher than that of a single approach model. The proposed hybrid model of CNN-LSTM achieved an accuracy of 92%, 88%, 86%, and 94% for 4 classes of severity. The overall accuracy of the model is 92%.

Keywords CNN · LSTM · Bacterial blight · Rice disease · Hybrid model

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1 Introduction

Agriculture plays a major role in the enhancement of the GDP of a nation. Rice is a staple food grain and is the primary food for almost half of the world's population. India is the second-largest rice-producing country [1]. Rice plays a significant role in Indian meals. It is grown almost everywhere. A maximum part of the rice produced is exported to other nations. As the population, and hence dem, increased, it creates pressure on the agriculture sector to either increase the production of rice or to reduce the losses in the yield. Crop production gets affected by various reasons. Various infections due to biotic, and abiotic diseases [2] are one of the factors which have a big impact on the yield of the crop. The diseases in rice can be categorized into two: parasitic, and non-parasitic diseases based on the cause of the disease. Based on the location of the disease, it can be categorized as, leaf disease, stem, root, panicle, etc. There are 24 diseases under parasitic, and non-parasitic diseases. Rice is a Kharif crop that grows in hot, and humid climates in flooded filed. This provides an adequate environment for different parasites to flourish, and damage the crop. Bacterial blight is a most affecting disease. It is a bacterial, pathogen, based disease which comes under the parasitic category of diseases. Almost 30–70% of the rice crops get devastated due to bacterial blight infection. There is a need to early detect the disease, and follow the treatment to prevent it to spread on the whole field. This is feasible only if one has complete information about the type of disease, and the level of severity of that disease. The recent enhancements in computer vision-based automatic approaches have made this task easy to achieve. The severity of a disease can be categorized based on the leaf area affected by the parasite.

1.1 Contribution

In this paper, an image classification approach ensemble the best features of CNN, and LSTM. This paper considers four levels of severity: mild, moderate, severe, and profound. Disease severity classification refers to the process of associating the level of infection of the diseases with one or more categories according to the area of the diseased leaf.

1.2 Outline of the Paper

The rest of the paper is divided into six sections. Section 1 is a brief introduction to the topic. Section 2 discusses the related work done in the field of hybrid models and rice diseases. Section 3 presents the methodology used for the feature detection and classification with the description of levels of severity considered in the paper. Section 4 provides information about the experimental setup utilized. Section 5 elaborates on the results of the numerical outcomes. Section 6 concludes the paper.

2 Related Work

In this section, an overview of the latest approaches used for the classification is presented. Table 1 summarizes the related work in the field of rice diseases, hybrid approaches, and severity detection. In this research article [3], the authors used a hybrid model of CNN-LSTM for the classification of severity of Covid-19 diseases using lung ultrasound. A vigorous, and noise-free model is proposed in this article assembling the autoencoder network with CNN, and LSTM. The 4-score disease severity levels are considered by the author. The authors in this article [4], generated a hybrid model by combining the best features of LSTM with a spotted hyena optimizer for the classification of multi-label text. Four different datasets are used for the evaluation of the model. This article also presents a comparative study of six other hybrid models with LSTM and demonstrated that the SHO-LSTM model gives best results. In this article [5], the classification of text takes place based on the CNN-LSTM hybrid model. Authors also use the skip-gram model and continue the bag-of-words model for vector representation. LSTM is used for saving historical information. Chinese news corpus is used as a dataset in this work. In this research work [6], the authors implemented a fusion approach of LSTM-CNN for text classification. The overall accuracy achieved is 91%.

The model is validated with CNN basic models, LSTM basic model, and LSTM-CNN with different filter sizes. LSTM-CNN fusion with filter size 5X600 provides the best results. The authors [7], provide a review of the different approaches used for human activity recognition. The paper briefed the hybrid model generated by the fusion of CNN, and LSTM, and compared different works of literature that implemented the approaches by combining both algorithms as well as using a single approach. In this article [8], 45 articles on disease classification of various crops are reviewed with their classification techniques, datasets, accuracy, and approaches. The authors [17], proposed an ensemble approach to two datasets. A deep learning model is used for the implementation of the classifier [9]. In this research paper, the authors classify 12 rice diseases using CNN. Depth-wise separable convolutional neural network-based classification model is proposed and achieved 95.3% testing accuracy. The dataset consists of 16,770 images of different varieties of diseases. The authors [10], implement the CNN approach for the diagnosis, and classification of rice leaf diseases. 3 classes are considered in the classifier: healthy, diseased but curable, and diseased with incurably severe. The dataset contains 650 images. The model classifies the categories with 97.692% accuracy. This research paper [11] classifies four rice leaf ailments using the CNN approach. The diseases considered are rice blast, bacterial blight, tungro, and brown spot. The overall accuracy of the model is 99%. The authors [12] implemented a multi-layer perceptron for the classification of three paddy infections: rice blast, bacterial blight, and brown spot. The accuracy

Table 1 Summary of the literature reviewed

Citation/Year	Disease	Methodology	Accuracy (%)	Category
[3]/2021	Covid-19	CNN-LSTM fusion	79	Severity-based classifier
[4]/2022	Multi-label text classification	LSTM-Spotted Hyena optimizer fusion (SHO)	64	Disease severity classifier
[5]/2018	Text classification	CNN-LSTM	90.68	Image classifier
[6]/2018	Text classification	CNN-LSTM	91.71	Image classifier
[7]/2022	Human activity recognition	CNN-LSTM	–	Image classifier
[8]/2022	Cereal crop disease	CNN	89	Severity classifier
[9]/2022	Rice diseases	Depth-wise separable CNN	95.3	based classifier
[10]/2022	Rice disease	CNN	97.692	Disease variety classifier
[11]/2022	Rice leaf diseases	CNN	99	Disease variety classifier
[12]/2022	Rice leaf diseases	Multi-layer perceptron	95.31	Disease variety classifier
[13]/2022	Rice leaf diseases	CNN	99.45	Disease variety classifier
[14]/2021	Potato blight	CNN	90.77	Severity-based classifier
[15]/2021	Tomato spotted wilt	CNN	95.23	Severity-based classifier
[16]/2021	Corn gray leaf spot	CNN	95.33	Severity-based classifier

in the testing phase of the model is 95.3%. In this article [13], CNN approach is used for the classification of four rice infections. Leaf smut, bacterial blight, sheath blight, and brown spot infections are considered in this paper.. In this article [14], the authors implements CNN approach for the classification of blight disease in potato plant. The accuracy achieved is 90.77%. The authors of the article [15], detected tomato spotted wild disease severity using CNN classifier. The dataset consist of 3000 images of diseased plant. The accuracy achieved is 95.23%. In the research article corn [16] gray leaf spot are classified in five different severity levels using CNN approach. The accuracy of the model is 95%.

3 Material, and Methodology

This paper makes use of bacterial blight rice leaf infection. Bacterial blight is a bacterial infection that causes infected leaves to turn grayish-green in color [18]. The infected leaves roll-up. The severity of the disease can be categorized based on the area of the leaf infected by the disease. The proposed severity classifier model is composed of four critical elements: Dataset creation, Image preprocessing, Data-augmentation, and CNN-LSTM hybrid classifier model. Figure 1 shows the architecture of the overall framework proposed. Firstly the images from various resources are collected to form a raw dataset. These images are then categorized based on the severity levels. The severity levels are finalized after discussing with the domain expert. As the images are taken from different resources, these are then converted into a standardized format to create a standard dataset of homogenous images. All the images are pre-processed to remove the noise and make all images of the same size, and shape. Then to increase the size of the dataset, data is augmented. Image Data Generator is used which augments the data while training the model. Various augmentation features are used to augment the dataset. The dataset is then passed through the CNN-LSTM hybrid classifier for the classification of the disease according to the severity level. The convolutional layers of the CNN model extract features from the images, and then it is passed through LSTM.

3.1 Dataset Creation

The dataset is collected from secondary resources. Various standard online repositories are referred to create the required dataset. Table 2 gives a detailed description of the sources of the dataset creation. The online repositories included are Mendeley

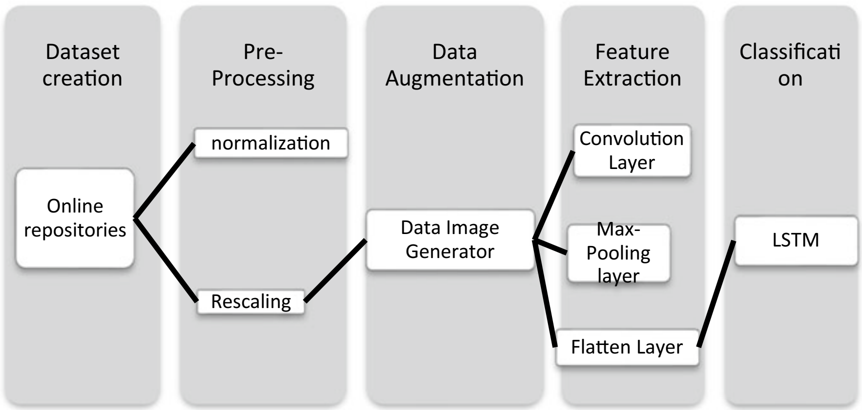


Fig. 1 Structure of the proposed classification model

Table 2 Dataset description

Disease	Online repository	Count of images before augmentation
Bacterial blight	Mendeley [19]	1584
	Kaggle [20]	40
	UCI [21]	40
	GitHub [22]	192
	Total	1856

Fig. 2 Sample image of bacterial blight from various repositories; **a** mendeley, **b** kaggle, **c** UCI, **d** GitHub

[19], Kaggle [20], UCI [21], and GitHub [22]. 1584, 40, 40, and 192 images are collected from Mendeley, Kaggle, UCI, and GitHub repositories, respectively. The dataset consists of a total of 1856 images of bacterial blight-infected leaves.

Figure 2 shows the sample images of the bacterial blight rice leaf disease. It specifies the images from different repositories. Figure 2 depicts the difference in the quality of the dataset of different repositories. Figure 2a is an image from Mendeley, Fig. 2b is from the kaggle repository, Fig. 2c is from UCI, and Fig. 2d is from GitHub.

The collected data is then categorized based on the severity levels. In this paper, the severity levels of the bacterial blight considered are mild, moderate, severe, and profound. This categorization is based on the area of the leaf infected. Table 3 provides the area-wise categorization of the severity of the disease. The severity level is considered mild, C1 if the infected area of the leaf is less than 25% of the total area of the leaf. It is moderate C2 if the infected area is less than 50% but greater than 24% of the area of the leaf. Similarly, it is severe C3, and profound C4, if it's less than 75%, and 100% but more than 49%, and 74% of the area of the leaf, respectively. It also provides information about the number of images of each class after dividing the dataset based on the severity levels. 733 images come under the category of mildly affected by bacterial blight disease. 324 images fall under the category of moderate severity, 221 images in severe, and 578 images in the profound category of severity.

Figure 3 shows the sample images of the bacterial blight rice leaf disease with various severity levels. It specifies the images having the mild, moderate, severe, and profound levels of severity of bacterial blight infection. Figure 3a is an image of mild

Table 3 Categories of disease severity

Disease	Category	Severity level	Area of leaf infected	Count of images
Bacterial blight	C1	Mild	0–24%	733
	C2	Moderate	25–49%	324
	C3	Severe	50–74%	221
	C4	Profound	75–100%	578

Fig. 3 Sample image of bacterial blight at different severity levels; **a** mild, **b** moderate, **c** severe, **d** profound

level, Fig. 2b is an image of moderate level, Fig. 2c is severe level, and Fig. 2d is an image of the profound level of disease.

3.2 Preprocessing

As the images are collected from various resources, all the images are not in a uniform format. To convert them in a single standardized format, images of the dataset are first pre-processed. The preprocessing consists of making the images of the dataset uniform in terms of size, orientation, shape, and contrast. Normalization and rescaling of the images are used for maintaining uniformity in the dataset. The size of the images is chosen carefully as a large size increase the training time of the model. The data is then divided into testing-training sets in the ratio of 20–80.

3.3 Data Augmentation

In data augmentation, the size of the dataset is increased by applying various operations on images to create new images. These new images are formed by rotating, flipping, and changing the zoom value for the image. This trains the model for various angles of the image. Various techniques are used for the augmentation of the data. The image data generator class of the Keras image library is used in this paper for the augmentation of data. Image Data Generator class executes during the training phase of the model. It creates new images at run-time and trains the model for new images. The transformations considered in this paper are rescaling, shear range, zoom range, and horizontal flip.

3.4 CNN-LSTM Hybrid Classifier

CNN is a combination of multiple layers executed consecutively. The various layers of CNN are: the convolutional layer, pooling layer, flatten layer, and dense layer. Each layer has a specific task to perform. The convolutional layer is responsible for feature extraction from the image. Each convolutional layer is combined with a pooling layer. The pooling layer can be max-pooling, average-pooling, min-pooling, etc. Which layer to choose depends on the need. The proposed hybrid model consists of eight layers in CNN. The first layer is the convolutional layer. Then max-pooling layer is combined with the convolutional layer. The output is then sent to the flattened layer which reduces the dimensionality of the image. After that reshape function is used to alter the shape of the image to make it adequate to input into the LSTM layer. The next layer is the LSTM layer. Then two dense layers are introduced, which are fully connected layers, and classify the diseased leaf image in the various severity levels. At the end reshape function is called again.

Table 4 describes the layers of CNN with information about the output shape and count of parameters at each layer. Convolution layer work on 1792 parameters, LSTM 17,680 parameters, and dense layer 1, and dense layer 2, uses 1344, and 65 parameters, respectively. Initially, the images of 64×64 dimensions are input to the convolution layer. 64 filters and kernel size 3×3 are used at the first layer of CNN. Relu activation function is used at the convolution layer, LSTM layer, and first dense layer. Softmax is used in the second dense layer. The model is compiled using an Adam optimizer with a binary cross-entropy loss function. The model is trained in 100 epochs. Figure 4 provides the architecture of the hybrid model proposed.

Table 4 CNN configuration

Layer type	Activation function	Output shape	Param#
conv2d (Conv2D)	Relu	(None, 21, 21, 64)	1792
max_pooling2d (MaxPooling2D)	–	(None, 10, 10, 64)	0
flatten (Flatten)	–	(None, 6400)	0
reshape (Reshape)	–	(None, 32, 200)	0
lstm (LSTM)	Relu	(None, 32, 20)	17,680
dense (Dense)	Relu	(None, 32, 64)	1344
dense_1 (Dense)	Softmax	(None, 32, 1)	65
reshape_1 (Reshape)	–	(None, 32, 1,1)	0

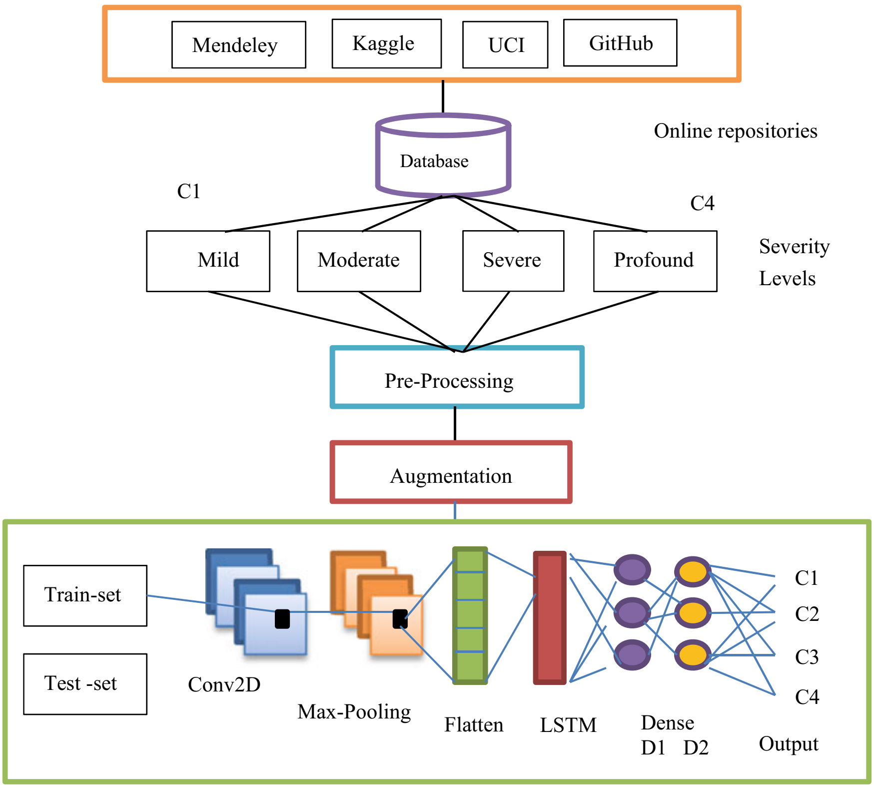


Fig. 4 Detailed architecture of the proposed classification model

4 Experimental Setup

Table 5 specifies the configuration used for the implementation of the proposed model. All coding is done in the python programming language. Jupyter notebook is used for providing the simulation environment for python execution. Python has a vast range of libraries. Keras, TensorFlow, NumPy, sklearn, and matplotlib are used in the proposed model.

5 Results, and Discussion

The evaluation of the quality of the CNN-LSTM hybrid model for severity detection of bacterial blight rice leaf diseases is performed by various performance matrices. Accuracy, precision, recall, and F1-score are the parameter checked for the performance of the model.

Table 5 Experimental configuration specifications

Parameter	Value
Operating system	Microsoft Window 10
Processor	Intel® Core™
Programming language	Python 3.10
Python libraries	Keras, sklearn, tensorflow, numpy, matplotlib
Integrated development environment	Jupyter Notebook

Figure 5 specifies the value of performance metrics for all levels of severity of the bacterial blight rice leaf disease by the proposed CNN-LSTM model. According to Fig. 5, the accuracy achieved by the model for the classification of the mild, moderate, severe, and profound categories of severity is 92%, 88%, 86%, and 94% respectively. The precision value of all categories of severity C1, C2, C3, and C4 is 89%, 65%, 75%, and 76%, respectively. The maximum value of recall and F1-score is 96%, and 91%, respectively, for images of mild severity of the bacterial blight disease.

Figure 6 shows the training, validation loss, and accuracy of the CNN-LSTM hybrid model. Figure 6a is specifying epoch-wise accuracy in the training, and validation phase of the model, and Fig. 6b specifies the epoch-wise loss curve in the training and validation phase of the model.

Figure 7 stipulates the contribution of each online repository in the formation of the dataset. Mendeley has maximum contribution in the generation of the dataset. Kaggle and UCI have the same number of images of bacterial blight disease. 85% of the total dataset belongs to Mendeley only. 11% of the data belongs to GitHub, and 2% of kaggle, and UCI each. Figure 8 gives insights into the contribution of each repository in the creation of the dataset based on a different level of severity.

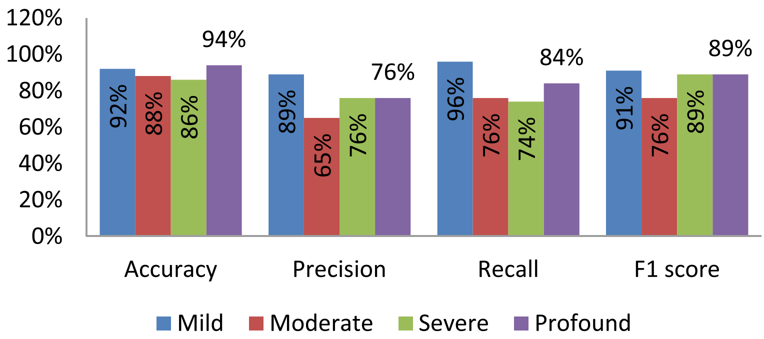


Fig. 5 Performance metrics of the CNN-LSTM proposed model

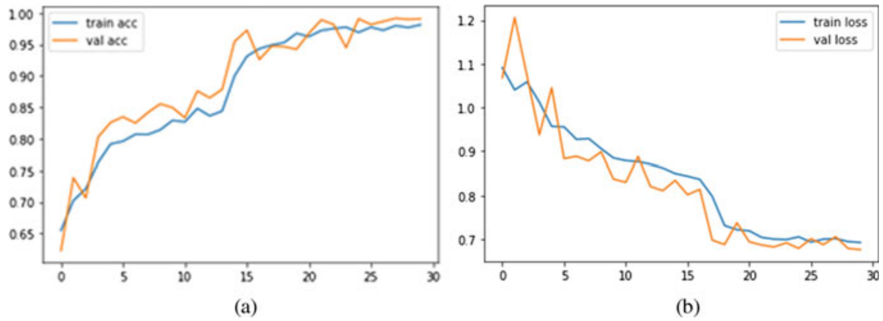
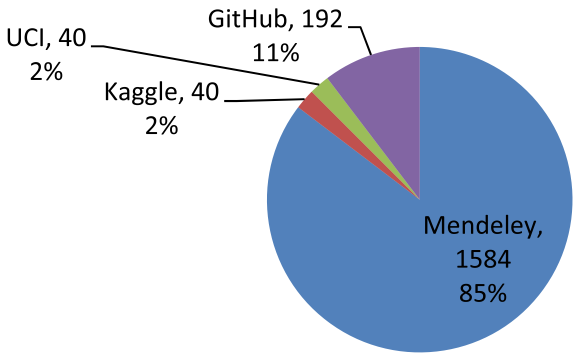
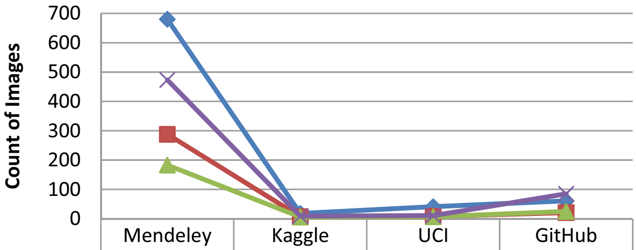


Fig. 6 Epoch-wise accuracy, and loss curve of the model during training, and validation phase; **a** accuracy curve, **b** loss curve

Fig. 7 Contribution of various repositories in dataset generation





	Mendeley	Kaggle	UCI	GitHub
Mild	680	18	41	61
Moderate	288	7	8	21
Severe	183	6	7	25
Profound	473	9	11	85

Fig. 8 Contribution of various repositories in dataset generation based on various levels of severity

6 Conclusion

This paper introduced a new ensemble of CNN, and LSTM approaches for the severity level classification of bacterial blight rice leaf disease. The ensemble used basic CNN convolutional layers for feature extraction to capture the diverse information about the severity level of the disease. Then the output of the convolutional layers is inputted to LSTM. It has been demonstrated that the ensemble model achieved higher accuracy in classification than other single approaches. The dataset generated in this work is collected from various online repositories: Mendeley, Kaggle, UCI, and GitHub. The dataset consists of 1856 images. These images belong to all categories of severity. 733 images belong to the mild severity level, 578 belong to profound, 324 images belong to a moderate level, and 221 images belong to the severe level of bacterial blight disease. Mendeley has 1584 images, kaggle, and UCI have 40 images each, and GitHub has 192 images of bacterial blight disease. The accuracy achieved by the model for the classification of mild, moderate, severe, and profound severity levels in bacterial blight rice leaf disease is 92%, 88%, 86%, and 94%, respectively. For future work, a multi-disease severity detection classifier will be generated which includes multiple diseases of rice leaf. The model first classifies the disease type and then provides information about the level of severity of the disease.

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Intelligent Detection of DDoS Attack in IoT Network

Parul Gahelot, Pradeepta Kumar Sarangi, and Lekha Rani

Abstract The Internet of things is playing a vital role in human life as well as society. Many mandatory services are provided by IoT devices like GPS, cab services, healthcare, weather forecast and the list is too long. Our life depends a lot on IoT devices. But these devices use sensor technology and data streams for acquiring the different types of information. With the growth of IoT devices based on IoT DDoS attacks is increased. Machine Learning techniques are already in use for detecting malicious network traffic. In this paper, we present the Convolutional neural network technique to detect botnet traffic in IoT devices and networks. This model shows enhanced accuracy results thus causing low loss. CNN is a capable automatic hierarchy of learning the most relevant features. This paper achieved a higher accuracy rate of 99.98% result applying Convolutional neural network (CNN). It presents the feasibility of DDoS attack detection in IoT networks.

Keywords DDoS attack · Feature extraction · IoT devices · Classification

1 Introduction

In the digital world Internet of things (IoT) is the key to associating with living. IoT devices increase day by day, in 2016 approximately 9 billion devices (laptops, cameras, parking lights, TV, microwaves, etc.) are available upcoming in 2020 the ratio will grow to 28.1 billion. By 2025, the Internet of things amount will be trillions annually. Security expert and researcher are identifying certain malware on IoT

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devices. That malware cleaning data from infected devices. Hacker creates malware that is infected IoT and embedded devices of data-wiping routine.

Amnesia, a malware which is essentially a variety of a more seasoned IoT botnet customer named Tsunami. It has been found compromised video recorder making use old vulnerability. The other such malware, again focusing on Linux based IoT devices, is named Bricker BoT and is start from targeting router switches and wireless access point. It is to be noticed that several distributed denial of service (DDoS) attacks are presently executed utilizing botnets and hacked IoT devices [1].

The appropriated distributed denial of services (DDoS) attacks has expanded more and more devices less secure and compromised to attack. The IoT device network have been a major casualty of the DDoS attacks because of their asset obliged characteristics. A very challenging task detection of DDoS attack in IoT devices and network. The Internet has turned into a key facilitator of expansive scale worldwide interchanges services in whole world every day. With the consistently extending development of Internet use, a few people doing harmful activities on the network. Network traffic arrangement classifies a vital job in this administration like detection of thread; provide quality of service and identifying potential security dangers. Attacker exploits this developing Internet network traffic.

In network traffic continues grow because cellular data is increase. That's why we are not able to easily identify malicious traffic in the network. Thus, traffic detection function (TDF) is impossible to inspection of packets. Therefore, Intrusion Detection Systems (IDSs) are required for detection of thread and provide security in network [2].

These detection frameworks can be ordered into two techniques:

- Availability of signature for classification of traffic and apply auditing in packet data.
- All observing network traffic we directly use packet filtering method or different thread detection techniques.

These intrusion detection systems are generally framed with relevant feature extraction and static analyzer. Which interface things like deep inspection of packet, its looks at packet payloads [3, 4]. Today, trend of internet activities is highly increase so security, need and malicious traffic intent very essential for us. Current method of detection malicious traffic use classification techniques is become less effective in recent time. Therefore, in present time we use more effective classification algorithm to deal with these conditions. So, we will utilize deep learning technique for deep packet examination. Objective that is achieved in this paper, we are identifying behavior of malicious and benign traffic in network. Detection of botnet attack, DDoS attack and scan malicious activities in network when transfer packet source to destination [5]. With IoT DDoS attacks increasing and more continuous so organization suffers from risk those are associate with IoT device. Because of that, a lot of financial loss has been lost in the business. Detection of DDoS in IoT devices we work to detect them before they're exploited [6].

In this paper we evaluate deep neural network method. This model we build of based on Convolutional neural network (CNN) algorithm. For this research we use

ICSX dataset for our deep learning model and compare them to soft-max regression (SMR) results performed on the ICSX dataset. Soft- max regression performed yielded an accuracy of 99.88%.

The overall paper is organized in five sections. Introduction discuss in Sect. 1. The associated work is discussed in Sect. 2. Section 3 presents the IoT network and its security. The methodology is defined in Sect. 4. In Sect. 5 we discuss Experimental results and comparison. Finally, the conclusion of the work along with the future research scope is explained in Sect. 6.

2 Literature Review

Today solutions to the problems of IoT botnet DDoS attack detection are widely presented in the literature. In recent times, if we talk about the top Cyber-attack, the first name in the list that appears is Distributed denial of service (DDoS) which happens when a hacker deliberately enslaves temporarily many internet-enabled devices into an arrangement known as a botnet.

Lysenko [7] proposed a method for botnet detection, especially in corporate territory systems. It depends on the utilization of the artificial immune algorithm. The proposed method uses a clonal selection algorithm for the classification of legitimate traffic from malware. It takes features that are representing the behavior of the Botnet in the network traffic. A methodology presents the main upgrades of the BoT GRABBER framework. It can distinguish the IRC, HTTP, DNS and P2P botnets.

Median [8] evaluated this method and Test on nine business IoT devices in his laboratory with two broadly known IoT-based botnets, Mirai and BASHLITE. The assessment results exhibited and proposed the technique's capacity to detect the attack. Attacks were being started for the influence of IoT devices that were identified as botnets.

Hodo [9] presents a thread examination of the IoT and utilizes an Artificial neural network (ANN) to solve these threads. A multilayer perception is a type of supervised learning Artificial neural network (ANN), for training purposes, it is to use internet traffic and then examine the ability of Distributed denial of service attack.

In this paper author takes useful dataset. Dataset contains network flow that inherits seven common attack properties and legitimate data. Subsequently, machine learning algorithm use to detect specific attack classification. It was taken as the best relevant feature from over network traffic feature [2].

To evaluate the effect on the intrusion detection rate, cost of inspection as well as latency rate of detection due to the inspection rate, an analytic model is proposed. The demonstration by the proposed model is verified through the numerical simulations. In this method achieves a satisfactory trade-off between the cost of inspection and the detection rate of latency [10].

In this paper, WRFS and Random Forest using top 5 features for classification are used for the experiment [11].

Doshi [12] present in this paper, detection of local IoT devices which is infected from DDoS attack. Detection module applies in home gateway router. It is automatic detect attack using lowest cost machine learning algorithm. Network traffic dataset related to flow-based and protocol agnostic.

Bayu Adhi Tama and Kyung-Hyune Rhee, use DNN in this paper, Deep neural network (DNN) is evaluate different type of validation method like cross-validation, sub sampling and repeated cross-validation on various novel labeled dataset. This experiment use grid search algorithm for to find the most learning features of DNN foe every dataset. This DNN detection module performed attack detection system in wireless devourment [13].

In this experiment, Sultana et al. [14] use Software define network (SDN) obtain forty-one features from NSL-kDD dataset but using only six features. It examines flow-based thread detection system using deep learning approach in SDN environment.

In this paper, [15] Shu, Jun Hua done comparison of different machine learning algorithm for network traffic classification like random-forest, naive Bayesian and depth learning. Deep neural network shows high accuracy result with better stability comparison to other machine learning algorithm. Its accuracy rate is 98.5%.

Abeshu and Chilamkurti [16] present a novel Distributed Deep learning (DL) method for the detection of fog-to-thing in cyber-attack. Shallow model is lowest model comparison to deep model in this experiment. Model calculates and show better result in IoT network which is produced large amount of network traffic.

Torroledo et al. [17] proposed deep neural based method for identification of malicious traffic use of internet certificates. This system was used TLS certificates for successfully purpose of distinguish benign and malicious traffic.

3 IoT Network and Security

A network of (cloud) servers, distributed (sensor) nodes, and related software is known as the Internet of things (IoT). Such an arrangement allows us to sense and then process the measures in real time which results in a direct interaction platform between cyber-physical systems which finally results in in the generation and usage of data with improved efficiency that further leads to economic benefits [18].

Classification of IoT threats can be done in following four types:

Denial of Service (DoS)—When due to introducing useless or unwanted traffic, a user's resources are denied or prevented. This kind of threat is termed as Denial of Service (DoS).

Malware—Executable codes used by Attackers for disrupting the devices on the IoT network.

Data breaches—Listening to the communication between peers on any network by Attackers by spoofing ARP packets.

Weakening Perimeters—Network security mechanisms are not often present in the devices making the network a vulnerable one for threats.

In this paper, DDoS attack is identified in the various part of the IoT network using CNN by analyzing the various information of those parts and extracting features for offline DDoS attack. In machine learning algorithms return an inaccurate prediction, then in this research need to step in and make adjustment in prediction of Botnet DDoS attack traffic. But with deep learning model the algorithms can determine on their own if a prediction is accurate or not so design more accurate model for prediction of traffic malicious or non-malicious.

4 Proposed Work

A DDoS is harmful thread for IoT devices which is not easily to monitoring. According to Stanford university research more than 2000 attack perform per day in network. In DDoS attack scenario attacker flow huge number of zombie and compromised the devices. Many IoT devices have default password so hacker easily hacked them from this attack. Attacker finds the vulnerability of IoT devices and flood traffic to hack IoT device. IoT devices consume low power, memory and limited sensing area. Then attacker easily attack in IoT devices. In our proposed framework we detect DDoS attack in gateway router which is available in the middle of cloud and IoT devices (Fig. 1).

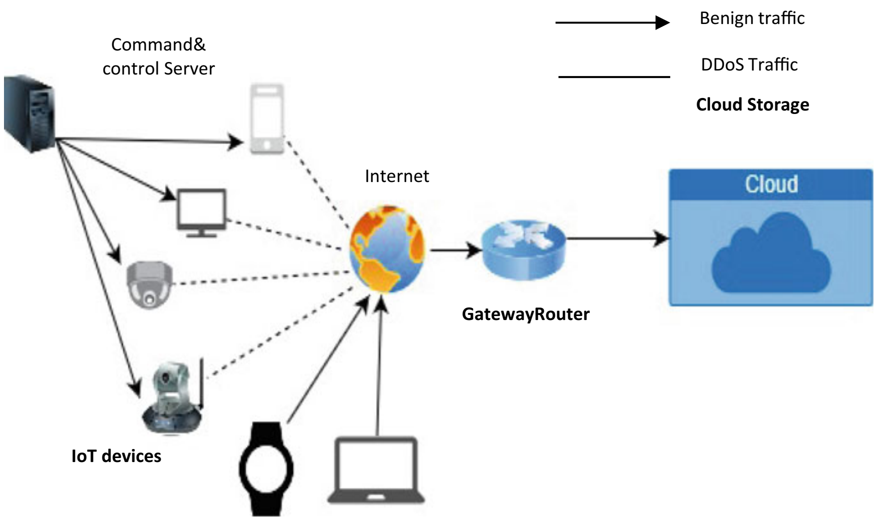

Fig. 1 Architecture of proposed detection model in real time

5 Methodology

In our methodology we can select higher rate features of DDoS attack. We have extract seventy-eight features from our benign and botnet datasets. We implement our model using deep neural network for best result detection of attack related traffic.

- Collection of Dataset
- Extraction of relevant features
- Classification Method.

In general, DDoS attack contains three main components.

- Firstly, there is a need for a mechanism for collecting data that traces the traffic of network as benign and malicious.
- After that, we use this data for the identification of network traffic features and then needs to create a feature vector.
- Finally, when the classification model is executed with the use of this vector, traced attack scenario for identification of normal or as malicious according to the knowledge, previously attended by the model (Fig. 2).

A. *Data set Collection*

In Detection model for the evaluation requires a different type of dataset which contain a blend of attack vector, normal IoT devices traffic and multiple of botnet communication. We collected our dataset from various sources both benign and DDoS. We have collected 95,000 benign packets in pcap file and 1, 25,000 infected from DDoS packets pcap files for analysis prediction and classification purpose.

B. *Feature Extraction*

For the DDoS detection in IoT network. We are extract total seventy-eight features. These features hold the major properties of DDoS attack that are infected to IoT devices in network. The major challenges are extraction of features of DDoS attack from IoT devices. After doing many research related to features, this work finds out a verified and more explained features these are used many times by the researcher for detection of malicious IoT traffic.

C. *Classification*

In present time machine learning cover largest research and innovation area including data security. In this using deep learning CNN algorithm because this method

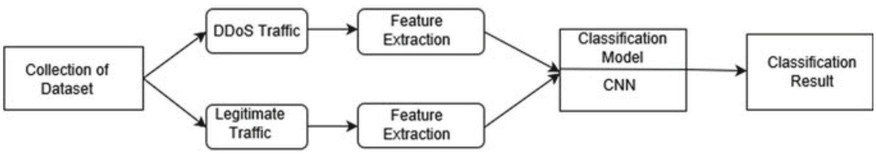

Fig. 2 Architecture of proposed methodology

demands large dataset for classification. It does not require feature selection because CNN algorithm automatic select features from all extracted features. In CNN model, for training and testing, each input dataset will pass through a filter with convolution layers series (Kernels), fully connected layer and pooling. Also, for the classification soft-max function is used object heuristic values lie between 0 and 1. We have extract 78 features in this experiment previously Table 1 in include.

Splitting data is two parts testing and training for classification purpose.

- Testing dataset
- Training.

Testing dataset—We are select randomly data from combine data that is contain both malicious and begin packets. It has contained 67,714 packets in 78 features, Testing Shape: (67,714, 78).

Training dataset—It has contained 157997packet in 78 features, Training Shape: (157,997, 78) (Fig. 3 and Table 2).

6 Result Analysis

This very section elaborates the results of the experiments which are achieved by our method. Botnet traffic instance is considered as positive and the benign traffic instance is considered as negative for the sake of evaluation of the experiments.

- DDoS packets labeled as DDoS in True Positive (TP).
- Normal packets labeled as DDoS in False Positive (FP).
- True Negative (TN) meaning number of normal packets labeled as normal traffic.
- False Negative (FN) meaning number of DDoS packets labeled as normal traffic.

In confusion matrix result shows if we pass benign data set in our proposed model it predicts 29,014 benign and 43 DDoS attack. And next we pass DDoS dataset for prediction of DDoS attack in our model this table predicts 36 benign and 38621DDoS attack (Fig. 4).

Many researchers have already worked in the scenario of network traffic classification. We discuss some proposed work that was previously classifying the network traffic using different datasets and method. At the last we are present our result in this comparison include Table 3.

Figure 5 represent an accuracy model for detection of DDoS attack in IoT network. For the purpose of the classification method, we had splitted our dataset into two parts, one for training and another is testing datasets. In our model predict classification result is 99.98% using CNN method.

Table 1 Relevant extracted feature

F_ID	Feature	F_ID	Feature
F_1	Protocol	F_22	Flow Duration
F_2	TotalFwdPackets	F_23	TotalBackwardPackets
F_3	TotalLengthofFwdPackets	F_24	TotalLengthofBwdPackets
F_4	FwdPacketLengthMax	F_25	FwdPacketLengthMin
F_5	FwdPacketLengthMean	F_26	FwdPacketLengthStd
F_6	BwdPacketLengthMax	F_27	BwdPacketLengthMin
F_7	BwdPacketLengthMean	F_28	BwdPacketLengthStd
F_8	FlowBytes/s	F_29	FlowPackets/s
F_9	FlowIATMean	F_30	FlowIATStd
F_10	FlowIATMax	F_31	FlowIATMin
F_11	FwdIATTotal	F_32	FwdIATMean
F_12	FwdIATStd	F_33	FwdIATMax
F_13	FwdIATMin	F_34	BwdIATTotal
F_14	BwdIATMean	F_35	BwdIATStd
F_15	BwdIATMax	F_36	BwdIATMin
F_16	FwdPSHFlags	F_37	BwdPSHFlags
F_17	FwdURGFlags	F_38	BwdURGFlags
F_18	FwdHeaderLength	F_39	BwdHeaderLength
F_19	FwdPackets/s	F_40	BwdPackets/s
F_20	MinPacketLength	F_41	MaxPacketLength
F_21	PacketLengthMean	F_42	PacketLengthStd
F_43	PacketLengthVariance	F_61	FINFlagCount
F_44	SYNFlagCount	F_62	RSTFlagCount
F_45	PSHFlagCount	F_63	ACKFlagCount
F_46	URGFlagCount	F_64	CWEFlagCount
F_47	ECEFlagCount	F_65	Down/UpRatio
F_48	AveragePacketSize	F_66	AvgFwdSegmentSize
F_49	AvgBwdSegmentSize	F_67	FwdHeaderLength.1
F_50	FwdAvgBytes/Bulk	F_68	FwdAvgPackets/Bulk
F_51	FwdAvgBulkRate	F_69	BwdAvgBytes/Bulk
F_52	BwdAvgPackets/Bulk	F_70	BwdAvgBulkRate
F_53	SubflowFwdPackets	F_71	SubflowFwdBytes
F_54	SubflowBwdPackets	F_72	SubflowBwdBytes
F_55	InitWinbytes_forward	F_73	Init_Win_bytes_backward
F_56	act_data_pkt_fwd	F_74	min_seg_size_forward
F_57	Active Mean	F_75	ActiveStd

(continued)

Table 1 (continued)

F_ID	Feature	F_ID	Feature
F_58	ActiveMax	F_76	ActiveMin
F_59	IdleMean	F_77	IdleStd
F_60	IdleMax	F_78	IdleMin

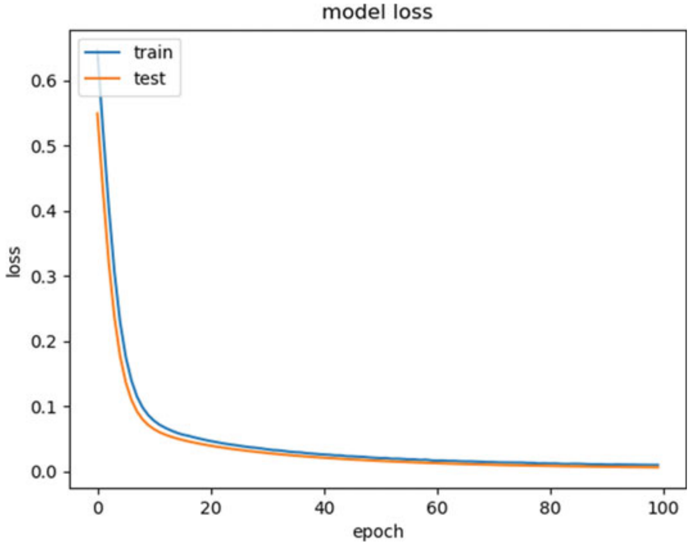

Fig. 3 Loss model in classification

Table 2 Convolutional neural network parameters

Layer (type)	Output shape	Parameter
dense_1 (Dense)	(None, 78)	6162
p_re_lu_1 (PReLU)	(None, 78)	78
dropout_1 (Dropout)	(None, 2)	0
dense_2 (Dense)	(None, 2)	158
activation_1(Activation)	(None, 2)	0

7 Conclusion and Future Scope

In this paper, we present the implementation of deep learning using CNN, for DDoS detection in IoT networks. In this method, we calculate the dataset for enhanced the accuracy of the results thus causing low loss metrics. Our experimental model presents enhance the accuracy and causing low loss metric for attack detection vectors using the DDoS traffic dataset. Result for DDoS attack detection accuracy 99.98% and 0.0063 validation loss matrices, respectively.

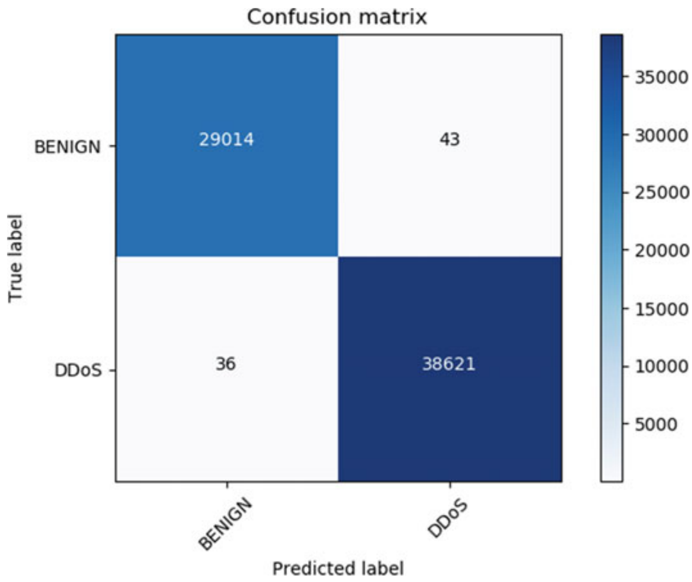

Fig. 4 Confusion matrixes, without normalization

Table 3 Result comparison with existing works

Author	Dataset	Methodology	Accuracy (%)
Doshi et al. [11]	459,565 malicious packets and 32,290 benign packets	Random forest algorithm using Gini impurity scores	99
Abeshu et al. [16]	Normal 77,054 and Attack 71,463	Deep neural network	99.20
Lysenko and Kira [7]	IRC, HTTP, DNS and P2P botnets	Clonal selection algorithm	95
Our model	95,000 benign packets and 125,000 DDoS attack	Deep learning (convolutional neural network)	99.98

This paper shows that enhance accuracy and diminishing the loss using the largest amount of sample size. In future we imply the mitigation in real time IoT DDoS attack. In router we capture flood traffic in network then apply deep neural network for prevent IoT devices. If DDoS traffic flow in network router that is connect to devices this is classifying the benign and DDoS attack in real time.

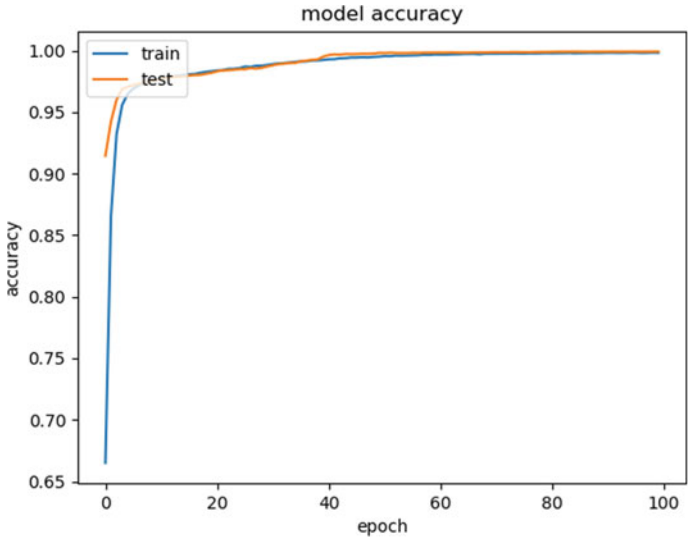

Fig. 5 Accuracy of the model

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Integration of IoT for MANET Network Security

Chetna, Shikha, Sunil Gupta, and Tejinder Kaur

Abstract MANET wireless network has proven to be a valuable tool in various communication applications. It has risen in popularity in recent years due to considerable advancements and the MANET network design presents the maximum difficulty. Recently, concerns about latency and availability have been worsened because of continual form and characteristic modifications, which have resulted in terms of performance and service quality difficulties. Self-organizations are the ones who have de-centralized MANET and without centralization, participating nodes are free to migrate. So, this paper undertakes a study to understand IoT for MANET network security where nodes can transit from being a host to become a router at any moment. This complicates the transmission of data packets among nodes in a de-centralized mobile ad-hoc network. Due to the nodes' proclivity for self-organization, MANET networks offer both advantages and disadvantages. This along with simplifying network maintenance also changes the topology, but data transit must be authorized. MANET may also be used to connect to bigger networks like the internet. However, there are no intelligent devices that can transmit data among machines.

Keywords MANET · IoT · Wireless networks · Networks · Security · Performance · Authorization

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1 Introduction

Nowadays, most businesses rely on electronic devices and smart phones as they are accessible to everyone. Individuals from across the world can now connect to the Internet because of the worldwide connectivity of Internet. This demonstrates that the Internet of Things is a major global trend (IoT). Numerous products which one uses daily, i.e., printers, phones, and other electrical equipment, are all connected to the Internet of Things (IoT). The vast internet network encompasses several of these elements and numerous more. Additionally, Internet of Things users can make phone calls and transmit files to one another. Maintaining the security of each connected device or user is critical along with minimizing latency in the IoT system and data transfer in the appropriate amount of time for the IoT network [1]. Wireless Networks (WSNs) are a sort of Internet of Things (IoT) system that makes extensive use of available space, it also consists of wireless nodes which perform several functions. These lately have been employed in several areas and various prominent locations. WSNs can acquire and transmit data for every unique environment, each being with its own set of goals and objectives. As WSNs are utilized in various applications, optimizing their performance and lowering their latency is critical. When it comes to optimizing wireless network performance in an IoT system, this is a significant task that can be accomplished in various ways. The performance of wireless IoT systems can be determined by the optimal method, i.e., data transmission between the source and destination with the least amount of latency. The MANET network, which is a collection of the same, will have a numerous node. This study will be based on the project concept. The devices communicate with one another via wired and wireless connections in order to function together. Because of nodes shifting often, it isn't easy to keep track of them, and as a result, the network's design and the course also fluctuate. This is what has motivated a great deal of study worldwide: resolving the central MANET challenge of determining the optimal path through a network along with extending the life of network nodes beyond what was previously achieved. However, there is currently no comprehensive answer or set of regulations to follow this. Numerous approaches to this problem exist, including ant colony optimization, lion algorithm, static particle swarm optimization, and genetic algorithm. Utilize a dynamic genetic technique as dynamic as MANET [2].

2 Methods

The information for this inquiry was collected from a variety of places. For further information, archives of journal articles and newspaper articles were searched. Several public and private sources are used to acquire information regarding the sports firms in both countries. Collecting secondary data from a variety of sources helps speed up the research process. There is no need to go straight to the data sources while compiling secondary data. Working with a wide range of data types will be easier if the secondary strategy is used. It can also be utilized with pre-existing data from a different perspective. One should do the additional procedure as a precaution just to guarantee a successful operation. This assists in locating reliable information on the subject. Because of this, the data from secondary sources will be reliable. Furthermore, the approach and the process are transparent and precise. It establishes a baseline for the results of the initial data collection to pave the path for future studies. You can be sure that your study plan is sound if you use secondary research methods.

3 Discussion

There is not one point of failure, and there never will be. Still, there may be a single or several hops between the nodes that comprise a MANET. There is a possibility that the same node can serve as the host itself when data is received or transmitted. It can also transport data to another node to be utilized there as a router. Because of MANET, the network design is dynamic as nodes constantly move that too in any nature (Fig. 1).

As a result of this dynamic movement, routing information keeps on changing [2]. IoT technology works efficiently even when it is deployed in places where several people are using it or also if devices are collaborated to accomplish a variety of tasks. Numerous files, including wireless applications, home automation applications, and others, are included with the IoT application. These files are used to link a variety of devices in the cloud system. Users are not required to establish the computer infrastructure, which is costly [3, 4]. Smart homes are an example of IoT applications

Fig. 1 A MANET system [3]

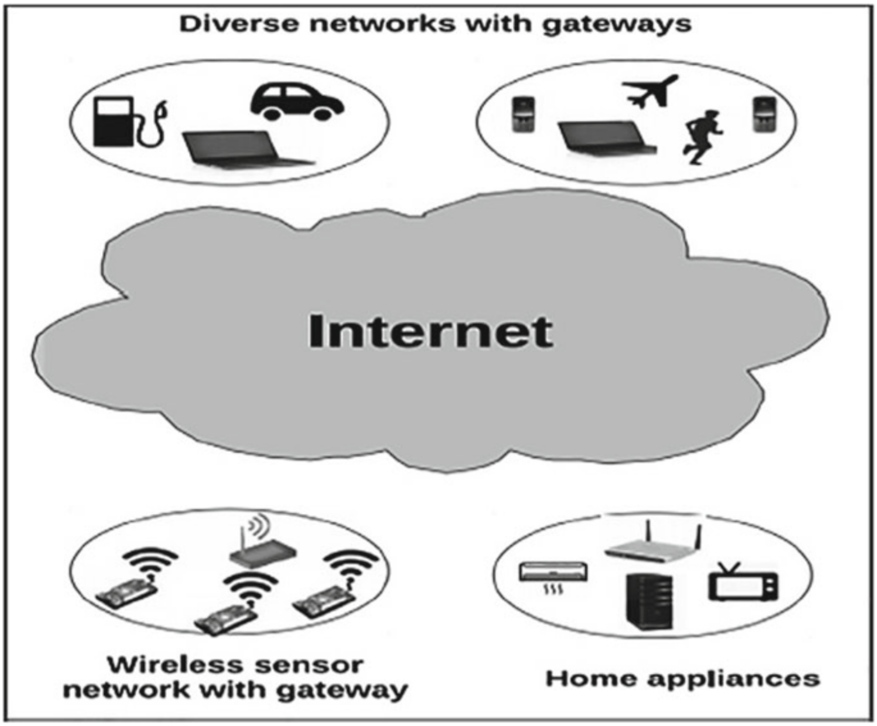

Fig. 2 IoT factors overview [5]

that are focused on enhancing service and reducing wait times. Numerous firms have begun to employ the non-IP technique [5] (Fig. 2).

With each day, an increasing number of electrical products are introduced to the market. These gadgets are capable of cooperating securely. The IoT is a modern application that requires security yet suffers from significant delays and latency. The curve of the Elliptic employs the Diffie Hellman algorithm. It is based on a public-key cryptosystem and employs the Diffie Hellman algorithm (EC-DH). Elliptic curves are insufficiently strong to protect the user's data due to a lack of storage capacity [6]. An individual utilizes the Internet of Things desire to increase their devices' connectivity, low latency, and bandwidth because the Internet of Things continues to grow in size [7]. As a result, a variety of factors might impact the network's Quality of Service (QoS). Those focused on the system's edges are developed on a cloud computing architecture that leverages emerging technologies to improve IoT applications. These technologies can assist in resolving issues with cloud models by providing individuals with other methods of resolving issues [8] (Table 1).

Table 1 Findings

Citation	Aim	Findings
Agrawal [1]	To understand security with respect to MANET and IoT	Handshaking between MANET and IoT allows for the creation of an appropriate interactive and Communicative IoT architecture
Alshaker and Almutairi [10]	To determine the availability of IOT for the MANET network	This technique will lower MANET network latency while also addressing availability concerns caused by dead nodes or low battery levels
Asemani et al. [3]	To propose a novel comprehensive definition for the IoT platform and its attributes in Cloud and Fog layer	The cloud and fog layer are presented based on scientific definitions in research articles, commercial product definitions and characteristics offered by IoT leader firms and IoT platform specifications in various open-source projects
Domb [5]	To show how to put together three parts to make an advanced smart home concept and implementation strong	He proposes a centralized real time event processing application to orchestrate and manage the massive data flow in a balanced and effective manner, using the capabilities of each component
Goyal and Saluja [6]	To find the Lightweight Security Algorithm for low Power IoT Devices	The ECDH algorithm has been shown to be superior to others in terms of power and area
Qin et. al. [9]	To make the IoT environment software defined so that it can change the quality level for different IoT tasks in very different wireless networks at the same time	Preliminary simulation results demonstrate that our method and the improved MINA system may make it easier to harness IoT multinetwork capabilities
Whitley [2]	Next-Generation Genetic Algorithm	Among the outcomes is the use of deterministic recombination operators capable of tunneling between local optima and deterministic constant time move operators

3.1 The MANET Routing Protocol Integration in the Internet of Things.

There are several protocols in MANET that can assist in improving network security, but maintaining security in the IoT is challenging due to the sheer number of connected devices [11]. As a result, IoT devices are subject to a variety of assaults, including malware, botnets, denial of service attacks, and a variety of web and Android malware. Therefore, a standardized architecture for IoT communication is required which can be utilized in a variety of contexts. Effective IoT security features Confidentiality.

3.2 The Security of IoT Confidentiality

The term “confidentiality” refers to the fact that any data stored or sent is protected from those who do not have the authority to see or attack it. Any data shared via IoT communication is safeguarded using a well-established, lightweight approach.

3.3 Router Security for MANET and IoT

Cryptographic techniques are employed to protect routing information during packet transmission in MANET and IoT. This is because both of these systems employ hop-to-hop protocols to transmit their packets and that is a difficult task in IoT because numerous safety protocols are being developed in MANET, but IoT is a new area of research.

3.4 Develop a Secure Method for IoT Communication in the MANET

We employ MANET for a specific purpose, but the Internet of Things (IoT) was designed to blur national boundaries, so we must develop a secure communication strategy that works for both the IoT and MANET. To do this, we should establish an authentication system capable of rapidly identifying apps, services and the individuals who use them [12].

3.5 The IoT SON Architecture is Applied in This Instance (Software Organizing Networking)

Numerous wireless networks employ SDN because it is simple to maintain and allows for rapid network changes due to software specifications. Network and devices, bandwidth utilization, transmission rate, and delay rate are critical statistics to consider

[9]. Innovative multinetwork architecture and control systems are created to ascertain the optimal performance metric for an IoT network. Data and information from several network systems can be consolidated and analyzed in a single database or cloud architecture, referred to as a "database." While a multinetwork architecture is configured correctly, getting higher throughput when dealing with large amounts of data is possible.

4 Conclusion

The dynamic genetic algorithm was used to read changes in the MANET as a function of network parameters such as power consumption, node location, availability, and latency. This approach was used to determine the existence of these alterations. Consider three factors while determining the optimal path: power, speed, and distance. Individuals with genetic mutations want the least time, power, and distance to obtain the most cost-effective solution. This study examined a variety of various network topologies to determine whether the genetic capacity to adapt to network changes can be demonstrated or not. People and IoT can only collaborate to create an interactive and communicative IoT architecture only if some minor adjustments are made, and a lightweight cryptographic system is used. IoT has the potential to play a significant role in a variety of services such as traffic management and smart cities. An extensive study and investigation should be conducted in this scenario, as IoT integration has two primary issues.

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Detection of Tomato Leaf Ailment Using Convolutional Neural Network Technique

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Abstract Tomatoes are very essential staple crop that is consumed by millions of people from all corner of the world. But, unfortunately, a huge part of the total tomato crop production is lost annually due to various plant ailments, and manual identification of this diseases is tedious and may need the assistance of trained expert. To overcome these issues, we have concentrated in relation to the usage of a deep learning algorithm according to a convolutional neural network to build a classification system to accurately classify leaf images and identify the disease. The tomato leaf ailment pictures in this paper is obtained from Kaggle database. If the plant is infected with a disease, the disease name is mentioned in the dataset. The dataset contains around 7928 images which are categorized into ten different classes. The dataset was divided into train, test, and validation sets in ratio 8:1:1. The first instance the dataset is iterated over, its elements are cached in memory. Subsequent iterations use the cached data. During a particular iteration, the dataset for the next iteration is also prefetched. The neural network is built by adding the rescaling and data augmentation layers first. Six convolutional and pooling layers were alternatively later applied for feature extraction. Dense layers were used for classification of the data from convolutional layers to the correct class name. The model gave an accuracy of 96.26% over the dataset which is much better than the traditional model.

Keywords Deep learning · Convolutional neural network · Feature extraction

1 Introduction

Tomatoes are a very essential staple crop that is enjoyed by millions of people all over the world. Tomatoes include the three most significant antioxidants that are

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vitamin E, vitamin C, and beta-carotene. They're also high in potassium, a mineral that's essential for overall health. It has a high market value and is mass produced in massive quantities. But, unfortunately, a huge part of the total tomato crop production faces loss annually because of various plant ailments. Late and inaccurate detection of plant ailments increases the losing percentage for the crop production. It is critical as to monitor the farmed crop's growth early on in order to ensure minimal losses. Many farmers make incorrect conclusions about the disease because visually discernible patterns in the leaf are difficult to classify at a glance. As a result, farmers' preventative measures may be ineffectual and, in some cases, detrimental. They don't have any expert recommendations on how to cope with their harvest infection. Overdosing or under-dosing pesticide has reflected in crop damage, resulting in increased output loss, in some cases due to a lack of understanding or misperception about the severity of the disease. Because manual disease monitoring is laborious, automatic disease detection in tomato plants will aid farmers in disease identification and decrease costs. Disease identification will aid in the prevention of losses and the creation of a high yield. As a result, a good method for detecting tomato disease promptly is essential. Plant disease detection has always relied on human interpretation via visual scrutiny. To identify pathogen-specific antigens or oligonucleotides, it is now coupled or replaced with various applied sciences. Furthermore, recent technological advancements and huge price savings in the digital imaging area collection have enabled practical implementation of a variety of diagnosis based on images. However, because the captured image contains compressed data that is tough for a machine to understand, it necessitates a preliminary processing phase to bring out specific characteristic (for example, color and shape) that is manually prearranged by specialists. Deep learning is often used in these scenarios because it allows the computer to train the most appropriate functions without the need for human intervention. Deep CNN became trainable in large scale in 2010s thanks to rapid technological development and improved learning methods. The method proposed in the study applies to some of the most frequent tomato plant diseases which are bacterial spots, curl virus and septoria spots, and other illnesses. The image of each leaf can be assigned to one of the ailments classifications or determined as healthy. The dataset was taken from Plant Village, a collection of 7928 photos. Broadly speaking, the proposed method contains three main steps: data acquisition, preprocessing, and classification. As mentioned earlier, pictures used to track the proposed approach were taken from a public dataset called Plant Village. The next step was to scale the image before inputting it into the classification model. The classification of the input in the final step was done using a so-called convolutional neural network model, which comprises layers of convolution, pooling, and fully connected. The first layer of the convolutional network is the convolutional layer. The rest of the paper is designed as: Literature review is explained in Sect. 2, experimental work has been put in the Sect. 3. Section 4 represents the result and discussion and concludes the paper in Sect. 5 with some future aspects.

2 Literature Review

To follow the right path, we need to identify previous research in this area. Image processing and deep learning techniques have long been in use for the reliable categorization of plant leaf ailments, which is a crucial research subject. This article describes the most commonly used techniques in the relevant field. This section describes the most widely used techniques in each field.

In [1], the author used the Histogram of Oriented Gradient (HOG) method to predict features and feed them into a classification model. Finally, they evaluated the leaves, diagnosed the disease, and sent the information to the farmers by text message. Next, the tomato leaves were taken and the disease was identified using SVM and ANN algorithms. Data acquisition, preprocessing, feature extraction, image segmentation, and classification phases were all part of those methodologies. The dataset contained 200 images of tomato and corn leaves. Fifty images were images of healthy tomato and corn leaves, and 110 images were images of tomato and corn leaves in the coaching and testing section. Similarly, 40 sheet images were used in the test phase. The arrow represents connection from output of one node with a standard ANN to the output of another node. The batch size was set at 20 for each batch. The learning rate was initially set at 0.01 and gradually reduced to 1/0.3 until the plateau where the loss did not decrease was reached. Early stopping was also used to track loss of validation and stop the training process when the validation process increased. We examined tomato and corn crops using SVM and ANN classifiers. The tomato harvest result with SVM and with ANN8085 accuracy was 6070%. SVM provided 7075% accuracy for maize, while ANN provided 5565% accuracy. This model consumes more time and is slow. The highest accuracy achieved is 85%. The goal of [2] was to create two models for identifying diseased tomatoes using deep CNNs and object detection architectures. Pictures from Internet were taken and carefully inspected to ensure that the visuals and disease types corresponded. The training set photos needed to be annotated in two different ways for two different object recognition architectures. A training set was used to train the model. Validation set was accustomed to provide feedback on progress of the training and whether training was completed. Finally, a trained model was used to evaluate performance on the test set. In this study, tomato plant diseases were detected at the fruiting stage. Detection of plant diseases at the fruit stage leads to detection of diseases at later stages, which are more difficult to treat. In [3], they segmented images of tomato leaves using adaptive clustering numbers from the K-means algorithm. This approach has not been able to achieve high accuracy in disease detection. The goal of their study at [4] is Extreme, a machine learning categorization technique with a one-layer feed-forward network for classifying plant diseases by analyzing leaf photographs. It was to use Learning Machine (ELM). In this study, the image was preprocessed in HSV color space, and features were extracted using Haralic textures. We then used these features to train and evaluate the model using the ELM classifier. After the test was completed, the accuracy of the ELM was calculated. As compared to other models, ELM results show 84.94% higher accuracy. However, training and processing the model is time consuming. In [5], they conducted a comparative study of five machine learning methods for plant ailment recognition. The results of this work show that the CNN classifier can detect more diseases with high accuracy. According to this work, in the future, other machine learning techniques like decision trees will be used to detect plant diseases using a Naive Bayes classifier, and all kinds of plant diseases detected by farmers can be automatically detected. The classification was accurate only to distinguish between healthy and unhealthy leaves. Another classification of unhealthy leaves was inaccurate.

In [6], they used the KFHTRL PBC method, which included three steps: pretreatment, feature extraction, and classification. Input leaf photo noise was taken out using a Kuan filter during preprocessing to enhance picture quality and disease diagnosis accuracy. They then used the Hough transform. The results of the experiments demonstrate that the KFHTRLPBC technique has improved the peak signal-to-noise ratio while reducing time complexity. However, accuracy achieved was only 88%. They used a random forest to distinguish between healthy and unhealthy leaves from the datasets obtained in [7]. The research they proposed included several implementation phases such as dataset creation, feature extraction, classifier training, and classification. To classify infected and healthy photos, we combined the generated diseased and healthy leaf datasets and trained under a random forest. They used an oriented gradient histogram to extract image features (HOG). Only 70% accuracy was achieved in random forest. In [8], they used a soft computing approach to automatically segment the disease from plant leaf photographs. They used BFO to optimally weight the RBFNN. This has improved the speed and accuracy of the network in identifying and classifying areas affected by various diseases of plant leaves. By finding and grouping seed points that have a common quality in the feature extraction process, the region expansion algorithm has improved the efficiency of the network. The proposed method advanced disorder identity and type accuracy. But the noisy pixels have been now no longer eliminated the use of the filtering method. To classify the 1.2 million excessive decision pictures, they educated a huge, deep convolutional neural community in [9]. The neural community consisted of five convolutional layers. They didn‘t use any unsupervised pre-education of their research to maintain matters simple. Due to the excessive quantity of layers withinside the neural community, a considerable quantity of processing time became required. It became now no longer prepared to categorize various agricultural sicknesses. The studies in [10] proposed a way for photo segmentation method that became used to locate and classify plant leaf sicknesses automatically. Image segmentation, that is a key a part of disorder analysis in plant leaf disorder, became achieved by use of the genetic algorithm. But there has been no type method used withinside the segmentation technique for enhancing the popularity rate.

3 Experiential Work

3.1 Data Collection

The tomato leaf ailment images adopted in this paper are obtained out of Kaggle.com. It consists of a labeled dataset of various images of tomato leaves. Each plant in the image is either healthy or unhealthy. If the plant is infected with a disease, the disease name is mentioned in the dataset. Around 7928 photos from ten different classifications make up the collection. Images are of high-resolution quality in RGB format. The dataset contains a higher number of images of unhealthy plants as compared to healthy plants since during prediction most of the images will be of unhealthy class type.

3.2 Data Preprocessing

The dataset was divided into 8:1:1 train, test, and validation sets. The neural network will be trained using the training dataset. The validation dataset is used to offer a rough indication of model skill while adjusting the hyperparameters. The test dataset is used for computing the final precision and prediction of the model after the training is completed. The items of the dataset will be cached in memory the first time it is iterated over. Subsequent iterations will use the cached data. During a particular iteration, the dataset for the next iteration is prefetched. Doing so reduces the step time to the maximum of the training and its time to extract the data. This enables faster computational speeds and higher efficiency of the model. Figures 1 and 2 represent Naïve implementation versus prefetch.

The RGB values of the image [0, 255] are rescaled to be in the [0,1] range. Images are also resized to fixed dimensions (256 × 256). This ensures uniformity in data so higher accuracy can be achieved without overfitting. Data augmentation strategy is used for increasing diversity of training set by applying random (but realistic) modifications to images, such as random rotations and flipping, image contrast, image hue, and so on. This increases the model's robustness when it comes to making predictions on a wide range of photos.

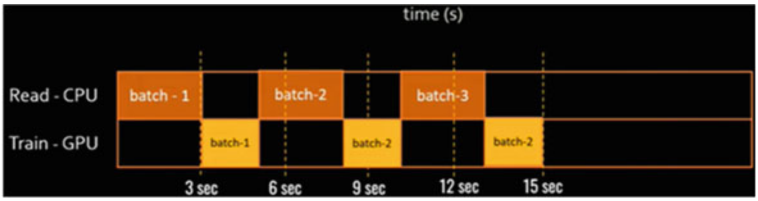

Fig. 1 Naïve implementation

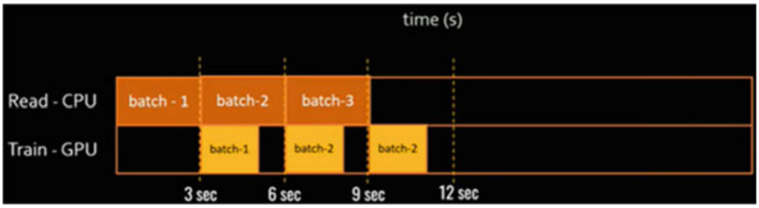

Fig. 2 Implementation using prefetch

3.3 Classification

We have used CNN to create a computer model that takes unstructured images as input and turns them into classification labels. They fall into the class of artificial neural network that could be taught to learn functions needed for classification. Performance is improved because it requires less preprocessing and can perform autonomous feature extraction compared to traditional methods. The CNN architecture is similar to organization of the visual cortex. Each block has three levels named as convolution, activation, and maximum pooling. This design uses two fully combined layers with a softmax activation layer on the output label, followed by six such blocks. For feature extraction, convolutional and pooling layers are used and for classification, fully connected layers are used. Since the classification problem is nonlinear in nature, the nonlinearity is introduced into the network via the activation function. The convolution layer consists of alternating convolution and pooling operations that help in feature extraction. The complexity of the retrieved features grows as the depth is increased in the network. Throughout, a 3×3 filter is utilized. In the first convolutional layer, we employed 32 output filters. This number is increased to 64 for all further convolutional layers. To compensate for the smaller feature map, the number of filters must be increased. Zero padding was used to retain the image size after the convolution operation. Nonlinearity is incorporated using the ReLU activation function. After every convolution operation, a max-pooling operation is performed to speed up training and to make the model lesser susceptible to slight input changes. For max-pooling, the kernel size is 2×2 with a stride of 1 in all directions. The final two layers are responsible for the classification of input. It is made up of two layers of neural networks that are fully coupled. To compute the probability scores for ten different classes, the first layer is made up of 64 neurons, whereas the second layer is made up of ten neurons with soft max activation function which is represented in Fig. 3.

3.4 Experimental Settings

The dataset used in this paper is gathered from Kaggle.com. It consists of around 7928 images of tomato leaves each belonging to one of ten different classes of tomato plant

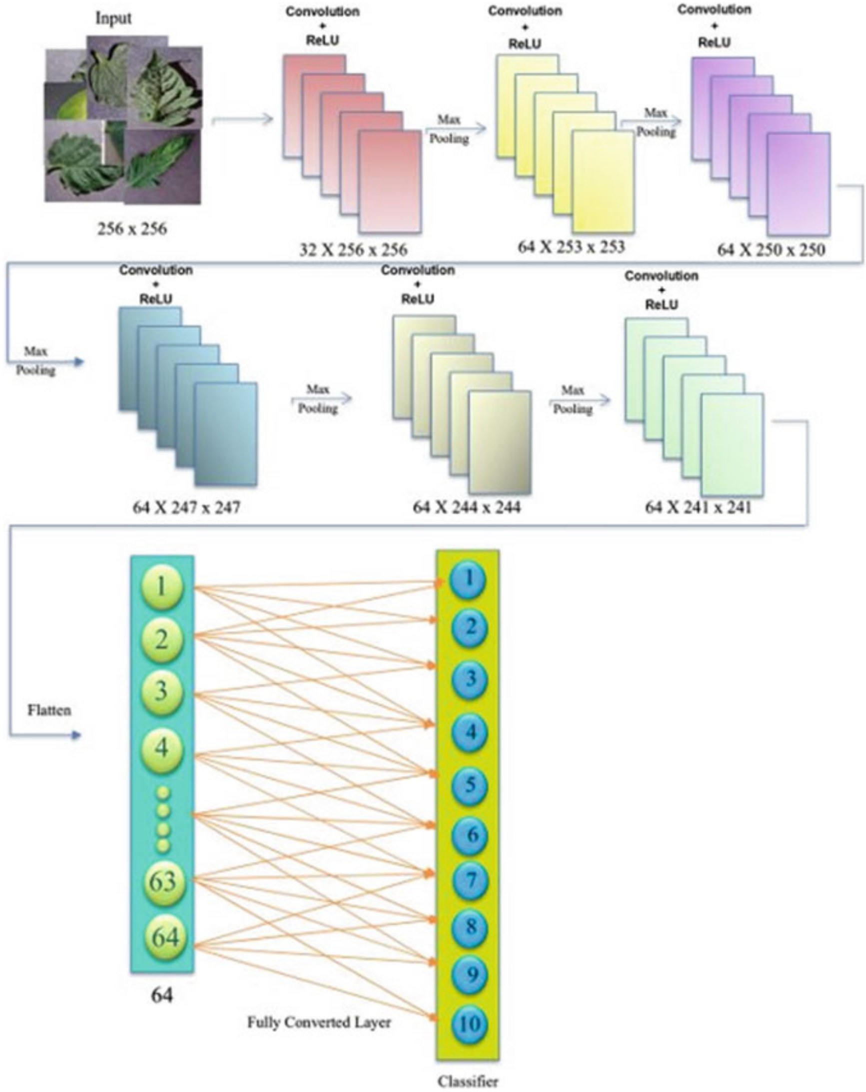

Fig. 3 Model diagram

diseases. Images are of high-resolution quality in RGB format. TensorFlow is used to implement the model. The dataset is split in an 8:1:1 ratio into training, testing, and validation datasets, respectively. Data augmentation has been used to boost the efficiency of the model on pictures that are distorted or misaligned. Random rotation of 72 degrees and horizontal and vertical flipping of images are performed to augment the dataset. The loss function is categorical cross entropy, and the Adam optimizer is used for optimization. For a total of 20 epochs, the model is trained and a batch size of 32 is employed for every iteration. The experiment is run on an Intel Core i5-10210U CPU running at 1.60 GHz.

4 Results and Analysis

The performance of the model has been assessed using accuracy. The training accuracy and loss graphs with respect to the number of epochs show convergence of the model. After 20 epochs of training, an accuracy of 96.26% has been obtained over the validation dataset. This figure of accuracy suggests that the model works well on the dataset and can be used to classify the ten tomato leaf diseases with a minimal amount of resources. Optimizations like data caching and prefetch enable the neural network to be quickly trained on a computer with minimum hardware requirements without any specialized hardware such as a Graphics Processing Unit (GPU). The model, therefore, gives a straightforward and practical solution of handling the problem of plant disease identification with accurate results.

In Fig. 4, the first image is the training versus validation accuracy graph, and the second image is the loss graph. The number of epochs is represented on the X-axis, while on the Y-axis we have accuracy measure in the first image and loss measure in the second image. So, we can see from Fig. 4 that initially we had an accuracy of nearly 0.5, which increased up to nearly 0.9 after 20 epochs. Whereas, in the loss chart we can see that error keeps reducing in backpropagation as we proceed forward with epochs.

5 Conclusion

Agriculture is one of the most important sectors with the bulk of the population relying on it. Therefore, identification of diseases in these crops is very important for economic growth. Tomatoes are a staple food that is cultivated in large quantities. Therefore, the purpose of this paper is to detect and identify ten different diseases of tomato crops. To classify tomato leaf diseases into ten classes, the suggested methodology employs a convolutional neural network model, achieving 96.26% accuracy. As part of future work, we can experiment with the proposed model utilizing a variety of learning rates and optimizers. It may also include experimenting with new architectures to increase the model's performance. Research can be extended to detect multiple diseases of multiple plants. We can also develop IoT-based real-time monitoring systems, websites, and mobile applications for this purpose.

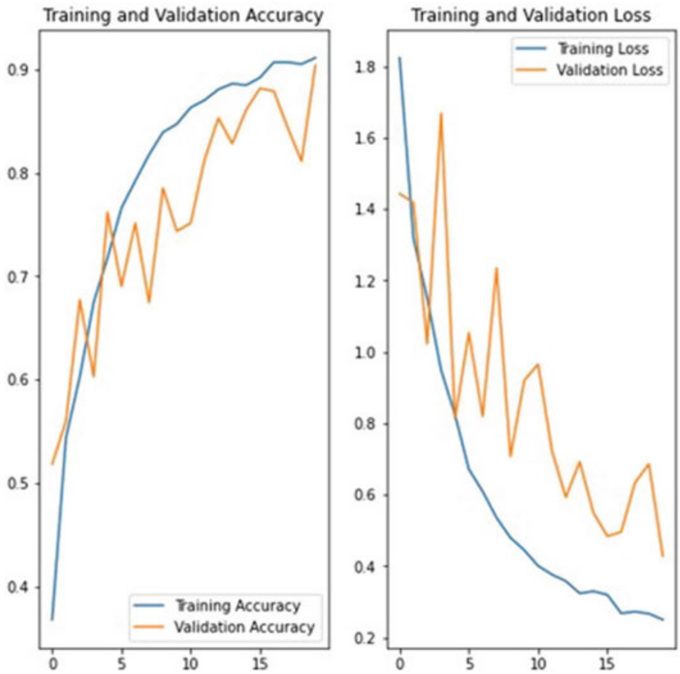

Fig. 4 Training versus validation graphs

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The Repercussion of AI Tools for Professionals in the Term of Compensation and Leadership on the Employee Retention and Job Satisfaction

Ravinder Kaur and Hardeep Kaur

Abstract To identify the variables of academic professionals on job satisfaction and retention. There is little research on academic professionals in private schools, especially in the north region. This study is examined to understand the short format used by the organization to engage its employees. Several factors such as remuneration and leadership will also focus on the pursuit of loyalty and job satisfaction for important employees. The structured questionnaire was received from the faculty members of private teachers. Good Compensation and good leadership give more satisfaction to the employee as well their long time with the organization. With the help, the Job Satisfaction Survey (JSS) questionnaire was used to evaluate the overall satisfaction of the teachers. There is a positive relationship between these two factors. The reliability and validity of the questionnaire were checked on Statistical Package For The Social Sciences (SPSS) and the value is 0.85. Random sampling is used to collect the data from 100 employees of private schools. The result indicates that a positive relationship between compensation and leadership plays an important role to maximize the job satisfaction of employees with the help of AI tools. This paper also contributes to society as well by encouraging the employees to contribute more to the growth of both.

Keywords Retention · Job satisfaction · Private teachers · North region · AI use in HR

1 Introduction

Human resource management performs multi-dimensional tasks which majorly includes retaining employees and making them satisfied with their jobs. The organization spends several resources to search for the legitimate labor force and afterward acquire, prepare, and hold them to understand the interests of the organization for their growth. The term human resource management manages the persuasive and

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proficient treatment of the labor forces. Staff maintenance and turnover will keep on being a significant issue of the twenty-first century. Thus, the key role is assigned to the human resource to give a fair chance of growth, opportunities, a good salary package, and a safe working environment to the employees. Organizational stakeholders are dissatisfied with today's working conditions and culture in the age of globalization teachers educationists and academicians are introducing and implementing a range of innovative models for the development of teachers which are taken by external management involvement and lower-level leadership is not able to successfully achieve the planned objectives and goals [1]. Nowadays, the competition is on a global scale, and most of the education institutes face obstacles to achieve quality education. Literature also shows that employees are a significant part of the organization and with the contribution of the skills, knowledge, and competencies of the employees, the organizations are getting success to achieve the objectives of the organization. In 2006 indicate in their book that organization invest in the employees [2]. To achieve the organizational goal and objectives, retention is one of the important factor, as it is vital in gaining a competitive advantage over the competitors in the era of globalization and competition [3]. The major challenge for organizations is to retain their employees as skilled employees are not easily available in the market. In the competitive world, working environment of all the organizations either small or large and dealing with facilitate the customers by providing the service or products are continuously triggered by social and economic advancements, which subsequently passed.

1.1 Research Gap

Numerous studies have been conducted on a national and international scale on job retention and job satisfaction in various organized and unorganized sectors. Researchers focused that the monetary, non-monetary factors and the working environment are the major factors which affects the performance of academicians. This study give attention on employee satisfaction and retention how these two factor effect on organization. However, there are scant numbers of studies in context to job satisfaction in academics in context to the Indian academic system especially at Private teacher's levels.

Following research gaps were recognized after a broad writing audit in the field of teacher's retention, explicitly in the field of private institutes. Most of the existing studies on employee turnover and retention in private educational institutes (teachers) have been carried out in the western context. There are extremely limited studies that have been attempted in-depth study of causes and consequences of faculty turnover in the private teachers of Punjab.

There are no studies which are related to the job satisfaction and retention among the academician of private teachers in Punjab.

There is a dearth of literature on the impact of retention and job satisfaction, most of the existing literature is based upon the one factor, like motivation, fringe benefits, learning opportunities, healthy working environment and organization commitment, but this research will focus to cover many factors to attempt the in-depth study of causes and consequences of turnover of academicians in the private teachers of Punjab.

There is not much literature that examines the relationship between retention and job satisfaction in the private Professional. This study would be an attempt to explore these factors and suggest measures to increase retention and job satisfaction.

1.2 Objectives of Study

(1) To identify the factors that lead to employee retention and job satisfaction among the academicians of private teachers in Punjab.
(2) To establish a relationship between recognized factors of retention and job satisfaction among academicians of private teachers in Punjab.

2 Review of Literature

Most companies today face the problem of employee retention. Organizations involve employees in new ways to be successful and reach new levels of success in the competitive world.

Carried out to discover the motivating factors (both monetary and non-monetary) that can effectively increase the motivation level of employees. Information was gathered from educators in the city of Birgunj for this review, which uncovered that persuasive variables and inspirational bundles affect representative inspiration in private instructors [4].

Strategic planning is a must in human resource management. When planning strategically, the HR manager will study and summarize previous work, and will pay special attention to the enterprise's potential development pattern (2020).

Big data analysis is particularly useful for conforming enterprise qualities, data optimization, industry growth patterns, and projecting future enterprise need (2019).

Insufficient data information and command, HR planning frequently deviates from precision planning and forecast of individual demand. As a result, HR requires time and labor in the HR planning process (2018).

In (2017) found that the maximum number of employees left the job due to dissatisfaction [5].

Conducted the study (2016) to determine the overall job satisfaction of undergraduate lecturers at universities in Sindh. The study was based on two factors of job satisfaction, a motivator (progress, recognition) and hygiene (interpersonal, guidelines, remuneration) [6]. University teacher training students used a well-structured questionnaire, and 125 people took part in this study. To improve job satisfaction and performance, the researcher suggested that management focus on the work motivators (progress, recognition) and hygiene (interpersonal/administrative relationship, guidelines, and remuneration) of the undergraduate faculty. Teachers who want to stay at their school for a longer period of time were discovered. There was also no correlation found between job satisfaction and teaching commitments (2015) [7]. Using the demographic variable gender, in (2005) investigated job satisfaction. Female faculty members were more satisfied with their jobs and colleagues, while male colleagues were more satisfied with their pay, promotion, and care. In ventilated the effects of school and organizational characteristics on teacher turnover and, as a result, teacher staffing issues Teacher characteristics such as specialty, age, and retirement account for a sizable portion of sales [8]. Previous theory and research have largely ignored the significant effects of school and organizational characteristics on turnover. According to the data, while public teachers in low-income areas do not have moderately higher rates, larger teachers, public teachers in large school districts, or urban teachers do not have high teacher turnover. Small private teachers, on the other hand, experience lot of ups and downs.

The AI the board framework should persuade representatives that it is fair and equity. For the most part, decency can be seen as the system to make sense of workers' trust toward their association [9] (Fig. 1).

Organizational characteristics such as insufficient administrative support, low salaries and problems with student discipline, and limited faculty influence on school decision-making all contribute to higher turnover rates and determine the characteristics of teachers and teachers. The findings show that, as a result of the organizational framework, the problem of low retention predominates.

Research has been contrasted covering a mix of the before referred to investigation typologies. Theories and models set out to explain the characteristic have been had a go at using varied creates to affirm their authenticity across unequivocal organizations. There is thusly a ton to browse to examine factors adding to worker turnover anyway the causal methodology is picked over different typologies because of the relative 'wealth' of systems, models and speculations for this space of exploration.

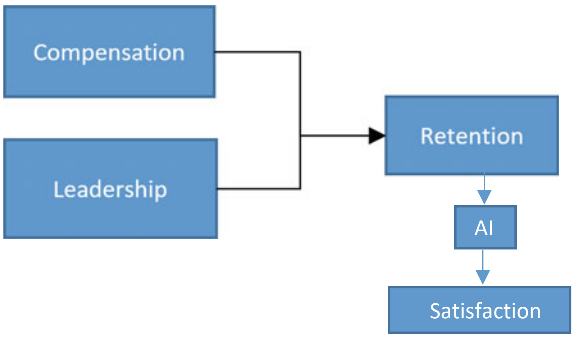

Fig. 1 The retention relationship

The creators accept that an examination of the significant worker maintenance speculations inside an industry will illuminate the steadiest structure for clarifying the peculiarity.

Herzberg identifies with inherent parts of occupation fulfillment. It centers on profession movement, obligation and accomplishments. This speculation thinks about these parts fundamental for work satisfaction and making the agent stay in the work. This speculation considers more money as a tidiness factor, the deficiency of which can make the specialist frustrated at this point its quality can't make the laborer more satisfied conversely, with business development and stimulating work. Our study uncovers the equivalent for example representative were happy with their pay rates however they were worried about their vocation. They accept there were insufficient freedoms for professional success.

Job satisfaction represents several separate but related criteria of job satisfaction. There is no precise definition because different authors or researchers approach job satisfaction from various angles depending on the type and importance of the job. Furthermore, job satisfaction was described as "any environmental scenario in which the employee believes that he is content with my work" [10].

2.1 Theoretical Framework

Job Satisfaction

Job satisfaction represents several separate but related criteria of job satisfaction. There is no precise definition because different authors or researchers approach job satisfaction from various angles depending on the type and importance of the job. Furthermore, job satisfaction is defined as any environmental scenario in which the person feels content with his employment [11].

Employee satisfaction is increased by retention factors such as perks, compensation achievement, and recognition at work. Employee dissatisfaction is caused by a lack of interaction between employees and management, job security, policies, and working conditions at the organization. The motivators themselves, i.e., the things that are principally responsible for job satisfaction, are one of the aspects. Work recognition and type, responsibility, and professional advancement He also mentioned the hygienic factors. The presence of hygienic variables does not add to job satisfaction, but their absence has a detrimental impact [12]. Company policy, supervision, interpersonal connections, working circumstances, and remuneration are all hygiene factors.

Versions of job satisfaction argue that terms like job attitudes, workplace satisfaction, and employee morale are interchangeable, which may explain why there is no uniform definition of job satisfaction [13]. Job satisfaction is defined as the reaction of employees who have a positive attitude toward the organization., referred to job satisfaction as attitude toward the job plays very important role positive shown satisfaction and negative shown dissatisfaction in the employees. Some of the studies

Fig. 2 Conceptual framework factor influence the retention and job satisfaction

explored that female faculty members are more satisfied then male member [14]. Gives importance to working environment at workplace which plays an important role for job satisfaction. Number of factor playing their role in employee retention and satisfaction Murnane, Richard. Worker having long experience and less expectation have stay more in institutions [15] (Fig. 2).

2.2 *Hypotheses of the Study*

Based on the results and inconsistencies in the literature review there is association between leadership and compensation played role in employee retention and job satisfaction and determine whether there is any relationship among these factor.

H01. There is no relationship between employee job satisfaction and retention.

2.3 *Research Methodology*

Based on the literature research discussed above, a theoretical framework was developed. It was created to examine the impact of the compensation and leadership for employee loyalty and to determine the role of job satisfaction and motivation moderator in the development of this relationship (Fig. 3).

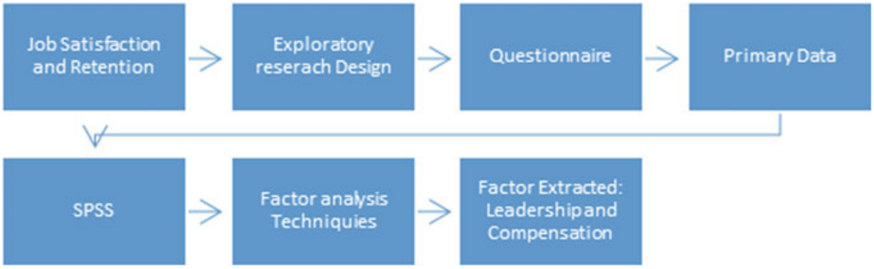

Fig. 3 Research model

Type of Study: Exploratory cum Descriptive Research Design

Exploratory cum descriptive research design will be used in this research. A cross-sectional data will be used where a sample will be taken only one time from the population.

2.4 *Primary Data*

The questionnaire method is going to be used to infer answers to the research questions. To find out job satisfaction factors that impact employee retention through a primary survey will be conducted from private teachers in Punjab with the help of a structured questionnaire. This questionnaire is developed with structured scales which have been used by different authors in previous studies.

A self-developed structured questionnaire will be developed. The pre-testing of the questionnaire will be done through a pilot survey from 50 respondents. The responses will feed into the appropriate software to check the value of Cronbach Alpha with value 0.85, which shows the reliability of the questionnaire.

2.5 *Secondary Data*

Secondary data is taken from various sources such as journals, journals, articles, research papers, books, published reports, e-resources.

The strength correlation that exists in the observed variables is shown in Table 1. The correlation between incentives and salary is estimated to be $r = 0.393$ (p 0.001). Furthermore, compensation as a variable covaries positively with awards ($r = 0.178$, p 0.05). The covariance between compensation and leadership relationship ($r = 0.37$, p 0.05) is positive, as expected.

Table 1 Demographic characteristics of respondents

Demographic characteristics percentage ($N = 50$)		
Gender	Male	68.4%
	Female	31.6%
Age	21–29 years	14.4%
	30–39 years	30.1%
	40–49 years	45.2%
	50 years and above	10.4%
Marital status	Single	27.1%
	Married	67.0%
Educational qualification	B. Sc B. Ed	22.6%
	M. Sc B. Ed	65.7%
	Others	11.7%
Work experience (present organization)	0–5 years	21.0%
	6–10 years	46.0%
	Above 10 years	33.0%

Table 2 Validity and reliability of research instruments

Variable	Item	R	Sig	Ket	Realiablites	Ket
Compensation	X2.1	0.586	0.00	Valid	0.746	0.760
	X2.2	0.618	0.00	Valid	0.739	
	X2.3	0.780	0.00	Valid	0.685	
	X2.4	0.664	0.00	Valid	0.730	
Leadership	X3.1	0.666	0.00	Valid	0.791	0.801
	X3.2	0.818	0.00	Valid	0.735	
	X3.3	0.785	0.00	Valid	0.754	

Research tool—The instrument for obtaining information would be structured questionnaire. The questionnaire will be pretested for its validity and reliability for each construct.

According to sekaran in 1992 the realistic limit is 0.7 is acceptable. So as per the table the shown in Table 2 that there is positive correlation with compensation and leadership (Table 3).

3 Result

Based on the result the regression analysis shown that compensation and leadership influence the employee retention, 0.45 value indicate by regression coefficient. With

Table 3 Factors with mean value

Factors	Statements	Mean
Adequate and fair compensation	I am satisfied with the income	0.529
	My financial need is fulfilled with this pay	0.583
	I will continue my present job	0.711
	I am overcompensated for my job	0.60
	I feel happy with my salary increment	0.76
Support and leadership	My supervisor pay attention to my grievance	0.577
	My management recognizes my merits	0.611
	The salary offered by the institution is very good	0.584

this result the first hypothesis is accepted that compensation and leadership has positive and significant influence on employee retention.

Result: Twelve institutional principals and teachers participated in this study. The analysis yielded 4 major themes: Environment impact, recognition, compensation, and leadership with the use of AI. The findings revealed a strong relationship between the main manager's leadership and the performance of the teachers. Compensation with performance has a high correlation and the combination of the principal's leadership qualities and compensation with performance has a very high correlation. The outcomes showed that between head administrative authority and instructor execution there is an extremely high relationship. Between pay with the presentation have high connection and the blend of directors' administrative authority and pay with the exhibition there is an exceptionally high relationship. The outcomes showed that there is an extremely high connection between's the administration of the primary chief and the presentation of the educators. The findings revealed a strong relationship between the main manager's leadership and the performance of the teachers. Compensation with performance has a high correlation and the combination of the principal's leadership qualities and compensation with performance has a very high correlation.

The absence of professional success potential open doors inside an organization is a significant reason for representative turnover. Agents in their 30 s are bound to stop because of an absence of expert advancement than for different reasons. Learning open doors and expert progression are fundamental for agent maintenance. While workers might be held by giving sufficient open doors to advancement, there are agents who might look for elective positions on the off chance that the association doesn't really try to mentally enamor these laborers and dole out them undertakings that require creativity. This may likewise infer that a specialist's assurance (PO fit) assumes a part in his support. A laborer whose calling targets don't match with those of the association will feel deadened to stay in the association and will leave once monetary circumstances are ideal.

Representatives can't be held exclusively based on money related benefits. Proficient motivation starts with creativity and mental satisfaction. While the real work might be invigorating, time limitations might change it into inauspicious and procedural, clearing out the creative part. Along these lines, a harmony among productivity and advancement ought to be accomplished [16]. An overemphasis on proficiency might bring about work that is dry and debilitating, prompting position disappointment and, subsequently, laborer turnover.

4 Discussion

AI can aid in the adoption of a transition and the creation of a new application experience. Following the completion of this study, the fundamental conclusion is obvious. Compliance with these changes inside activities is becoming increasingly vital, and employees should consciously shun from simple owner skills and repetitive chores. In doing so, the human resources department requires basic information based on computer services in order to meet the challenge faced by large organizations and increase their competence in providing important information to management in order for management to make informed decisions regarding the HR department. If organizations want to remain competitive in today's market, they should consider ways to incorporate conversational AI for HR transactions into their decision-making process. Organizations need to rely on AI to perform administrative tasks to make HR departments more efficient. A Harvard Business Review (HBR) reports that as 9 out of 10 senior management executives have reported positive and tangible business benefits from AI applications. 66% said that leveraging AI technologies for business process automation helped to deliver quick improvements—Infosys report on 'Leadership in the Age of AI.' Organizational leadership is evolving with changes in technology.

Companies are beginning to appreciate the value of staff retention and are investing in employee development. Regardless of industry, organizations benefit more from long-term employee cooperation than from hunting for new things. It involves additional expenses for human resources, marketing, education, and the time-consuming process of becoming acquainted with staff and responsibilities. That is why breakthrough technology and artificial intelligence (AI) aid in employee connections. The prospective application involves the interface between the employer, employees, and the desired culture of the firm [17]. AI may create a distinct competitive advantage, engage people in decision-making, and present them with a compelling incentive to stay with the organization.

5 Limitations and Direction for Future Research

The study is limited to just two variables, remuneration and leadership. The study measured the relationship between job satisfaction and employee retention using these two variables. Another limitation is a study that focuses only on private schools in the northern region.

In the future, more factors can be involved to give more satisfaction to the employees. A similar study can be conducted in the industries like telecom, IT, Business process outsourcing in which they are facing issue in employee retention and job satisfaction. Future research needs to develop the model with common factor of retention and job satisfaction suggested by Farooq (2016).

6 Conclusion

Employees are the most important assets of an organization and their contribution gives growth and expansion. The study was focused on the two factors adequate and fair compensation and support and leadership of employee retention and job satisfaction. The findings indicate that remuneration and leadership have a good and considerable impact on employee retention; nevertheless, the volume of data makes it impossible to integrate and present the study in a clear way. This research article tried to compile all information that is relevant to job satisfaction and employee retention and also paid attention to a factor which gives an impact on it. The study illustrates that job satisfaction improves employee retention.

There were certain limits during the study, such as the availability of time to conduct the research to obtain the necessary information. Time was one of the obstacles faced that forced us to add more data on the importance of this topic. Another limit was access to information that should have been obtained from various associations. The data collected was difficult to obtain because representatives of some associations were reluctant to reveal their actual findings.

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A Critical Analysis of AI-Based Techniques for Heart Disease Prediction

Deepika Arora, Avinash Sharma, and B. K. Agarwal

Abstract Data Mining (DM) is a process which assists in mining the significant data from the irregular data. The current information is employed to predict the futuristic results in the prediction analysis. The heart disease prediction techniques have various phases such as dataset input, to pre-process the image, extract the attributes and classify the data. The various types of techniques are proposed in the previous decades for predicting the cardiac disorder. These techniques are broadly classified as machine learning, deep learning and clustering. In this paper, all techniques are reviewed in terms of methodology and results. It is analyzed that deep learning techniques are more popular now to predict the heart disease.

Keywords Machine learning · Heart disease · CVD · Clustering

1 Introduction

1.1 Machine Learning

Machine learning (ML) defines the appliance of computer algorithms having potential to perform learning in order to accomplish specified operations from instance data without requiring openly programmed instructions, i.e., image-oriented heart diagnostics. This area of computer intelligence employs advanced statistical methods to derive prognostic or preferential patterns from training data with the aim to generate the most accurate prediction results using the original data. A powerful

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machine learning framework is presented, depending on the obtainability of appropriate and correct data. Thus, preparing data is a crucial condition to making ML model more robust with high efficiency on inner and exterior authentication. Within cardiac imagery, the quality sources of pre-arranged big data are increasingly accessible through the miscellaneous bio banks, bioresources and registries. Recently, the expansion of big data and the readiness of high computational strength have impelled the phenomenal progress of AI in clinical imaging. ML strategies of image-specific detection depend on algorithms for learning from earlier medical cases after recognizing the concealed and complicated imagery patterns. Existent works already exhibits the increment value of image-oriented process of detecting CVD with Machine Learning for several critical conditions like CAD and HF. The improved clinical efficacy of computer intelligence-based image analysis has the ability to significantly reduce the concern of CVD by facilitating the accelerated and more accurate clinical decision making.

There are various kinds of heart diseases. The abnormalities, present in diverse kinds, lead to cause diverse issues such as cardiac disease, arrhythmia and heart failure, in different parts of heart. The symptoms of heart disease are not same in every person [1]. Though, main signs are pain in chest, issue in breathing and heart palpitations. The major reason of heart disease is lack of oxygen. The busy events or tiredness leads to cause angina. The living style of person also has major cause of heart disease. Some habitual acts such as smoking, overweight and fatness diabetes, family history, staying in a same position for a long period, hypertension and high cholesterol lead to maximize the chances of heart disorders.

1.2 Heart Disease Prediction

The medical field makes the deployment of machine learning that brings innovation in predicting the cardiac disorder. This technology contributes a lot in the process of predicting heart disease. At present, various ML methods are implemented for diagnosing and to extract the considerable information from the clinical dataset. For this, a least number of inputs and efforts are utilized [2]. The researchers make the implementation of diverse methods for deploying DM in medicinal field in order to predict distinct categories of heart diseases in accurate manner. The efficiency of ML is not same in every method and the selection of attributes is done. In general, the clinical datasets present in medical field is found ineffective and impulsive. Thus, the innovative and suitable preparations are required for exploiting the ML methodologies. Figure 1 represents diverse phases for predicting the heart disease which are discussed as:

Data preprocessing: The initial phase is significant for predicting the heart disease. Various methods are employed to pre-process the data on the input data for establishing the completeness. This phase focuses on analyzing the input data in efficient way to acquire the promising outcomes. The major aim of this procedure is to clean the data, and to detect and remove the repetitive records, spelling

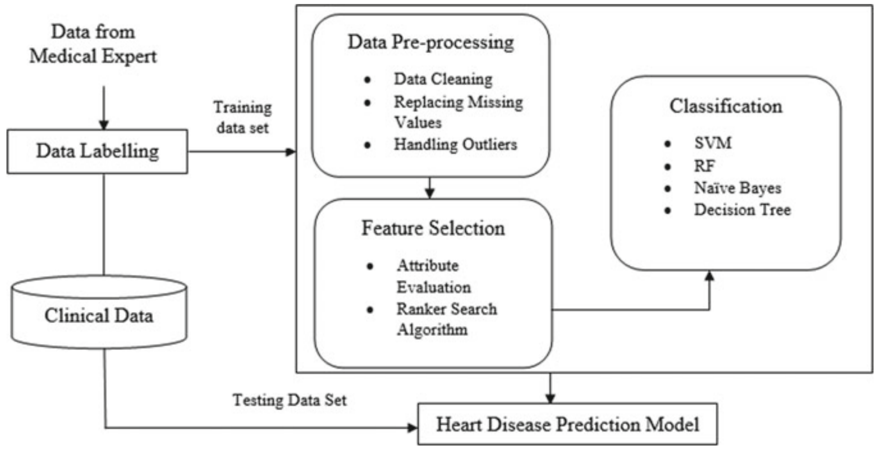

Fig. 1 Heart disease prediction model

errors and suspected data. Same procedure is applied to the missing data and outliers. Initially, the mathematical filtering method is implemented for marking the missing values in the data. The numeric data, which is of long and small size, is cleaned using these techniques. The marking and detection of the outcomes of the missing values is done after replacing them with the mean value of the provided data. The process, in which the attributes are selected, employs the clean and de-noised data. This phase is executed to remove the inadequate features from the dataset which results in improving the proficiency of the training system.

Feature selection: In this phase, a subset of highly unique features is selected in order to predict the heart disorder. The fundamental objective of this phase is to select the unique attributes which are available in several presented kinds. The dataset of cardiac disorder has a variety of attributes. Nevertheless, some of them are useful to make the decision in order to classify the disease possibly [3]. Therefore, the dataset values are utilized for executing this phase. The size of feature vector is lessened to a significant sample size. Two tasks are executed to select the features. The initial task employs a feature evaluator method to quantify the features contained in dataset. Thereafter, a search algorithm and various mixtures of attributes are implemented for selecting an effective set to carry out the classification procedure.

Prediction: This phase emphasizes on mapping the selected attribute in the training model to categorize the given features such that the heart disorder is predicted. The experienced physicians focus on assigning the labels to the gathered dataset to predict the heart disorder. The classification process is taken in account as a multi-class issue and this process classifies the medicinal data into 4 dissimilar classes. Thus, a certain type of heart disease is displayed using every class. The probabilities of patient who suffered from the heart disease are investigated in accordance with the selected crucial attributes in this phase.

The predictive system is trained using different ML algorithms. Some universal metrics are tuned to deploy these algorithms. For this, the suitable metrics are selected possibly. The results obtained after the prediction are computed on the basis of various metrics namely, accuracy, Receiving Operator Characteristic (ROC), sensitivity, specificity etc. [4].

ML techniques utilized to forecast the cardiac disorders are discussed as:

Support Vector Machines: This algorithm is adopted for classifying the data with the help of hyperplane that is employed as decision boundary among diverse classes. The concept of a margin is taken into consideration in this algorithm. A margin may occur at side of a hyperplane for separating 2 data classes. The major focus of Support Vector Machine (SVM) is on maximizing the margin in order to alleviate an upper bound on the projected generalization error. The longest possible distance is made from the separating hyperplane to the points on either side of it. The training data that is linearly separable, is present to illustrate a pair (w, b) as:

$$W^T X_i + b \geq 1, \text{ for all } X_i \in P$$

$$W^T X_i + b \geq -1, \text{ for all } X_i \in N$$

The decision rule is utilized to denote the $f_{w,b}(X) = \text{sgn}\big(W^t X + b\big)$. In this, the weight vector is illustrated with W and b is bias. Two classes are separated linearly to define this process. The finest separating hyperplane is investigated with the mitigation of the squared norm of the separating hyperplane. In case, the data is found linearly separable when the effective separating hyperplane is discovered, the data points available on its margin are known as support vector points. The result is obtained in the form of linear combination of these points without considering the remaining data instances.

Decision Trees: It refers to a hierarchical data structure. The concept related to dividing and conquering is adopted in the Decision Tree (DT) algorithm. This algorithm is utilized to arrange the data points according to their feature values so that they are classified. Its each mode is employed to illustrate any feature in an entity whose selection is done to classify the data [5]. A value, which a node can easily assume, is defined as branch. The instances are classified at the initialization of the root node. The training data is split using the attribute. This algorithm is utilized to select this attribute as the root node of the tree. The other nodes available in a tree are known as leaves. DT considers the leaf nodes as terminal or decision nodes. Each test concentrates on adopting a single feature in a common scenario. The reason of this provision is that the instance space is divided on the basis of the value of the attribute. The occurrence of numeric attributes results in representing a range. Each leaf is assigned with a class. The best destination value is illustrated with a class. Otherwise, the leaf adopts a probability vector to display the probability of involvement of some value in the target feature. The instances are classified after their navigation among the root of the tree down to a leaf on the basis of result of the tests with the route.

Random Forest: RF is a non-parametric method using which an ensemble model of DTs is generated from the random subsets of attributes and bagged samples of the training data. This technique provides good performance, even though the inadequate characteristics are comprised in the predictive attributes. The decisions are made by integrating the bagging with the random subspace and a voting decision making is deployed to attain the final result [6]. The procedure of Random Forest (RF) algorithm is executed in two phases such as to develop the Decision Tree (DT) and implement the voting procedure. The first phase aims to select the training set at random in order to generate the RF and split the node. The attribute, which contained the least coefficient Gini as the split attribute, is selected using the procedure of splitting the node. The coefficient formula for the computation of the samples is defined as:

$$\mathrm{Gini}(S) = 1 - \sum_{i=1}^{m} P_i^2$$

In this equation, P_i represents the probability of category C_j which is available in the sample set S.

2 Literature Review

Chang et al. [7] suggested a python-based application for medical research due to its reliability and efficiency for tracking and establishing diverse kinds of health monitoring applications. This application had different tasks in which the databases were gathered, logistic regression (LR) was implemented and the attributes of dataset were computed. Random forest (RF) algorithm was constructed for recognizing the heart diseases (HDs) at superior accuracy. The results depicted that the suggested algorithm yielded the accuracy around 83% for diagnosing the heart diseases.

Pan et al. [8] investigated an EDCNN algorithm for assisting and enhancing the process to predict the cardiovascular diseases. A deeper framework was deployed to cover MLP model with regulation techniques of learning. When the attributes were diminished, the efficacy of the classification algorithms was affected concerning processing time, and accuracy. Internet of Medical Things (IoMT) platform was applied to deploy the investigated system for decision support system (DSS) that was useful for physicians in diagnosing the information about the heart of patients. The testing outcomes revealed that the investigated system was capable of evaluating the risk level of coronary diseases in effective manner and this system acquired the precision of 99.1%.

Rahim et al. [9] introduced a MaLCaDD architecture for successfully predicting CVDs at higher accuracy. Specifically, the architecture initially addressed missing values and data imbalance issues. Thereafter, features were selected by applying the feature importance methodology. Eventually, an ensemble framework consisting of logistic regression (LR) and K-Nearest Neighbor (KNN) classifiers were adopted to generate highly accurate predictive outcomes. The architecture was validated over three standard datasets known as Cleveland, Framingham, and cardiovascular disease and respectively yielded 99.1%, 98.0% and 95.5% of accuracy.

Arul Jothi et al. [10] developed a system in which KNN and DT algorithmic strategies were exploited for predicting the coronary disease in order to estimate the severity rate of heart disorder. Thirteen medical parameters such as aging, gender, were considered in this system. The results obtained from the developed system provided the probabilities of heart disease at initial stage and the accuracy of the implemented algorithms was found good.

Bhoyar et al. [11] projected a Neural Network (NN) model in which Multilayer Perceptron (MLP) was implemented with the purpose of predicting the heart disease . The python programming was executed to generate a simple web application tool for testing this predictive system. This approach provided an efficient tool for medical professionals and common people. The experimental results indicated that the investigated model yielded 85.71% accuracy on UCI dataset and 87.3% on another dataset. The enhancement in accuracy was found upto 12–13% as opposed to standardized solutions.

Khan et al. [12] formulated a hybrid technique was formulated in which various phases are comprised to predict the coronary disease. A hybrid of Random Forest (RF) and Decision Tree (DT) was implemented. Afterward, the RF was utilized to abstract the attributes. The classification was performed using decision tree (DT). The formulated technique was quantified with reference to universal performance indices. The analysis revealed that the formulated technique offered 94.44% accuracy. Also, other indices obtained from the developed architecture was measured 95%.

Bertsimas et al. [13] devised an original solution to foresee the form of ECG recording which was performed electronically by extracting ECG-based features. The machine learning models took advantage of a set of approximately 4 k ECG signals marked by the heart specialists in various infirmaries and nations. These models had the potential to identify different signal types. This task models were trained using a popular machine learning methodology named XGBoost algorithm and it obtained F1 score within 0.93–0.99. In the author's perception, it was the first ever attempt to report the improved productivity crosswise infirmaries, nations and recording principals.

Repaka et al. [14] made an attempt to diagnose the heart diseases using the preceding data and information. This work adopted naïve Bayes to predict risk factors of cardiovascular diseases by constructing SHDP. Mobile health innovation, a web application, was expanding because of the swift development of technology. The combination of info was performed in a standard format. In this research, several knowledge abstraction methods were defined and explained through the data mining methodologies for forecasting CVD ailments. The output indicated that the diagnostic framework was suitable for predicting the risk factors with respect to the cardiovascular diseases.

Amin et al. [15] aimed at identifying important features and DM methods to make the prediction of heart diseases more accurate. Features in different mixtures with several classification methods called KNN, DT, NB, LR, SVM, NN and Vote were applied to build the predictive framework. The outcomes of the test revealed that constructed framework and the data mining technique (called Vote) obtained 87.4% accuracy in the prediction of heart diseases.

Raju et al. [16] stated that to accurate diagnose the heart disease was the major challenge in the healthcare sector. This work focused on applying data mining methods to design an efficient treatment to help treatable conditions. Apart from this, various classifier frameworks were adopted for diagnosing the cardiovascular diseases. Support vector machines (SVMs) offered the most optimal results in these algorithmic approaches.

Mirza et al. [17] aimed to apply the field of data science and analytics to the healthcare sector to provide reliable meaningful inspiration and predictions to physicians and health professionals around the world. To achieve this objective, this work used machine learning algorithms to apply data mining on clinical datasets of patients to locate patterns in the data to make predictions extremely accurate on the incidence of heart disease in a person. This work acknowledged a catalog of 13 clinical characteristics etc. that had a direct influence on an individual's chance of getting heart disease. This work put forward a proposal regarding the use of RBF-SVM and Linear SVM as well as KNN and Naive Bayes classifiers to create taxonomy of patients that reflected non-zero for risk present and zero for absence of cardiovascular disease. This work also measured the classifier models' performance.

Motarwar et al. [18] presented a machine learning-based formation that used diversified algorithmic approaches to forestall the probability of CVD in an individual. The algorithms used in this architecture were RF, NB, SVM, Hoeffding DT and LMT. This work used the Cleveland dataset to perform the training and testing of this architecture. Preprocessing of the dataset was performed. Later, by means of feature selection, the most significant features were selected. The resulting dataset was adopted for training the architecture. The integrated results validated that the random forest algorithm provided the greatest accuracy.

Chakarverti et al. [19] aimed to cluster and classify the input information to predict the cardiac disorder using KMC and SVM classifier based on predictive analysis techniques. This work performed data clustering by applying BP algorithm with KMC. Such algorithms supported to increase the accuracy of PA. A data set retrieved from the UCI was considered to evaluate the introduced algorithmic approach. Comparisons between the proposed study and the standard methodology were made with respect to some universal metrics like execution time, accuracy, error detection rate etc.

Alim et al. [20] put forward a proposal regarding applying a new methodology in an attempt to predict heart diseases in the early stage using machine learning algorithms. In particular, this work was aimed at finding the features via correlation to achieve more robust predictive outcomes. In this respect, the presented approach was quantified on UCI dataset and results were compared with a newly issued report. The presented framework obtained 86.94% accuracy, which was better than the Hoeffding tree methodology.

Nayak et al. [21] highlighted the need for early diagnosis of heart diseases to help their successful remediation. This work used repeated item mining to filter properties along with a number of DM algorithms namely, KNN, DT, NB, and SVM. These algorithms were used in the primitive state to determine and provide protection against heart diseases.

Rahman et al. [22] discussed that in clinical research requiring informative information for disease detection, data mining proved to be one of the most efficient technologies. Therefore, some data mining methodologies were solely adopted in clinical analysis to predict the cardiovascular disorders. For selecting important attributes, this work used PCA algorithm that obtained a critical value for each attribute. Later, various algorithms were used, in which the DT classifier outclassed the other algorithms in terms of accuracy. In future, the research will focus on deploying data mining methods with methodological frameworks to address multiple health concerns.

Krishnani et al. [23] presented a wide-ranging preprocessing methodology for the prediction of CHD. This work aims to adopt ML algorithms to predict the risk of heart diseases. In addition, this work deployed k-fold cross validation for introducing the randomness in the data. The Framingham dataset, consisting of thousands of records, employed these algorithms to perform the experiments. The tested outcomes revealed that the accuracy obtained from RF was calculated to be 96.8%, 92.7% from DT and 92.89% from KNN. When pre-processing steps were included, it was proved that RF classification yielded more accurate results than other methodologies.

Haq et al. [24] proposed a ML supported detection architecture to classify heart patients and healthy people. This work used Sequential Backward Selection (SBS) algorithm to pick more suitable traits for maximizing the accuracy as well as mitigating the computing time of the prediction framework. The heart disease dataset used to evaluate this framework was Cleveland. The experimentation revealed that SBS algorithm selected suitable traits and k-nearest neighbor classifier was utilized to further improve the accuracy. A high accuracy of this work confirmed the efficiency of the proposed architecture in identifying heart patients and healthy people.

Chandrika et al. [25] presented a predictive framework in which diverse attributes were integrated and different classifiers. The accuracy obtained from DL was 75.8%, 85.1% from RF, 82.9% from GLM, 87.4% from NB, 85% from LR, 86.1% from DT, and 88.4% from HRFLM in the presented framework to detect the cardiac disorder.

2.1 Comparison Table

See the Table 1.

3 Conclusion

The heart disease is termed as a heart related disorder. The coronary disease is defined as an issue occurred in the blood vessels, circulatory system and the heart.

Table 1 Comparison of techniques used for predicting heart diseases

Author	Year	Technique Used	Dataset	Findings
Victor Chang et al.	2020	LR and RF algorithms	Cleveland	The results depicted that the suggested algorithm yielded the accuracy around 83% for diagnosing the heart diseases
Yuanyuan Pan et al.	2020	EDCNN	UCI repository	The testing outcomes revealed that the investigated system was capable of evaluating the risk level of coronary diseases in effective manner and this system acquired the precision of 99.1%
A. Rahim et al.	2021	Machine learning-based cardiovascular disease diagnosis (MaLCaDD) model	Cleveland, Framingham, and cardiovascular disease	The architecture was validated over three standard datasets namely Cleveland, Framingham, and cardiovascular disease and respectively yielded 99.1%, 98.0% and 95.5% of accuracy
K. Arul Jothi et al.	2021	KNN and DT algorithms	Cleveland	The results obtained from the developed system provided the probabilities of heart disease at initial stage with respect to percentages and the accuracy of the implemented algorithms was also good
Sakshi Bhoyar et al.	2021	Multilayer perceptron (MLP)	UCI repository and cardiovascular disease dataset	The experimental results indicated that the investigated model yielded 85.71% on UCI dataset and 87.3% for another employed dataset

(continued)

Table 1 (continued)

Author	Year	Technique Used	Dataset	Findings
Ufaq Jeelani khan et al.	2021	A hybrid of random forest (RF) with Decision tree (DT) algorithms	Cleveland	The analysis revealed that the formulated technique had offered 94.44% accuracy approximately. Also, other indices obtained from the developed architecture weremeasured95%
Dimitris Bertsimas et al.	2021	A new method	Dataset from Physionet	This task models were trained using a popular machine learning methodology named XGBoost algorithm and obtained sample F1-scores from 0.93 to 0.99
Anjan Nikhil Repaka et al.	2019	SHDP model using Navies Bayesian	UCI dataset	The output indicated that the diagnostic framework constructed was suitable for predicting the risk factors with respect to cardiovascular diseases
Mohammad Shafenoor Amin et al.	2019	KNN, DT, NB, LR, SVM, NN and voting algorithm	UCI Cleveland dataset	The outcomes of the test revealed that the constructed framework obtained 87.4% accuracy in the prediction of heart diseases
Cincy Raju et al.	2018	Decision trees, k-nearest neighbor, association rules, neural networks, Bayesian classifiers, support vector machines	Cleveland dataset	Support vector machines (SVMs) offered the most optimal results in these algorithmic approaches

(continued)

Table 1 (continued)

Author	Year	Technique Used	Dataset	Findings
Imran Mirza et al.	2019	Machine learning algorithms	UCI dataset	This work put forward a proposal regarding the use of RBF-SVM and Linear SVM as well as KNN and Naive Bayes classifiers to create taxonomy of patients. This work also measured the classifier models' performance
Pranav Motarwar et al.	2020	A machine learning-based architecture	Cleveland dataset	The resulting dataset was adopted for training the architecture. The integrated results validated that the random forest algorithm provided the greatest accuracy
Mohini Chakarverti et al.	2019	k-means and SVM	UCI repository	Comparisons between the proposed study and the standard methodology (using the arithmetic mean) were made with respect to some universal metrics like execution time, accuracy, error detection rate, etc
Muhammad Affan Alim et al.	2020	A new methodology	UCI vascular heart disease dataset	The presented framework obtained 86.94% accuracy, which was found better than the Hoeffding tree methodology
Sinkon Nayak et al.	2019	Many ML algorithms	MIT-BIH arrhythmia database	These algorithms were used in the primitive state to determine and provide the protection against heart diseases

(continued)

Table 1 (continued)

Author	Year	Technique Used	Dataset	Findings
Mafizur Rahman et al.	2019	PCA algorithm	UCI dataset	Later, various algorithms were used in which the DT classifier outperformed the other algorithms in terms of accuracy
Divya Krishnani et al.	2020	Wide-ranging preprocessing methodology	Framingham heart study dataset	The tested outcomes revealed that the accuracy obtained from RF was calculated 96.8%, 92.7% for DT and 92.89% for KNN
Amin Ul Haq et al.	2019	Sequential backward selection (SBS) algorithm	Cleveland	A high accuracy of this work, confirmed the efficiency of the proposed architecture in identifying heart patients and healthy people
L. Chandrika et al.	2021	A prediction model	UCI dataset	The prediction model was effective for predicting the cardiovascular disorder

Moreover, the issues and problems in the heart are called a heart disease. According to the CDC, several deaths are occurred because of cardiac disorder in the United Kingdom, United States, Canada and Australia. The coronary disease causes deaths in US. Various diseases are occurred because of coronary disorder that effect different parts of the organ. The schemes which are related to predicting the cardiac disorder are reviewed and analyzed concerning their outcomes. The proposed techniques are published in the reputed journals. In future, transform learning models will be proposed to forecast the cardiac disorder.

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Empirical Analysis of Existing Procurement and Crop Testing Process for Cocoa Beans in Ghana

Richard Essah, Darpan Anand, and Surender Singh

Abstract Cocoa is worldwide most significant crop grown across the world. The crop generates revenues and employment for countries producing cocoa. Ghana's cocoa industries play important role in the global cocoa market. Ghana is the second-largest producer and exporter of cocoa beans of worldwide production. In Ghana cocoa industries have large impact on social and economic services. In this paper, propose a mechanism to perform crop testing process for Coco Beans dataset. In cocoa beans dataset six image classes are used such a Bean_Fraction_Cocoa, Broken_Beans_Cocoa, Fermented_Cocoa, Moldy_Cocoa, Unfermented_Cocoa, and Whole_Beans_Cocoa. However, cocoa beans produced are tested for its quality before selling. Quality cocoa testing defines cocoa that has been properly dried, fermented, and is disease free, other physical flaws, and contamination. To perform empirical analysis, we applied three different ML algorithms such as CNN, DNN, VGG16 trained model. The performance of these techniques is analyzed using performance metrics such as data loss and accuracy. The results depict that in VGG 16 model the accuracy is 65.6% in perspective of other two techniques.

Keywords Coco Beans · Ghana · Machine learning · CNN · DNN · VGG16 and Smart farming

1 Introduction

Ghana's GDP highly depends on the industry of cocoa production. Similarly, 30% of its population is dependent on cocoa industries for its employment. Tetteh Quarshie from an island called Fernando Po in Equatorial Guinea first introduced cocoa to

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Ghana in 1876 (earlier Gold Coast). Ghana used to be cocoa's largest producer from 1911 to 1976 which is clear from the fact that cocoa contributed around 40% of the entire output in cocoa producing areas, it is one of the major employees of labor and has also become a huge source of income for the people [1]. The colonial government of 1930 was compelled to take over the control of cocoa industry because of the significance of cocoa output to the Ghana's economy as well as the huge dependence of cocoa farmers for their livelihood. In order to take over the industry, government of Ghana has set up a board for marketing, the Cocoa Marketing Board aka [2]. COCOBOD in order to export and purchase whole of cocoa produced in the country. The marketing board did not turn out to be as effective as it should be because it could not ensure a good price for farmers. Therefore, the government enhanced its activities by introducing more institutions such as quality control and research & development in order to give more services to the farmers for improving the sector of cocoa industry. Simultaneously, the government also provided the funded farm inputs like pesticides and fertilizers to the cocoa farmers. This move by the government has retained Ghana's reputation for good quality of cocoa till date. By the late 1970s cocoa's cost reduced by two thirds in the international market. Thus, cocoa farmers of Ghana received below 40% of international market price from COCOBOD. Resultantly, the volume of cocoa production dropped highly in Ghana as most of the farmers left their farms and changed their occupation. This condition further got worsened after droughts & bushfires in the early 1980s [3]. After the introduction of COCOBOD in 1947, determination of price of cocoa products is being made by some mechanisms. According to the 1st mechanism which was present till 1984, the prices of producers were set by COCOBOD that had to be consented by the government. Since 2001, Ghana government had made a common committee called 'Multi-stakeholder Producer Review Committee' (PPRC) for setting the price of cocoa [4]. The price setting committee of institution PPRC consists of farmers' representatives, COCOBOD, Ministry of Finance & economic Plaining, Stakeholders like Hauliers (transporters), Licensed Buying Companies (LBCs), etc. According to such mechanism for price setting, estimated average cost of production (COP) & the cost of industry is reduced from COCOBOD net revenue. The remaining net FOB is to be paid to the smallholder farmers of cocoa [5].

The production of Cocoa kept reducing till the IMF and the World Bank interrupted by bringing structural Adjustment programme (ASP) to prevent the economy from collapsing [6]. This initiative had impacted the lifestyle of small holder farmers in a negative sense. By enhancing the living cost and low farming inputs, it involved a policy reform of the cocoa domestically. Consequently, this brings in cocoa industry liberalization and provided licences to private companies of cocoa commodities on behalf of the government of Ghana. However, it could not address the monopoly of the government in bringing competition to the market internationally which could enhance the income of all the farmers. The GDP of Ghana depends on cocoa production industries. The employment of 30% of population of Ghana depends on cocoa industries [7].

This paper is divided into seven sections. In this section study of Ghana cocoa beans has been presented, in Sect. 2 literature survey of various existing research papers has been discussed, in Sects. 3 ML and its algorithms has been discussed with their working frameworks. Section 4 presents proposed framework, in Sect. 5 results and analysis has been presented in Sect. 6 conclusion and future work has been discussed.

2 Literature Survey

Being an agricultural country, it is necessary to have knowledge of everything about farming. The 60% of land available as agricultural land and it is expanding with average rate of 0.03%. So, it is necessary for any agricultural country to effectively use their available land resources. The traditional methods of farming take too much time and man power for collecting soil samples and take them in laboratory for the purpose of testing. To overcome this kind of hazard IoT and ML can be used for smart farming. In Agriculture 4.0, it is very challenging task to propose a mechanism based on automatically testing using IoT and ML algorithms. In this section literature review of various existing papers has been presented. Table 1 presents the findings what authors done and journals used by authors to present their work.

From the literature survey of the existing techniques, it is clear that there is ambit of exploring research in the area of cocoa beans crop testing based on IoT and ML that can effectively and efficiently handle the uncertainties present in the existing methods. In Refs. [8, 11–13, 16, 20] discussed various issues, challenges and future research of Agriculture 4.0, they further provide comparative analysis on various ML algorithms for cocoa beans crop testing with advantages and disadvantages.

3 Machine Learning

Machine learning is widely used technology which provides prediction of data. It is used to classify data in to classes. It consists of two types of algorithms called supervised and unsupervised algorithms. These algorithms are designed for classification. The classification can be done on trained data. In smart farming, role of ML is to explore the ideal quantity of composts that are required for soils before the sowing of crops [6]. Figure 1 depicts the types of ML algorithms.

3.1 Machine Learning Models

Deep Neural Network (DNN)

DNN is supervised ML algorithm used to predict image dataset and give output in the form of accuracy and data loss. It processes data in the form of layers called

Table 1 Literature review

Author & year	Findings	Journal
Ahoa et al. (2021) [8]	Studied that supply chain of Ghana cocoa sector is limited Lack of access of information to the farmers Deployment of IT systems improves the supply chain as well as prdcution	Sustainability (MDPI)
Hati and Singh (2021) [9]	Focused on smart indoor farming App based mobile device is used to collect and process data for smart farming Analysed various machine learning algorithms with various performance metrics	AgriEngineering (MDPI)
Adhitya et al. (2020) [10]	Presented textural feature analysis on digital images of cocoa beans They compared the features of Gray level cooccurrence matrix (GLCM) and Convolutional neural network (CNN)	Agronomy (MDPI)
	Provided the use of IoT to increase the security of supply chain	
Elijah et al. (2018) [11]	Identified various pros and cons of IoT Discussed role of data analytics and IoT in smart farming Presented applications future perspectives and business innovations of smart farming	IEEE Internet of Things Journal
Goyal et al. (2021) [12]	Demonstrated analysis of different methods food adulteration detection Discussed different machine learning algorithms used for classification of food classes Studied different dataset available for food analysis	Archives of Computational Methods in Engineering (Springer)
Sharma et al. (2020) [13]	Discussed study on various research papers on machine learning in smart farming Presented role of machine learning in agricultural supply chain	Computers and Operations Research (Elesvier)

(continued)

Table 1 (continued)

Author & year	Findings	Journal
Ahoa et al. (2020) [14]	Presented current business processes and IT Systems of the cocoa supply chain in Ghana Depicted that lot of handovers are their in supply chain and it will take lot of time. To overcome this hazard IoT systems are deployed	NJAS—Wageningen Journal of Life Sciences (Elsevier)
Oluyisola et al. (2022) [15]	Proposed a method for supply chain management using IoT Discussed case studies on food companies such as sweet and snacks with various parameters Provides issues and challenges of IoT in smart farming applications	Journal of Intelligent Manufacturing (Springer)
Ouhami et al. (2021) [16]	Reviewed different methods of machine learning for the detection of plant disease Perform comparative analysis of data fusion techniques with various parameters to detect plant disease Provides issues and current trends on plant disease detection	Remote Sensing (MDPI)
Balakrishna et al. (2021) [17]	Focused on food security problems Proposed IoT and Machine learning based model Compared different machine learning platforms	Global Transitions Proceedings (Elsevier)
Isaac (2021) [18]	cused on presenting farmer support system to predict coffee yield in the Eastern Ghats region of Tamil nadu IoT module is used for measuring temperature and humidity whereas ML module is used for prediction of coffee yield	Annals of R.S.C.B
Senthilmurugan and Chinnaiyan (2021) [19]	Proposed a distributed model based on block chain for supply chain and crop testing with interconnected farmers and sellers together Focused on selling the product at same prize Focused on vegetables and fruit disease detection	International Conference on Computer Communication and Informatics (ICCCI—2021) (IEEE)

(continued)

Table 1 (continued)

Author & year	Findings	Journal
Thakur and Mittal (2020) [20]	Provide study on crop disease detection using IoT and ML in cloud environment Presents Raspberry based model for crop disease detection Apply K-means algorithm for prediction and classification Apply image processing mechanism for acquisition of image data	International Journal of Innovative Science and Modern Engineering

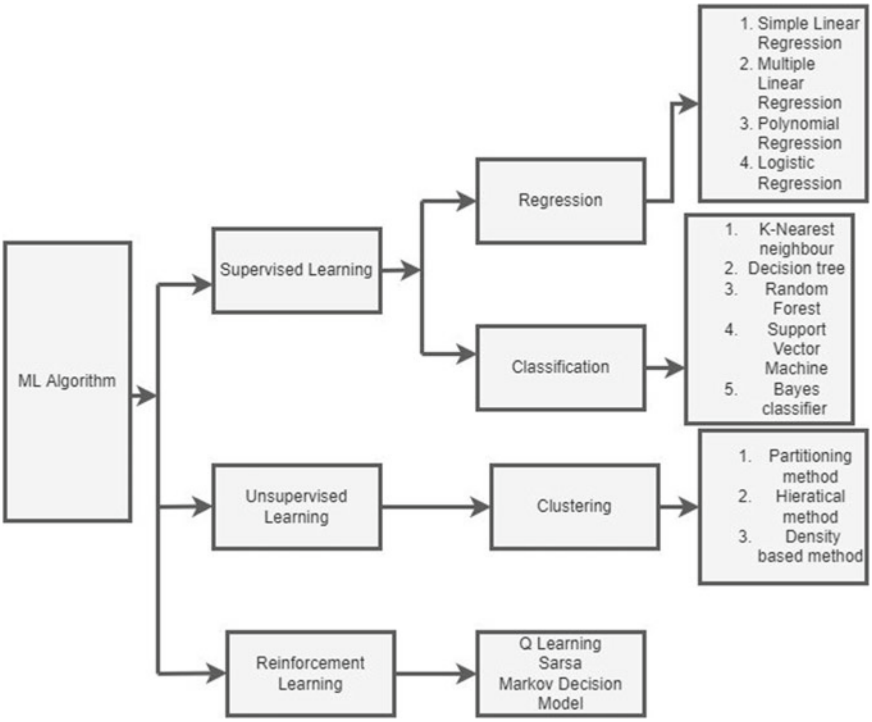


Fig. 1 Types of ML-based algorithms

input layer and output layer and hidden layer. The hidden layers are used to store information that is stored in input layer. DNN, contains neuron layers that works with the help of rectified linear unit (ReLU) activation function. Figure 2 depicts the working framework of DNN Model [21].

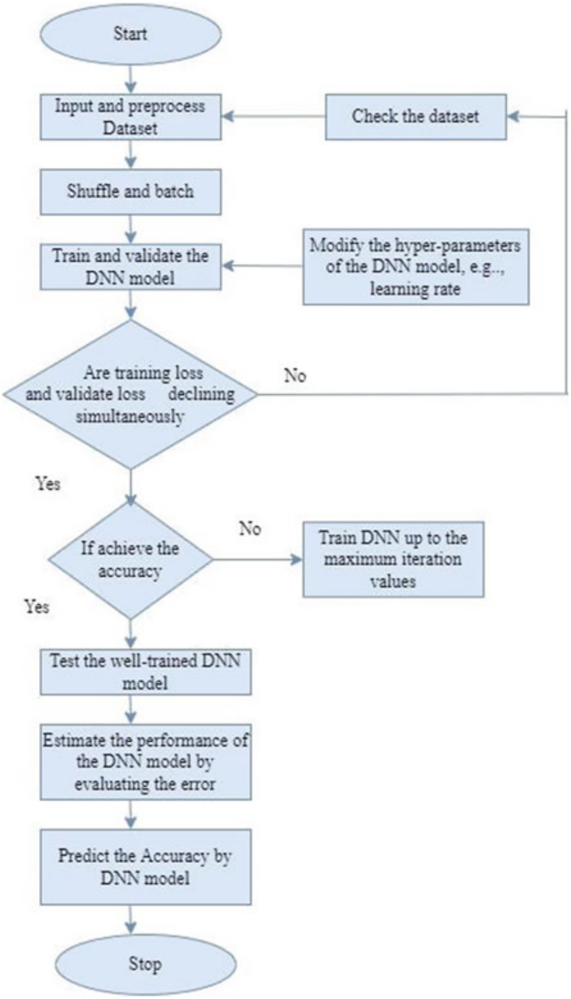


Fig. 2 DNN model working framework

Convolutional Neural Network (CNN)

CNN is AI-based ML algorithm used to pre-process and recognize the Cocoa Beans image dataset. It works on the pixel data to process image and perform both generative and descriptive tasks available in NLP for image recognition Figs. 3 and 4 depicts the working of layers used in CNN [22]. Figure 5 depicts the working framework of CNN model. Given below are the layers in CNN models.

Convolutional Layers

At this layer the features from image dataset are extracted for pre-process dataset. It is first layer of CNN model. This layer allows to reserve the relationship in different pixels of image as the pixels are related to adjacent pixels only. The main purpose of this layer is to filter the image by decreasing its size without losing the relation between pixels. For example, when we apply convolution to 5 × 5 image by using a 3 × 3 filter with 1 × 1 stride then retrieve a 3 × 3 output.

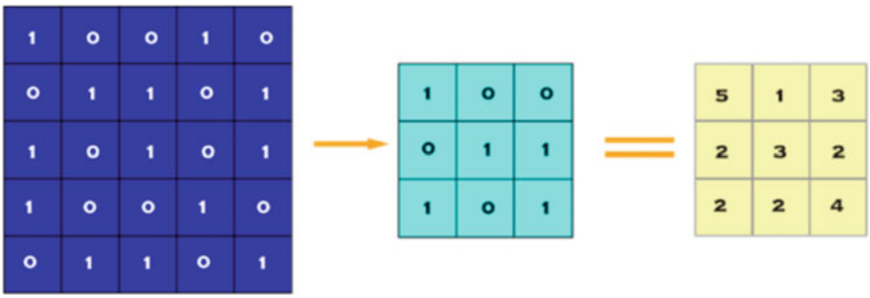


Fig. 3 Working of convolutional layer

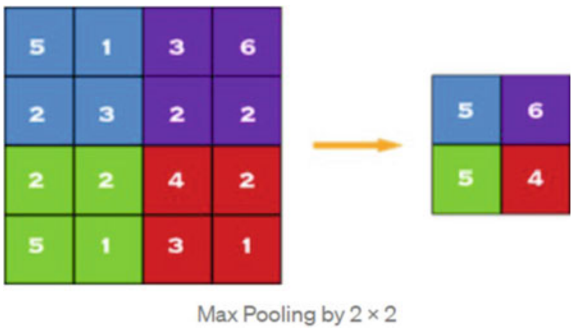
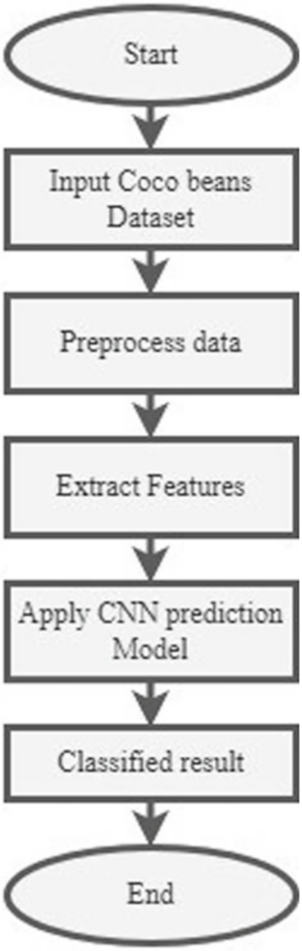


Fig. 4 Working of pooling layer

Fig. 5 CNN model working framework



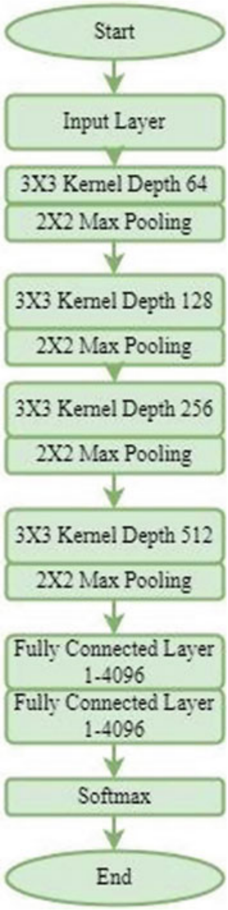
Pooling Layer

Pooling layer is used to solve overfitting problem. This layer is inserted after convolution layer to reduce the size and computational complexity of image. Figure depicts the max pooling process. Here, we select maximum pixels to reduce the size of image.

Transfer Learning using VGG16

It is a ML-based training model which uses pre tested models to extract features and predict accuracy of coca beans dataset. It processes dataset in the form of 3 × 3 filtered RGB image to provide optimal outcomes. Figure 6 depicts the working framework of VGG-16 model. In VGG 16 model, the convolutional layers i.e., first and second layers are divided into 64 feature kernel filters with the size of filter is 3 × 3. This RGB file image is processed into 224 × 224 × 64, dimensions and the output are transfers to max pooling layer with a stride of 2. In next phase, the 3rd and 4th convolutional layers with same previous size kernel filter is processed, and resultant output is transfers to max pooling layer with a stride of 2. Here, the output is reduced to the size 56 × 56 × 128. Furthermore, in next phase the size of kernel is 3 × 3 for 5th, 6th and 7th convolutional layers these layers use 256 feature Kernel filters. The 8th to 13th layers are processed with kernel size 512 kernel filters with 3 × 3 per filter. The result output is transferred to max pooling layer with stride of 1. At last, the 14th and 15th layers are fully connected hidden layers of 4096 units with a softmax output layer of 1000 units [23].

Fig. 6 VGG-16 model working framework

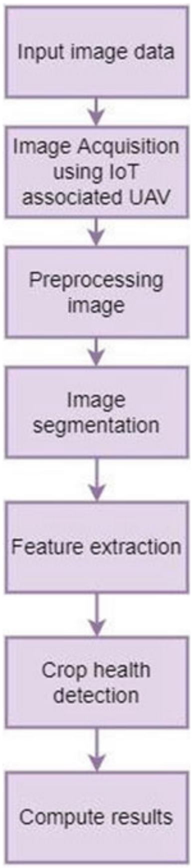


4 Proposed Work

Figure 7 depicts the working of proposed mechanism. In proposed mechanism, the input data is imported for processing coco beans dataset. The first step is image acquisition using UAV-based platforms. These platforms are very flexible and cost effective in nature. The captured images are in high resolution so it is difficult to process these images directly. In the next step, pre-process image using Arduino. Here, high-resolution images are converted into RGB with the help of color matching method. In the next step, the RGB image is divided into segments to point out boundaries' objects in images. The pixel having common attributes are classified into same classes.

In the next step features are extracted with the help of extraction tools such as Principal component Analysis (PCA) in which covariance matrix are used to extract features. In the last step, apply machine learning method to compute result after

Fig. 7 Proposed framework



processing the extracted features with the help of some trained model. The computed output is given back to farmer.

5 Results and Analysis

To analyze proposed mechanism cocoa beans data set is used which is collected from Kaggle. The dataset contains total 614 images with six classes such as Bean_Fraction_Cocoa, Broken_Beans_Cocoa, Fermented_Cocoa, Moldy_Cocoa, Unfermented_Cocoa, and Whole_Beans_Cocoa. This dataset is processed by using CNN, DNN, and VG-16 model in python using Jupyter Notebook. Table 2 describes the classes used in dataset and their description.

5.1 Performance Metrics Used

Accuracy:

It depicts the total number of positive (+ve) outcomes in perspective of the total number of negative (-ve) outcomes from complete dataset. The formula for calculation is as follows:

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

Data loss:

It depicts the loss of signals occurs during prediction of data.

Figure 8 depicts the accuracy and model loss comparison in perspective of CNN, DNN and VG-16 model. The result show that in VGG-16 model the accuracy is high

Table 2 Attributes used in Dataset

Image classes	Description
Bean_Fraction_Cocoa	The beans that contain less than half part of bean
Broken_Beans_Cocoa	The beans that contain half part or may miss fewer half parts of whole cocoa bean
Fermented_Cocoa	It is final furnished dried bean
Moldy_Cocoa	In this type of bean, the beans are molded inside and the fungus can be seen by an eye
Unfermented_Cocoa	It is semi furnished bean with grayish blue colour
Whole_Beans_Cocoa	The beans that cover all seed parts without showing any fracture

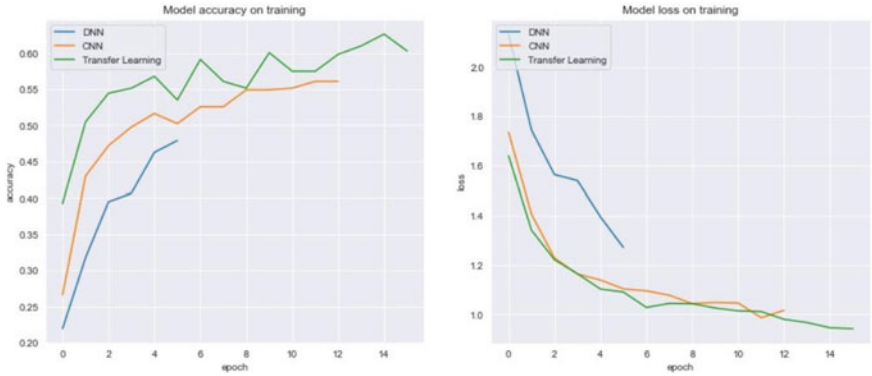


Fig. 8 Accuracy and Data loss comparison of CNN, DNN and VGG-16 models

in comparison to other two techniques whereas data loss is also low in VGG-16 as compare to other two techniques.

Figure 9 depicts the confusion matrix generated during training of models. The matrix shows values of six classes of cocoa beans used in dataset. Tables 3 and 4 depicts the accuracy and data loss comparison between CNN, DNN and VGG-16 model. In VGG 16 model the loss is 0.9% whereas accuracy is 65.62%. The accuracy is high in VGG-16 model, whereas data loss is also low in VGG-16 model as compare to other CNN and DNN techniques.

6 Conclusion

The GDP of Ghana depends on cocoa production industries. The employment of 30% of population of Ghana depends on cocoa industries. In this paper, empirical analysis is performed on three different ML-based algorithms with the help of coco beans dataset. These algorithms are used to provide pre-process the image dataset and extract features to get more accurate predictive outcomes. In VGG 16 model, the loss is 0.9%, whereas accuracy is 65.62%. The accuracy is high in VGG-16 model, whereas data loss is also low in VGG-16 model as compare to other CNN, DNN techniques. In the future, propose a mechanism based on transfer learning framework that uses IoT to automatic coco quality testing.

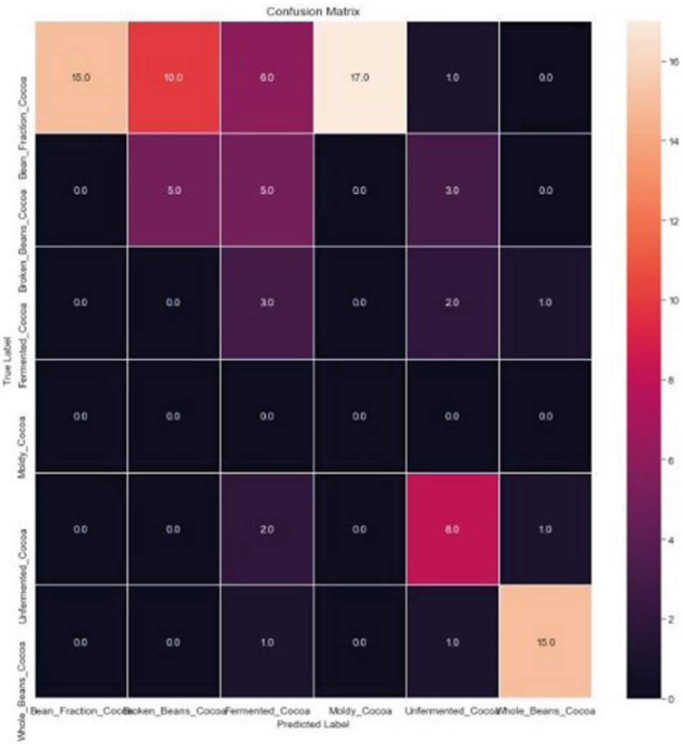


Fig. 9 Confusion matrix of various classes used in cocoa beans dataset

Table 3 Data loss comparison

Techniques	Loss %
DNN	1.60
CNN	0.99
TRANSFER LEARNING (VGG16)	0.90

Table 4 Accuracy comparison

Techniques	Accuracy %
DNN	44.79
CNN	54.16
TRANSFER LEARNING (VGG16)	65.62

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Water-Body Segmentation from Remote Sensing Satellite Images Utilizing Hierarchical and Contour-Based Multi-Scale Features

R. S. M. Lakshmi Patibandla, Adusumalli Yaswanth, and Syed Inamulla Hussani

Abstract Satellite image photography with very high resolution (VHR) presents a significant problem in identifying water bodies. In this work, correlations between extracted features at each scale, which extract the whole target. Using data from several sources, including the immediate environment, a broader geographic area, and the relationships that exist between the various channels, display features. In addition, to better anticipate water bodies' delicate contours, use Fusion of many scales of prediction. In addition, feature semantic inconsistency is resolved. Encoder-decoder semantic fusion allows us to combine the encoding and decoding processes module for promoting the fusion of features. The outcome demonstrates that our approach is cutting-edge superior performance in the segmentation process compared to the most contemporary and traditional approaches. In addition, have offered methods that are reliable even when used in the most difficult water body extraction situations.

Keywords Satellite image · Contour-based · Multiscale features · Segmentation

1 Introduction

In monitoring water supplies, natural water bodies are critical. There is a need for catastrophe prediction and nature conservation. They are dependent on the measurement of the change in a water body. Recognizing the water body in detail A critical task is to be able to monitor changes in water bodies through remote sensing images. The objective of this research is to accurately discover waterbodies in strenuous and complex environments. High-resolution remote sensing footage was used to create scenarios [1–3]. The board has a variety of instruments. Remote sensing photography from satellites and airborne vehicles covers large-scale water areas. Sensing pictures might be difficult to interpret. Aquatic organisms are often to blame for such degradations [4]. The bank is blocked by vegetation, silts, and boats, as well as shadows

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Lecture Notes in Networks and Systems 588,
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cast by the surrounding tall tree plants. Imagery conditions and water quality may all play a role in producing these unique hues and microbes are involved [5, 6]. Consequently, obtaining the shape of aquatic bodies is a major difficulty (Fig. 1).

VHR remote sensing imaging may be used correctly in complicated settings. Existing remote sensing image extraction approaches concentrate on the spectral features of each band and manually constructed algorithms to extract water bodies methodologies, such as band cutoff point methods, supervised classification-based methods, water and vegetation indices-based methods, and spectral interaction ways the techniques [7]. These approaches, on the other hand, do not pay a lot of attention to the geographic information (i.e., shape, size, texture, edge, shadow, and context

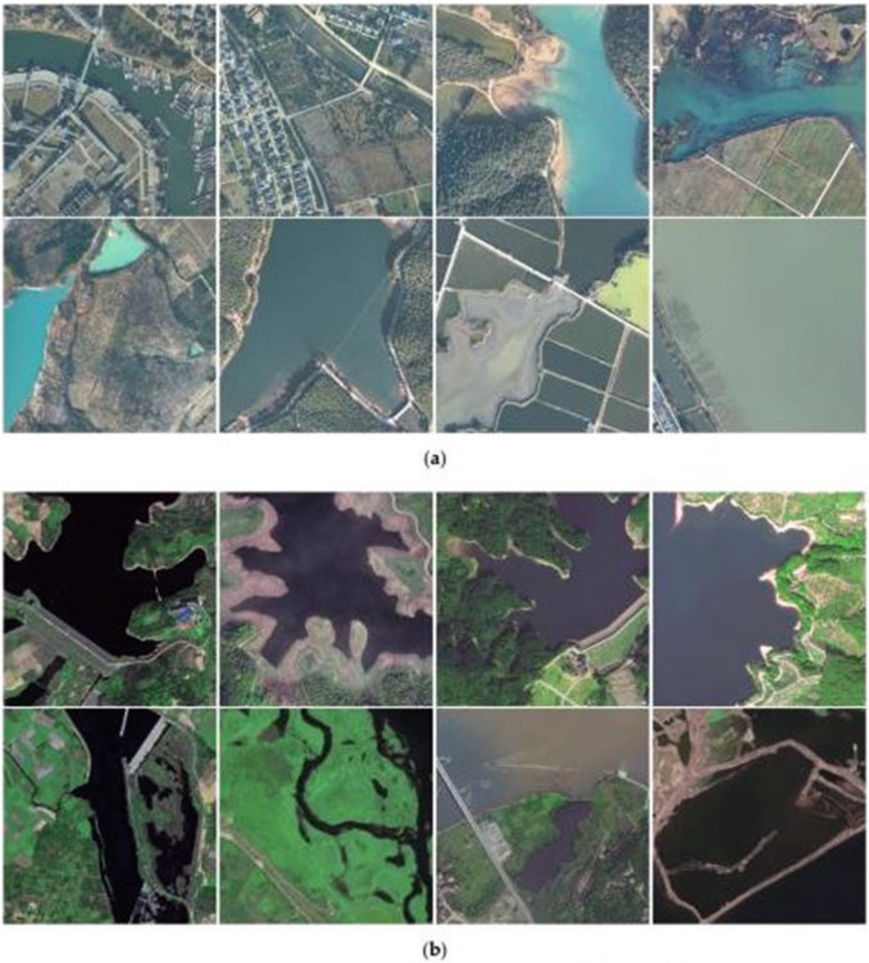


Fig. 1 Some typical water-body samples **a** in VHR aerial images and **b** Gaofen2 (GF2) satellite images

semantics) of the water bodies, which has a substantial impact on classification accuracy. The scarcity of automation in traditional approaches is also a barrier to large-scale remote sensing visuals. The tremendous convolutional capabilities of convolutional neural networks (CNNs) can indeed be attributed to image classification, target recognition, and semantic segmentation [8–13]. Long et al. [8] pioneered the thoroughly convolutional network (FCN), which replaces the last fully connected layers with convolutional ones for entire semantic segmentation. End-to-end FCNs are broadly utilized and well-developed in the realm of semantic segmentation, making them a mainstream technology.

Deep learning-based water-body segmentation using remote sensing images has triggered a lot of interest recently. The FCN-based method's feature fusion combines high-semantic features and features with exact locations, making it easier to identify waterbodies and extract waterbody borders with precision. Three parts of our technique are considered: feature extraction, prediction optimization, and the merging of shallow and deep layers.

2 Methodology

To begin, we'll go through our ideas for a MECNet architecture. A multi-feature extraction and combination (MEC) module is then described in order to get more diversified and richer features as well as enhanced semantics. This is why, to better anticipate the water-fine body's contour, we create an MPF module that combines prediction results from three separate levels. Once we've solved the issue of semantic inconsistency between encoding and decoder, propose an encoder- decoder feature fusion module (DSFF).

2.1 MECNet's Underlying Network Architecture

The MECNet is made up of three primary components. A first multi-feature extraction and combination modules are then built, which provides a more diversified set of encoded characteristics. Three alternative feature extraction sub-modules are suggested for the MEC module to simulate the spatial and channel interactions between feature maps in the proposed MEC module. Local feature extraction, bigger receptive field feature extraction, and between-channel feature extraction are the three sub-modules that make up this system. An encoder-decoder semantic feature fusion module is built to resolve the semantic discrepancy of features from the encoding stage and the decoding stage. Water-body segmentation contours may be generated using a simple multi-scale prediction fusion module that takes input from three distinct scales. The mask that offers a binary label to each pixel in our attention-guided, multi-scale image is derived from this input tensor. The encoder-decoder architecture of the proposed MECNet [9] is portrayed in Figs. 2, 3 and 4.

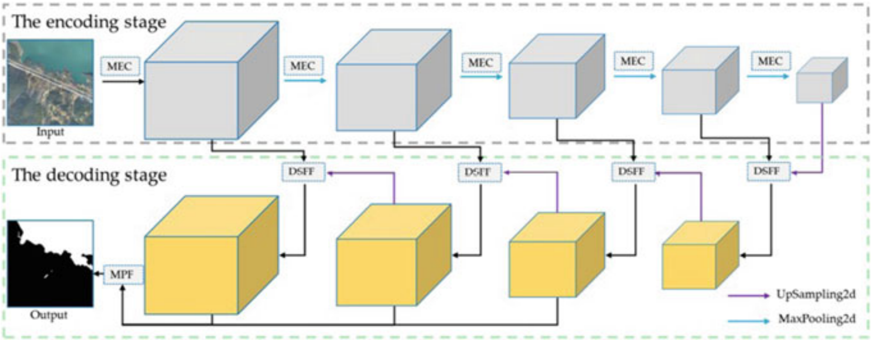


Fig. 2 An overview of our proposed Multi-feature Extraction and Combination Network (MECNet).MECNet has three modules: Multi-feature Extraction and Combination (MEC), Encoder and Decoder Semantic Feature Fusion (DSFF),and Multi-scale Prediction Fusion (MPF)

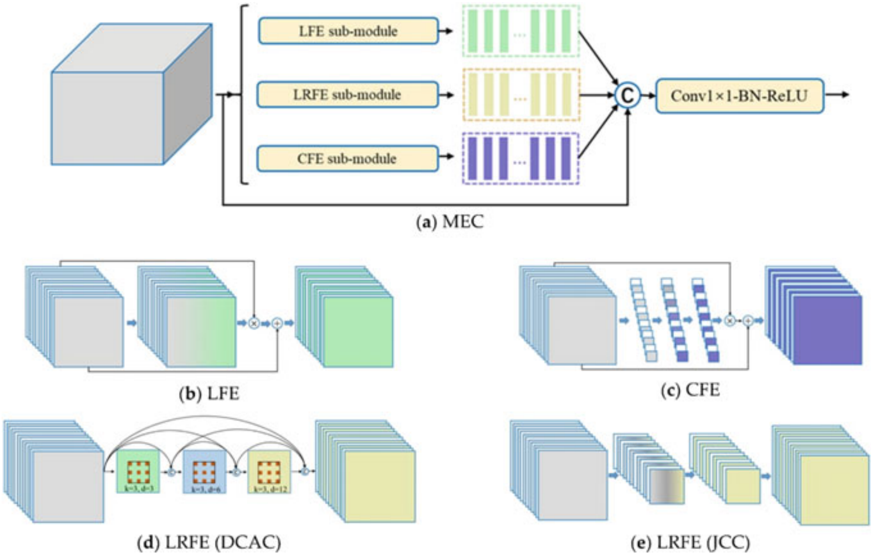


Fig. 3 The details of multi-feature extraction and combination module. **a** The Multi-feature Extraction and Combination (MEC) module consists of **b** a Local Feature Extraction (LFE) sub-module, **c** a between-channel feature enhancement module (CFE) and a longer receptive-field feature extraction sub-module (LRFE); **d** Densely Connected Atrous Convolutions (DCAC), and **e** JCC (Joint Conv7-S4-Conv3-S1, for the longer receptive field feature extraction.to properly forecast the water-body segmentation map, whereas DSFF combines distinct information from the encoding and decoding phases at the same scale

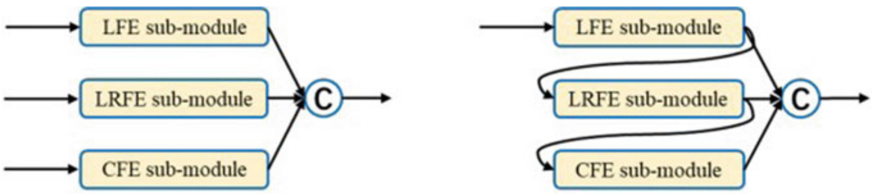


Fig. 4 Two ways to combine different feature sub-modules in the MEC (Multi-feature Extraction and Combination), Left: in a parallel way. Right: in a cascade way

Two methods in the MEC for combining various feature sub-modules (Multi-feature Extraction and Combination), Right: in a similar fashion. In a cascading fashion, that's correct.

2.2 Semantic Features Fusion Module for Encoder-Decoder

The DSFF module (Fig. 6) extends the 3D channel attention module described in our earlier work [28] to overcome the issue of semantic inconsistency in feature fusion at the decoding stage. To minimize the number of channels in the concatenated feature maps at the same scale from both the encoding and decoding stages, the DSFF first conducts a 1 1 convolution using BN and ReLU. The concatenated features are then used to construct the global context, which is then used to do 1 1 convolutions using BN, ReLU, and a Sigmoid function. As a guide for combining various semantic characteristics, it automatically learns how to link the channels of feature maps together semantically. The concatenated characteristics multiply and add the global context information. To finish, 3 × 3 convolutions with BNs and a ReLU are applied to the feature maps that were generated. To accomplish an effective fusion of distinct semantic features, the DSFF module is used on various scale characteristics at the decoding step. 2021, 03, ×8 of 19 Remote Sensing Multi-scale Prediction Fusion (MPF) is seen in Fig. 5.

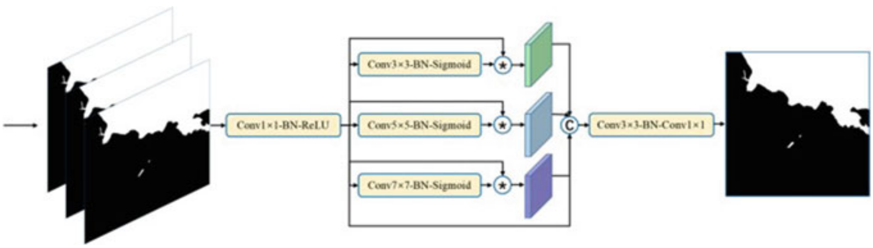


Fig. 5 MPF: Multi-scale prediction fusion module

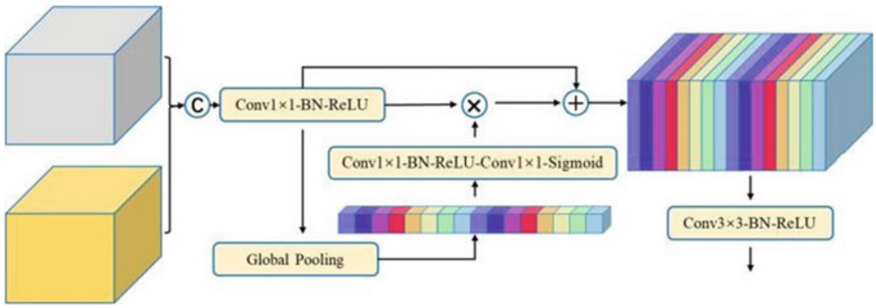


Fig. 6 Different semantic feature fusion module, DSFF

The Total Loss Function (TLF) The difficulty of training deep neural networks grows as the network's depth increases [20]. We implement a simple and effective output layer at each scale in the decoding step and apply loss restrictions between its result and the ground truth to train our proposed model more efficiently.

The total loss function and the cross-entropy function L are illustrated in the following manner. Figure 6, The DSFF module, which stands for Different Semantic Feature Fusion.

3 The Architecture of the Proposed Model

The proposed architecture mainly depends on four steps. The first is the Image Processing where all the goes through the geometric correction, i.e., all the color, texture, and shape are identified and produces the image immediately after analyzing which is knows as Image Fusion. Later, in the second step the image which is produced in the preprocessing is transformed to sample generation state in which the image is analyzed by pixel-by-pixel and forms two datasets one is the training dataset and the other is test dataset. Later, the training dataset values are compared with the test dataset. In the third process, the data gets water extraction where the image is predicted with the accurate position on the water content on the image, and the final step is the accuracy assessment where the percentage and the accuracy is evaluated and represented in the graphical format (Fig. 7).

4 Experimental Results

Extraction of characteristics at many scales, there are three main methods of feature extraction for the multi-featured integrated network: local (LFE), receptive longer features (RLFE), and channel-based feature extractions (RLFE) (CFE). In this study,

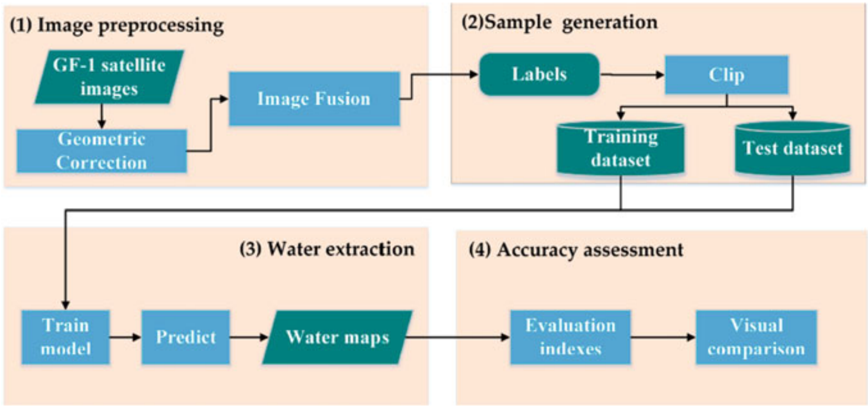


Fig. 7 Architecture of water-body segmentation

spatial feature relationships between linked features are characterized using LFE and RLFE, and the maximum features acquired across multiple channels are explored.

Optimization of the Contour Map, there are a variety of state-of-the-art methods for detecting contours in a picture that include localization information. Based on multi-scale globalization and semantic picture attributes such as texture, color, and form, we explore contour detection from a satellite image.

Multi-scale feature extraction using contours, multi-feature extraction using a contour-based approach is quite different from typical multi-scale extraction methods, and we employ the following modules to test its viability: local feature extraction (LFE), channel feature extraction, and long receptive field feature extraction (LRFFE) (CFE & LRFE). Submodules LFE and LRFE are used to identify regions with certain features, whereas CFE investigates the relationships between distinct feature maps.

Optimized water-body segmentation extraction, training is finished, and the weights of each pixel are evaluated using the proper neighbor pixel selection for each picture once the multi-feature extraction procedure is done. Raw images of the linked objects are used as input, and the probability maps derived from the multi-scale feature search approach are used to segment the water. A lot of pixels are involved in this work, hence this module includes a significant number of pixels from the picture. The most effective model for evaluating pixels with varied decoding variables is optimal water-body segmentation with multi scale-feature extraction (Figs. 8 and 9).

5 Conclusion

To enhance water-body contour identification from VHR remotely sensed photos, combining aerial and satellite pictures, we use the structure of the embedding. Our

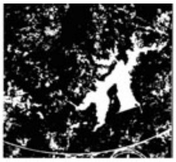
Original Image	True Mask	CNN Prediction	Accuracy	Duration
			72.355419	3.30596

Fig. 8 CNN prediction

Original image	True Mask	MECNET prediction	Accuracy	Duration
			81.70690 0	3.0280 74

Fig. 9 MECNET prediction

approach relies on the following three components: A DSFF module solves the issue of semantic inconsistencies of features extraction between the encoding and decoding stages by automatically extracting richer and more diverse features in the encoding stage and obtaining more advanced semantic information for feature fusion in the decoding stage. On VHR aerial and satellite photos, our technique achieved the greatest accuracy as well as the best resilience under tough conditions, according to the results of our studies. In addition to feature extraction, this new design module may be used for semantic segmentation and object recognition. In this, we compared this project between CNN, MECNET, and MECNET-CMO among these we could find that CNN consumes more duration and results with the less efficiency where as MECNET consumes less duration and produces more efficiency which is proved in our project.

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Image-Based Disease Detection and Classification of Plant Using CNN

Madhusudhana Rao Dontha and Nalagatla Sri Supriyanka

Abstract Image-based detection and classification using CNN, its aim to detecting and classification of the plant diseases. Farmers are the back bone of the nation to help them, we present these plant disease detection. Nowadays, many of the farmers are facing these plant diseases for their crops and paddies, and it is the crucial issue to be addressed in the world. In order to detect the plant leaf disease, we address the present prospects and issues. Plant diseases are one of the most serious threats to food safety. Some plant diseases are infectious diseases and parasites that can spread throughout the entire field, affecting the almost all of the yields. It is not only the process of contextual but it is also time-consuming, labor intensive, and un-reliable. Some farmers were use the pesticides for the crops with far less experience. Food insecurity will worsen if plant diseases are not discovered in time. To tackle these issues, researchers are investigating the use of image processing techniques for plant disease recognition.

Keywords Plant disease detection · Deep learning · CNN · Data augmentation · ResNet

1 Introduction

A country's innovative growth is dependent on agribusiness. Agriculture, it provides the food for people like raw materials, millets etc. It is very important to humans as a source of food. As a result, plant diseases have become a major issue for humans. Plant diseases can strike at any time. It is possible that it will occur between sowing and harvesting. It represents a significant decrease in the market's economic value. As a result, detection of leaf disease is critical in agriculture. As a result, traditional

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methods of disease detection were used. However, in old days many people were used eye's to identify the disease of the respected people or plant pathologists.

As a result, the descriptor is less sensitive to image distortions. For recognizing the object we use the descriptor, the HOG gradient histogram is used to make the possible to give the sufficient and quick results.

The method of "deep learning" is a study for agriculture used has strengthened for research and It is used for the new applications and improving the performance over the current methods. "Deep learning" is used to determine the extraction of a characterization in an artificial manner and it provides a clear classification on proposed data set. In this paper mainly we used CNN method. Generally, CNN [1] is the best method to determine the large image data. It is also designed to identify the large-scale images.

Implementing these type of model in mobile applications it is used to detect the various plant diseases and classifies using mobile cameras for the formers and taking the necessary actions of diseases spreading. In this paper, we take some sample data sets plant leaf's to detect and classify the disease in plants. Click or tap here to enter text.The plant dataset is used to train the CNN [2] (Convolutional neural network), VGG19, ResNet-152v2, and DenseNet models. The DenseNet model exceeded the others in high accuracy.

For example, Mohanty et al. [1] takes the samples of 14 plant leaf's from the dataset with the convolutional neural network (CNN) and get the 99% accuracy in the image base network.

The ResNet architecture for the identification of the plant diseases, it will divides the leaf into 34 certain layers of plain network architecture inspired by the VGG19 (VGG19 is a VGG model variant consisting of 19 layers) (16 convolution layers, 3 fully connected layer, 5 MaxPool layers, and 1 SoftMax layer). Other VGG variants include VGG11, VGG16, and others. VGG19 has a total of 19.6 billion FLOPs.

The purpose of this is used to detect the healthy and unhealthy (disease) leaves of a plant from the given dataset using CNN method and it gives the best result of accuracy [1].

2 Proposed System

The proposed system evaluates the disease of a plant leaf's from the dataset, by using CNN, ResNet, and augmentation, we can identify the results of this paper with more accuracy. In the above are the main methods in this paper. After that, classifying the disease we get the healthy and unhealthy diseases using convolutional neural network (CNN) with the help of we get the best accuracy. The performance efficiency will be calculated using multilevel k means and the SVM algorithm. By this, we easily guess the disease effect by the plants and can take a precaution.

CNN architecture is used to detect and classify images by utilizing various layers of various types; it is made up of multiple levels followed by one or more grouping layers and one or more re fully connected layers. We employ the convolutional

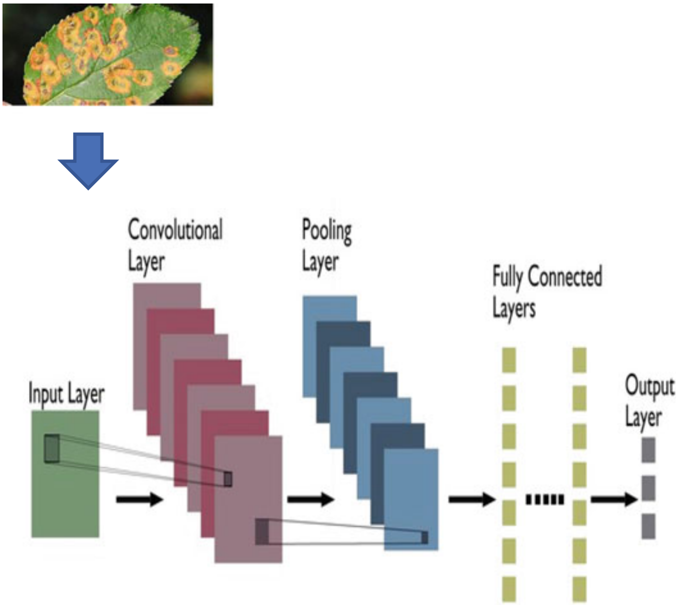


Fig. 1 Diagram of convolutional neural network (CNN)

operator to extract the features of an image, as well as a clustering layer to reduce the size of the feature map (Fig. 1).

The following are the diagram shows the process of detecting and classifying of a leaf from the dataset using CNN through some other methods in "deep learning" (Fig. 2).

In this, we have two types of steps they are: training step and testing step now we discuss about these two steps.

Training steps: Determines the initial weight that will be applied to the hidden layer. Feedback and retro-propagation are the two main processes.

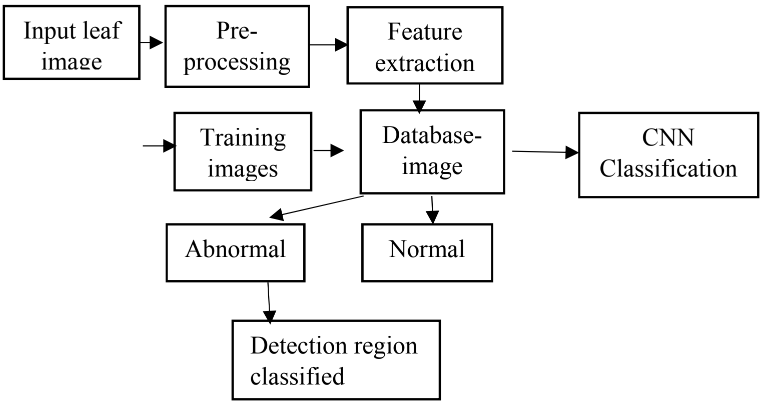
Testing steps: It is an identification process using the following methods for the leaf's from the dataset using the CNN we can get the best accuracy results [1] (Fig. 3).

3 Methods and Models

CNN MODEL: convolutional neural network CNN [1] is an use of mathematical operations it is made up of a series of layers.

Now we discuss some types involved in this identification (Table 1).

- Convolutional layer: it is the process of combining the mathematical way of two signals to form a third signal.



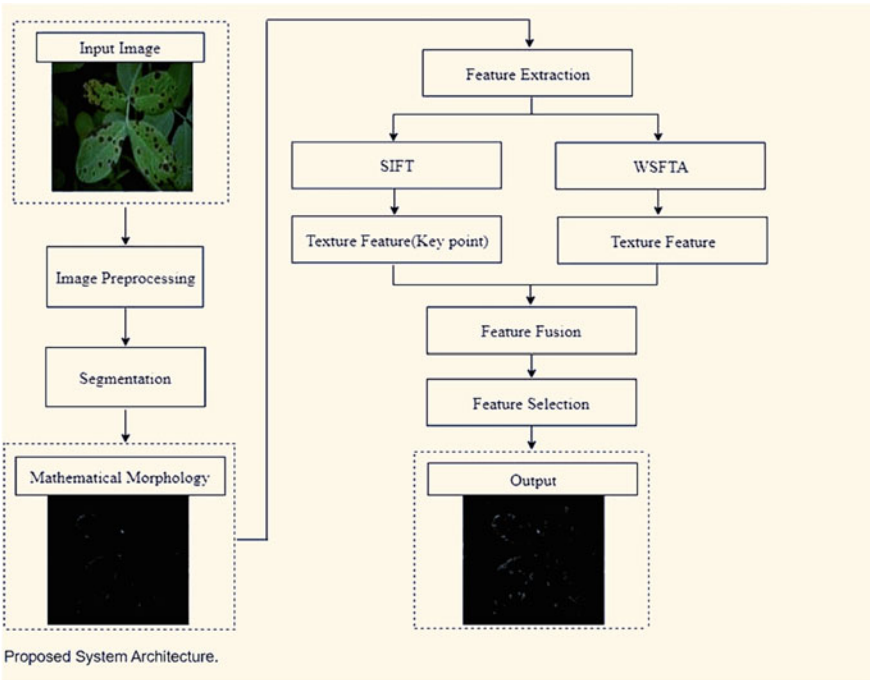


Fig. 2 Overview of proposed system frame work

- Pooling layer: it is another CNN construction piece that decreases the number of parameters (image). Each feature map is treated separately by the Pooling Layer.
- Correction layer (ReLU): ReLU (rectified linear units) refers to the real non-linear function definition by $\mathrm{ReLU}(x) = \max(0, x)$. it acts as a activation function.
- Fully connected layer (FC): The last few layers are completely connected layers that assemble the data collected by previous layers to generate the final

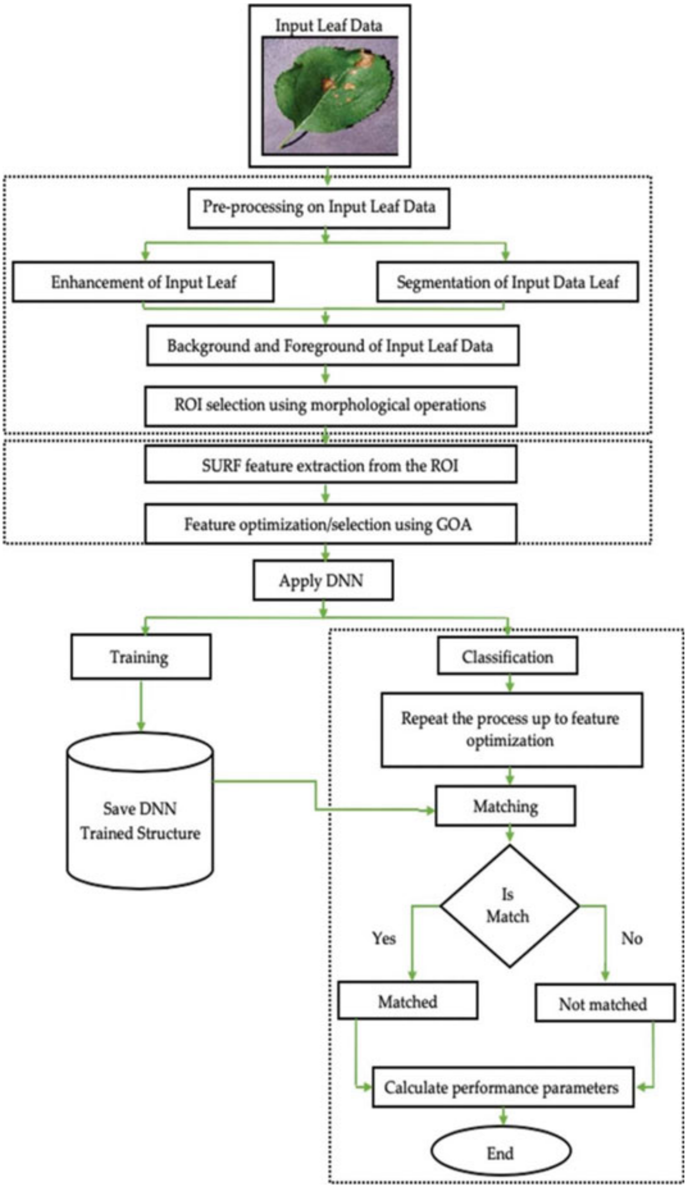


Fig. 3 Proposed structure

Table 1 CNN model

Layer (type)	Output shape	Parms#
Input_1(input layer)	(none,65,66,3)	0
Conv2d_9(conv2D)	(none,65,66,3)	1793
Max_pooling2d_9	(maxpooling2(none,30,30,64)	0
Conv2d_10(conv2D)	(none,29,29,64)	36,927
Max_pooling2d_10	(maxpooling(none,15,15,64))	0
Conv2d_11(conv2D)	(none,11,12,64)	36,927
Max_pooling2d_11	(maxpooling(none,6,7,65))	0
Flatten_3(Flatten)	(none,128)	0
Dense_6(Dense)	(none,128)	295,039

output, where all the inputs from one layer are connected to every activation unit of the next layer.

A. ResNet MODEL: it is one of the "deep learning" model, the residential model additional layers are added to a CNN [1] to improve accuracy and performance and are useful in solving complex problems in the process of detection.

4 Data Discription

The data is used of this paper is from plant village dataset. It consists of more than 18,632 images. In this study, we take many type of leaf's like fruits plants leaf's, agriculture plants leaf's, flowers plants leaf's and seeds plants leaf's, Beans leaf's, etc. [3], after classifying and identifying the images of an dataset we get some of the leaf's are healthy and some leaf's are unhealthy (effected by the disease). The following are the classes of diseases leaf's is shown in Fig. 4. For these large datasets, we use "deep learning" with the according model. We use the keras for image data generation, it resizes the image into 224 $\times$ 224 [1] pixel size and augmentations. Augmentations is used to prevent the overfitting during the stage of training, to detect these dataset we use two types: one is training and another is validation set, accordingly we split and identify the images (Fig. 5).

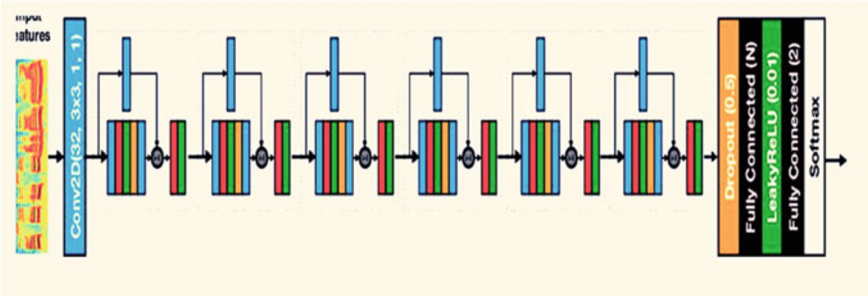


Fig. 4 ResNet model

Fig. 5 Different diseases in leafs

5 Image Based and Data Augmentation

See Fig. 6.

5.1 Data Augmentation

Data augmentation is a strategy for increasing the amount of data available for training models without actually collecting new data. It is also used to enable practitioners to dramatically enhance the diversity of data available for training models without actually collecting new data.

The following are the Fig.7 is the process of augmentation of leaf and it is used to extract the features of an disease and it identifies the spot of an disease using RGB colors after data augmentation of a grapes leaf.

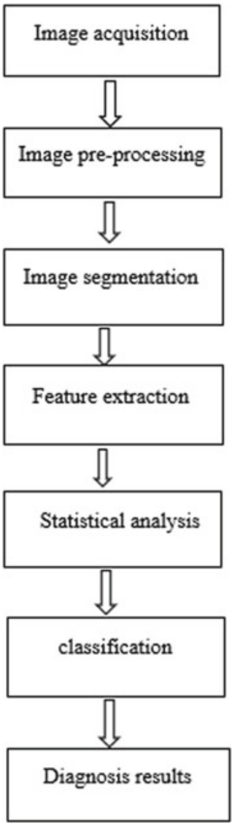


Fig. 6 Steps for proposed system

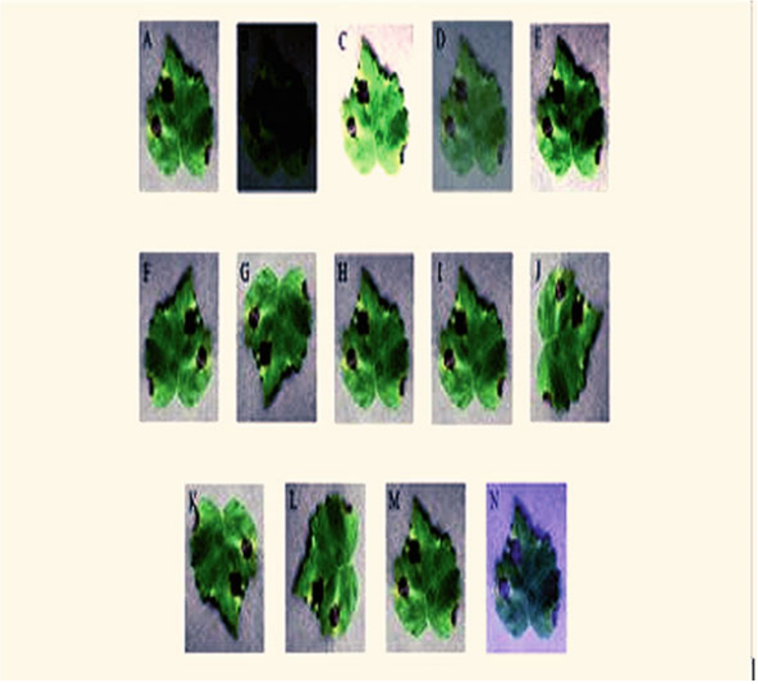


Fig. 7 Identifies the spot of an disease using RGB colors

As a result, the table below shows the final success and error rates of our deep learning approach to plant disease detection (Tables 2 and 3).

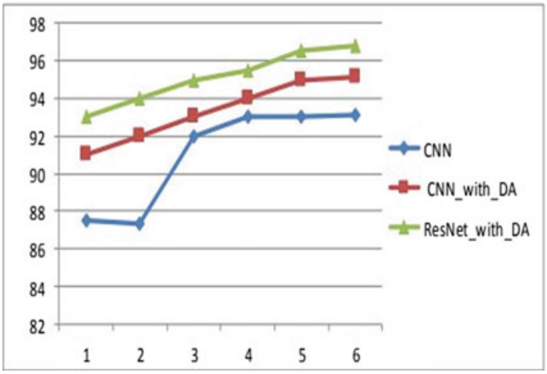
With a satisfactory accuracy of 98.96 percent, our proposed system demonstrates its dependability and speed.

Table 2 The above table, it is apparent that the ResNet architecture performs better CNN and requires less testing time

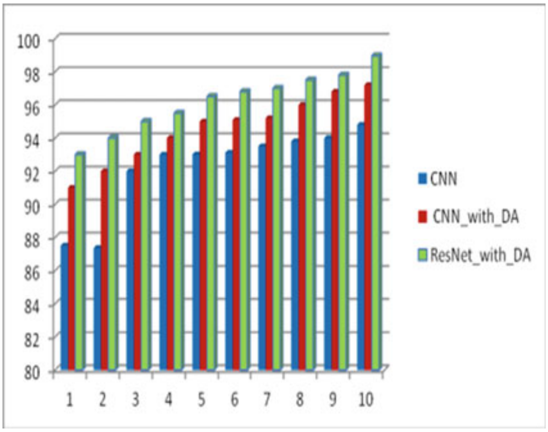
datasets	methods	epochs	loss	Accuracy (%)
	CNN (without DA)		0.11	94.81
Dataset using (data augmentation)	CNN (with DA)	1…10 epochs	0.07	97.2
	ResNet (with DA)		0.33	98.96

Table 3 Accuracy rate and loss rate of our proposed rate

Methods	Our approach (CNN and ResNet) using DA	
Accuracy	97.3%	98.96%
Test/Time (ms)	1.5	1.6



In the above graph showing our results.



Accuracy rate for each model.

6 Result

The following are the result of detection of plant disease, shows that is the plant effected or not. By using database, we detect the plant leaf's with CNN and after analyzing the data we found that the trained models get the accuracy of 93.04%. In this, we use the data augmentation for the results it will improves the accuracy for the data we gave without reducing the learning efficiency. After implementing the data with ResNet and CNN we get more accuracy than before. And by using these algorithms, we created a web application to predict the data easily and effectively (Figs. 8, 9, 10, 11, 12 and 13).

Fig. 8 Home page of plant disease detection

Fig. 9 User login page form

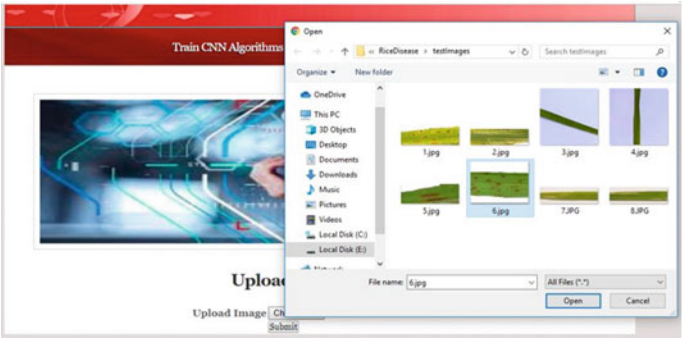


Fig. 10 Uploading the images from chosen file, ex: Taken a rice leaf

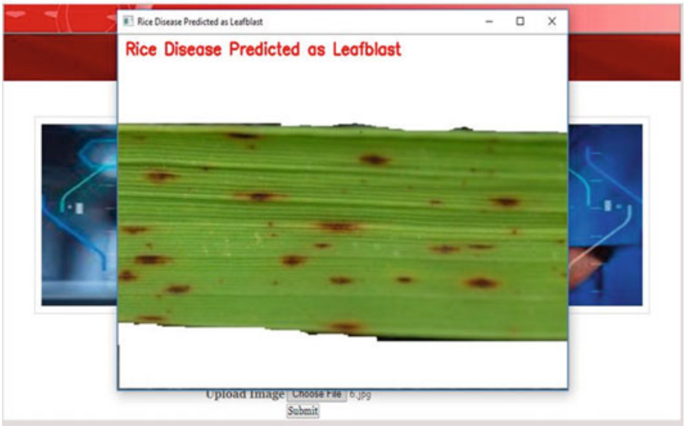


Fig. 11 Detecting the disease from the image

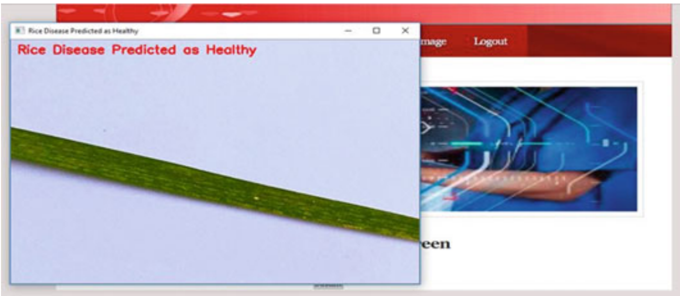


Fig. 12 Detecting that healthy or not

Fig. 13 This fig shows that accuracy data of this project to reuse of a previously learned model on a new problem

7 Project Implementation

- Gathering the plant image database
- Pre-processing the dataset and analysis dataset
- Apply image processing technique
- Training the models to analysis the documents
- Obtain the accuracy in prediction of detection diseases.

8 Conclusion

In this paper, the proposed method of approaching is a precious approach, which can be give better performance. By using CNN by deep learning and ResNet this methods, we can predict the data sets easily of different diseases. CNN is used for the purpose of identifying the healthy or unhealthy of a plant image. And ResNet also used to divide the layer of an image processing and classifies the disease. By using these methods, we can get the results quickly and accurately.

We present this paper for the purpose of plant detection for the farmers who is suffering from the several issues of diseases of plants leaf's and the augmentation is also an important thing in this process it gives the high accuracy for the dataset. Finally the result will get accurately as per the given dataset of plant leaf's and some leaf's are effected by the diseases, some leafs are not.

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Predictive Analysis of Air Pollutants Using Machine Learning

Reema Gupta and Priti Singla

Abstract Air pollution is a major concern nowadays as it affects all living organisms. Air quality is dependent on the pollutants present in the air which include oxides, ozone, carbon monoxide, particulate matter etc. Air pollution is now acknowledged as a major public health problem, causing a growing number of health effects that have been extensively documented by the findings of numerous research conducted throughout the world. The air quality index allows us to rate different sites according to the amount of pollution they have, showing the more contaminated areas as well as the frequency of potential risks. The AQI aids in determining changes in air quality over time, allowing for prediction of pollution and it's mitigation. Prediction of air quality helps people, and organizations in planning; managing various activities. In case of poor air quality, people can take precautions and look into the methods to reduce its adverse effects of it. It helps in protecting public health by predicting air pollutants. This literature review focuses on the various techniques used by different researchers in the prediction of air quality and air pollutants using machine learning. Machine learning techniques have been applied to different areas with various pollutants, and the performance of various machine learning algorithms is compared using performance metrics.

Keywords Air pollutants · Air quality index · Machine learning · Support Vector Machine (SVM) · Random Forest (RF) · Accuracy · Confusion matrix

1 Introduction

Air quality prediction is necessary to predict the concentration of various pollutants in different regions. Pollutants affect the quality of air which may create mild to

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severe problems in our respiratory system. Many studies have been done in different areas using different techniques. The traditional approach is not able to capture the non-linearity behavior. To avoid this, limitation machine learning technique is used to predict the air pollutants and air quality. There is a need to control the air pollutants as it may lead to death.

The researcher showed that during the lockdown period concentration of air pollutants has decreased except for ozone in Delhi and COVID-19 deaths having a positive correlation with air pollutants [1]. Air quality prediction is necessary for both indoors and outdoors. Indoor air is concerned for us in places like school, offices, and home. These places must be properly ventilated to avoid the effect on the lungs [2] AQI is used to measure air quality. AQI is a numeric value that indicates whether the breathing air is polluted or not. If air is polluted how much it is as AQI value reflects the effects on air quality by gas particles, smoke, etc. If the value of AQI is high, it means it is highly polluted and can cause health problems. If the value of AQI is low, it means it is less contaminated.

With rising technologies and industries, there is a constant acceleration of baleful pollutants that results in terribly affecting the health of living beings. With the progress of industrialization and civilization, the quality of air is seriously becoming ill. The perils of this unhealthy environment and particularly poor air make people vulnerable to numerous diseases such as disastrously affecting lung functions and the respiratory system. In recent years also, there has been a rise in the diseases caused by air pollutants. The harmful gases present in the air causing respiratory problems have reduced human life expectancy. The rising air pollution has become a global issue and many steps are taken to improve it. Various tools are used to facilitate measuring air quality. Analyzing and inspecting the air pollutants can prepare the basis of what changes are required to make to provide ambient air and to apply preventive measures to lessen the diseases caused by it.

This work involves several recent studies regarding machine learning techniques to predict air pollutants and air quality. It discusses the algorithm applied, dataset consideration, preprocessing, and performance metrics.

2 Recent Studies and Background

Developed an air quality monitoring model to predict air quality using machine learning. The work was applied to five years of datasets from 2013 to 2018 and considered the four pollutants i.e., CO, SO_2, $NO_2$and Ozone. The study aimed to predict the concentration of pollutants using machine learning techniques. ANN, Multilevel Regression, Neuro-Fuzzy, and DL-LSTM algorithms were used for this task. The algorithm's performance was compared using evaluation criteria MAPE, $R^2$and RMSE. It has been found that the performance of DL-LSTM is better compared to the other algorithms [2].

Conducted research in Jordon aiming to predict the air quality using machine learning. The work applied to 2 year dataset (2017–2019), which consists of 9777 records. The study aimed to implement Machine Learning algorithms DT, SVM, K-NN, RF, and LR. The Researcher conducted research across 13 sites in Jordon. The performance of applied algorithms was compared based on accuracy. It had been concluded that the DT algorithm has the highest performance as accuracy is 99.964% in complex one while in simple, accuracy is 99.714% which is same in case of RF algorithm and numeric distance K-NN algorithm [3].

Developed the AQI prediction model for acute air pollution events 1, 8, 24 h in advance. The work applied to an eleven-year dataset (2008–2018) in Taiwan and considered six pollutants (ozone, PM2.5, PM10, CO, SO_2, NO_2). The study aimed to implement machine learning algorithms i.e., RF, Adaptive Boosting (AdaBoost), SVM, ANN, and Stacking ensemble methods to predict the air pollutants in three air monitoring stations. The dataset has been split into 80 and 20 ratio training and testing respectively. The performance of machine learning algorithms was evaluated using RMSE, MAE and R^2 with and without imputation. It had been concluded that the performance of stacking ensemble is better as compared to others algorithm (without imputation).But with imputation preprocessing technique the performance of AdaBoost algorithm is better. SVM algorithm provided considerable results only for 1 h prediction [4].

This study analyzed the changes in six major pollutants (PM2.5, PM10, SO_2, NO_2, O_3, CO) of air pollution during the Corona Virus Disease 2019 (COVID-19) lockdown in Changchun. There's still a need of advance stricter measures ceaselessly such as vitality structure and mechanical rebuilding in future contamination control endeavors, actualize stricter joint territorial control of toxins in Jilin Area [5].

Compared four algorithms, i.e., neural network, K-NN, SVM, and DT to find out their accuracy in measuring the air pollution. 2017 database of Capital of the Republic of Macedonia, Skopje was considered for this process. This paper concluded that SVM algorithm accuracy is high when linear kernel function was used. DT Algorithm is faster but accuracy percentage is low. Most accurate algorithm is NN (classification) as compared to the others [6].

Machine learning techniques was used for ozone prediction and splitted the testing data according to the seasons. XGBoost algorithm was used for the pollutant forecasting [7].

Conducted research in California to predict air quality. The work applied to two years of datasets from 1 Jan 2016 to 1 May 2018 and considered the five pollutants i.e., CO, SO_2, NO_2, Ozone, PM2.5, and environmental parameters such as temperature, humidity and wind. The study aimed to build models for hourly air quality forecasting using a machine learning approach, i.e., support vector regression (SVR). SVR was applied to both the datasets one containing all dependent variables excluding PCA and the other that was reduced using principal component analysis (PCA). Both were compared using evaluation criteria MAE, RMSE, and nRMSE. It has been found that evaluation has been done on training and validation sets using error metrics (MAE, R^2, RMSE, nRMSE) [8].

Reviewed the air quality of ten major cities and compared the pollutants concentration of a city in respect to each other. This paper presented the concentration of every pollutant of every city in the tabular form. In the last, preventive measures taken in India were mentioned [9].

Presented strengths and weaknesses of some statistical models and methods (regression models, models based on decision tree, artificial neural networks, clustering, and factor analysis). This paper summarized Indoor air quality prediction using the algorithms with the parameters (data, data transformation, indoor type, pre-analysis, model, inputs, outputs, percentage of data for training/validation testing, etc. [10]. Presented machine learning techniques, i.e., artificial neural network, decision tree, and fuzzy logic how these techniques can be applied for air quality forecasting [11]. Reviewed the relationship between COVID-19 pandemic, air mobility, and air quality and summarized the results of machine learning techniques used in air quality and COVID-19 study [12].

Compared current research work on the air quality evaluation. Purpose and area of study of China region was compared using machine learning-based models with mentioned parameters. Features of ANN, genetic algorithm-ANN, deep network, decision tree, RF model, and SVM models compared based on their features, i.e., Real-time prediction, simplicity, accuracy, regression based, robustness, flexibility, and air quality factors [13].

The methodology was proposed by Amado and Dela Cruz [14] which air quality characterization can be done. The study aimed to implement supervised machine learning algorithms, i.e., KNN, SVM, RF, NN, and NB and compare their performance in terms of accuracy and Logarithmic Loss performance. The experiment data had been split into 70% and 30% in training-test, respectively. It had been concluded that the NN algorithm's performance is better compared to the other algorithms. But, sometimes slow response may be the issue. This issue is not seen in the second-best algorithm, i.e., the RF algorithm.

Conducted research in the smart cities of Malaysia. The work applied to a one-year dataset from 2017 to 2018 taken from ten air quality stations and considered the PM2.5 pollutant. The study aimed to implement machine learning algorithms i.e., MLP and RF to find the accuracy in predicting the PM2.5 and compare these two algorithms performance-wise. After analysis of the dataset, it has been concluded that the concentration of PM2.5 has increased from 2017 to 2018. The experiment split the data train-test in a 60–40 ratio. For the evaluation purpose, a confusion matrix was considered. The confusion matrix reflects the gap between the predicted and actual values. This paper concluded that when applied the MLP algorithm in predicting PM2.5 pollutant concentration accuracy is 92%, precision value is 93%. But the accuracy improved if the same is predicted using RF algorithm, i.e., 97%, precision value is also 97%. Comparatively RF algorithm is better compared to the MLP in the prediction of PM2.5 in terms of performance and processing time [15]. Discussed the Results obtained by various researchers with different algorithms using parameters, i.e., techniques, Prediction Performance, pollutants, Areas [16].

Conducted research on the estimation of air pollution in three major polluted cities in New Delhi. The work applied to a 1.5-year air quality dataset obtained from the Pollution board website and considered mainly No_2, So_2, CO, PM2.5, PM10, and Ozone. The study aimed to consider the parameters related to the temperature and wind in the estimation of the air quality along with the pollutants. The experiment considered the instances in three monitoring stations and the implementation of the Regression models. For the evaluation purpose, MSE, MAE, and R^2were considered. It had been concluded that the performance of SVR and MLP is better as compared to other regression models in terms of error and accuracy [17]. Proposed a model to predict the air quality using gradient descent and Box plot analysis. Linear regression algorithm was applied to calculate the air quality index (AQI) [18].

Conducted research in Algeciras (Spain) to forecast the air quality index. The work applied to five years dataset (2010–2015). The study aimed to implement the machine learning model ANN, SVR, and LSTM network. The dataset was divided into two sections—Training set data for the 2010–2014 years and test set data for the 2015 year. Prediction of air pollutants ozone, PM10, CO, NO_2, and SO_2 was done using above said algorithms with autoregressive window size 48, 72, 96, 120 h. Performance was evaluated using RMSE and MAE. It has been concluded that the performance of ANN is better as compared to LSTM and SVR. After prediction of air pollutants concentration, AQI prediction has been done using these algorithms and ANN's performance is better as compared to SVR and LSTM [19].

Proposed a hybrid machine-learning algorithm to predict the air quality index. The work applied to 3 years dataset (2016–2019) of Gurugram (Haryana). The study aimed to implement a hybrid machine learning algorithm and compare its performance with the SVM algorithm. The hybrid algorithm combined SVM and K-means Clustering algorithm to predict the air quality index. Evaluation metrics Precision, Recall, Accuracy, Error rate, and F1 score have been used. It had been concluded that the performance of the hybrid algorithm is much better compared to the traditional SVM algorithm in terms of evaluation metrics. The error rate is low and precision, Recall, Accuracy, and F1 score has higher value in the case of hybrid algorithm [20].

Conducted research in the prediction and analysis of Urban air quality. The work applied on ambient air quality dataset obtained from Govt. website of India and considered mainly No_2, So_2. The study aimed to build a machine learning model to analyze and predict air quality. The experiment split the data train-test in a 9:1 ratio respectively. The study aimed to implement the k-means algorithm for clustering and Multinomial Logistic regression, Decision tree algorithm for analysis. For the evaluation purpose, a confusion matrix was considered. It had been concluded that the regression model's performance is better compared to the decision tree. The error rate is low in the case of the regression model [21].

Estimated the impact of COVID-19 on the air pollutants. GBM algorithm was used for the prediction of the air quality [22]. Reviewed the techniques used by the researchers for the prediction of air quality index and air pollutants of different regions. It had been discussed about the importance of air quality index and parameters on which basis AQI can be calculated [23].

Developed a prediction model to predict PM2.5 in New Delhi. The work applied on two years dataset May 2016–May 2018.The study aimed to implement machine learning algorithms, i.e., SVM and ANN to find the accuracy in predicting the PM2.5 and compare the performance of these two algorithms. The experiment was done on the dataset 80% for training and 20% for validation. The algorithm's performance was evaluated using R and MSE. In the ANN technique, feed-forward single hidden layer NN is applied for the prediction of PM2.5. It has been concluded that there is a good correlation between predicted and actual values in the case of ANN while the performance of the SVM algorithm is not so good. ANN model with some enhancements and optimization can be used for the prediction of air pollutants [24].

Focused on the estimation and forecasting of air pollutant concentration. Estimation had been done using ensemble learning and linear regression algorithm, forecasting had been done using NN and SVM [25]. Reviewed techniques of machine learning clustering and regression. Machine learning application had been discussed in the air quality field [26].

3 Analysis

Table 1 depicts the dataset considered in predicting the air pollutant in different regions and how data had been split in training/testing/validation. Different studies covered different areas and most of the studies covered the most polluted area.

Table 1 Analysis of Dataset

Dataset	Area covered	Percentage of data for training/testing/validation	Reference
5 year (2013–2018)	General Area	Train-Validation 80:20	[2]
2 years dataset (2017–2019)	Jordon	Train-test 70:30	[3]
11 years dataset (2008–2018)	Taiwan	Train-test 80:20	[4]
2 years (Jan 2016–May 2018)	California	40 Dependent variable/target pollutant	[8]
750 observations	General Area	Train-test 70:30	[14]
1 year (2017–2018)	Malaysia	Train-test 60:40	[15]
1.5 year (Jan 2016–September 2017)	New Delhi	3400–3500/station instances	[17]
5 years dataset (2010–2015)	Algeciras (Spain)	Train-test 80:20	[19]
3 years (2016–2019)	Gurugram	NA	[20]
Large dataset	Urban Air	Train-test 90:10	[21]
2 years dataset (May 2016–May2018)	New Delhi	Train-Validation 80:20	[24]

4 Methodology

Air quality prediction is necessary to predict the concentration of various pollutants in different regions. Pollutants affect the quality of air which may create mild to severe problems in our respiratory system. Many studies have been done in different areas using different techniques. The traditional approach is not able to capture the nonlinearity behavior. Machine learning is a branch in which a system can learn automatically. Machine learning [3] is one of the successful sciences that have been deployed recently in many applications due to recent advancements in computing technologies and the availability of data, which added many benefits in various fields, including healthcare, finance, retail, and environment. Accurate predictions and classifications in machine learning projects depend on several measures such as data quality, therefore, biased, low quality, or insufficient datasets can cause low and unjustified accuracy. Machine learning [4] involves computational methods which learn from complex data to build various models for prediction, classification, and evaluation.

Table 2 shows the various machine learning algorithms applied in the prediction of air pollutants and the technique applied in data preprocessing to remove the outliers and inappropriate data. Evaluation criteria are used to know the efficiency of an algorithm in prediction.

5 Results and Discussion

Table 3 reflects the performance of the machine learning algorithm used by various researchers in terms of accuracy and MSE, RMSE.

6 Conclusion

In light of the growing pollution borne difficulties, effective forecasting of air pollutant levels is the need of the hour. This present study reviewed various existing machine learning techniques which help predict the air quality and air pollutants. The performance of proposed models by researchers is considered and compared in terms of their performance in predicting our target variable. Monitoring air pollution and air quality do not reduce pollution; however, it does indicate that preventive measures and precautions are necessary to reduce the effects of air pollution and that actions to improve air quality can be implemented.

Table 2 Various machine learning algorithms applied in the prediction of air pollutants

Reference	Technique	Target variable	Feature selection	Evaluation criteria
[2]	ANN, Multilevel Regression, Neuro-Fuzzy, DL-LSTM	CO, No_2, So_2, Ozone	NA	RMSE, MAPE, R^2
[3]	DT, SVM, K-NN, RF, LR	Ozone, PM10, CO, No_2, So_2, H_2S	Binary classification	Accuracy
[4]	RF, AdaBoost, SVM, ANN, Stacking Ensemble	Ozone, PM2.5, PM10, CO, No_2, So_2	Highest Index	RMSE, MAE and R^2
[8]	SVR	CO, No_2, So_2, Ozone, PM2.5	Pearson Correlation Based	MAE, RMSE and nRMSE
[14]	KNN, SVM, RF, NN, NB	Air pollutants	Centering and Scaling	Accuracy and Logarithmic Loss performance
[15]	MLP and RF	PM2.5	SelectKBest	Confusion matrix
[17]	LR, SDG Regression, RFR, DTR, GBR, SVR, ANN, ABR	CO, No_2, So_2, Ozone, PM2.5, PM10	Feature Extraction	MSE, MAE, R^2
[19]	ANN, SVR and LSTM	Ozone, PM10, CO, No_2, So_2	NA	RMSE and MAE
[20]	Hybrid Algorithm (SVM and K-means Algorithm)	No_2, So_2, CO, PM2.5	Scaling	Precision, Recall, Accuracy, Error rate and F1 score
[21]	K-means, Multinomial Logistic regression, Decision tree	No_2, So_2	NA	Confusion Matrix
[24]	SVM, ANN	PM2.5	Linear Interpolation Technique (Preprocessing)	R and MSE

Abbreviations DT, Decision tree; SVM, Support Vector Machine; K-NN, K-Nearest Neighbour; NN, Neural Network; RF, Random Forest; LR, Logistic Regression; NB, Naïve Bayesian; MLP, Multilayer Perceptron; LSTM, Long Short-Term Memory; SGD, Stochastic Gradient Descent; RFR, Random Forest Regression; GBR, Gradient Boosting Regression; RMSE, Root Mean Square Error; MAPE, Mean Absolute Percentage Error

Table 3 Performance of machine learning algorithms

Algorithm	Reference	Performances	Predicted variable
Logistic Regression	[3]	91.598% Accuracy	
SVM	[14]	97.78% Accuracy	
	[24]	MSE (Train data) 0.0171	PM2.5
	[20]	65.93% Accuracy	
	[3]	99.837%	Ozone, PM10, CO, No_2, So_2, H_2S
RF	[15]	97% Accuracy	PM2.5
	[14]	94.22% Accuracy	
	[3]	99.714%	
MLP	[15]	92% Accuracy	PM2.5
	[17]	MSE 0.2797 S1	PM2.5
		MSE 0.4129 S1	PM10
		MSE 0.5111 S1	Ozone/NO_2/CO/SO_2
	[17]	MSE 0.2856 S2	PM2.5
		MSE 0.4667 S2	PM10
		MSE 0.6456 S2	Ozone/NO_2/CO/SO_2
	[17]	MSE 0.3976 S3	PM2.5
		MSE 0.5358 S3	PM10
		MSE 0.5551 S3	Ozone/NO_2/CO/SO_2
DT	[3]	99.964% complex 99.928% Medium 99.714% Simple	
K-NN	[14]	98.67% Accuracy	
	[3]	99.714% Numeric distance Accuracy	
NB	[14]	98.67% Accuracy	
NN	[14]	99.56% Accuracy	
LR	[17]	MSE 0.3434 S1	PM2.5
		MSE 0.4837 S1	PM10
		MSE 0.5870 S1	Ozone/NO_2/CO/SO_2
	[17]	MSE 0.3081 S2	PM2.5
		MSE 0.5049 S2	PM10
		MSE 0.7676 S2	Ozone/NO_2/CO/SO_2
	[17]	MSE 0.5196 S3	PM2.5
		MSE 0.5149 S3	PM10
		MSE 0.6006 S3	Ozone/NO_2/CO/SO_2
ANN	[24]	MSE (Train data) 0.00669	PM2.5

(continued)

Table 3 (continued)

Algorithm	Reference	Performances	Predicted variable
	[18]	RMSE 0.1623	CO
		RMSE 0.2371	SO_2
		RMSE 0.1523	NO_2
		RMSE 0.1671	Ozone
Hybrid(k-means + SVM)	[20]	91.25% Accuracy	
Neuro Fuzzy	[2]	RMSE 0.1623	CO
		RMSE 0.1320	SO_2
		RMSE 0.1233	NO_2
		RMSE 0.1671	Ozone

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Machine Learning Techniques Applied of Land Use—Land Cover (LULC) Image Classification: Research Avenues Challenges with Issues

Reena Thakur and Prashant Panse

Abstract An easy-to-use programming environment, open access to satellite data, and access to high-end consumer computation power has made it very easy to align remote sensing and machine learning during the new era. A variety of remote sensing applications have utilized publicly available data. Land use (LU) image classification has become vitally important in the natural environment because of the expansion of some global changes relating to the temperament of the earth. Therefore, researchers should investigate this area more deeply. This paper presents a complete review to help out the researchers to carry on with the land use/land cover for image classification process, as there are limited numbers of review articles to assist them. The purpose of this paper is to discuss the classification of satellite images using mainly employed machine learning algorithms. We discuss the general process of LU/LC based on multi-image classification, as well as the challenges and issues faced by researchers. Only a few studies evaluate machine learning algorithms for image classification using openly available data, however.

Keywords Land use/land cover · Satellite · Remote sensing · Classification · Machine learning algorithm

1 Introduction

A lot of interest has recently been shown in machine learning algorithms for LULC mapping that use remotely sensed imagery [1]. We have divided machine learning techniques into two categories: supervised and unsupervised [2]. A novel method of interpreting remote sensing data is offered by deep learning. With CNNs, you can

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directly do feature extraction from a large amount of image data and utilize their semantic content to make predictions about the image [3].

By using support vector machine (SVM) and random forest (RF) techniques, we investigate the quality information in the classification of hyperspectral image [4]. As perceived by pixel-based RF classification research, the most accurate method (88.13%) is DWT-based dimensionality reduction method and has the highest Kappa value (0.87) as compared to other reduction approaches and SVM classification methods [5]. The paper addresses topics such as the rationale for accuracy evaluation, some common accuracy measures, the typical spatial units employed, the nature of reference data sets, and the presentation and interpretation of results [6]. Natural and biological processes such as highways, pastures, rivers, forests, marshlands, meadows, sea lakes, water lands, and constructed and urbanized places are examples of landscapes observed from the earth's surface. In general, land use categories refer to the current uses of land, such as developed institutions, industries, annual crops, perennial crops, herbaceous vegetation, residential areas, and shopping malls, parks, and reservoirs [7].

Satellite-based as well as conventional terrestrial mapping methods have both been constituted to map LULC dynamics and patterns. However, it is a labor-intensive, costly, time-consuming, and manpower-intensive method of mapping vast areas [8]. Furthermore, there is the possibility of subjectivity in mapping. For the LULC mapping, satellite maps and aerial photographs are profitable, geographically encompassing, time saving, and multi-temporal [9]. Until now, satellite data had a lower spatial resolution than maps made by terrestrial surveys.

2 Motivation

According to the findings of the aforementioned study, none of the available literature studies on LU/LC provide a comprehensive survey of LULC image classification study procedure. The author only looked at one step, either LU/LC change [10] or LU/LC categorization [11]. We are therefore inspired to write a review paper encompassing all aspects of LULC classification study for the benefit of future researchers.

3 Objective

The following is a list of the paper's primary goals:

(i) In the paper, the primary purpose is to give researchers a road map to follow when they work on the LULC classification to guess the areas that will be used and covered.

(ii) In this paper, we present a detailed review of techniques, advantages, and challenges, beginning with image preprocessing, acquisition, and ending with analysis and validation from the beginning of the process to the end as given in Table 1.
(iii) As given in Table 3, the paper presents a general approach and probable framework for LULC image classification.
(iv) Researchers were able to identify and brief the challenge in each stage of LULC image classification, helping future investigators to work efficiently on this problem.
(v) This paper provides the research avenues which might show path to the future researchers as given in Table 2.

3.1 Research Avenues and Challenges

Though the research in deep learning and machine learning is new [56]. There are some interesting topics for data analysis.

1) Detection and recognition success is dependent on a large number of training examples, despite the fact that deep learning techniques can create fairly abstract feature representations from raw RS photos. However, because gathering captioned high-resolution image is difficult, high-quality training images are typically scarce.
2) RS image complexity: Unlike natural scene photographs, HR RS images have a range of things in a single scene with varied sizes, colors, rotations, and locations, whereas distinct scenes from other categories may resemble each other in a variety of ways.
3) Feature detector transfer between data sets: In some domains of RS, no training images are provided, so using deep networks to detect features between data sets is an intriguing approach. When dealing with large variances in RS data sets, it may be significantly more difficult, necessitating more research.
4) Deepness of the DL model: The deep networks are depending on the performance of the model. Deeper layers in supervised networks like CNNs can learn more intricate distributions, but they also add a lot more parameters to learn, which can lead to overfitting, especially if the training samples are not large enough. The computation time is another something to think about.
5) Acquisition: As a researcher, determining the region of interest within the study area using a suitable satellite system's datum coordinate is a challenge throughout the acquisition process.
6) LU/LC classification: It remains a concern that the ground survey does not provide adequate training data sets during the LU/LC categorization procedure.
7) Post-classification: Following classification, it remains difficult to check for misclassification errors.

Table 1 Various methods/algorithms/applications and its advantages and disadvantages

S. No	Applications/algorithms/methods	Advantages or disadvantages
1	SVM, RF, boosted DTs [12]	Very influential methods for remotely sensed data classification Machine classifiers such as k-NN and DTs produce high overall accuracy compared to alternatives Robust Training data imbalance can affect classification accuracy
2	CNN [3]	Extract characteristics from large volumes of image data directly Good at identifying and utilizing semantic aspects in visual data
3	RF, DT, SVM, Naive Byes, k-means clustering [2]	Canola point classification can de accurately done by RF
4	CNN [13]	Target recognition and scene comprehension have yielded significant results Pixel-based classification and image preprocessing have not been as effective
5	RF [14, 15, 16, 17]	Impervious to varying algorithmic parameters Computationally operative parallel processing method Handle high data multicollinearity and dimensionality
6	Land Change Modeler (LCM) [18]	Considered deforestation rate successfully
7	Random forest (RF) and support vector machine (SVM) [5]	Increases the overall accuracy—pixel-based classification
8	SVM [19]	Object-based classification accuracy is increased
9	Spectral mixture analysis [20]	Metropolitan areas are classified effectively Analysis of vegetation Propagation of error terms
10	Maximum likelihood classification [21, 22]	Land cover classification—83%
11	Decision tree, SVM, and k-NN [23]	SVM method has the highest accuracy as compared to the k-nearest neighbor and decision tree approaches
12	2D-CNN and GM-RF [24]	Further in features are extracted, resulting in higher accuracy
13	Rotation forest, random forest (RF), and gentle AdaBoost (GAB) [25, 26]	RTF outperformed the competition
14	K-means, iterative self-organizing [27]	The employed object-based technique performs substantially better and offers sufficient land use pattern estimates

(continued)

Table 1 (continued)

S. No	Applications/algorithms/methods	Advantages or disadvantages
15	RF and CART [28]	An automated, detailed, and remotely accessible LULC classification method
16	Fuzzy ArtMap [17], ensemble learning updating classifier, RF [29]	Overcast tropical environments require a classifier to accurately assess land cover Find the densely cloud-contaminated area's land use/cover with the least amount of preprocessing Error accumulation and the "salt and pepper" impact are addressed
17	Random forests (RF), support vector machines (SVM), extreme gradient boosting (Xgboost), and deep learning (DL) [30]	In remote sensing community, random forests and support vector machines are broadly used Deep learning and extreme gradient boosting are prominent in data science, but they are also gaining traction in remote sensing
18	Extreme gradient boosting (Xgboost) [31]	Works with VHR data sets and categorization techniques, although at the penalty of longer computation times
19	Particle swarm optimization, artificial neural network, and extreme gradient boosting algorithms, RF [32]	Improve the learning process by determining the most important aspects more effectively

Table 2 Types of software

Software type	Source for software	Important features	Uses
Environment for Visualizing Images (ENVI) FLAASH Tool ([18, 33–36]; FLAASH 2009; López-Serrano et al. 2016; Fikire Belete et al. 2021, Hsiao-chien Shih et al., 2018)	Geospatial documentation center https://www.l3harrisgeospatial.com https://hyspeedblog.wordpress.com/tag/image-analysis-tools/	Restoration and management, visual interpretation, analysis, accuracy assessment Geometric correction, anomaly detection, image sharpening, feature extraction, topographic modeling, radiometric correction, mosaicking, post-classification, supervised and/or unsupervised classification, spatiotemporal analysis	Correction of airborne hyperspectral data Hyperspectral and multispectral imagery

(continued)

Table 2 (continued)

Software type	Source for software	Important features	Uses
ArcGIS ([34, 35, 37, 38]; Fikire Belete et al. 2021; Feyera Senbeta et al. 2016)	https://uhcl.libguides.com/gis/download	Visual interpretation, analysis, image enhancement coefficient of sensitivity, accuracy assessment Georeferencing, mosaicking, panchromatic sharpening, supervised and unsupervised classification, spatiotemporal analysis, post-classification	Hyperspectral imagery, multispectral imagery
IDRISI Selva Online Help System [39–41]	https://clarklabs.org/support/%20IDRISI-Taiga-Help-System.cfm	Generation of distance variable, modeling, image enhancement and restoration, segmentation and transformation, image classification, distance measures, accuracy assessment, simulation models prediction methods	IDRISI assists in the processing of multispectral data and provides hyperspectral data processing services
ERDAS IMAGINE [4, 22, 37, 38, 40, 42–44]	http://www.erdas.com/ https://www.hexagongeospatial.com/	Image geoprocessing, image rectification, discrimination, identifying and deliminating restoration, image classification, enhancement, and accuracy assessment Scanning, modeling compression Radiometric correction, geometric calibration, pan sharpening, supervised, sub-pixel and unsupervised-based classification, and terrain feature analysis	Handle hyperspectral as well as LiDAR data from a variety of sensors Effective in evaluating the separability of each class in the study area Improving the study area's government's ability to devise comprehensive land management strategies at the local and national levels

(continued)

Table 2 (continued)

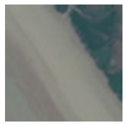
Software type	Source for software	Important features	Uses
Quantum GIS (QGIS) [21, 24, 41, 45–49]	QGIS Development Team 2019 [50] https://www.qgis.org	Image processing, analysis of land subsidence Georeferencing, classification, ruggedness index analysis, accuracy, preprocessing, image clipping, and post-processing, mosaicking, distance measures, image orthorectification, topographic areas modeling, monitoring, verification prediction modules, and terrain	Instant regulatory act hyperspectral as well as multispectral imagery
Google Earth Engine [16, 28, 51–53]	https://earthengine.google.com https://earthengine.google.com	Band manipulation, metadata properties, edge detection, terrain operations, image clipping and registration, area measurements, and spatial filtering, resampling, detect changes, quantify differences, and map trends	Process that is efficient, adaptable, and quick Processes multi-source satellite images quickly Google Earth offers multi-temporal, time series data, which aids in the accuracy assessment process
ArcMap ([42, 54]; Mark Matsa et al. 2021; Hsiao-chien Shih et al. 2018)	https://www.esri.com/	Create maps, map accuracy, perform spatial analysis, computing time, manage geographic data, finding loss of green spaces, identifying and delaminating, GPS data, discrimination	efficient way to minimize bias, ability to execute any geoprocessing model

(continued)

Table 2 (continued)

Software type	Source for software	Important features	Uses
R (Hsiao-chien Shih et al. 2018)	https://www.rstudio.com/	Highly active community, map accuracy, strong graphical capabilities, computing time, a wide selection of packages can perform complex statistical calculation, comprehensive environment, distributed computing	worth plotting as well as graphing
TerrSet (Hsiao-chien Shih et al. 2018, Muhammad Salem et al., 2021	https://clarklabs.org/	Monitoring and modeling map accuracy, analysis, computing time	In this sector, decision-makers should implement appropriate measures for sustainable land use Land change, habitat, earth trends, climate change, ecosystems, and biodiversity modeler
AgisoftPhotoscan [19, 25, 26, 47]	https://www.agisoft.com/	Mosaicking, editing and classification, image orthorectification, visualization, georeferencing, embedding, sharing	Generating 3D content of great quality from still images
Trimble eCognition	https://geospatial.trimble.com/	Intuitive, using specified, structured workflow blocks, analysis can be completed more quickly, graphical user interface, support for a variety of use case	find out, download and then make use of geospatial data

Table 3 Description of LULC classes in the data set [55]

Classes	Description of class	Sample of class
Permanent crop	The soil is occupied by permanent crops that produce harvests for several years, for example, vineyards, olive groves, fruit orchards, etc.	
Annual crop	Soil is occupied by annual crops, which yield harvests for a limited amount of time, for example; maize, barley, etc.	
Pastures	Grasslands are used to raise livestock, such as cattle, sheep, goats, etc.	
River	Flowing rivers are natural watercourses that flow toward sea, ocean, and lake	
Sea and lake	Water surrounds a certain area	

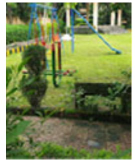
(continued)

Table 3 (continued)

Classes	Description of class	Sample of class
Forest	Forest is a very large land area, covered with trees	
Herbaceous vegetation	Vegetated areas, which are also known as herbaceous areas plants that grow in herbaceous or vascular terrain	
Industrial building	Machines are sheltered by human covered areas	
Residential building	Covered areas used by humans for shelter	
Highway	Covered areas used by human for their traveling	

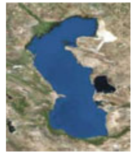
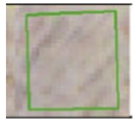
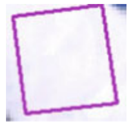
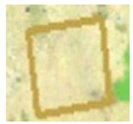
(continued)

Table 3 (continued)

Classes	Description of class	Sample of class
Shopping centers	Covered areas used by human for indoor shopping center	
Parks	Land area used by human for recreation	
Reservoirs	The source of water is an artificial or natural lake	
Grassland	Grasslands are areas where grasses are prevalent	

(continued)

Table 3 (continued)

Classes	Description of class	Sample of class
Barren land	Includes strip mines, quarries, gravel pits, beaches, dry salt flats, sand dunes, exposed rock, deserts, etc.	
Water bodies	Most of the year, there is standing water on the surface	
Agricultural land	Land shielded by crops of agriculture	
Built up area	Land shielded by road settlement	
Fallow land	Land without vegetation	

4 Conclusion

In this study, different machine learning classifiers were examined to determine which was the most accurate. It sought to identify the most accurate classifier. In addition, numerous studies have indicated that LULC mapping accuracy is not perfect. In the future, it should be investigated whether the classifiers are accurate under different morphoclimatic and geomorphic conditions.

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Crime Analysis Using Computer Vision Approach with Machine Learning

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Abstract Depending on the seriousness of the offence, any deliberate act that causes harm to oneself or another, as well as damage to or loss of property, qualifies as a crime for the purposes of criminal law. The number and diversity of unlawful activities are increasing at an alarming rate, necessitating the creation of efficient enforcement tools by law enforcement agencies. Due to their slowness and inefficiency, traditional crime-solving methods are no longer effective in today's high-crime climate. As a result, we may be able to reduce the workload of police personnel and contribute to crime prevention if we develop ways for reliably anticipating crime in advance of its occurrence. In order to do this, we suggest using ML and computer vision technologies and methodologies. Throughout this study, we describe the results of several cases in which such strategies were used, which sparked our interest in further study. The fundamental reason for the change in crime detection and prevention strategies is based on the prior and subsequent statistical observations made by the authorities. Machine learning and computer vision may help law enforcement and other authorities detect, prevent and solve crimes more quickly and accurately, and this is the primary goal of this research effort. With the use of artificial intelligence and computer vision, law enforcement agencies might be transformed.

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1 Introduction

Computer vision is a branch of artificial intelligence that focuses on teaching computers to understand and interpret their surrounding visual environment [1, 2]. For the most part, it is used to analyse data from a camera's surroundings. A variety of applications are possible, including the recognition of objects, licence plates, augmented and mixed worlds, as well as the assessment of one's whereabouts [3]. Computers can't yet interpret three-dimensional images, but scientists are working to build mathematical ways to help them do so. Personal photo collections, instance recognition, geometric alignment and large databases all benefit from three-dimensional visuals of an object, as does eigenfaces active appearance and three-dimensional shape models and eigenfaces active appearance and three-dimensional shape models in personal photo collections and personal photo collections, respectively. Each of the categories above may be investigated in further detail, and these are the most basic usage.

Computer vision research may be done significantly faster with the help of VLFeat, a library of computer vision algorithms that can be used for rapid prototyping, according to ref. [4, 5]. Additionally, a person's body position may be tracked during face detection/recognition. When it comes to envisioning our surroundings, computer vision is a great option.

It is possible for a system to learn and improve on its own without being explicitly designed using machine learning (ML) [6–8]. In certain cases, it is not feasible to determine a particular pattern or piece of information after analysing the data [9–11]. According to the researchers [12, 13], machine learning is utilised to understand the exact pattern and data. ML develops the idea that a computer can learn and solve both large mathematical problems and some specialised difficulties if the correct data are provided to it [14–17]. Supervised and unsupervised machine learning [18, 19] is the two main types of machine learning in general. For example, supervised learning uses a specific set of training examples to teach the computer how to correctly interpret new data [20, 21]. If you send a bunch of random data to a computer, and then tell it to figure out what's going on by itself, you are doing unsupervised learning [22, 23]. When it comes to neural networks, they have been around since the 1980s [24, 25]. To avoid nondeterministic polynomial (NP) completeness, a number of qualities are needed, and architectural limitations alone are not sufficient. According to ref. [26, 27], NP-completeness concerns may be extended to neural networks utilising sigmoid functions. Research on new machine learning algorithms has attempted to illustrate many of the features [28–30] although the conclusions are not always right.

Is it really possible to forecast the fundamental character of such crimes? According to the authors of ref. [31], a prediction system is becoming more necessary as society and the economy change. Using a dynamic temporal wrapping technique described in ref. [32], a crime trend and forecast system named Mahanolobis may be used to anticipate crimes and catch their culprit. Crime mapping was one of five projects funded in 1998 by the National Institute of Justice (NIJ) as detailed in ref. [33]. Police departments in the United States and other countries are now employing crime forecasting programmes [34]. As technology improves, criminal intelligence continues to rise year after year. Since this is the case, we need a new and powerful machine (a collection of programmes) that can aid the police and the government in their investigations. Because the fundamental goal of crime forecasting is to predict crimes before they occur, it is imperative that these methods be used. The capacity to save a victim's life, prevent long-term suffering and protect private property may necessitate the use of crime prediction at times. It might potentially be used to predict terrorist attacks and other criminal activity. A final benefit of using predictive policing is that governments may divert resources like police officers, investigators and finance to other areas of crime fighting by using predictive policing with a high degree of accuracy.

In this paper, machine learning and computer vision techniques may be used to predict the nature of the crime and even identify the offender. In the past, we wondered whether the crime's nature might have been foreseen. It is possible to classify every component of a crime, despite the appearance that it is impossible. The adage goes something like this: "There's always a motive behind everything a criminal does." If we use motive to identify the nature of a crime, we may be able to construct a list of probable classes for crimes. Using machine learning techniques and computer vision technologies to provide visual information about the surrounding environment, we examine a hypothesis that suggests we may predict criminal activity before it occurs using a database of all previously reported crimes.

2 Related Works

Technology now available is being used to identify and forecast criminal activity. A major part of "crime forecasting" is to predict crimes before they happen. To be able to foresee a crime before it occurs, one needs predictive technologies. There are a number of technological tools that police use, such as listening in on a suspect's phone call or filming suspected unlawful behaviour with a body camera. To give you a better idea of how they might perform with more technological assistance, we have compiled a list of some of these tools. A new frontier in police surveillance, the stingray [35] may be used to determine the position of a mobile phone by imitating cell phone towers and blasting signals to mislead adjacent cell phones into communicating their location and other data. The United States government opposes the deployment of stingrays because it would violate the fourth amendment. This technology is in use in 23 states and the District of Columbia.

According to the authors of ref. [36], this is more than just a surveillance system and raises privacy issues. For its part, the FCC intervened and made it clear that "marketing and sale of these devices shall be restricted to federal, state and local public safety & law enforcement officials only," as well as "State & Local Law Enforcement

Agencies Must Coordinate Acquisition & Use of the Equipment Authorised Under This Authorisation in Advance with the FBI." Although its use is warranted, there is much disagreement on how it should be put into practice.

Since the beginning of surveillance, the "stakeout" has been a popular method of conducting a thorough investigation. It is the most common surveillance tactic utilised by police officers and is used to gather information on a wide range of people. The authors of ref. [37] argue that police personnel are required to report on a broad range of events, and a stakeout is a useful tool for doing so. Staging or patrolling, finding evidence in the suspect's home and describing the suspect's behaviour during arrest are all examples of illegal activities that can be observed. As a result of the officers' first-hand observation of the significant events, stakeouts are considered 100% reliable. Are they completely accurate? It is normal for officers to become tired since they are all human. The main goal of a stakeout is to keep tabs on unlawful conduct. Is there a substitute for this tool? We will go into more depth on this in the paragraphs that follow.

Using drones, for example, may be useful in mapping cities, tracking down criminals, investigating crime scenes and accidents, controlling traffic and coordinating rescue efforts in the wake of a disaster. Reference [38] discusses the legal issues surrounding drone usage as well as the problems associated with allocating airspace to them. As the police's authority and influence grows, so does the public's concern about privacy. Questions regarding the altitude at which a drone may fly have been raised due to concerns about the distribution of airspace. Surveillance also includes face and licence plate recognition, as well as body cameras. Reference [39] mentions that facial recognition may be used to gather a suspect's profile and compare it to other databases in order to get more information. Similarly, a vehicle's licence plate may be scanned to get information about whether or not it was involved in criminal activity. As a result, a reader can watch and record everything that a police officer is doing, even if it is outside the scope of the human sight. As a general rule, when we see anything, we can't remember it in its entirety. Reference [40] examined the impact of body cameras on officer misconduct and domestic violence during arrests. Consequently, patrol officers must wear body-mounted video cameras. Additional protection against police misdeeds is provided in reference [41]. When it comes to body cameras, they aren't only used to record what's going on in front of them, but they are also used to capture important events throughout ordinary activities and crucial operations. Despite the fact that each of these approaches has merit on its own, they all have the trait of being stand-alone. Having a system that combines the greatest qualities of all of these technologies would be tremendously helpful, but the police may use any of these ways separately or simultaneously.

3 Methodology

Crime prediction using machine learning techniques: Using open-source data mining application Waikato Environment for Knowledge Analysis (WEKA), a comparison of violent crime patterns from the Communities and Crime Unnormalised Data set to actual crime statistics data was performed (WEKA). Communities and real-world crime data sets were analysed using linear regression, additive regression and decision stumps, all with the same restricted set of attributes. Subjects were chosen at random for the testing. It was found that the linear regression method handled the test samples' unpredictable nature the best of all three algorithms tested. For this study, machine learning algorithms were used to anticipate violent crime patterns and other purposes, such as generating criminal profiles, detecting criminal hotspots and learning about criminal trends.

The knowledge flow graphical user interface may be used in lieu of Internet Explorer when considering WEKA [42]. Individual learning components (represented visually by Java beans) are used to show a specific information flow in a process-oriented approach to data mining. A new graphical user interface, the experimenter, is then presented by the authors, and it is designed to compare the performance of various learning algorithms across various data sets.

Reference [43] explores the prospect of applying predictive analysis to anticipate crime in metropolitan areas. It was determined that three types of crime were grouped together into 250 m grids: residential burglary, street robbery and battery. An ensemble model was used to combine the results of logistic regression and neural network models in order to produce biweekly and monthly forecasts for 2014 based on the previous three years of crime data. The forecasts were evaluated using the direct hit rate, accuracy, and prediction index. A predictive analytic approach to data can yield accurate forecasts, according to the fortnightly predictions. By comparing fortnightly predictions to monthly predictions with a day-night separation, the researchers found that the results were significantly improved.

Machine learning was applied to investigate crime prediction in ref. [44]. The last 15 years of crime data in Vancouver, Canada, were analysed for forecast purposes. As part of this approach, data are collected, categorised and analysed using machine learning techniques. K-nearest neighbour (KNN) and boosted decision tree approaches were also used to analyse the crime data set. Machine learning algorithms were used to analyse 560,000 crime reports from 2003 to 2018 and accurately forecast crimes in the range of 39–44% of the time. However, despite its low accuracy, the authors came to the conclusion that the model's accuracy may be improved by tailoring the algorithms and crime data for specific applications.

According to ref. [45], a machine learning approach is used in Philadelphia, Pennsylvania, United States, to anticipate crime statistics. The problem was divided into three parts: determining whether or not a crime was committed, determining when a crime is committed and determining which crime is the most likely. For more accurate and complete quantitative crime predictions, the data sets were trained using methods including logistic regression, KNN, ordinal regression, and tree approaches. Also shown was a map illustrating various crime categories in different areas of Philadelphia over a certain time period, with different colours denoting each kind of crime. A wide range of offences, such as assaults and computer fraud, were included to present a comprehensive picture of the criminal activity in Philadelphia during a certain period of time. In addition to predicting the possibility of a crime happening, their method also accurately forecasted the number of crimes occurring between 1 and 32 with a 47% success rate.

They looked at a data set that included several crimes and made predictions about the types of crime that would occur in the near future based on a range of characteristics in ref. [46]. Crime data from Chicago, Illinois, were used to forecast criminal activity using machine learning and data analytics. The crime data set includes information on the crime location, the kind of crime, the date and time of the occurrence and the particular geographic coordinates. KNN classification, logistic regression, decision trees, random forests, a support vector machine (SVM) and Bayesian techniques were all tested, with the most accurate model chosen for training. The KNN classification was the most accurate, averaging a precision of 0.787. In addition, they used a variety of visual aids to make sense of the data set's various facets. Law enforcement agencies may use machine learning in this research to predict, detect and solve crimes faster, resulting in a reduction in crime. This is the major purpose of the study.

Using a graphical user interface-based model, crime rates may be predicted in ref. [47]. It was the major goal of this study to discover and evaluate the best accurate machine learning-based algorithms for projecting crime rates. The data set was examined using supervised machine learning algorithms to validate, clean and visualise the data. Several supervised machine learning algorithms' outputs were compared to predict the results. In Fig. 1, the suggested system includes data collection, data pre-processing, the creation of a predictive model, data set training, data set testing and algorithm comparison. It is the goal of this research to show how well a machine learning system predicts violent crimes.

Based on data fusion and deep neural networks (DNNs), researchers in ref. [48] have developed an effective technique for accurately forecasting crime occurrence, which incorporates multi-model data from many fields and environmental context information. An online database of Chicago crime statistics, as well as demographic and meteorological data and images, is all included in the collection. Regression, kernel density estimation (KDE), and support vector machines (SVMs) are some of the machine learning techniques utilised in crime prediction (SVM). Data collection, statistical analysis of the relationship between crime events and the acquired data, and accurate crime prediction were the three main aspects of their method. Geographic, temporal, and environmental data make up the DNN model. The accuracy of the SVM and KDE models was 67.01%, while the proposed DNN model had an accuracy of 84.25%. There was a significant improvement in accuracy for the proposed DNN model over the other prediction models tested during the research phase.

Machine learning algorithms were studied and built by the authors of ref. [49] with the objective of decreasing crime rates in India. Machine learning algorithms were used to a large amount of data in order to discover patterns. With this research, we attempted to forecast future crime based on the frequency of recently committed crimes, as seen in Fig. 2. It was determined that the scaled algorithm outperformed the other two techniques in terms of data analysis and interpretation using Bayesian neural networks, Levenberg–Marquardt algorithms and a scaled algorithm.

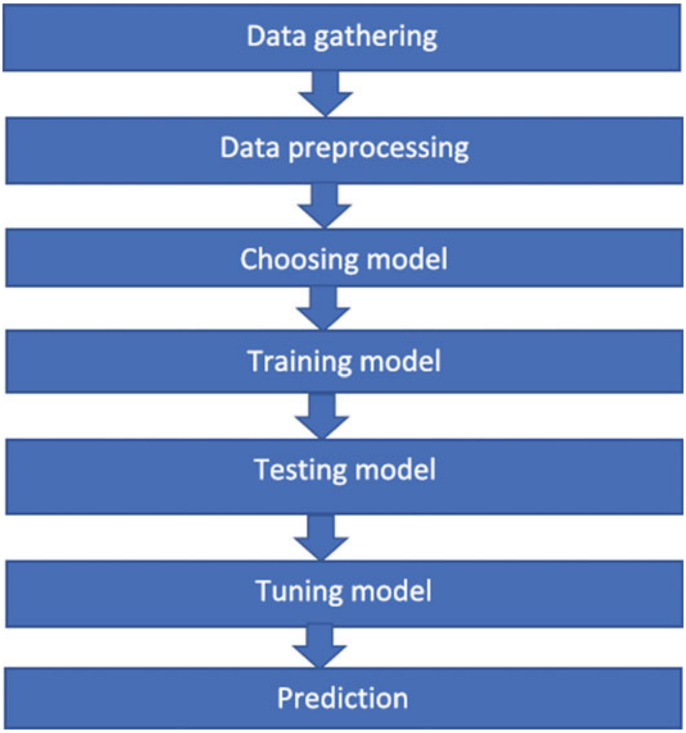

Fig. 1 Data flow representation

According to a statistical examination of correlation, analysis of variance and graphs, the scaled method may cut crime by 78%.

Based on the analysis of previously committed crimes and their trends, a method for crime prediction has been developed in ref. [50]. Decision trees and KNN are two machine learning algorithms at the heart of the proposed system. We used methods like the random forest algorithm and adaptive boosting to increase the accuracy of our prediction model. Crimes were divided into two categories: those that occur often and those that do not. The most common offences were in the frequent class, while the least common offences were in the rare class. In San Francisco, California, during the last 12 years, the proposed system was supplied data on criminal activity. The random forest technique was used with under sampling and oversampling approaches to increase the accuracy to 99.16%.

Fig. 2 Proposed approach of functionality

Reference [51] summarises a large-scale study on the classification and prediction of crime using machine learning and deep learning architectures. Numerous machine learning approaches, such as random forest and Naive Bayes (as well as SVM), have been used to predict crime rates in the past. Deep learning is a machine learning method that overcomes the limitations of other machine learning approaches by extracting features from raw data. In order to better forecast crime, this paper explores three different deep learning configurations: spatial and temporal patterns, spatial and temporal patterns in parallel and spatial and temporal patterns. Ten current state-of-the-art algorithms were tested on five unique crime prediction data sets, which included almost a decade of crime data.

Using huge data sets and machine learning, the source [52] offers a method for analysing behaviour and making criminal predictions. Utilising big data, several ways to data collecting and the final step of crime prediction using machine learning algorithms based on data collection and analysis are all discussed in this article. Machine learning and RapidMiner were used to conduct a crime prediction research based on historical data. Data collection, preparation of data, analysis of data, and visualisation of data were the four main steps of the study. Using the given data sets, a Naïve Bayes method based on ML was shown to be more accurate than a big data framework since it is able to handle massive data sets, has high throughput and fault tolerance and produces consistent results.

Referring to ref. [53], several data mining and machine learning techniques are discussed. This work contributes to the field of criminal data analytics by outlining the various approaches employed. Many machine learning approaches, such as Naive Bayes, clustering and KNN, were used to categorise, understand and analyse information based on specified criteria. A person's criminal history might reveal the kind of crime committed as well as potential hotspots for further criminal conduct. The proposed model was designed to perform a wide range of actions on the data sets provided, including feature selection, clustering, analysis, prediction and assessment. It is clear from this research that machine learning technologies are crucial in the assessment and prediction of criminal behaviour.

For a city in Taiwan, authors of ref. [54] used 84 distinct sorts of geographic locations to create a range of geographical and temporal variables. The objective is to apply machine learning algorithms for each grid to find patterns and anticipate crime for the next month. A DNN was found to be the best machine learning model out of the many that were tested. Innovative machine learning approaches, particularly feature learning, are at the heart of this study's major contribution. Moreover, in terms of crime displacement, the new model design surpassed the old one.

The decision tree (J48) method was explored by the authors of ref. [55] in constructing a crime prediction model. Judgement 48 is commonly considered to be the most effective machine learning algorithm in the field of crime data prediction when used to law enforcement and intelligence analysis. In order to build J48, the WEKA toolbox was used, and a pre-processed crime data set was used to train the model. Predicted an unknown criminal category with 94.25287% accuracy using the J48 algorithm's testing results. Algorithms may be relied on to predict future crime because of their high degree of accuracy.

4 Comparative Study of Different Forecasting Methods

A comparison of several forecasting methods to begin, in references [56, 57], the authors used the KNNs approach to predict crime in 2014 and 2013. An improved crime prediction accuracy may be achieved by combining grey correlation analysis with the KNN classification approach, according to Sun and colleagues [56]. Using the suggested method, we were able to achieve an accuracy of roughly 67%. To put it another way, Shojaya et al. [57] used a simple KNN approach to sort crime data into important and non-critical categories. They were very accurate, with a score of 87%.

According to references [58, 59], crime is predicted for the years 2015 and 2013 using a decision tree technique. ZeroR and a decision tree were used by Obuandike et al. [58], but they were unable to achieve an accuracy of more than 60%. With the use of a decision tree, Iqbal et al. [59] achieved an incredible 84% success rate. However, in both cases, even a little modification in the data may have a big impact on the structure. To round up the discussion, references [60, 61] described a novel technique to criminal detection known as Naive Bayes.

Although Jangra and Kalsi [60] were able to predict crime with an incredible 87% accuracy, they were unable to apply their strategy to data sets with a considerable number of attributes. To put it another way: Wibowo and Oesman [61] had an accuracy of only 66% and overlooked factors such as computational scalability, durability and resilience. As a follow-up to the comparison above, we have included additional models to illustrate the accuracy of certain often used models. Integrating machine learning and deep learning models with computer vision.

Computer vision models combined with machine and deep learning techniques: Three main questions are addressed in ref. [62]. Computer vision algorithms are first questioned as to their effectiveness. Using fewer complex data sets, they found that the prediction accuracy is 90%, but drops to 60% when dealing with more complex data sets. Reduced storage and processing costs are also a priority. They also question its efficiency as a police tool. As a result, they found a vital component, the Public Safety Visual Analytics Workstation (PSVAW), which has several features, including object identification and location, as well as the ability to identify particular events in video feeds and search for them using queries. Every incident will be seen as an example of computer vision training, recognition and labelling. Computer vision is also examined to see whether the criminal justice system is affected by it. To put it gently, their reaction is optimistic, but they want to rely only on computer vision, which we believe is inadequate.

Reference [63] outlines a multi-camera video surveillance infrastructure. Detection, representation and identification are the three main goals of a typical police "stake-out," and the framework is designed to achieve all three with ease. In order to quickly and effectively extract motion trajectories from videos, the detecting section integrates video inputs from many cameras. Hierarchical invariant and content-rich motion event descriptions may be generated from raw trajectory data using this format. For example, robbery, murder and molestation are all examples of crimes that might be classified in this area. Using sequence data learning on suspicious/possible criminal events, they developed a sequence-alignment kernel function.

People may be identified and tracked by their height, skin tone, shirt and pants colour, motion pattern and trajectory history using a novel technology called soft biometry, which integrates a person's height, colour of shirt and pants, as well as their movement and trajectory history. They have even brought up some weird instances of human error where the perpetrators got away with it. Additional tests were also done, and the findings were astounding. Individuals giving piggyback rides are captured in many frames of a single shot movie. Security officers and passengers alike may be discerned by the camera's capacity to distinguish between the two.

A multi-camera surveillance and monitoring system, known as Knight, was used in a real-world scenario by the authors of ref. [11]. Detection, tracking and categorisation skills were the focus of their investigation. Detection, tracking and classification had accuracy scores of 97.4%, 96.7% and 88%. They also spoke on the importance of altering light, hiding, boring moving objects and shadows. Computer vision models are once again shown to be reliable in this research. As a general rule, a camera cannot achieve perfect resolution in any given setting.

Low-quality video from surveillance systems may hamper the collecting of forensic evidence, according to ref. [64]. They assessed the ability of respondents to identify individuals recorded on video surveillance by a commercially available video security system. People who were familiar with the targets performed well in the first trial, whereas those who were unfamiliar with the targets performed poorly. In spite of these results, police officers with forensic identification experience did as poorly as those who were unfamiliar with the goals. To find out how well-known people could perform, they used the same camera equipment to edit videos to hide the subjects' heads, bodies and gaits in the second trial. There was a little decline in recognition performance when the body or gait was concealed. The subject's ability to recognise the targets is considerably hindered by hiding the target heads. Despite the poor video quality, the target's head was clearly seen and recognised.

In ref. [65], an automatic number-plate recognition (ANPR) model is described. A "progress in image processing" was the phrase used by the paper's authors. The ANPR system consists of the following components: The method begins with a photograph of the car, followed by pre-processing, number-plate extraction, character segmentation and character recognition. Pre-processing comprises converting the RGB photos to grey scale, reducing noise, and brightening the border before the actual main image processing begins. Plates of various sizes are then separated using a slicing device. Using character segmentation, the alphabetic and numeric characters are shown independently. Optically recognising a database's characters is character recognition. Despite the importance of real-time crime prediction, it is very difficult to implement in practice. No known physical model can produce a good approximation with reliable findings for such a sophisticated system.

Researchers employed a spatial temporal residual network to represent well-represented data to estimate the distribution of crime on an hourly basis in Los Angeles neighbourhood-sized parcels. Numerous existing prediction methods were compared to the proposed model in these experiments, which confirmed the model's greater accuracy. It was compared to ARIMA, KNN and the historical mean using their method of deep learning. For real-world deployment, they included a resource conservation approach called ternarization.

There was a lot of work done by the authors of ref. [66] on crime prediction, and they established that nonprime data may be useful. The fundamental goal of this research was to apply DNNs to the prediction of crime in a finely divided metropolis. It was based on crime statistics from Chicago and Portland, as well as data on weather, demographics and public transportation systems. In the article, each city was split into grid cells (beats for Chicago and square grid for Portland). For each geographic region, their computer predicts the most likely crime category on a daily basis using the data they collect. They use increasingly complex neural network topologies to train these data sets, including versions that take into consideration the spatial and temporal components of the crime prediction problem. Using their system, they were able to accurately forecast the appropriate bin for the overall number of crimes in Chicago (75.6%) and Portland (65.3%).

Increase the value of non-crime data is crucial; they showed. They noticed that the model's accuracy was dramatically diminished on days when there was a lot of rain or snow. A factor of transportation was then used to display bus and train lines inside beats, and it was determined that the beat hosting an airport is on average 1.2% bigger than its adjacent beats. Beats with railroad tracks crossing through them were 0.5% more accurate than those in the immediate vicinity.

At night, the authors of ref. [67] showed how to educate a system to observe traffic and identify autos. After determining that an object was a car by its headlights and tail lights, they used a segmentation method to analyse the strong light, and then tracked the light's location using a spatial clustering and tracking strategy. A 20-min trial with a detection rate of 98.79% and 96.84% for automobiles and motorcycles, respectively, was also conducted. The detection rates for automobiles and motorbikes were 97.58% and 98.48%, respectively, after a 50-min rerun of the test. The simplicity of machine construction serves a purpose. In addition to daytime monitoring, this method may also be used at night.

Reference [68] discusses a critical approach to human motion analysis. Focusing on marker-free vision-based human motion analysis may provide an obtruding way for measuring body locations, according to the author. As stated by the author, the use of this technology extends beyond surveillance and human–computer interaction to include automatic annotation. Analysing human mobility is the focus of this essay. Modelling and estimation make up the first half of the analytical process. Modelling and estimation are two separate processes that work together to create a probability function for a surface. The modelling step comprises the production of an image descriptor, a human body model and matching function and (physical) restrictions (function result). Separately, we will talk about strategies that don't need models.

Satellites may be used to map crime, according to the authors of ref. [69]. Collecting data manually for mapping is inefficient and costly. Satellite photography, on the other hand, is proving to be a practical choice. In this study, they looked at how deep learning may be used to predict crime rates straight from raw satellite pictures. Satellite pictures from the 15-year collection of the Chicago Police Department's over 1 million crime-incident data were used to train a deep convolutional neural network (CNN). One of the best algorithms used raw satellite photos and was able to accurately estimate crime rates by as much as 79%. To be confident that their results could be used again, they undertook a reusability test in Denver and San Francisco, using the previously tested and taught models from Chicago. When compared to years of data collected by different law enforcement organisations, their maps are 72% and 70% correct. It was shown that: (1) Visual characteristics in satellite imagery may be utilised as a proxy for crime rates; (2) ConvNets can train models for crime rate prediction from satellite imagery, and (3) Deep models can be reused across numerous cities once they are used and learnt in one location.

5 Proposed Idea

Conceived idea after recognising and grasping the several distinct methods in which the police use surveillance for reasons, we rated the worth of each strategy. Even if we use a Sting Ray, it can only help us catch the suspect if the suspect is using an unlocked phone that should be switched on, for example. Therefore, it is only advantageous if the stakeout position is precise. As we can see from this data, ever-evolving technology has once again developed a cunning means of spying for us to take note of. Computer vision techniques, deep learning and machine learning have given us a new perspective on surveillance approaches. This is a smart monitoring technology since it mimics human behaviour 24 h a day, 365 days a year, and it learns to perform new things automatically.

The various uses of machine learning and computer vision have been discussed, but what are these applications in their most basic form? By now, you should have a good idea about what we are trying to do with this article. We are going to use a system that combines the best parts of Sting Ray with body cameras, facial recognition software and stakeouts. All of these new features have been added to the core analytics suite, including neural networks, heuristic processors, Bayesian networks, data acquisition, cryptographic algorithms, document processors, computational linguistics, voiceprint recognition, natural language processing, gait analysis, biometric recognition and pattern mining. The new features are fully computer dependent, necessitating human engagement during production; nevertheless, once generated, they function independently of human intervention, permitting humans to engage in other tasks. Please allow us to fully grasp the significance of each feature.

(1) Fundamental analytics: There are a lot of statistical methodologies that need to be understood in order to accurately predict future occurrences, which in our instance may include anything from a robbery of a local business to human behaviour.

(2) Neural networks: Algorithms in this idea mimic the human brain, mimicking nerve cells and trying to think for itself in order to understand or even predict a crime scene. This is a concept made of numerous algorithms.
(3) Heuristic engines: To increase the system's security, these engines integrate information about antiviruses and hence knowledge about viruses. This helps detect and remove threats using recognised antiviruses.
(4) Cryptographic algorithms: Cryptographic algorithms of two kinds are used. To begin, they safely encrypt the previously revealed criminal data. For the second time, they are used to encrypt freshly discovered evidence that may be illegal.
(5) Recursion processors: These are used to guarantee that our machine's activities continue to run and do not infringe on the machine's surveillance at all times.
(6) For example, Bayesian networks may be used for anomaly detection and diagnostics as well as time series prediction and decision-making under uncertainty. Bayesian networks are probabilistic acyclic graph models.
(7) Data acquisition: Since our system must be able to learn from previous crimes in order to predict future criminal acts, this is the most important stage.
(8) Document processors: A post-collection analysis of the data is carried out using these tools.
(9) Computer linguistics: It is the goal of this approach to teach a computer–human speech recognition and comprehension via the use of algorithms and machine learning models.
(10) One of the ways computers may enhance their comprehension of human language is by using a natural language processor (NLP).
(11) Speech print identification: It is a fascinating programme that tries to distinguish between various people's voices in order to improve recognition and identification. It uses mathematically definable factors like the speaker's mouth and throat shape to pinpoint a specific target.
(12) Gait analysis: Using this method, the walking posture and gait of a person may be observed. In order to acquire a better sense of a person's usual speed and hence detect an abnormal pace, this method will be used.
(13) Biometric identification: This method may be used to locate a person's face or, in certain cases, a thumb print in a database that has been stored electronically.
(14) Pattern mining allows for the detection of patterns in daily activities and is a subset of data mining

    Using this technology, we will be able to tell whether a person is being viewed unusually often behind a drugstore glass, allowing the machine to alert the authorities.
(15) Intelligence interpretation: Almost all of the above-mentioned factors are used in this process, which merges all of the facts together to provide an accurate prediction.
(16) Threat detection: If a certain number of checkboxes are ticked during intelligence processing, a danger is discovered.

(17) Threat classification: Identifying and classifying a danger enable it to be placed in one of many criminal case categories, such as theft, murder or a possible terrorist attack.

Consequently, threats in the near or distant future may be predicted based on the time horizon. A ubiquitous police officer with ears and eyes everywhere is what we want to achieve by merging all of these traits into one piece of software. In order to observe how such software functions in a real-world context, we use CCTV cameras in urban regions. All previously recorded crimes for which video is available (at least 5000 instances for best results) have to be trained and taught to the software, employing supervised learning, unsupervised learning, semi-supervised learning and reinforcement learning to aid it in understanding what a crime is. As a result, it will have a better understanding of criminality and will be able to explain how and why crimes occur. To better anticipate future crimes, we suggest not just constructing a world-class crime prediction model, but also increasing the model's comprehension of previous crimes. Using this technology, we want to prevent crimes from happening in the first place and then thoroughly investigate a crime scene, allowing the system to unearth nuances that even a human eye would miss.

The use of scenario simulations is one of the most exciting and evolutionary concepts that we believe should be included. The software should run at least 50 simulations of the present circumstance in front of it, helped by historical crime data, after analysing the situation and applying the 17 major elements stated above. By simulating a real-world situation, the application may assess the threat level and then propose a course of action or contact law enforcement authorities.

6 Challenges and Future Scope

Despite the fact that this essay was meticulously researched and prepared, there may still be challenges to overcome in the future. There must be an immediate and proper implementation of the whole system, so that it may be created properly and totally soon. Implementation is also a major difficulty since these technologies cannot be immediately used in the real world.

An initial test run in a small portion of the city is necessary before the system can be rolled out throughout the whole metropolis (revisions to the initial model). It is via these obstacles that the model is improved, and a more practical version is created. Because the learning data are so large, it will take days or weeks to analyse; there are a few technological obstacles to solve as well. As real worries, they are also problems that can be handled by a team of professionals, and if they can, the end result will be well worth the work and patience.

The strategies and approaches for forecasting crime and aiding law enforcement were explored in this article. Different technology for crime prediction and prevention may change the landscape of law enforcement organisations. Law enforcement agencies' overall performance may greatly benefit from combining machine learning and computer vision. When security cameras and spotting scopes are used in conjunction with computer vision and machine learning techniques, a machine will soon be able to recognise patterns in past criminal activity, understand what constitutes criminal activity and correctly forecast future criminal activity.

For example, an automated system that can identify crime hotspots in a city may be developed. In order to alert law enforcement and prevent criminal activity, it may be necessary to increase surveillance inside the forecast zone.

In the near future, law enforcement agencies will increasingly depend on automation to overcome the system's inadequacies. A system that can predict and detect patterns of similar crimes is the subject of our future study. A "universal police officer" might be the next big step in revolutionising crime rate prediction, detection and prevention, even if current approaches have an important role to play in that effort already.

7 Conclusions

Predicting crimes before they happen is a simple concept, but making it a reality requires a lot more than that. As a result of this paper, researchers will be able to make crime prediction a reality and employ advanced technology in the actual world. Despite the frequency with which police agencies adopt new technology like as Sting Rays and facial recognition, the adoption of such software has the ability to transform the way police departments work for the better. Machine and deep learning, as well as computer vision, may be used to design a system that is more beneficial for police. For example, we have proposed an integrated system that would monitor crime hotspots and identify persons based on their voice notes. This system is built of many technologies. Following the development of the system, there will be challenges in implementing and using it, as well. All of these difficulties, however, can be dealt with, and a citywide security system that is operational 24 h a day might be beneficial. As a result, tips and leads might be considerably more reliable, and perhaps crime could be removed much more swiftly if such a technology is adopted into a police force in the future.

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Natural Language Processing Implementation for Sentiment Analysis on Tweets

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Abstract In this article, we describe our early efforts with sentiment analysis on tweets. This project is meant to extract sentiment from tweets depending on their topic matter. It utilises natural language processing methods to determine the emotion associated with a certain issue. We used three different approaches to identify emotions in our study: classification based on subjectivity, semantic association and classification based on polarity. The experiment makes advantage of emotion lexicons by establishing the grammatical relationship between them and the subject. Due to the unique structure of tweets, the proposed method outperforms current text sentiment analysis methods.

Keywords NLP · Sentiment analysis · Classification

1 Introduction

Twitter, a prominent microblogging site, enables users to publish tweets, or status updates, of up to 140 characters in length [1, 2]. These tweets often include personal opinions or sentiments about the issue being discussed. Sentiment analysis is a method for determining the user's sentiment and opinion based on their tweets. User

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thoughts and views may be elicited in a more convenient manner than via questionnaires or surveys. The automatic extraction of sentiment from text has been the subject of a great deal of study. Using movie review domains and machine learning techniques (Naive Bayes, maximum entropy classification and support vector machine (SVM)), Pang and Lee [3–5] tested sentiment classification. Using SVM and unigram models, they were able to achieve an accuracy of up to 82.9%. However, as the performance of sentiment classification is context dependent, machine learning approaches have trouble distinguishing the emotion of text when sentiment lexicons with opposing sentiment are present. With minimum edits in graphs before sentiment classification using a machine learning technique, Pang and Lee [6] then offered the strategy of categorising texts only on their subjective content [7]. They began by determining whether or not the text included sentiment before determining whether or not the emotion was positive or negative. The accuracy was 86.4%, which was higher than in the previous trial.

Machine learning and natural language processing (NLP) methods were also featured. The polarity of sentiment lexicons may be classified using NLP to characterise the sentiment expressions connected with a certain subject. It is possible for NLP to categorise the sentiment of a text fragment rather than the whole text based merely on its subject [8]. In natural language processing, a feature extraction approach is applied. As well as collecting and correlating sentiment with certain topics, it can also extract topic-specific qualities, such as emotion, from any vocabulary that includes it. Achieving an accuracy of up to 87% for online reviews and a 9139% for general web page and news item ratings, it beats machine learning methods. In order to produce a better result, this technique focused on the overall text and deleted particular problematic conditions such as confused words or sentences that lack emotion, for instance [9, 10].

For sentiment analysis of text, previous machine learning and natural language processing research may not be relevant to tweets because of their structural peculiarities. Twitter sentiment analysis is unique from previous textual research in three ways: The size of the object. The maximum character count for a tweet is 140. Tweets are often only 14 words in length, and sentences are typically 78 characters long, according to research by Go and colleagues [11]. Sentiment analysis in tweets and text is separate since tweets are shorter in duration while text sentiment analysis focuses on long review articles 2. Easily accessible data. When comparing tweets with regular text, the amount of information is different. Pang and Lee [12–15] employed a 2053-word corpus for training and testing and categorised feelings using machine learning algorithms. But, for their work on Twitter sentiment analysis, Go et al. [16–18] gathered up to 15,000 tweets of sentiment. We can now collect tens of thousands or even millions of tweets for training thanks to the Twitter API. The sentence's will give different verticals to various organisations. Acronyms, abbreviations and long sentences abound in tweets, resulting in a disjointed language. In addition to text, emojis, a URL, a photo, hashtags, punctuation and more may be included in the message. Since these components aren't actual words that can be found in a dictionary or read and comprehended by a computer, they detract from the analysis process's accuracy. Since robots are unable to understand informal languages, some method must be developed [19, 20].

To better understand how people communicate, researchers combined grammatical analysis with word frequency analysis. Grammatical analysis looked at the structure of the text and established a relationship between the emotion lexicons and the subject in order to tie them to the topic [21, 22]. There has been a significant leap forward in sentiment analysis for short colloquial texts because older techniques were unable to identify sentiment accurately. In spite of the fact that it didn't need any supervised teaching, this method boosted previous job accuracy by 40%. The goal of this project is to provide a mechanism for analysing the sentiment of tweets in relation to a certain topic. Many pre-processing methods were used to reduce noise from tweets and show them in a more formal language. It is possible to determine the sentiment of tweets by analysing the content of the tweets and using natural language processing to detect and categorise the sentiment of the tweets. Tweets will be labelled as either positive or negative or as neutral as possible. Here is the remainder of the essay: Sect. 2 provides an overview of the proposed system's architecture and the test data set. When comparing a suggested system's performance to that of current tools, Sect. 3 analyses the experimental data, and Sect. 4 summarises the work's conclusion.

2 Overview of Framework

This section explains the architecture of the proposed system. Tweets were retrieved from a Twitter database for the experiment. Each tweet was meticulously categorised as either positive, negative or neutral based on how it was received. As a way to evaluate the proposed system's accuracy and precision, this set of tweets was employed. Pre-processing of the dataset was necessary before the suggested approach could be used to analyse the tweets. In order to ensure that robots can read and comprehend tweets, pre-processing is required. Sentiment classification may be used to determine the emotional tone of tweets after pre-processing. Subjectivity, semantic association and polarity are the three components of sentiment categorization. After determining whether tweets were subjective or objective, semantic association was utilised to find sentiment lexicons that were connected with the subject matter. Positive, negative or neutral emotion lexical categorization predicted whether tweets were positive, negative or neutral [23–25].

Data gathering more than 1500 tweets were manually tagged on Twitter and then extracted for this study. Tweets with the hashtag "Unifi" allude to a Malaysian telecommunications company. Furthermore, it is used to classify people's emotions about it [26]. There are 345 tweets that are positive, 641 that are negative and 531 that are neutral. The proposed method analyses tweets in order to predict future emotion. Alchemy API1 and Weka2 were used to analyse 1513 tweets for benchmarking purposes. Alchemy API uses natural language processing to analyse sentiment, while Weka uses machine learning techniques to mine data. As far as machine learning methods go, we settled on Naive Bayes, decision tree (J48) and support vector machines. Raw and pre-processed tweets were both imported into Weka, and the results were compared to see how much of a difference pre-processing made. In Weka, features are extracted using an algorithm. Cross-validation was used to train and assess the data by selecting the top 100 terms and doing a tenfold cross-validation. Results from Alchemy API and Weka were combined with the manually labelled tweets in order to calculate accuracy, precision, recall and F-measure B. Assembled proposal as seen in this graphic, the suggested system's steps begin with pre-processing and culminate with sentiment classification [27–30].

Pre-processing is covered in Sect. 1, while the emotion classification approach is explained in detail in this section. Because most tweets are unstructured text, pre-processing is employed to organise and present them. It also helps machines better understand the content of the tweets [31–33]. Replace special symbols, extend abbreviations and acronyms and capitalise topics by removing URL and #hashtags [34].

For the sake of brevity, URLs and image links are not included in the text. There are no hashtags in this text to avoid confusion, as a hashtag may not be directly linked to the subject. By using words instead of specific symbols, the text processing process is made simpler. For example, '>' is replaced with 'greater', and '&' is replaced with 'and'. Word-based sentiment analysis beat emoticon-based sentiment analysis in research on automatic sentiment analysis of Twitter messages.

Because of this, emoticons in tweets are disabled. In order to make unstructured tweets more readable, it is common practise to abbreviate long words like 'good' to 'good.' Abbreviations, acronyms, and contractions have all had their letters and numbers increased in size. The phrase "I'm not going to work 2mr," for example, may be expanded to mean "I'm not going to work the next day." To make it easier for the machine to read and understand your text, you should utilise topic capitalization. Sentiment classification will be used to the processed tweets in order to forecast their sentiment. Sentiment Classification: The sentiment classification process is shown in Figs. 1 and 2.

(a) Subjectivity Classification: It is possible to categorise tweets into subjective or objective categories using subjective categorization. The programme analyses each tweet word by word to determine whether or not it contains any emotive language. The message will be classified as subjective if the phrase used in the tweet evokes either good or negative feeling. Otherwise, it will be objective, which is neutral. Alternatively, it will be subjective. A good example of this would be, "Come acquire an internet package" or "Come get a new internet plan." The first tweet does not include a phrase that indicates an emotional rating. Objectivity and neutrality are assigned to it. The adjective "new" is used in the second tweet to convey positive feelings. Substantive association will be performed on the tweet before classifying it as subjective.

(b) Semantic Association: In semantic association, grammatical linkages between the topic and sentiment lexicons are used to identify sentiment lexicons that are relevant to the subject. There are fewer rules to follow while composing a tweet

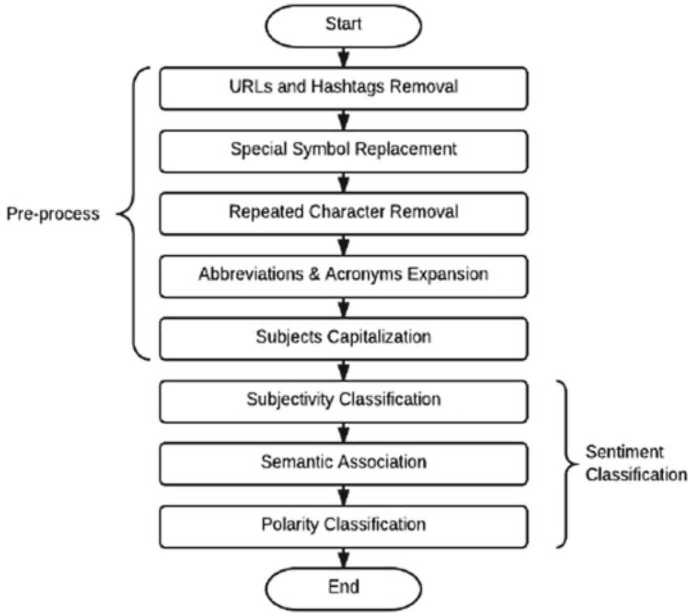

Fig. 1 Sentiment classification flowchart

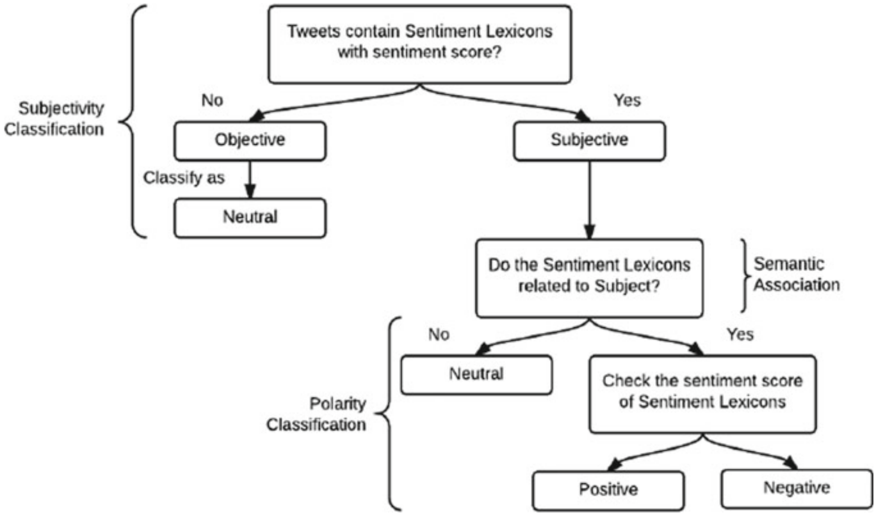

Fig. 2 Processing of sentiment classification

since they are shorter and more to-the-point. Adjectives and verbs are two types of sentiment lexicons that are often used in conjunction with a subject. Tweets [12] may provide first-person perspectives and side-by-by-side comparisons.

Using prepositions and conjunctions, emotion lexicons describe one or more topics in a direct opinion. In contrast, there are at least two subjects in an opinion, but the subjects are linked to the same emotional lexicons without the existence of a conjunction. They are connected. You may see "I love Unifi" as a simple statement at Alg. 1. If 'I' is the nominal subject and 'Unifi' is the direct object of 'love', then the illustration illustrates the relationship between the two. It is a straightforward statement, and this is how the majority of tweets are phrased.

The bulk of grammatical connections show that verbs and adjectives are linked to the subject, as described earlier. 'Unifi' is the direct object of the attribute 'love' in this instance; thus, we must validate it. To summarise, the POS tag shows that "I," "love" and "Unifi" are all nouns. "Love" will be classified as either positive or negative since it is a verb that connects with the subject of the sentence.

It is important to look for grammatical patterns that are related to the subject matter:

Adjective used to describe a subject (good Unifi finally upgrade the service).

Adjective or verb that is attached to a noun or pronoun (happy when Unifi is recovered).

Adverbs that describe the subject matter (Unifi speed is fine).

Between it and the subject, there is an adjective with a preposition (fast like Unifi).

Adjective with a preposition between it and the subject that is superlative in nature (let us face it Unifi is not the best but it is better than M). Verbs, adjectives or nouns used in connection with the subject matter (50% of my draughts are about Unifi to be honest). Adjectives and verbs that describe the subject matter (Unifi forever no lag). To invert an emotion, use a negate word in the adjective or verb (I do not want to uninstall Unifi). However, the sentence structure and grammatical connections of comparison opinion are unique. Algorithm 2 provides a comparative assessment of the concepts in the text. It is better than M.

In this case, the nominal is used instead. Prepositions are used between the subject of 'better' and another word called 'M', and 'Unifi' is the object of comparison. For example, the adjective "Unifi is better" may be seen as a grammatical pattern, as can the preposition "better than" in the superlative adjective "better than M." In this section, we will discuss polarity classifications. Polarity classification is used to classify tweets based on their subjective content. Sentiment lexicons related with certain topics are used to classify tweet sentiment.

To provide an example, when someone says, "I love Unifi," they are using the emotion lexicon. SentiWordNet reports that "love" gets a score of 0.625%. Because of this, we may conclude that "Unifi" is feeling happy and hence label the tweet as such [13].

Comparative opinion relies on the subject's viewpoint. Even though the tweet 'Unifi is better than M' includes two subjects—'Unifi' and 'M', the adjectival term "better" appears. When a comparative adjective precedes a topic, it expresses a different sentiment than the previous subject. Unifi will be scored positive in this circumstance since ‘better’ has a positive score of 0.825%, whereas M will be rated negative.

Algorithm of Dependencies Type and POS Type of Direct Opinion

Sentence *I love Unfi*
Pos Tagging
I/PRP
love/VBP
Unfi/NNP
Parse

```
(ROOT
  (S
    (NP (PRP I))
    (VP (VBP love)
      (NP (NNP Unfi)))))
```

Typed dependencies
nsubj(love-2, I-1)
root(ROOT-0, love-2)
dobj(love-2, Unfi-3)

Algorithm of Dependencies Type and POS Type of Comparison Opinion

Sentence *Unifi is better than M*
Pos Tagging
Unifi/NNP
is/VBZ
better/JJR
than/IN
M/NNP
Parse

```
(ROOT
  (S
    (NP (NNP Unifi))
    (VP (VBZ is)
      (ADJP
        (ADJP (JJR better))
        (PP (IN than)
          (NP (NNP M)))))
```

Typed dependencies, collapsed
nsubj(better-3, Unifi-1)
cop(better-3, is-2)
root(ROOT-0, better-3)
prep_than(better-3, M-5)

3 Result and Discussions

Findings have been summarised in an incoherent matrix of confusion. Both predicted and actual outcomes are recorded. Confusion matrix is of size $\ell \times \ell$, where ℓ is the number of different label values [6]. Positive, negative and neutral labels are employed in this research. We may calculate the accuracy, recall and F-measure scores by comparing the predicted results to the actual ones.

Table 1 summarises the performance of the proposed system and the Alchemy API. With an accuracy of 59.85%, a precision of 53.65% and F-measurement of 0.48, the proposed system outperforms the Alchemy API. Alchemy API has an F-measure of 0.43 and an accuracy, precision and precision of 58.87%. Since tweets have a different structure than ordinary text, Alchemy API may not be able to accurately analyse their sentiment. Algorithm performance is summarised in Table 2. Pre-processed tweets provide 64.95% accuracy, 66.54% precision and 0.57 in the F-measure, whereas raw tweets yield 58.67% accuracy, 60.44% precision and 0.48 in the F-measure. Even when using pre-processed tweets, it was able to outperform Naive Bayes and decision tree classifiers and come out on top in the end. According to Weka's research, NLP-based pre-processing greatly improves performance when compared to those that use raw tweets as a corpus. 'Classifier accuracy, precision, and F-measure' dropped on average by 2.09%, 5.23% and 0.10 in pre-processed tweets when trained and assessed. Alchemy API and SVM are contrasted in Table 3 based on their respective performance. The Alchemy API is beaten in general but not SVM. SVMs perform better when they are trained and tested on tweets that have been pre-processed. Consequently, the proposed system has to be improved to reach a greater degree of performance.

Table 1 Result from proposed system and Alchemy API

	Proposed system	Alchemy API
Accuracy	59.85%	58.87%
Precision	53.65%	40.82%
F-Measure	0.48	0.43

Table 2 Result from Weka using machine learning algorithm

	Naïve Bayes		Decision tree		Support vector machine	
	Raw tweets	Pre-processed tweets	Raw tweets	Pre-processed tweets	Raw tweets	Pre-processed tweets
Accuracy	55.04%	60.58%	49.70%	57.60%	58.67%	64.95%
Precision	47.47%	53.59%	44.05%	53.65%	60.44%	66.54%
F-Measure	0.44	0.55	0.35	0.43	0.48	0.57

Table 3 Summarised result for 3 different sentiment analysis tools

	Proposed system	Alchemy API	SVM (Pre-Processed Tweets)
Accuracy	59.85%	58.87%	64.95%
Precision	53.65%	40.82%	66.54%
F-Measure	0.48	0.43	0.57

4 Conclusion and Future Work

There is a wealth of study on extracting emotion from tweets, owing to Twitter's popularity as a social media site. We provide early findings for our proposed system, which incorporates natural language processing techniques to extract topic from tweets and classifies tweets' polarity using sentiment lexicons linked with subject.

SVM outperforms Alchemy API in the tests, while the proposed system exceeds Alchemy API. Research in this area will focus on ways to make sentiment analysis more accurate. The use of slang and misspelt words makes it difficult to derive emotion lexicons from tweets that haven't been formalised beforehand. Due to the need for additional training data, pre-processing needs turning tweets into formal phrases, which is still inefficient.

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VLSI Implementation of BCH Encoder with Triple DES Encryption for Baseband Transceiver

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Abstract This paper proposes the implementation of BCH Encoder in the ZYNQ-7000 AP SOC to guarantee the sensitive data that is acquired from capsule endoscopy is transmitted without any errors though a wireless medium. The BCH Encoder and Decoder is designed, Synthesized and Simulated using Xilinx Vivado. On successful Simulation, the code is dumped to the ZYNQ-7000 which features a single-core ARM Cortex™-A9 processor mated with 28 nm Artix-7-based programmable logic. ZYNQ-7000 is proposed because it is the most flexible & scalable platform for maximum reuse and best TTM, also Industry-leading design tools, C/C++, and Open CL design abstractions with Largest portfolio of SW & HW design tools, SoMs, design kits, and reference designs. To ensure the safety and security of sensitive encoded data, Encryption is done using the Triple DES algorithm. Triple DES is the sophisticated version of DES. It is a block cipher technique based on Feistel Structure and it uses symmetric-key block cipher which applies the DES algorithm thrice to each data block. TDES comprises a key bundle of three keys. By doing this sensitive data's are secured, and provides no chances for stealing or modifying the data. The abstract should summarize the contents of the paper in short terms, i.e., 150–250 words.

Keywords Wireless communication · Sensitive data transmission · BCH Encoder · Triple DES Encryption Capsule Endoscopy

1 Introduction

When an idea of connecting the whole world with wires/cables to communicate with each other for exchanging information or data seemed to be impossible, group of visionary Engineers thought of using the technology to its fullest, which led to the invention of the "Wired Communication" in the late 1800s.

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When wireless communication was taking over the future of data transmission, a huge impact has been made in various fields, such as healthcare, emergency contacts, entertainment and military operations. Wireless communication involves three major components which is Transmitter, Communication channel and Receiver. When an information or data is initiated to send via wireless communication, it is first source encoded and then encrypted for security purposes and sent the channel encoder, the data from the channel encoder is then sent for modulation and multiplexing. The obtained information is transmitted via wireless channel and then captured by the designated receiver, which does the de-modulation and de-multiplexing and then sent to the channel decoder, the decryption is done and sent to the source decoder and the estimated information is obtained. During this process, the date transferred is sometimes lost partially or completely, therefore errors occur at the receiving end, which results in misinformation. Misleading information can result in the wrong conclusions, therefore the encoding is done using accurate algorithms and made sure the data sent in received without any errors. Another important aspect when it comes to wireless communication is security. Wireless medium is an open source transmission process, therefore the chances of altering or the abduction of the information is highly possible, and therefore, protection of data comes as an important aspect for wireless communication. Encryption is the process of securing the information with mathematical techniques, and a key, which is later used to decrypt the required information, by doing this the information is secured and safe.

Transmitting a data/information without any errors is very important for an efficient communication, A combinational circuit, that is the encoder is used to encode a 2^n inputs to n outputs, that is to a binary form which is further sent for encryption, modulation and multiplexing. A Bose–Chaudhuri–Hocquenghem (BCH) encoding provides a cyclic error correcting mechanism. This marks a unique property compared to any other encoding. Due to its precise error correction even for multiple bits, data that is transmitted are error-free and reliable. In Medical field such as Wireless capsule endoscopy, the data that obtained is very sensitive and accurate. When this BCH encoder is implanted to an ARM—based processor—ZYNQ-7000 AP SOC, the sensitive data that is obtained from the capsule endoscopy is made sure it is error-free and accurate. Encryption is done to secure this sensitive data, data can easily be manipulated or stolen in a wireless communication. Triple DES is the sophisticated version of DES. It is a block cipher technique based on Feistel Structure and it uses symmetric-key block cipher which applies three times the DES algorithm to each data block. TDES comprises a key bundle of three keys. The Cipher text is given as E K3 (D K2 (E K1 (Plaintext))).

2 Literature Survey

The Low-power advanced encryption standard (AES) can be achieved with 7-bit and 8-bit data paths. The newly developed AES is compared with all the existing AES and thus concluded that this newly developed AES consumes less power compared to any other existing AES [1].

Advanced encryption standard (AES) power minimization is done using correct resource sharing, compact and simple memory architecture, optimizing the field arithmetic and reducing unnecessary switching activity and adopting to the 8-bit data path width [2].

A Capsule endoscopy is method of inserting a small wireless camera inside the mouth to study and capture the images of Gastrointestinal (GI) mucosa, initially it is called as M2A that is mouth to anus. The capsule endoscopy is safe and efficient and will have a great impact in medical field in the nearby future [3].

The CCE with the capsule endoscopy was taken through the mouth and the process was simple and the quality of the image was clear to conclude accurate results due to the advancement in the cam and endoscopy technology, therefore it is concluded that Pill-Cam colon endoscopy showed promising results than colonoscopy. The wireless capsule endoscopy can we further developed for its accuracy [4].

Video Capsule Endoscopy (VCE) which is initially used to detect abnormalities in the Obscure Gastrointestinal bleeding. Video Capsule Endoscopy is said to be very effective with promising future use for it. Along with minute modifications it can said that this endoscopy is the most effective non-invasive image analysis that any other non-invasive approach for small intestine study [5].

The endoscopy mechanism transit in seconds of time, the stopping mechanism should be accurate, thus use of force sensors are used to stop the process whenever the endoscopist desired to. Therefore a microcontroller with battery is implanted along with the force sensors as a stopping mechanism to the camera, making it easier and compact to control the mechanism, avoiding any harm, or misleading pathway of flow [6].

When new non-invasive methodology such as wireless capsule endoscopy and virtual colonoscopy are introduced, the accuracy and precision are noted, also small bowel lesion are founded in the patients undergoing wireless capsule endoscopy and colonoscopy. The endoscopy had shown better results for treating the small bowel lesion compared to the colonoscopy. The colonoscopy is uncomfortable and needs intravenous sedation for the process [7].

Technique of using DNA cryptography system based on the bases A-Adenine, C-Cytosine, G-Guanine, and T-Thymine that gives great security. These alphabets are further assigned to binary values (A-00, C-01, G-10, T-11). It minimizes the size of cipher text and gives keys with 256 combinations for maximum security. These keys are generated in pseudo random sequence. The encryption key and the primer sequence key can be used to decode the image. [8]

Implements a haze reduction methodology in FPGA employing Nexys 4 DDR. The dark channel prior (DCP) has proven to be a reliable dehazing method. The suggested approach is used to remove haze from images with reduced complexity, avoiding haze color distortion in both bright and non-bright areas. However, this method might cause erroneous transmission approximation, resulting in color distortion and halo effects in the image and brighter portions [9].

Combining sophisticated machine learning algorithms with countermeasures approach employing chaotic logistic maps to extract secret key information. For experimentation of this work, several evaluation metrics such as Accuracy, F-calls, Precision rates, sensitivity, and correlation co-efficient, entropy were calculated and studied using the integration of FPGA with Cortex-A57 architectures. Furthermore, the parameters of the suggested system that have been analyzed, revealed that it surpasses other contemporary algorithms in terms of detection and effectiveness [10].

3 Methodology

In this wireless communication era, transmitting and receiving a message/information is very common, the process of transmission of data requires certain efficient criteria so that the signal/message sent is accurate and error-free, since it deals with accurate results and values. Same way at the receiving end the signal that is captured should be the same message transmitted and no loss of signal should be found as mentioned in the Fig. 1 block diagram.

To make sure the process is done efficiently, the input signal is encoded, encoding helps in making the signal more accurate data loss or misinterpretation is avoided. The right algorithm is chosen for encoding, BCH encoder and decoder are known for its error correction properties. A Spartan 7 FPGA kit is initially used to dump the BCH codes that is synthesized for encoder and decoder using Xilinx ISE Design Suite, on successful dumping, it is later dumped in the ZYNQ-7000 ARM processor implemented with FPGA. This high performance Processor is used to achieve encoding and decoding in a wireless transmission.

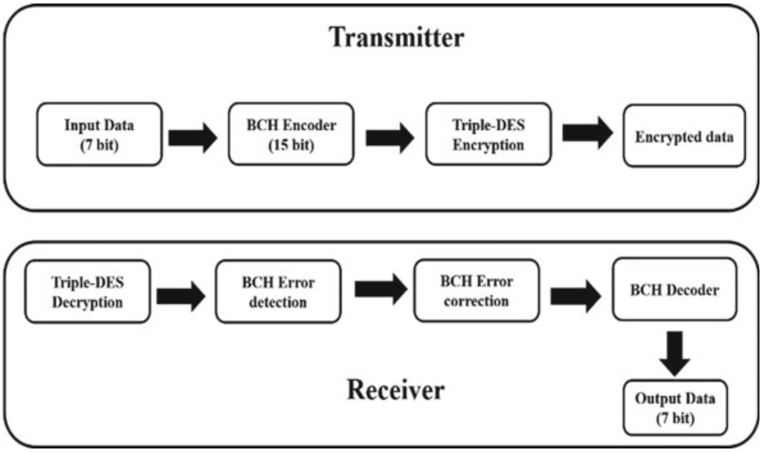

Fig. 1 Block diagram of wireless transceiver

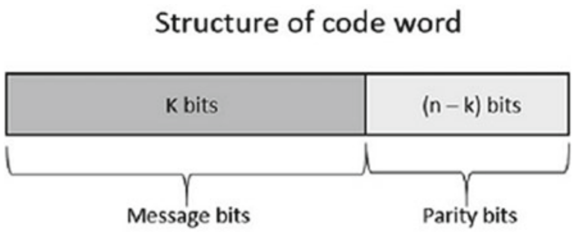

Fig. 2 Structure of codeword of BCH Encoder

Initially a Message which is referenced as source is selected and it is given in a binary form (1 or 0's) in the transmitter side, the input message is considered as a 4-bit data. This message bit data is the source data which is to be encoder using BCH encoding as shown in Fig. 2. The encoder adds parity bits (3 bits) to the existing message bit for error correction and error detection. The encoded message bit now has 7-bits which is sent for encryption, a suitable encryption algorithm is used to encrypt the message bit. A key is noted for decoding it in the decryption process. Encryption secures the sensitive data thereby avoiding misinterpretation of data. This encrypted message is sent to the communication channel. The receiver grabs the message signal and it is decrypted using the key generated in the transmission side or a common pre-defined key is used to decrypt the message signal. The decrypted message bit is sent for error detection, where change or wrong bit is identified by checking the message and parity bits. The detected errors are corrected with error correction methodology. The corrected message signal is decoded by removing the parity bits, thereby obtaining the original message sent from the transmitter, this process is shown as a flowchart below in Fig. 3.

3.1 BCH Codes

The Bose–Chaudhuri–Hocquenghem (BCH) codes uses polynomials over a finite field. A binary multiple error correcting and detecting codes. Forward Error Correction systems uses some redundant data is concatenated with the information data in order to allow for the detection and correction of the corrupted data without having to retransmit it.

$N = 15$ (total Number of codeword), $K = 7$ (Total number of message bit), $T = 2$ (Double error correcting capability),

$$M = 4((2^m) - 1)$$

BCH Encoding:

BCH codewords are encoded as $c(x) = i(x)*g(x)$, data bits do not appear explicitly in the codeword. To overcome this,

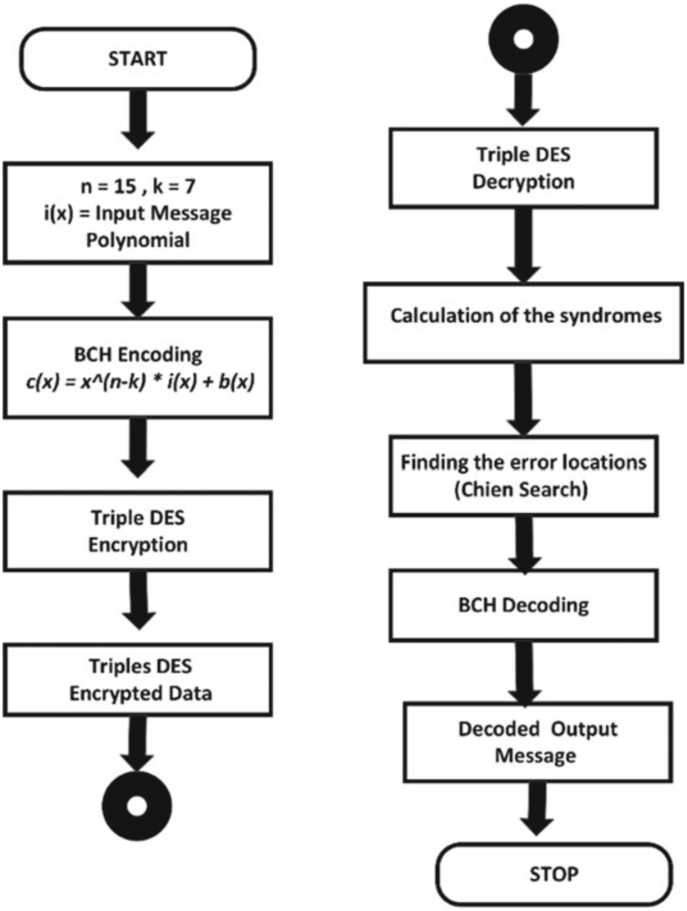

Fig. 3 Flowchart of the message transmission and receiving process with BCH Encoder and Encryption implemented

$$c(x) = xn - k * i(x) + b(x). \tag{1}$$

BCH encoders consist of two entities, an LFSR (entity name—ering) and a control system (ecount). The control system consists of a modulo n counter and an additional flip-flop which is synchronously set when the counter equals 0 and reset when the counter equals k.

For clock cycles $k + 1$ to n, the parity bits in the LFSR are transmitted (switch S2 in position 1) and the feedback in the LFSR is switch off (S1—off). A (15, 7) 2-error correcting BCH code is considered as shown as a signal flow graph in Fig. 4. The generator polynomial $g(x)$ for (15, 7, 2) BCH code is

$$g(x) = 1 + x^4 + x^6 + x^6 + x^7 + x^8. \tag{2}$$

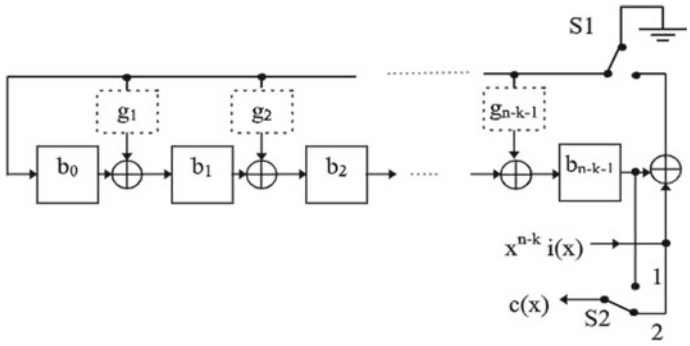

Fig. 4 Signal flow graph for BCH encoder

BCH Decoding

The decoding process can be done in two steps,

1. Syndromes are calculated
2. Error locations are found.

BCH decoding consists of single error correcting (SEC), double error correcting (DEC) and triple & more error correcting (TMEC) BCH codes.

1) **Calculation of the syndromes**

The transmitted polynomial, the received polynomial, and the error polynomial, respectively, so that

$$r(x) = c(x) + e(x) \tag{3}$$

Storing the received polynomial $r(x)$ in a buffer
Register is the initial process needed for decoding.
To generate the syndromes, expression,

$$Sj = (\ldots((rn - 1 * \alpha j + rn - 2) * \alpha j + rn - 3) * \alpha j + \ldots) * \alpha\ j\ +\ r\,0 \tag{4}$$

Calculating the syndrome circuit Sj carries out $(n - 1)$ multiplications by the constant Value (αj) and single bit summations.

2) **Finding the error locations**

A circuit implementing the Chien search operation follows. The registers c 0, c 1, …, $c\ t$ are initialized by the coefficients of the error location polynomial $\sigma 0$, $\sigma 1$, …, σt. Then the sum = summation of t to $j = 0$ of Cj is calculated and if this equals zero, the error has been found and after being delayed in a buffer, XOR gate uses the faulty received bit and is corrected as shown in Fig. 5.

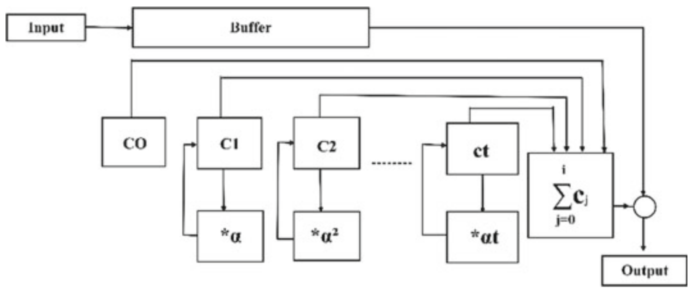

Fig. 5 Error finding technique in BCH Encoder

3.2 *Triple DES Encryption*

Triple DES is the sophisticated version of DES. It is a block cipher technique based on Feistel Structure and it uses symmetric-key block cipher which applies three times the DES algorithm to each data block. TDES comprises a key bundle of three keys as shown in Fig. 6. The methodology for encryption and decryption is as follows-

- First encryption of the plain text is done using single DES with key K1.
- Now the decrypting the output of the step 1 is done using a single DES with key K2.
- At last, encrypting the output of the step 2 is done using a single DES with key 3.
- And therefore the output of the step 3 is a cipher text.
- The decrypting of this cipher text is a reverse process, the first decrypting process is done using K3 and then encryption using K2 and finally decryption is done with K1.

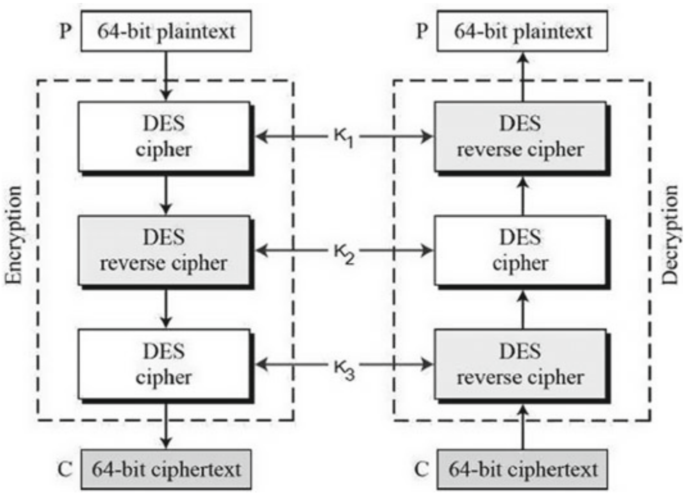

Fig. 6 Triple DES Encryption and Decryption process flowchart

$$\text{Cipher text} = EK3(DK2(EK1(\text{Plain text})))$$

4 Results and Discussion

The input message will be transferred to the FPGA. This FPGA has BCH Encoding incorporated in it that converts the message bit into encoded bit.

This encoded bit is then encrypted with a compiler using TDES algorithm, and thereafter the encrypted message is transmitted. Following which, the decryption of the message takes place in the receiver's end.

The decrypted message is fed into the design implemented FPGA that debugs the errors if found and decodes the bit. Finally the original data is obtained. Overall, our results demonstrate a strong effect of the secure data transmission with BCH encoding and TDES encryption techniques.

4.1 BCH Encoding with Xilinx Vivodo Synthesized Results:

The implementation of ECH encoder using the Xilinx Vivado 2021.2 software in Zynq-7000 board gave better results than the Spartan 7 and Spartan 3.

The above Fig. 7 Shows the Design of the BCH encoder and decoder design consisting of Registers and XOR logic gates in different regions.

The above Fig. 8 Shows the power report of the synthesized Bch encoder and decoder, a total On—Chip Power of 3.4 W is obtained with 94% dynamic power and 6% static power, the lesser static power gives added advantage in power efficiency.

The above mentioned table in Fig. 9 Includes the timing characteristics of the design, with setup and hold endpoints of 95, without including any timing constraints. When time constraints are given, the total negative slack for setup and hold can be estimated.

The simulation of the design, resulted in the above mentioned table Fig. 10, including the values of buffer, decoder with its buffer and encoder with its buffer values, respectively. The slice Look-Up-table implements combinational logic. The bonded input/output specifies the number of pins to be used. And BUFGCTRL is a general clock buffer. BCH Encoding implementation of this mroject module on Zynq-7000 FPGA shows the Encoder, Decoder, and its respective error correcting and detecting buffers, consisting of 35 I/O Ports. err[0] and err[1], clk, reset, and din[0] and din[1] are the input signals, and dout[0] and dout[1], vdin, vdout, wrong, wrongNow are the output signals. The buffers include encoder buffer, decoder buffer, and common buffer. Registers include vdin register reset register, wrong register, and wrongNow register.

The table Fig. 11 shows the logic utilization summary of Slices, FlipFlops, LUTs, IOBs, and GCLSKs. Using Xilinx ISE Design Suite Software. Each shows the

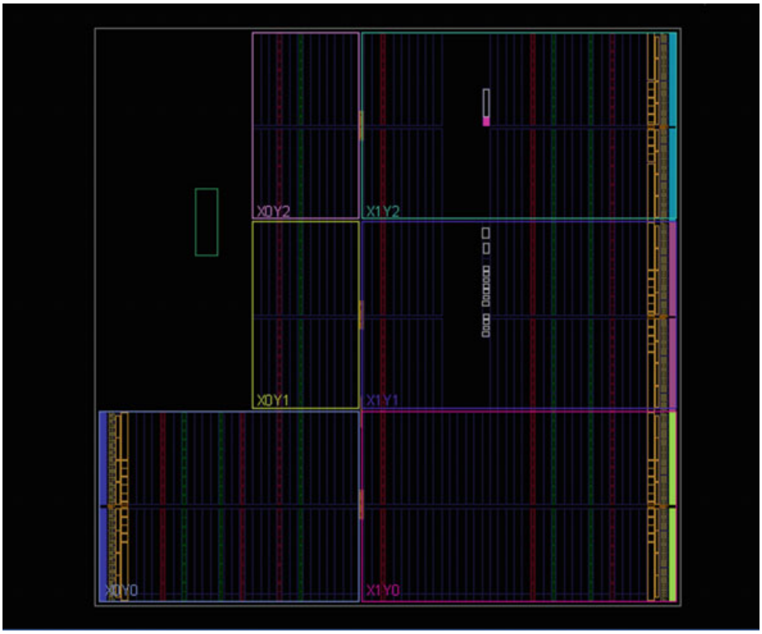

Fig. 7 Implementation Design of BCH Encoder on Zynq-7000 FPGA

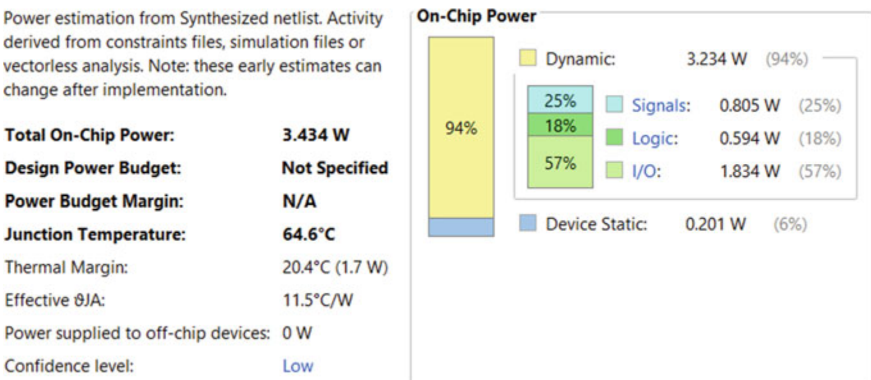

Fig. 8 Power report of BCH Encoder on Zynq-7000

used values and available values along with its utilized percentage. This helps in understanding the Device Utilization.

The table Fig. 12 shows the timing summary of the device synthesized using Xilinx ISE Design Suite software, the minimum period, the minimum input/output arrival before/after clock and the maximum combinational path delay values are specified.

Design Timing Summary

Setup		Hold		Pulse Width	
Worst Negative Slack (WNS):	inf	Worst Hold Slack (WHS):	inf	Worst Pulse Width Slack (WPWS):	NA
Total Negative Slack (TNS):	0.000 ns	Total Hold Slack (THS):	0.000 ns	Total Pulse Width Negative Slack (TPWS):	NA
Number of Failing Endpoints:	0	Number of Failing Endpoints:	0	Number of Failing Endpoints:	NA
Total Number of Endpoints:	95	Total Number of Endpoints:	95	Total Number of Endpoints:	NA

There are no user specified timing constraints.

Fig. 9 Design Timing Summary of BCH Encoder on Zynq-7000 FPGA

Name 1	Slice LUTs (53200)	Slice Registers (106400)	Bonded IOB (200)	BUFGCTRL (32)
N sim	63	72	35	1
comB (comBuf)	1	1	0	0
d1 (dec)	32	27	0	0
decB (decBuf)	0	7	0	0
e1 (enc)	24	11	0	0
encB (encBuf)	6	7	0	0
errB (errBuf)	0	15	0	0

Fig. 10 Device Utilization summary of BCH Encoder on Zynq-7000 FPGA

Device Utilization Summary (Estimated values)			
Logic Utilization	**Used**	**Available**	**Utilization**
Number of Slices	59	2448	2%
Number of Slices Flip Flops	73	4896	1%
Number of 4 Input LUTs	94	4896	1%
Number of Bonded IOBs	35	158	22%
Number of GCLSKs	1	24	4%

Fig. 11 Device utilization summary of BCH encoding on Spartan-3 FPGA

Timing Summary	
Speed Grade : -4	
Minimum Period	8.143ns (Maximum Frequency :122.805 MHz)
Minimum Input Arrival Time Before Clock	5.412ns
Maximum Output Required Time After Clock	6.206ns
Maximum Combinational Path Delay	6.932ns

Fig. 12 Timing summary of BCH encoder on Spartan-3 FPGA

The above table Fig. 13 Shows the power properties such as on-chip power, junction temperature, thermal margin, and device static. These are the synthesized values obtained by using Spartan-7 kit and Zynq-7000 kit respectively with Xilinx Vivado Software. An Input (number/message) from the user is obtained and it is then

	SPARTAN - 7	ZYNQ - 7000
Total On-Chip Power	3.002W	3.434W
Junction Temperature	32.3°C	64.6°C
Thermal Margin	52.7°C(21.5W)	20.4°C(1.7W)
Effective θJA	2.4°C/W	11.5°C/W
On-Chip Power		
Dynamic	2.899W(97%)	3.234W(94%)
Signals	0.517W(18%)	0.805W(25%)
Logic	0.617W(21%)	0.594W(18%)
I/O	1.765W(61%)	1.834W(57%)
Device Static	0.102W(3%)	0.201W(6%)

Fig. 13 Comparison of Power report analysis of BCH Encoder on Spartan-7 FPGA and Zynq-7000 FPGA

encrypted using single DES with key K1, thereby creating a cipher text, the cipher text can only be decrypted using the key. After successful decryption the plain text, i.e., the original message is obtained.

5 Conclusion

Data transmission through wireless communication increases its efficiency constantly, with greater development, more errors and insecurities occur, which leads to misleading data and inaccurate results, in various fields and application. In medical and military operations, such minute inaccuracies and insecurities can lead to dangerous results. This paper aims to provide better transmission with less power consumption by encoding the message bit (4-bits) with parity bits (3-bits) to obtain an encoded message bit (7-bits) and then encrypting the message in the transmitter side and to capture the transmitted signal without any errors, thereby if any error detected, the error is corrected in the receiver side. The aim of this paper is to provide an error-free wireless transmission using BCH error detection and correction and encrypting the obtained data, thereby securing its confidentiality. Improving the error correction and securing the message in a wireless communication results is better accuracy and security in sensitive data transmission.

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Design and Implementation of Image De-hazing Using Histogram Equalization

E. G. Radha, D. Suresha, and E. Ramesh

Abstract In the actual world, images are extremely significant and these are used for describe environment changes. The existence of smog, fog, mist, and haze in the climate corrupt the quality of image acquired by photographic device. Based on the investigation that a hazy picture displays low disparity, we recover the hazy picture by improving its clarity. However, the over damages of the depraved contrast can trim pixel elements values and cause data loss in picture. In this paper using color, attenuation method with histogram equalization, and it is helpful to clear the hazy images. In this paper, we remove haze from a foggy image, improve image quality, and finally, restore and enhance a haze-free image with clear clarity. The proposed technique has been developed and tested in MATLAB2012b, and experimental results show that proposed method completely discards the haze.

Keywords Haze · Atmospheric model · Color attenuation

1 Introduction

1.1 Atmospheric Model

Narasimhan [1] and Naya [2] derived atmospheric model and the equation can define as follows:

$$\text{Haze} = \text{Direct} - \text{attenuation} + \text{air} - \text{light} \tag{1}$$

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$$G(p) = R(p)h(p) + B(1 - h(p)) \tag{2}$$

where

$p =$ position of the element within image.
$G =$ input unclear image.
$R =$ output de-haze image.
$B =$ climatic light.
$h =$ transmission medium.

Transmission $h(p)$ is outlined as

$$h(p) = e - \alpha m(p) \tag{3}$$

where

$\alpha =$ scattering of the climatic light.
$m =$ distance map.

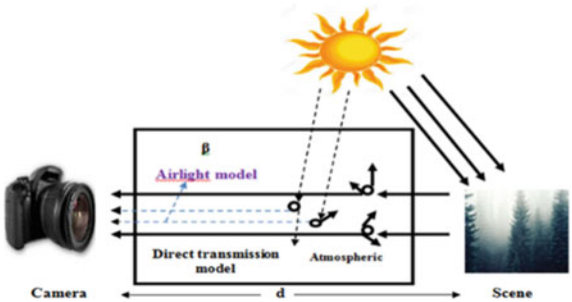
The scattering factor α is constant in uniform climatic condition. The transmission medium h is calculating using Eq. (2) if the distance of the object is given.

1.2 Haze Formation

Haze is created by the presence of suspended very little particles within the climate, known as aerosols that area ready to absorb and scatter the sunshine beams. Aerosols will vary from tiny water droplets to mud or pollution, looking on their size. Figure 1 shows the formation of the haze.

Direct-attenuation induced through the minimization of reversed intensity points up in the little energy of the illumination. The indication $R(p)h(p)$ represents the direct-attenuation in Eq. (2). The energy of the pixels inside the picture can decrease

Fig. 1 Haze formation



in an exceedingly increasing manner. Therefore, it seems that the illumination turns to decline underneath the impact of the direct-attenuation.

1.3 Problem Description

Poor visibility reduces the realization of the computer-vision methods like surveillance, detection of objects, segmentation and also tracking together with image quality. Poor visibility is the result light is absorbed on the photographic device and between the items. They endlessly float within the air and these droplets are extremely very tiny in size and result in the filth of the image once clicked within the terrible atmospheric condition like haze, etc. To beat the degradation within the picture, visibility recovery methods are placed on the image, therefore, to get away the better quality of the picture. The degeneration could also be on account of various factors sort of a relative camera blur as a result of miss focus of the camera, object movement, comparative region turbulence, and others. During this project, we have proposed a new fast de-hazing methodology for real-time image process.

1.4 Proposed Solution

To overcome some challenges, we introduce a color attenuation prior technique. With the help of supervised-learning, easily restore the distance data. Finally, de-haze image is displayed and retrieve improved quality of image using the proposed method.

2 Literature Review

This section covers the literature from the study of various research papers. Many image de-hazing models have been proposed over the past two decades. In order to enhance visibility in hazy image/videos, to upgrade quality of hazy picture, some de-hazing techniques have been introduced.

Fattal proposes a technique to get rid of haze from the color pictures that is ICA method is long and cannot be used for gray-scale pictures [3]. The most disadvantages are its some difficulties to affect dense hazy pictures.

The colours and contrast of the scene of the object under bad climate conditions. Based on the particular models present three methods to de-weather a single picture [4]. The user provides easy inputs in all the cases through a visible interface to physics-based method for recover color and contrasts of the object. The types of input might vary from object to object but are easy to provide for an individual's user. We additionally use similar interactive ways to feature physically based climate effects to pictures.

Clahe methodology is does not want predefined outside data for the process of input hazy picture. The picture initially is taken from the camera in hazy climate and so it's changed against RGB to HSI color space [5].

Wang proposed that de-hazed method in bad climate circumstance induced through suspended-particles like smog, dimness. De-hazing from the picture of climate degenerated object remains a difficult function because depend upon the unknown distance info. This method relies on the assumption of climatic model [6]. During this technique on preferred locality, a DCP method is tested to lust the very distinctive calculation of climatic bright. The planned scheme relies upon a few remarks on haze-free outdoors picture.

Ancuti et al. proposed that the dimness is the physical aspect so that reduces the accuracy of the outside picture taken beneath hazy and foggy climate conditions. This method illustrates the de-hazing path for single picture [7].

Dark-channel method is employed to erase dimness from a 'single' image. Later calculating a climatic light within the haze-free picture to get the lot of real outcome. The present system is mostly used for non-sky patches in single color medium have very small intensity in some pixel [8]. The small energy within the dark channel is predominant attributable to three components: shadows, colorful things, and dark things. Finally calculated density of dimness and restore the better-quality de-haze picture.

Wiener filtering [9] de-hazing is predicted on dark-channel technique and is benefit to resolve the issues like color alteration and halo impact in final picture of the dark-channel strategy. The median filtering is employed so the edges may be sustain and is associated along wiener-filtering by the picture recovery drawback is converted into improvement drawback.

This strategy makes a degree inspection of the de-hazing issue on video and image. The target is to attain better de-hazed pictures and videos at the accepter whereas preserving little bitrates within the transmission [10]. Initially, this method proposes a unique methodology for an image de-hazing that is employed for the investigation. It produces at a faster quickness than present methods and may bypass halo outcomes by victimization the median application.

3 Methodology

In this paper, we have proposed method for removing of haze from image captured during different environmental conditions like fog, haze, etc. The proposed method will enhance the quality of pictures and produced de-haze image results.

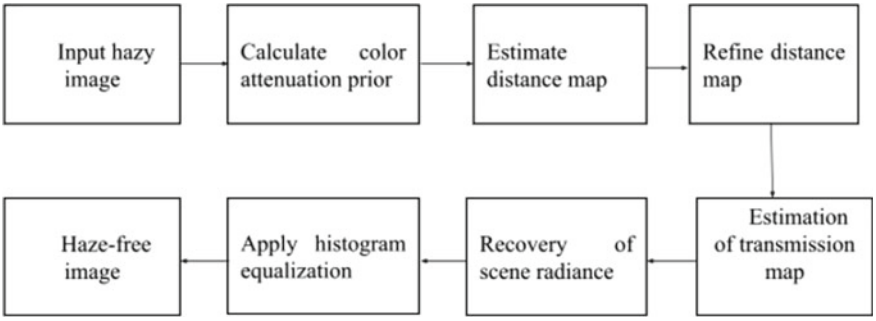


Fig. 2 Block diagram showing system architecture of the paper

3.1 System Architecture

On this paper, a brand-new technique known as color attenuation prior for image de-hazing is suggested. Here, Fig. 2 describes the system architecture of this paper. This easy and powerful technique facilitates to make a linear model for the object distance map of the input picture. The white or gray light which is fashioned through the scattering of the illumination supply has a tendency to reduce the saturation with the aid of improving brightness.

Hazy areas within the image are characterized through low saturation and high brightness because while the brightness receives accelerated, the saturation is decreased. The concentration of haze is directly proportional to the intensity of the image. So, by the usage of this, the depth may be predicted.

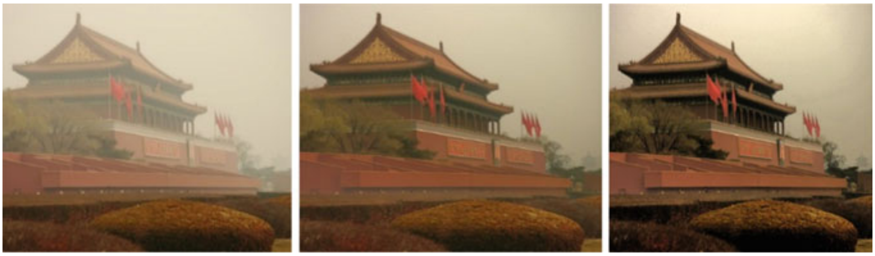
4 Experimental Results

This chapter contains the experimental result of the proposed method and performance evaluation.

4.1 Example Results

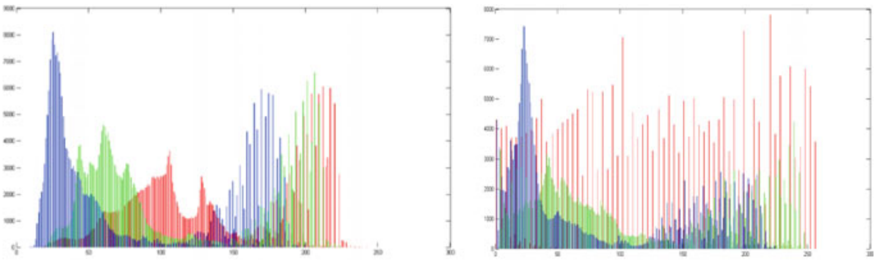
In this work, we have obtained restored enhance the haze-free image with clear visibility using image processing approach in MATLAB 2012a (Fig. 3).

Bellow graph shows the how contrast various from [a] existing method to [b] proposed method



[a] [b] [c]

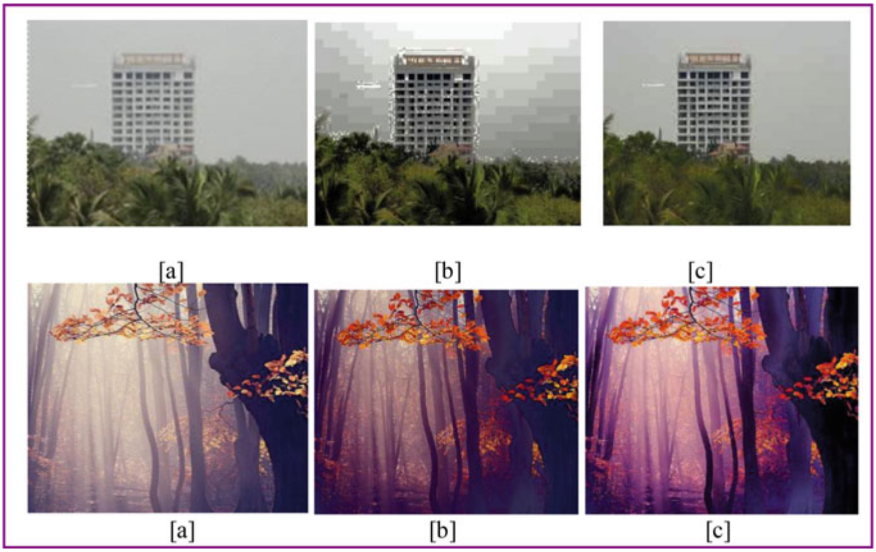
Fig. 3 **a** Input hazy image, **b** Existing de-hazing method, **c** Proposed de-hazing method



[a] [b]

4.2 Quality Comparison on Real-world Images

The de-hazing methods to obtain better good outcome by de-hazing the overall outside pictures and very tough to judge them visibly. So as to match them, we feature out the methods on some difficult pictures with large gray or white regions.



4.3 Performance Evaluation

The proposed method is approved on distinct variety of pictures. This method is tested accepting performance-indices structural similarity, mean square error and 'peak signal-to-noise ratio'.

Mean square error (MSE)

Mean square error is the performance 'measure' between the input picture and squared error picture. Squaring the distinction removes the chance of addressing negative numbers MSE should be lesser for the planned technique for accessing good results than the existing method. Table 1 shows MSE calculation as the results for proposed method are less MSE in testing every image. It indicates the high performance of the proposed technique.

Table 1 MSE calculation

Image	Existing method	Proposed method
1	199.38	185.00
2	214.22	193
3	211.52	192.06

Table 2 PSNR calculation

Image	Existing method	Proposed method
1	25.18	25.50
2	26.16	26.56
3	25.19	26

Table 3 Structural similarity evaluation

Image	Existing method	Proposed method
1	0.7287	0.899
2	0.7564	0.8176
3	0.6752	0.8863

Peak signal-to-noise ratio (PSNR)

PSNR is described for the significant relation between an input picture and proposed picture that changes the constancy of its illustration. As a result of several momentous associated awfully large energetic vary.

PSNR of the proposed method is high as compare with an existing method. Table 2 shows the results for proposed method are high in testing every image. So, the proposed method is providing good outcome than the existing technique.

Structural similarity (SSIM)

SSIM is used for the measurement of image quality between original image and proposed image. The structural similarity index is that the activity or prediction of image quality relies on associate initial uncompressed or distortion-free image a reference.

The structural similarity method is imported to judge the power to preserve the similar data of the method. The high structural similarity describes more 'similarity' between the proposed picture and reference picture and less structural similarity between the proposed picture and reference picture is not acceptable.

Table 3 shows structural similarity evaluation.

The comparison of structural similarity values of existing method and proposed method. SSIM value of the proposed method in every test case is higher than existing method. SSIM is meant to boost on performance ways such as PSNR, MSE that has verified to be not consistent with human perception.

5 Conclusion

In this paper, the proposed color attenuation prior with histogram equalization dehazing method is designed to remove the fog and haze effect from the input image in bad climate. The presented work has shown fine improvement in terms of mean-square-error, peak signal-to-noise ratio, and structural similarity.

The proposed de-hazing method produces better de-hazing result and calculates the performance. After performance analysis, we get high structural similarity, peak signal-to-noise ratio, and less mean-square-error in the proposed de-hazing method. The enhancement in structural similarity shows the raise in information content in the de-haze picture over the hazy picture.

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Improved Hybrid Unified Power Flow Controller Using Fractional Order PID Controlled Systems

Akhib Khan Bahamani, G. Srinivasulu Reddy, I. Kumaraswamy, and K. Vimala Kumar

Abstract In two bus systems, the UPFC is a common device for improving voltage of weak buses. UPFC has advantages in terms of power system static and dynamic operation. The goal of this research is to model and simulate a closed loop controlled three-phase voltage source inverter-based UPFC in a three-phase system. The performance of closed loop PI and FOPID-controlled UPFC systems is explored and compared. The analysis compares time domain response metrics such as steady-state error settling time and THD. The FOPID-controlled UPFC is shown to be quicker than the PI-controlled system.

Keywords UPFC-unified power flow controller · PI-proportional integral · FOPID-fractional order proportional integral derivation

1 Introduction

Power quality issues have become a major concern in recent years, prompting numerous academics to seek out the best solutions. Today, power system quality is a major concern for industrial, commercial, and residential applications. The under voltage condition over current produced by a short circuit or fault someplace in the system is the most common voltage issue [1]. Flexible AC transmission systems (FACTSs) [2] are a new way of employing power electronics to manage the power flow along a transmission corridor in a preset way. The size of the voltages at both

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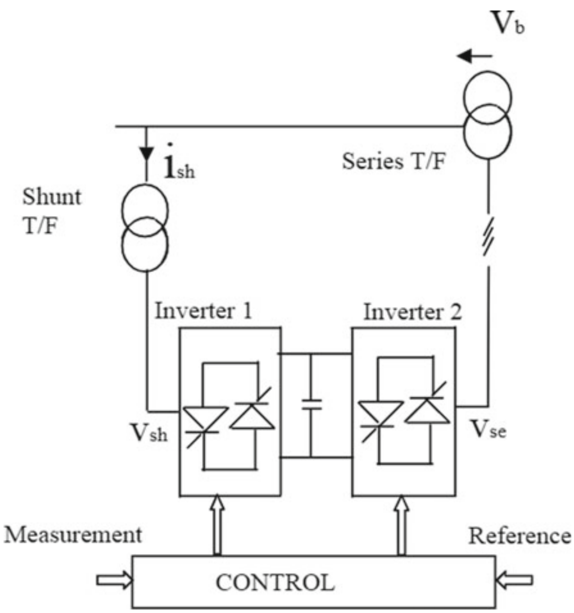
the sending and receiving ends, the transmission line's impedance, and the phase angle between the two voltages all influence the power flow through a transmission corridor. Thyristor series compensation systems (TSCSs) manage the impedance of a transmission line, for example, and FACTS devices are designed to control one or more of these variables. The concept of the unified power flow controller [3–5] was proposed to offer simultaneous control of the three main parameters described above.

2 Operation of UPFC

Two voltage source inverters (VSIs) share a shared dc storage capacitor in the UPFC and are coupled to the power system through coupling transformers. A shunt transformer connects one VSI in shunt to the transmission system, while a series transformer connects the other in series. By injecting a symmetrical three-phase voltage system (Vc) with changeable magnitude and phase angle in series with the transmission line, the series inverter manages active and reactive power flows. As a result, the inverter on the line will alternate between active and reactive power [6–9]. The series inverter provides the reactive power electronically, while the active power is sent to the dc terminals. The shunt inverter is configured to draw dc terminal power from the line while maintaining a constant Vdc across the storage capacitor. As a result, the net actual power pulled from the grid by the UPFC is only equivalent to the losses incurred by the inverter and transformer (Fig. 1).

Fig. 1 Basic structure of UPFC



3 Proposed UPFC

Figure 2 shows a simulation block diagram of a UPFC closed loop PI/FOPID controller. The load bus voltage is measured and compared to the reference voltage. PI/FOPID is subjected to the voltage error. The pulse-width applied to the UPFC is adjusted by the controller's output.

PV system modeling: The solar system equation is as follows

$$I = I_{pv} - I_D \tag{1}$$

where

I Output current
I_{pv} Current supplied by PV
I_D Diode current

$$I_{pv} = I_o\left(e^{kV\tau} - 1\right) \tag{2}$$

where

I_o Leakage current
$V\tau$ Threshold voltage
K Constant

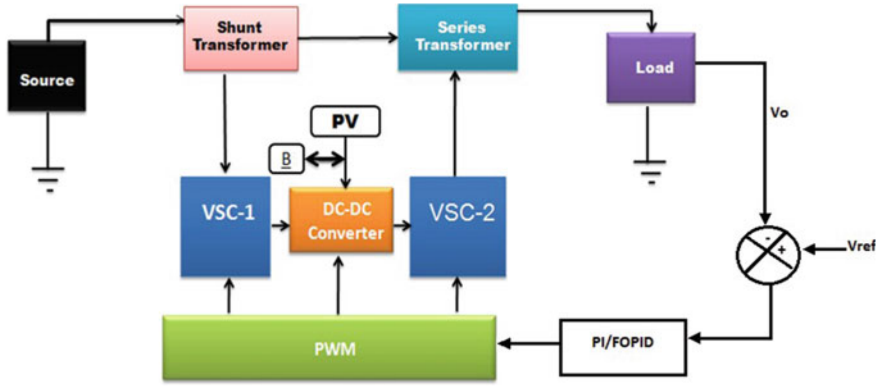


Fig. 2 Simulation block design of UPFC closed loop PI/FOPID controller

4 Controller Technology

4.1 Designing the PI Controller

Combining the proportional and integral control modes yields this composite control mode. The integral part of such a composite control allows a reset of the zero error output following a load change, which is an essential advantage of this control. One to one correspondence of proportional mode is accessible with the offset minimized due to integral mode [10].

The Zigler Nocols approach was used to create the PI controller. The following formulas are used to create the K_p and K_i.

$$K_p = \frac{L}{T} \tag{3}$$

$$K_i = 1.6L \tag{4}$$

where L is dead time and T is time constant

The values works out to be $K_p = 0.016$ and $K_i = 1$.

4.2 Designing the FOPID Controller

The FOPID representation was created via fractional differentiation. FOPID responds more quickly than a PI-controlled system. The FOPID control architecture is depicted in Fig. 3 as a block diagram. The transfer function of a FOPID controller looks like this

$$C_{\text{FOPID}}(s) = K_P + K_I 1/S^{\lambda} + K_D S^{\mu} \tag{5}$$

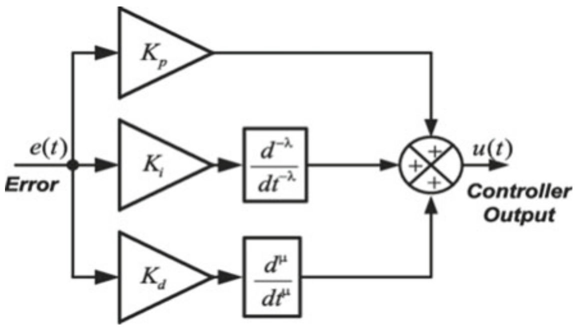


Fig. 3 Architecture of FOPID controller

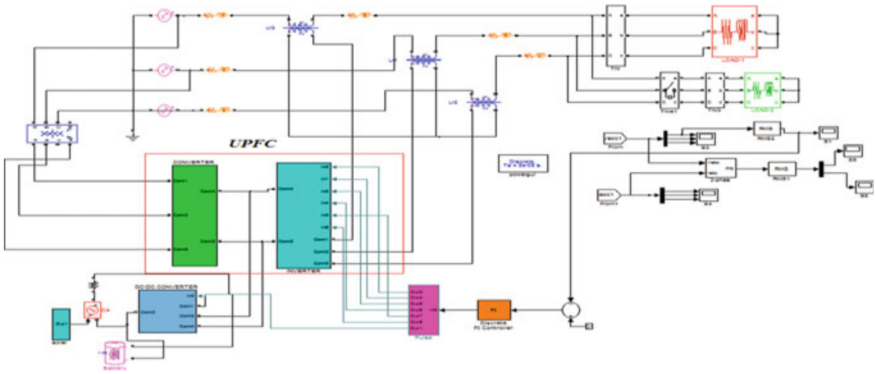


Fig. 4 One line diagram of closed loop UPFC with PV and battery using PI controller

where λ is the "order of an integral part", μ is the "order of the derivative part", while "K_P, K_I, and K_D" is the same controller as the conventional PID controller.

5 Simulation Results

5.1 *One Line Diagram of Closed Loop UPFC with PV and Battery Using PI Controller*

Figure 4 depicts a closed loop UPFC with PV and batteries that use a PI controller. Figure 5 shows the voltage across the RL load, which is 620 V. Figure 6 depicts the current flow through the RL load, which is 7A. Figure 7 illustrates the RMS voltage across the RL load, which is 410 V. Figure 8 depicts the real power, which is 0.5720 MW. Figure 9 depicts the reactive power, which is equal to 0.2750MVAR. Figure 10 depicts the current THD with the PI controller, which is 4.38%.

5.2 *One Line Diagram of Closed Loop UPFC with PV and Battery Using FOPID Controller*

Simulink model of line diagram of with PV, battery, and UPFC FOPID closed loop controller system is shown in Fig. 11. The voltage across RL load is shown in Fig. 12 and its value is 620 V. The current through RL load is shown in Fig. 13 and its value is 6A. The RMS voltage across RL load is shown in Fig. 14 and its value is 410 V. The real power is depicts in Fig. 15 and its value is 0.5780 MW. The reactive power is shown in Fig. 16 and its value is 0.2820MVAR. The current THD with FOPID controller is shown in Fig. 17 and its value is 3.56%. Bar chart comparison with PI

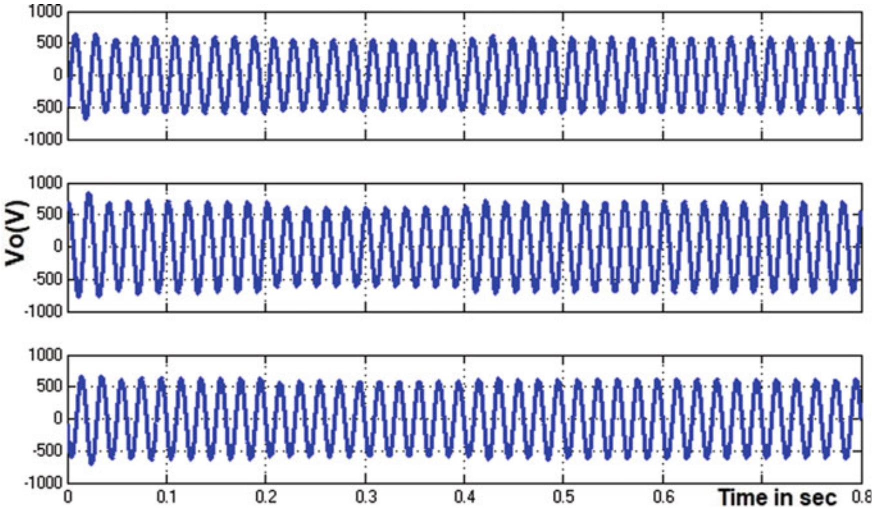


Fig. 5 Voltage across RL load UPFC based with PV and battery

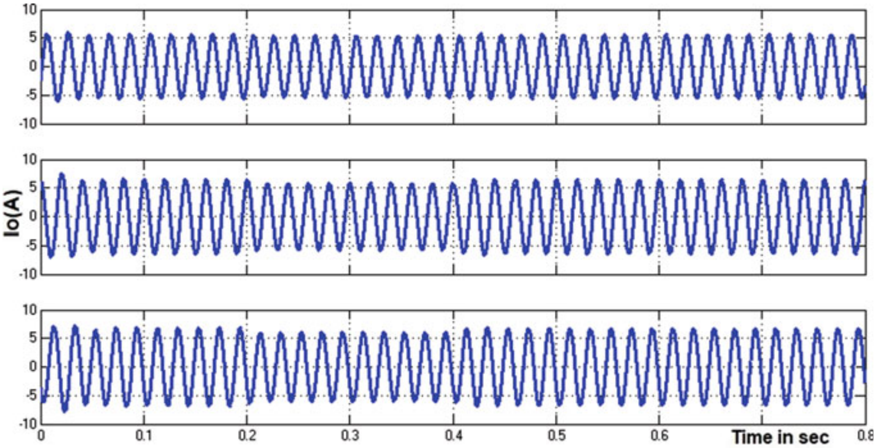


Fig. 6 Current through RL load UPFC based with PV and battery using PI controller

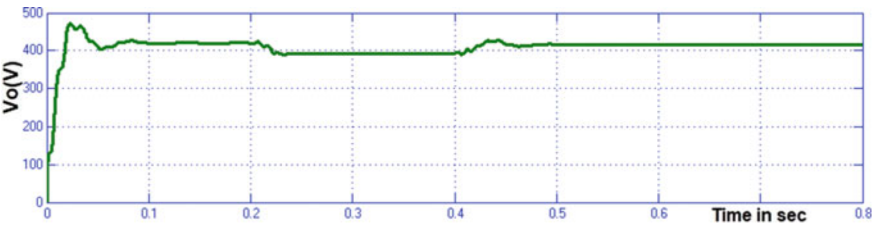


Fig. 7 Voltage across RL load UPFC based with PV and battery using PI controller

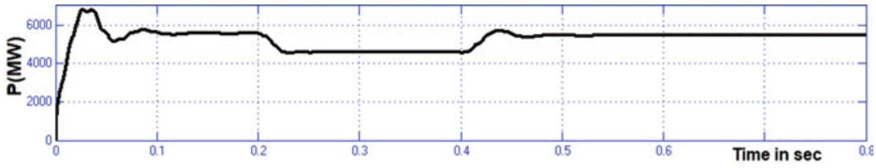


Fig. 8 Real power across RL load UPFC based with PV and battery using PI controller

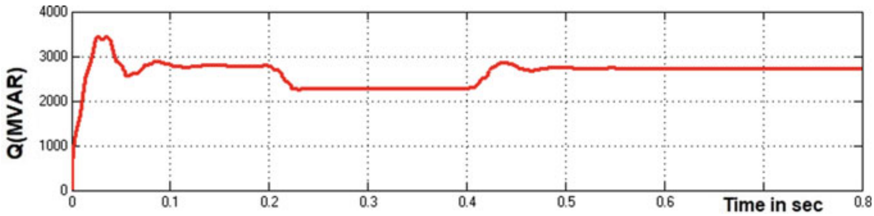


Fig. 9 Reactive power across RL load UPFC based with PV and battery using PI controller

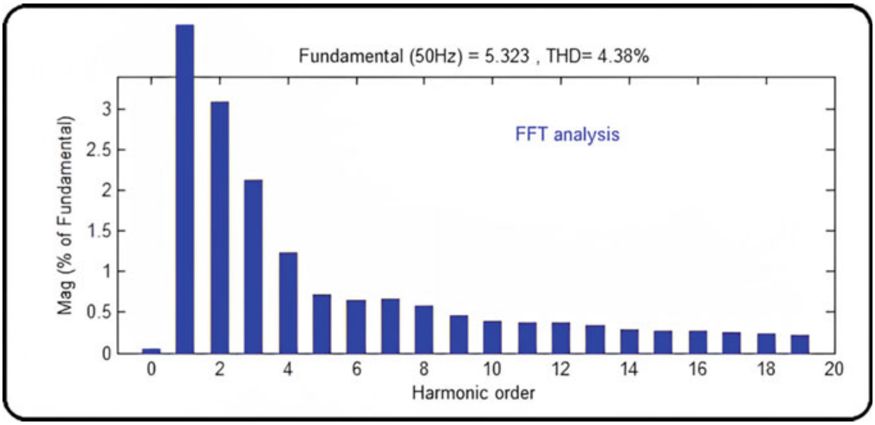


Fig. 10 Current THD using PI controller

and FOPID is shown in Fig. 18. Table 1 depicts the PI and FOPID comparison with time domain parameters.

6 Conclusion

Simulink model of closed loop PI controller system with PV, battery, and UPFC is simulated. Simulink model of closed loop FOPID controller system with PV, battery, and UPFC is simulated. Time domain parameters are compared for PI and FOPID

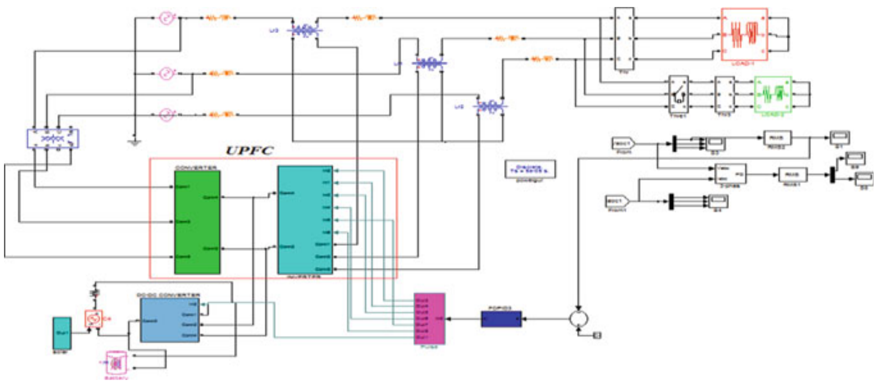


Fig. 11 One line diagram of closed loop UPFC with PV and battery using FOPID controller

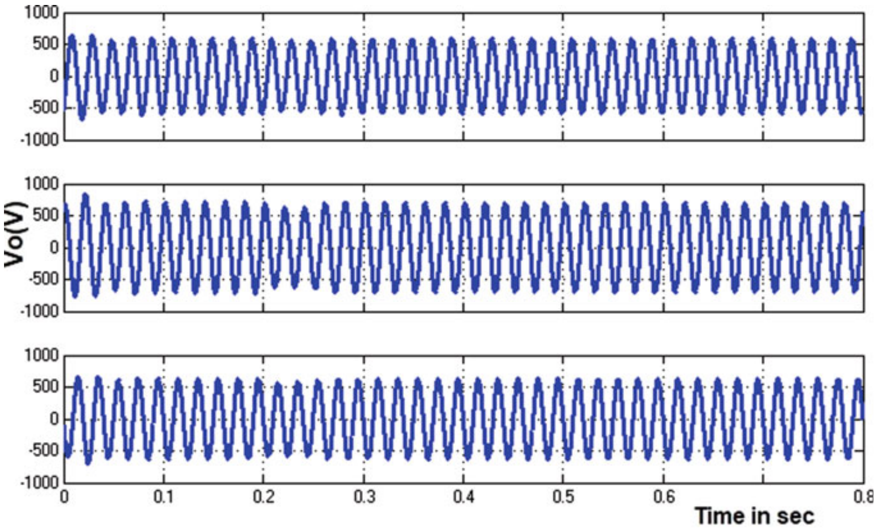


Fig. 12 Voltage across RL load UPFC based with PV and battery using FOPID controller

controllers. The FOPID controller reduces the rise time from 0.23 to 0.21 s. The FOPID controller reduces the peak time from 0.43 to 0.28 s. The FOPID controller reduces the settling time from 0.48 to 0.33 s. The FOPID controller reduces the steady-state error from 1.45 V to 1.16 V. THD is decreased from 4.38 to 3.56%. As a result, the closed loop FOPID controller outperforms the line model of PV and the battery with UPFC.

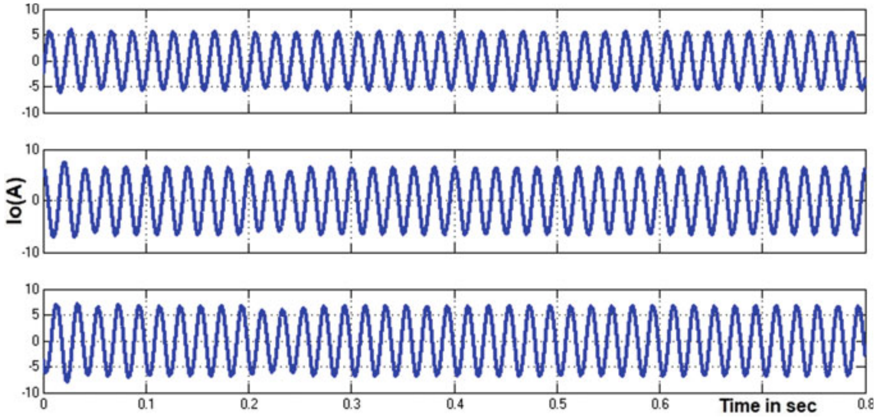


Fig. 13 Current through RL load UPFC based with PV and battery using FOPID controller

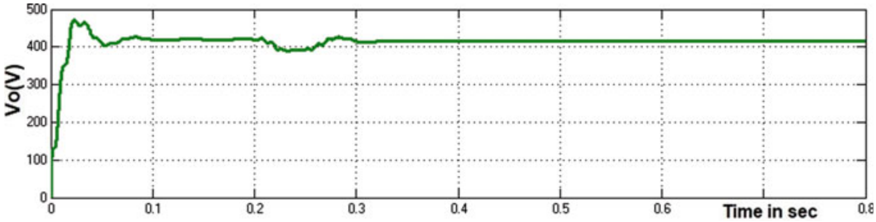


Fig. 14 RMS voltage across RL load UPFC based with PV and battery using FOPID controller

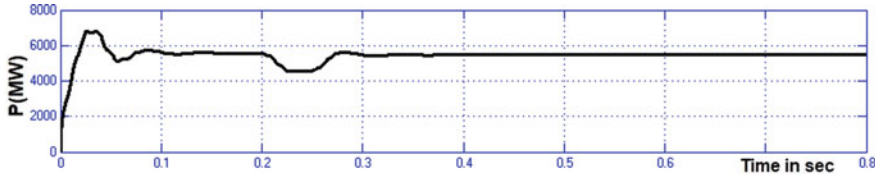


Fig. 15 Real power across RL load UPFC based with PV and battery using FOPID controller

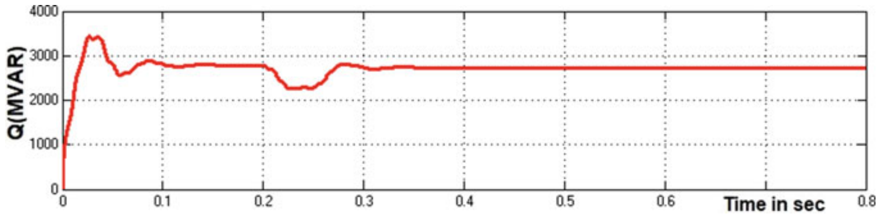


Fig.16 Reactive power across RL load UPFC based with PV and battery using FOPID controller

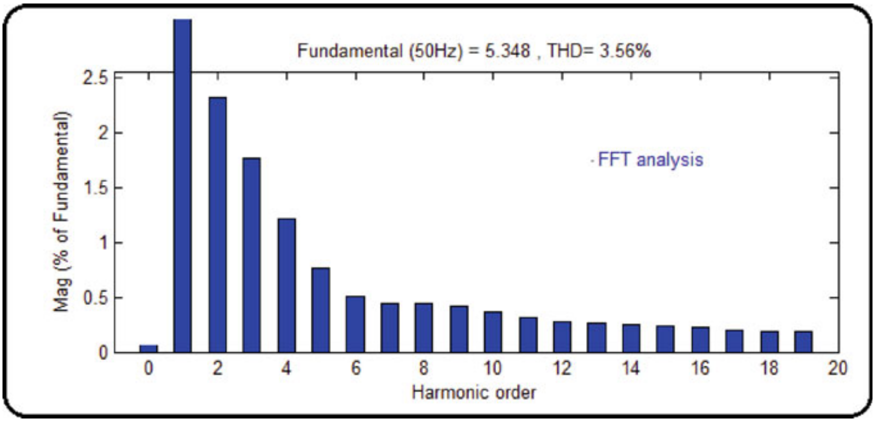


Fig. 17 Current THD using FOPID controller

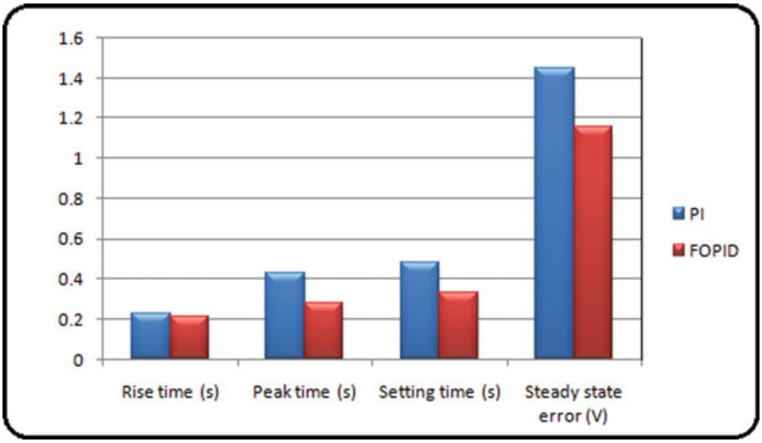


Fig. 18 Bar chart comparison of time domain parameters

Table 1 PI and SMC comparison of time domain parameters

Type of controller	Tr (SEC)	Tp (SEC)	Ts (SEC)	Ess (V)
PI	0.23	0.43	0.48	1.45
FOPID	0.21	0.28	0.33	1.16

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Framework for Implementation of Smart Driver Assistance System Using Augmented Reality

P. William, N. K. Darwante, A. B. Pawar, M. A. Jawale, and Apurv Verma

Abstract This research is to investigate momentum innovation for constantly detecting street signs from a moving vehicle. The most encouraging innovation for perceptive vehicle frameworks is vision sensors and image preparation, therefore this is examined the most thoroughly. Various handling calculations and study the world over concerned with sign acknowledgment are investigated. A functional framework has also been implemented using a regular web-camera installed in a testing car. This framework is limited to speed signs and achieves outstanding displays due to rapid but hearty computations. The division is based on shading data, and the recognition is based on a model coordinating computation. The human–computer interface is a voice that announces which sign has been discovered. Driver carelessness is a key element that commonly results in distortion of surroundings, for example, erroneous recognition or disregard of street and traffic signs. Although significant progress has been made in developing a vehicle capable of autonomous guided driving, development has been slow because to concerns of speed, safety, and the ever-changing complexity of the on-road situation. Street plays a key role for the motorist in gathering data from the sign and then acting in a similar fashion.

Keywords Augmented reality · Smart driver · Road accident · HCI · Street sign

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1 Introduction

With the improvement of the astute vehicle, safe driving help frameworks are turning out to be increasingly significant. In safe driving help framework, the traffic sign acknowledgment is a key innovation and has been broadly utilized. The precision and short preparing time are significant for traffic sign acknowledgment. Be that as it may, in genuine driving circumstances, the different circumstances of traffic signs including the pivot, perspective, scale, and enlightenment are unpredictable and bothersome. Accomplishing vigorous traffic sign acknowledgment with short handling occasions is a difficult undertaking. Traffic sign discovery incorporates traffic sign acknowledgment and traffic sign arrangement [1, 2]. So as to accomplish fast and hearty traffic sign identification, planning a processing effective and exceptionally discriminative element is fundamental. In the interim, so as to accomplish fast and hearty traffic sign arrangement, setting up a grouping procedure that can diminish the measure of highlights and continue order precision is likewise significant [3–5]. Current deals with the traffic sign location and acknowledgment can be separated into three unique sorts. To begin with, pre-handling strategies are inquired about to find and perceive the traffic signs. Second, pre-handling strategies consolidating with groupings are received to accomplish fast and strong traffic signs acknowledgment. Third, explicit structure highlights brushing with the classifiers are utilized to accomplish the vigorous and registering proficient acknowledgment [6–8]. This research is driven by the desire to devise a better system for driving where the smartness and efficacy of the driving may be improved to provide better outcomes [9–12]. This new system that uses state-of-the-art technology such as augmented reality (AR) and embedded systems will allow drivers to get a better understanding of the findings, making it easier for them to act on it by providing relevant alerts [13–15].

1.1 Background

The road sign recognition (RSR) is a field of applied PC vision look into worried about the programmed location and grouping of traffic signs in rush hour gridlock scene pictures procured from a moving vehicle. The after effect of the RSR look into exertion can be utilized as an emotionally supportive network for the driver. At the point when the neighbor condition is comprehended, PC backing can help the driver in pre-crash forecast and evasion [16–19]. Driving is an assignment put together for the most part with respect to visual data and picture handling. The street signs and traffic signals characterize a visual language translated by drivers. Street signs give numerous data essential to effective driving—they depict the present traffic circumstance, characterize option to proceed, disallow or license certain headings, caution about unsafe components, and so on. Street signs additionally help drivers with route [20–23] (Fig. 1).

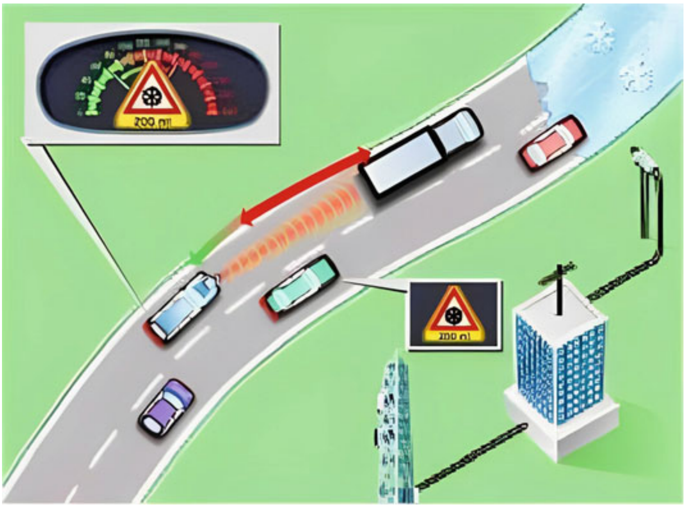


Fig. 1 Intelligent infrastructure and intelligent vehicles to warn about slippery road ahead

1.2 Motivation

Out of the car, smart driver assistance systems are comprehensive frameworks that assist the driver in a variety of ways. These frameworks may be used to provide important data regarding agreements, conclusions, and clog clearance [24–26].

Frameworks may be used to determine whether the human driver has reached his or her limit, and if so, implement preliminary alerts or assess the driving. Larger frameworks may take away the human's ability to evaluate danger (like surpassing and stopping) [27–30].

The primary benefits of using the assistance framework are that they enable communication across different cars, vehicle frameworks, and transportation, allowing the executives to concentrate on their respective areas of responsibility. By making this available, valuable data for carmakers will be exchanged, allowing for improved vision, limitation, arrangement, and fundamental leadership of cars [31–35].

Advanced driver assistance systems and self-driving vehicles depend on locating and recognizing traffic signs to function properly. To make this announcement, we offer a system that can see and recognize traffic signs as a motorist is looking at them. This method relies on the driver's real-time 3D view gathered using a stereo imaging framework to see ahead and a non-contact 3D gaze tracker [36–38].

For identification, we applied a straightforward support vector machine and made highlights via the histogram of situated gradients. Scale invariant feature transforms and coloring data are used to conduct acknowledgment [39, 40]. The approach we have developed both recognizes and detects warning indicators the driver is facing (and identifies signs which may have been ignored by the driver).

2 Literature Review

When applied to the issue statement, a variety of approaches may be used. We have referenced many scholarly publications. When we go over the papers for our final decision, we utilize different criteria to come up with the best solution approach. A summary of these review papers is presented below:

Mehdi Mekni, Andre Lemieux, 2017 has introduced the paper on "Increased Reality", in which virtual setting is initially coordinated with the presentation of genuine environment visuals, a developing field of aggregate plan. The PC's continuous blending video produces content with live exhibitions. AR depends on advancements created in augmented reality and collaborates with the virtual world as well as has a level of reliance with this present reality. The expression "expanded the truth" was first begat at Boeing in 1990 by specialist Tom Coddell, who was approached to improve the costly graphs and checking apparatuses used to direct laborers on the manufacturing plant floor. Coming up next are its favorable circumstances in that it has an assortment of utilizations—medicinal, instruction, military, amusement and sports, and so on. There are sure constraints with AR that must be survived. AR frameworks need to manage a lot of subtleties in all actuality. In this way, little equipment ought to be utilized, effectively versatile and light and quick enough to speak to designs. Additionally, the battery life utilized by these intricate AR gadgets is another constraint for AR utilization [41].

K. Govindaraju, 2017 proposed a paper on Embedded Systems. An embedded system computer system that performs certain pre-determined program that are typically used on a large scale by a mechanical or electrical systems. Typically, it is introduced from small MP3 players to large scale hybrid vehicle systems [42]. Some other examples of embedded systems often used in our daily life are—keyboards, mouse, ATM's, TV, PDA, cell phones, printers, elevators, smoke detectors, DVD player, refrigerator, cameras, GPS navigators, radios, TV remotes, telephones, game controllers, monitors, digital images processors, bar code readers, SD cards, washing machines, anti-lock braking systems, blender, and more. We especially use embedded systems due to its dependent, efficient and it meets real-time constraints. Examples of embedded systems illustrate that we now take embedded systems for granted. Due to the implementation of smart embedded technologies in our house, we are quite acquainted with the phrase "smart home". Embedded systems are linked to the Internet nearly all the time now. Embedded system applications may be roughly divided into two groups: household applications, such as dishwashers, washing machines, and microwaves, and commercial applications, such as gaming and movie playback devices. Embedded systems have a major drawback since they are very cost-sensitive. Small adjustments in the price of a piece of construction equipment may have a significant impact on the case.

Ronald Azuma, 2016 an augmented reality-based research proposal an AR system's ultimate aim is to increase the amount of information the user sees and interacts with by augmenting their perception and interaction with the actual world with virtual 3D objects that seem to be physically located alongside the real world.

Augmented reality work in synergy with other technology such as Internet of Thing (IOT) and many other to give people a rich view on their reality. Augmented reality is exactly what the name suggest, this is when a various reality dominates your already existing reality using certain device such as smartphone and smart-glass. Computer generated image of a different setting is superimposed on your device to change the view of reality. AR has limitations in that it may require a large amount of hardware. Despite many recent advances in AR, much remains to be done [43].

Hassan Fleyeh, Mark Doughtery, 2016 a study describing an advanced way of roadside sign detection and recognition was given. This phrase explains the features of road signs, the procedures, and obstacles that need to be overcome while trying to find road signs, and finally, road sign detection and recognition are essential in ITS. This is because traffic signs and road signs are vital in everyday life [44]. These icons make it possible for motorist to comprehend the visual languages presented to them. They display current traffic conditions on the road, dangers and potential obstacles to drivers, and provide valuable information that helps drivers with their navigations. Color-based and shape-based road sign detection are among the features of road sign recognition. Because it needs more gear and is costly, it has certain restrictions.

Lotfi Abdi, Meddeb, September 2016 "The application of augmented reality inside a vehicle" TSR, which incorporates in-vehicle augmented reality (AR). For many years, the design of TSR has been a challenging issue. The road signage classifications and localizations provide as the groundwork for further methodology that's utilized for proper TSR. Weather conditions, angles of view, sign distortions, and different backdrops all contribute to an obstruction of signals. It is critical to develop computing-efficient and highly discriminating features in order to produce a quick and robust TSR. In order to enhance driving safety and cut down on the effort, information that is easier to comprehend and process must be made available. The AR-TSR completes the vehicle's external view of traffic conditions with information about those conditions, which is shown on the driver's monitor [45–47].

Felipe Jimenez, Aurelio Ponz, April 2016 presents a paper on "Advanced Driver Assistance Systems for Road Environments to Improve Safety and Efficiency", which deals with two sides that were detected as key themes is "Safety and Efficiency". It facilitates the flow of details between vehicles and assists in the identification and data transmission process. Applications developed include: "Adaptive control with optimization, overtaking support systems and driver assistance". To give an early reply to risk conditions, and optimize safety measure for occupants of the vehicles and the characteristic of collisions, pre-collisions in system arise. Nevertheless, it should be noted that these systems demand high amounts of reliable data about the vehicle and surrounding. It also requires support systems with motion control during man oeuvres, collision avoidance system with the potential for developmental man oeuvres which includes pedestrians, cyclists, and motorists and cooperative optimization consideration of other vehicle and road verticals side and traffic signal detection characteristic.

Mauricio Hincapié, Andrea Caponio, Horacio Rios, Eduardo González Mendívil made a presentation on AR as a branch of virtual reality technology (VR), which is sometimes referred to as "the use of unusual equipment and computer programming to create a replica of a replacement environment, which customers perceive as real or legitimate". It is innovation in virtual reality (VR) that enables a scenario in which the customer experiences himself inside a PC-generated virtual world while immersed in the world. Customers who are in the world feel and appear to be inside the PC-generated virtual world, as people do while immersed in the real world. While AR makes the client able to perceive this current world, it expands it with virtual information overlaid on top of it. On the other hand, since virtual reality supplants reality, augmented reality complements it, creating a realm in which genuine and virtual content may coexist. The positive aspects of AR are that it is extraordinarily flexible, particularly in industrial settings, and also may very well be realized in many applications. Despite its many positives, there are a few negatives that may jeopardize its authenticity in real-world applications. An additional important point to bear in mind is the weight of the equipment.

Filip Malawski, July 2018 exhibited that as of late, propelled picture preparing calculations have been utilized to investigate nature while driving and furnish the driver with helpful data. Driver help frameworks can identify people on foot, perceive street signs, and give route directions. Then again, the methods for showing this data are somewhat unrefined and ordinarily incorporate a little show. Along these lines, the driver needs to isolate consideration between the presentation and this present reality. Tending to this problem may be done via augmented reality (AR). We propose a system in which a substantial amount of relevant data for the drivers is displayed on semi-straightforward glasses that are then inserted into the current world using AR technology. We conduct a condition inquiry on a cell phone, which is then connected to the headset. Thus, the headset is responsible for determining the location of each individual phone and changing the phone's viewpoint. Evidence of an idea in the context of a person just dozing off includes a passer-by finding as well as someone nodding off, with the use of an implicit accelerometer.

Paul George, Indira Thouvenin, Vincent Fr'emont and V'eronique Cherfaoui By looking at how the drivers feel, we can assess how robust our planned new propelled driver assistance frameworks will be. A driving assistance architecture presented in this article is inherently linked to the client. Daria is useful for autonomous vehicles since it uses augmented reality (AR) to enhance the functionality of the sensor. Snags and their risk quantification are in the middle of the identification. Driver behavior is the other option. The driver is able to see the risky areas while keeping his eyes open by means of a suitable perceptual representation At this point, the preliminary results indicate that our approach may be extended to automobiles, ships, or water routes. While the organizing assistance allows the client to get at its objective without earlier information out.

Lucas Morillo Méndez, June 2018 proposed a paper on Augmented Reality. AR is progressively being created in the car space as an ADAS framework. This inexorably mainstream innovation can possibly decrease the fatalities out and about which include HF, anyway the psychological segments of AR are as yet being examined. This survey gives a brisk outline of the investigations related with the intellectual systems engaged with AR while heading to date. Related research is changed, a scientific categorization of the results is given. AR frameworks ought to pursue certain criteria to stay away from bothersome results, for example, subjective catch. Just data related with the fundamental driving errand ought to be appeared to the driver so as to stay away from impediment of the genuine street by non-driving related undertakings and high mental remaining task at hand. Notwithstanding, data ought not to be appeared consistently so it does not influence the driving aptitudes of the clients and they do not create overreliance in the framework, which may prompt hazardous practices. Some famous employments of AR in the vehicle are route and as security framework. AR subjective results ought to be considered in these specific settings later on. This article is expected as a small scale control for makers and architects so as to improve the quality and the effectiveness of the frameworks that are presently being created. One of the potential disadvantages of AR inside the vehicle is that it can prompt intellectual catch if the AR territory is overloaded with data. This may make the driver react to the offered data instead of to the driving errand and an issue of overreliance, and subsequently that clients take part in dangerous driving.

Chin-Chen Chang, Shu-Chun Huag, June 2018 showed a presentation about where traffic signs are placed and how to use an assistance system. Driving along the street might provide several types of messages from street signs. To capture the attention of drivers, traffic signs have eye-catching colors and simple graphics. Drivers overlook signals from traffic signs when they drive in complicated situations or if their mental state is poor. In the case that there is a programming framework for reporting the discovery and acknowledgment of traffic signs, it can pass that information on to the driver and lower the burden of having to memorize the different types of traffic signs. When the vehicle misses a traffic sign, the platform is capable of showing a cautioning signal. This framework can help the driver software navigate the roadway, by figuring out the road state. So the driving experience is improved in huge ways, with the dangers of errors being minimized. In this research, we focus on the identification and finding of traffic signs to support vehicle assistance applications. We tried several different types of frameworks, although also checking to see if the framework execution was satisfactory. Street signs may convey numerous signals to the motorist, even while they are simply operating a car. To make sure the traffic signs stand out, they are made with striking colors and simple graphics. Despite this, a motorist can have an extremely poor understanding of traffic signage, especially if the driver is perplexed about what they are supposed to do, or if they are in a poor mental state. Should there be a traffic sign recognition and reporting system in place, the motorist will get relevant notifications quicker and also find it easier to navigate the road. The framework has the ability to see whether the motorist misses a traffic sign. An encouraging warning this framework can help the driver software navigate the roadway, by figuring out the road state. It follows that a driver's comfort is much increased, and the risk of getting into an accident is reduced. This study focuses on how traffic indicators for driving assistance programs may help the driving population be found and distinguished. Additionally, we investigate several design blends of the framework in order to confirm the framework's performance.

2.1 Comparative Study

See Table 1.

3 Design and Implementation

The main focus is to develop a rotating inductive road sign detection system by augmented reality and advanced posit algorithm. Glyph-based augmented reality is used in our project in conjunction with the posit algorithm. The posit algorithm is extended by our novel approach. The objective is to use image processing with glyph recognition technology and better and efficient recognition and detection of road signs to aid the driver and reduce road accidents. Some glyph recognition markers have been created that show street signs in particular. (These markers should be placed on the road and made standard for real-life application). When these markers are placed in front of the camera they are identified and information is stored in the system. Information will be displayed in front of the driver in an automobile system using any device, which will be notified by using an LCD or mobile phones.

3.1 Posit Algorithm

The purpose of 3D pose estimation is to determine the change required to map an object from a 3D coordinate system to a 2D image. It plays a very important role since the beginning of computer vision. One specific application is to help mobile robots self-localize in unknown environments. Another application area that I am particularly interested in is augmented reality, it can help visual perception of 3D in areas such as hospitals, navigation, and admissions. These techniques have already been used and will be widely used in the future. Therefore, it is very important to study pose estimation. Many algorithms can perform currency estimation. One of the most popular and widely used algorithm is POSIT (from orthography to scaling with pose and repetition). Unlike some other algorithms, POSIT does not require preliminary estimation. It just requires four or more corresponding attribute points between the 3D object and the 2D image. In the POSIT algorithm, the 3D model should not have the feature points coplanar (in the same plane), otherwise it does not work. However, there is a low algorithm called coplanar POSIT that can deal with this situation.

Table 1 Comparative analysis of exiting work

Title	Author and year	Technique used	Proposed work	Limitation	Conclusion
DAARIA: Driver Assistance by Augmented Reality for Intelligent	Paul George, Indira Thouvenin, Vincent Fr'emont and V'eronique Cherfaoui	Prototype of driver assistance system in augmented reality has been presented based on the weathervane metaphor adapted for a use in real conditions metaphor adapted for a use in real conditions	A lot of problem of integration (calibration, synchronization—not described here—and data exchange) have been resolved to conduct first experiment and prove the feasibility	Ax for future research is focused on the metaphor improvement	Prototype of driver assistance system in augmented reality has been presented
Augmented Reality: Applications, Challenges and Future Trends	Andre Lemieux, Mehdi Mekni	Mobile technology, virtual environment, and augmented reality	Various applications in military, medical, manufacturing, and entertainment	AR systems have to deal with large amounts of details in reality. Therefore, small hardware should be used	It describes work performed in different application domains
Driver Assistance System Using Augmented Reality Headset	Filip Malawski, 2018	Image processing algorithms, augmented reality	Proof-of-concept scenario includes pedestrian detection as well as falling asleep detection, with use of a built-in accelerometer	Driver needs to divide attention between the display and the real world	Detect pedestrians, recognize road signs, and provide navigation instructions
Traffic Sign Detection and Analysis	Ms. Yamini Gowardhan, Dr. Ramchand Hablani, 2016	Color segmentation, shape analysis, conversion of color models	SVM classifier and edge detection provide improved results	Regions detected by color detection cannot be determined to the exact sign region	Using HIS color model to detects the traffic sign followed by circle detection

(continued)

Table 1 (continued)

Title	Author and year	Technique used	Proposed work	Limitation	Conclusion
Traffic Sign Detection and Recognition for Driving Assistance System	Chin-Chen Chang, Shu-Chun Huag, 2018	Convolutional neural networks, color features	Utilized two types of deep learning structures to train our system	Hierarchical grouping methods make it little bit complex	Selective search in the color space with the accuracy and recall rates, and the red filter screening results
Road and Traffic Sign Detection And Recognition	Hassan Fleyeh, Mark Doughtery	Color models, neural networks, template matching, and classical classifiers	Input does not need to be transformed into another representation state	Training overhead, multilayer neural networks cannot be adapted due to its architecture	List of candidate objects that could be probable road signs
Augmented Reality as an Advanced Driver Assistance System: A cognitive Approach	Lucas Morillo Méndez, 2018	Cognitive and perceptual implications of AR inside the car	Provides safety, navigation, and take over request assistant	Occlusions of the road elements may disturb the availability of AR information	Cognitive outcomes of interacting with AR while driving
Smartphone-based traffic sign detection using OpenCV	Mohammad S. Aminian, Christina Olaverri-Monreal, 2017	Image processing techniques	High object detection rate (84%) within few milliseconds of time	A high resolution device needs more time to process	Displays detected traffic signs and assists the driver in not missing important traffic information
In-Vehicle Augmented Reality TSR to improve driving safety and enhance driver's experiences	Lotfi Abdi, Aref Meddeb, 2017	Haar cascade and the bag of visual words approach	Good compromise between resource efficiency and overall performance	Does not makes use of augmented markers instead uses spatial information	

3.2 Details of Input/Data Used

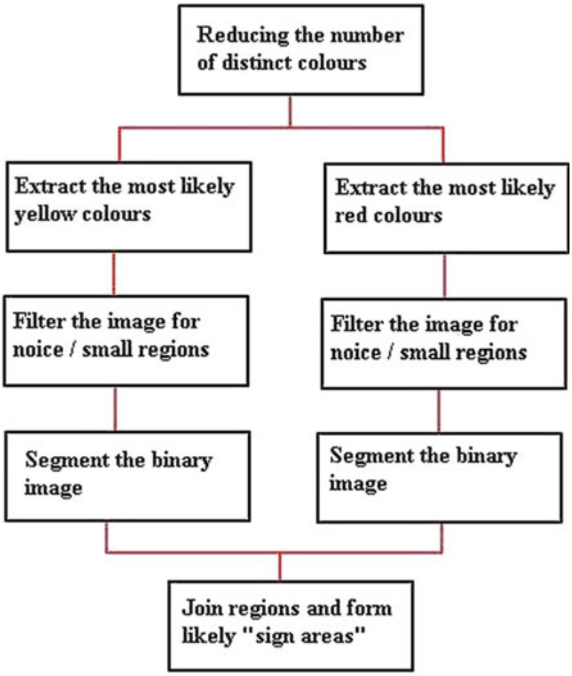
Knowledge is available that can be used to deal with the difficulty of recognizing and detecting road sign in an effective manner. Every road signs are design, built, and installed as per stringent set of rules set forth by federal committee.

Color is set not only for the signal range (red = stop, yellow = hazard, etc.), but also according to the blot of color or paint that shadows the signal, with a tolerance that is visible, at a specific wavelength should correspond to spectrum. This is certainly an important detail, but caution will be exercised for getting use of it as the standards are set as per the controlled illuminations that prevails while performing experiments, whereas during practice, weather situations are subject to external illumination and of course results will be affected by the colors captured by the camera. Color over road signs also fades over time.

Text fonts as well as character heights are also regulated for shapes and dimensions as well as picture lines (Fig. 2).

Signs are mainly located at the right side of the road, in usual practice two to four meters from the roadside, which are not strictly followed and their lies expectation of overhead and clearance signs which are located on the central lane. This phenomenon is beneficial for sign recognition because a big portion of image of road can be neglected and thus speed up process.

Fig. 2 Localizing signs



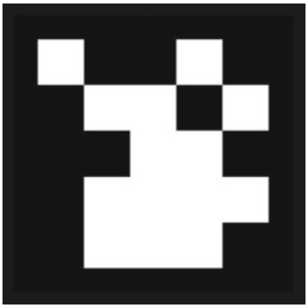


Fig. 3 Augmented marker

Signs could appear in a variety of situations, including damaged, partially cloudy, and exposed to sunlight. Signs may also occur, for example, three or four signs appear above/beside each other (Fig. 3).

4 Experimental Results and Analysis

The Proteus Design Suite is a device suite, including one component in particular, the component that will robotize electrical structure. Schematic design and electronic print preparation are the common uses of the solution for electronic structure architects and experts. Only a few subnets of the roadway network can benefit from the concept of ad hoc architecture. A great illustration of this is a completely automated roadway in which only self-driving cars may be operated.

The fact that the first steps of intelligent vehicle research have yielded positive results, such as vehicles being able to operate themselves, means that it is technologically possible to have a complete vehicle and road automation that includes things like traffic lights and road signs (at least on highways or very structured roads). As a designer, you should be aware of and attentive about several factors outside of technical aspects, including any difficulties. Factors include laws dealing with responsibilities, failure to operate correctly, and the influence of automated driving (both human and passenger).

A good car should have an elegant, well-proportioned design, and provide a comfortable environment. This is mostly down to how well-designed the passenger compartment is. The framework's interface will have a huge effect on how the framework's frame is seen and understood. There are many lengthy evaluations and reconfigurations that are required before these frameworks are open to the public. Additionally, the public has to endure more years of manually driven cars and markets before the street network can be transformed into one that uses intelligent and adaptable drivers and other means of data trade (Fig. 4).

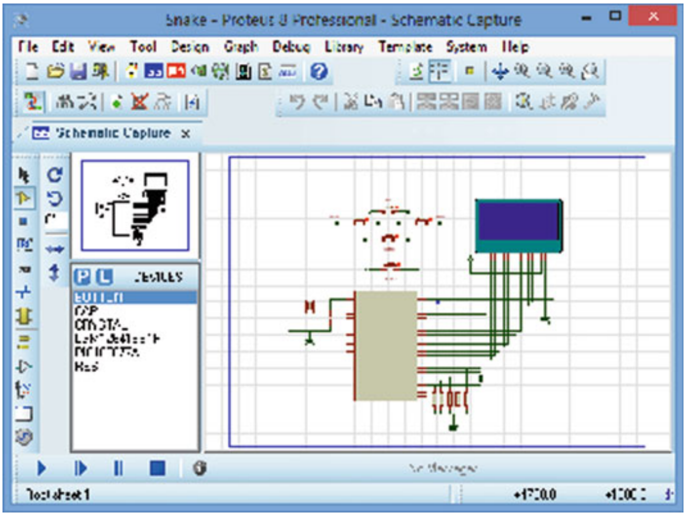


Fig. 4 Screenshot of Proteus design suite

5 Results and Future Scope

The developed system quickly recognizes road signs and notifies to drive. The program also keeps track of the already passed public places such as petrol pumps and restaurants on the way and notifies the same to the driver (Fig. 5).

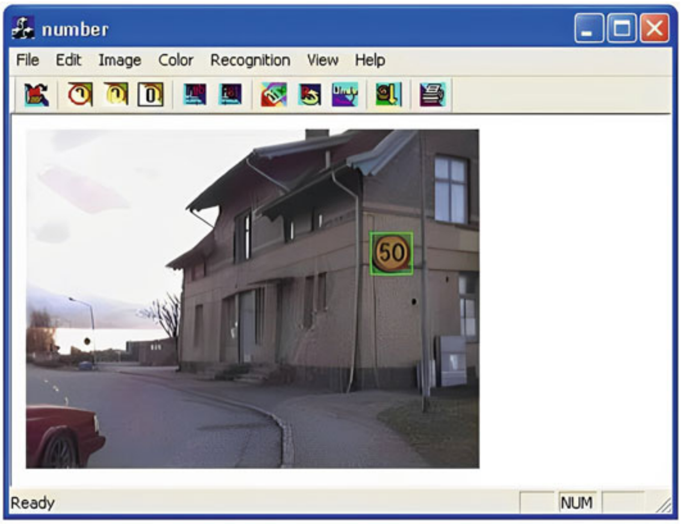


Fig. 5 Screenshot ‘fifty’

5.1 Dataset Used Dataset

In the back end (embedded system), whenever the road sign will be recognized it will show a code on the display corresponding to that sign like for example for right turn it will display R, for left turn it will show L, etc. (Table 2).

AR is a colossal innovation at the same time, right now, it is as yet having significant issues by causing major issues that endanger its usage in mechanical world. In this report, we have displayed the fundamental advantages that AR can offers to modern methods, with incredible consideration regarding look after tasks. AR could improve human exhibitions without a doubt, and this can give us extraordinary advantages not just from a practical perspective. A superior support of a car does not only mean lower price, but also great reliability and, thus, leads few failures and corresponding accidents. In our project, embedded systems would be used at the back end and Microsoft Visual Studio would be used at the front end.

The developed system quickly recognizes road signs and notifies to drive. The program also keeps track of the already passed public places such as petrol pumps and restaurants on the way and notifies the same to the driver.

In the back end (embedded system), whenever the road sign will be recognized it will show a code on the display corresponding to that sign like for example for right turn it will display R, for left turn it will show L, etc. (Fig. 6).

In-vehicle contextual augmented reality (AR) provides users with real-time visual and visceral input for a more efficient and impactful driving experience. To aid the driver in various driving situations, this technique is used to improve the traffic sign recognizer. It also makes drivers more comfortable, and also reduces the risk of vehicle accidents. Through this analysis, we have shown that AR can enhance TSR greatly. To improve driving safety and decrease driving stress, AR may be utilized. A visualization of the information presents it in a manner that's simple for the driver to comprehend, requiring minimal cognitive effort.

To control the traffic for road signs recognition using mobile phones or other smart devices, applications can be developed. Results based on calculations show quite high object detection rate, i.e., 84% within a time of few milliseconds. The time used in detecting road signs is different from time used with the help of resolution of the device which is being used. More time is required to process more number of pixels in high resolution, but the detection comes out to be much accurate. By improving the application in the future analysis one can reduce the amount of false and misleading detections of road signs.

A latest application using augmented reality approach is developed for creating real-time interactive traffic animations is introduced, in terms of rules for placement and visible to users, various traffic signs and movement of these are done to an in-built vehicle display of the device.

Important drawbacks that are majorly taking AR technology behind in the industrial environment were detected and solutions are proposed. Scientific solutions to solve these drawbacks are required to make AR more breakthrough technology. Much better substances, faster algorithms for solutions, small hardware elements are taken.

Table 2 Data used for train the model

Name	Road signs	Augmented markers
No parking		
Right turn		
Left turn		
U turn		
No left turn		
No right turn		

Fig. 6 Recognition of augmented marker

The research committee takes responsibility of these needs and provides solutions in order to solve the problems.

5.2 Conclusion

Complete mechanization will be done distinctly to uncommon foundations, for example, in uses of businesses or open transportation for the present. At that point, mechanized innovation of vehicles will be gradually and bit by bit stretched out to numerous other significant transportation regions, for example, delivery of products. For instance for expensive trucks, where the expense of the vehicle itself and the administration it gives is a lot higher than the expense of an autopilot which is practically oblivious before the previous one. At long last once innovation has been created and kept up and the most worthwhile arrangement and best calculations are utilized, huge. The developed model can recognize road signs but traffic lights had to be done in more detailed way that is the future scope of this project. The road sign recognition systems will probably become an important element of future support systems of drivers in a very short period of time. Many experts and researchers have concluded that the initial generation of individual driver information and warning systems will be visible in the market in upcoming six to nine years. One of the first on the market would probably be Daimler Chrysler. The improvement of upcoming cars could be gained depending on both infrastructure and vehicles as well. Based on the particular app, user can get either some of the advantages or disadvantages. Improving the infrastructure and condition of road may give advantages to the architectures of transportation which are dependent on looping and already scheduled routes for driving, like transportation used in public and robotics in industries. On the contrary, a difficult and extensive organization and maintenance would be required for extended road networks for private vehicles which may become hard to understand and ambiguous as well as extremely costly.

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Power-Efficient Hardware Design of ECC Algorithm on High Performance FPGA

Vikas Jalodia and Bishwajeet Pandey

Abstract Data security and GC concepts are the two most promising areas with which the world is most concerned nowadays. As everyday technological progress is witnessed, hackers also develop new techniques for penetrating security. People are migrating toward GC since the power consumption is also a big problem. Using the Zynq 7000 FPGA, we have tried to optimize the total power dissipation (TPD) for the ECC algorithm in our proposed work. The implementation is implanted on VIVADO ISE. In the proposed work, the TPD for ECC design on Zynq 7000 is analyzed for various clock (clk) pulses. From the power calculation, it is observed that the TPD gets decreased as the time clk pulse increases.

Keywords ECC algorithm · FPGA · Zynq 7000 · VIVADO · Data security · Green communication

1 Introduction

Security of data is the topic with which the global community is most concerned. Data security is the process of preventing unauthorized access to private data. It includes all the cyber security approaches you deploy to secure your data from misuse, including encryption, physical and digital access restrictions, and others [1]. Priority has always been placed on data security. However, as a consequence of the current health crisis, more people are working remotely (and cloud use has increased to match), there are more opportunities than ever before for unauthorized access to your data. And crooks are profiting from it. Interpol and the US Chamber of Commerce, for instance, assert that the frequency of cyber-attacks has increased significantly since the outbreak started. Algorithms of cryptography are used to improve the security of data services.

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Encryption of data is achieved using cryptographic methods. Generally speaking, there are two types of cryptography standards: symmetric and asymmetric [2–4]. Symmetric encryption employs a single key for both encryption and decryption of any data. Data encryption standard (DES), triple DES, and advanced encryption standard are examples of symmetric encryption techniques (AES). For encryption and decryption, asymmetric encryption algorithms employ two keys. Among the asymmetric cryptographic, approaches are the Rivest-Shamir-Adleman (RSA) algorithm and elliptic curve cryptography (ECC) [5, 6]. All these standard cryptography algorithms can be implemented on a software-based model or either on a hardware-based model. The software implementation of such algorithms is bit time consuming and requires time to time up-gradation. In this era of technology hacking, a software is not a big game. Therefore, to enhance the level of security, researchers have started to move on the hardware implementation of such algorithms, since they are handier to use and are more secured than the software implementations. This work gives an insight about the hardware design of ECC algorithm. ECC is one of the key algorithms which is used for pseudo random generator and digital signatures. It is difficult to determine the discrete logarithm of a random elliptic curve element with respect to a publicly known base point; this is known as the "elliptic curve discrete logarithm problem" (ECDLP). The security of elliptic curve cryptography depends on the inability to calculate the multiplicand given the original point and the product point. The degree of difficulty is dictated by the size of the elliptic curve, which is the total number of discrete integer pairs satisfying the curve's equation. For the hardware implementations, we have used a field programmable gate array (FPGA) device. FPGAs are the semiconductor devices which are designed with configurable logic blocks (CLBs) and are linked with programmable interconnects. The major advantage of using FPGA over other hardware devices is, it can be re-configured after its manufacturing. The feature of reconfigure is not found in the other hardware. Apart from this, FPGA devices provide flexibility, are less complicated, and give consumers with high throughput, frequency, and speed [7–9]. FPGAs devices are also used for designing the high-performance energy-efficient computing (HPEEC) modules which can be helpful for green communication (GC). The major components of FPGA are shown in Fig. 1. The major components required to build are such as

- Random access memory (RAM)
- Flip flop (FF)
- Look up tables (LUTs)
- Memory
- Input output (IO)

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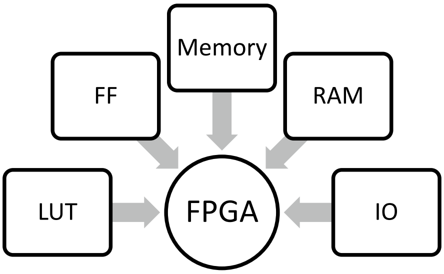


Fig. 1 Major components of FPGA

1.1 ECC Algorithm

ECC is an example of asymmetric encryption, which requires two keys for performing the encryption and decryption. These two keys are public and private keys, respectively. These two keys are exchanged between the sender and receiver to perform the encryption and decryption. The phenomenon of key exchange is represented in Fig. 2.

2 Existing Works

In [10], authors have used Virtex-5 FPGA to design an ECC processor. The processor uses substantial pipelining methods for Karatsuba-Ofman method multiplication in order to attain high throughput. In addition, an efficient modular adder without

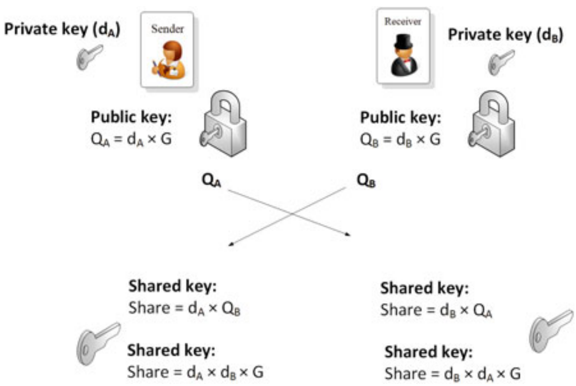


Fig. 2 Key exchange phenomenon of ECC algorithm

comparison and a high-throughput modular divider are constructed, resulting in a short datapath for increased frequency. In [11], researcher have compared the implementation result of ECC on two different FPGA devices. Authors have used the concept of Galois field (GF) technique to implement the ECC over FPGA. In [12], (MMM) Montgomery modular multiplication method is used by the researchers to implement the applications of ECC on three various FPGA devices such as Virtex-7, Virtex-6, and Virtex-5. Using the concept of GF, authors have designed a ECC processor for low area applications. The design has been implemented in four distinguished FPGAs such as Virtex-7, Virtex-6, Virtex-5, and Virtex-4 [13]. For enhancing the security of IoT application, researchers have designed an ECC processor on Kintex-7 and Virtex-7 FPGAs [14]. In [15], authors have used the point multiplication technique to implement the ECC design on Virtex-6 FPGA. In [16], authors have implemented the ECC design on FPGA for small embedded applications using GF techniques. With the help of discrete Fourier transform (DFT) modular multiplication and Edward curves, authors have implemented ECC processor on FPGA [17]. In [18], researchers have used Spartan 3E FPGA to implement ECC design using Vedic multiplication method. From the existing work, it is observed that a lot of work has been done to implement ECC design over FPGA for various applications. But according to author knowledge, a very few works have been done to implement the ECC design over Zynq 7000 FPGA for (GC) green communication. Therefore, in this work, authors have proposed a power-efficient model of ECC design on Zynq 7000 FPGA to promote the ideas of GC.

3 Implementation of ECC on Zynq 7000

The implementation of ECC is done on the VIVADO ISE, and the results of the implementation are observed on Zynq 7000 FPGA. In the implementation, various FPGA resources have been used such as look up tables (LUT), flip flops (FF), global buffer (BUFG), and input output (IO) [19]. The resource utilization is described in Table 1 and Fig. 3. From Table 1, it is observed that for the implementation the number of FPGA resources utilized is such as IO 116, BUFG 1, FF 142, and LUT 138. The register transfer level (RTL) schematic of ECC design is shown in Fig. 4.

Table 1 Resource utilization for ECC design on Zynq 7000

Resource	Utilization	Utilization %
IO	116	46.40
BUFG	1	3.13
FF	142	0.18
LUT	138	0.09

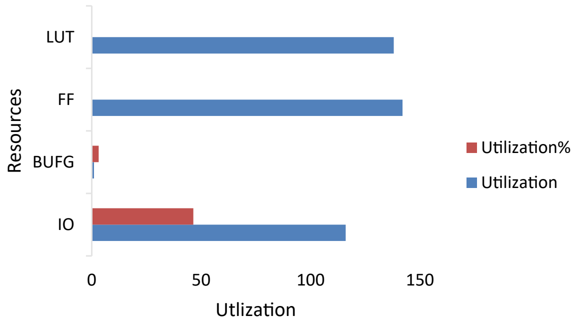


Fig. 3 Resource utilization for ECC design on Zynq 7000

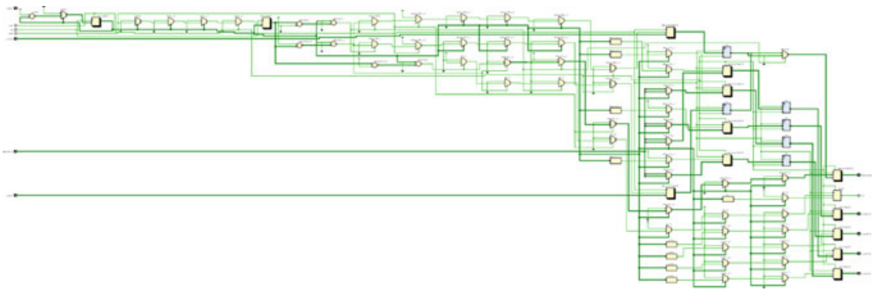


Fig. 4 RTL of ECC design on Zynq 7000

4 Power Analysis

For promoting the ethics of GC, the power dissipation from the devices should be as minimum as possible. Therefore, power analysis of any hardware device is a concerned thing. In the FPGA, there are a number of different approaches through which power dissipation is minimized for GC [20]. In the proposed work, we have tested the ECC design at various clk pulses. The encryption of data has been tested for various clk to optimize the power dissipation of the device. The power analysis is tested for various clk pulse ranging from 1 to 20 ns. The TPD is calculated by the summation of device static power (DSP) and dynamic power (DDP).

$$TPD = DSP + DDP$$

4.1 Power Analysis for 1 ns

When the data is encrypted at 1 ns clk pulse, the TPD of the device observed is 0.156 W. The TPD is the sum of DSP (0.123 W) and DDP (0.032 W). The DDP

Fig. 5 On chips power dissipation at 1 ns

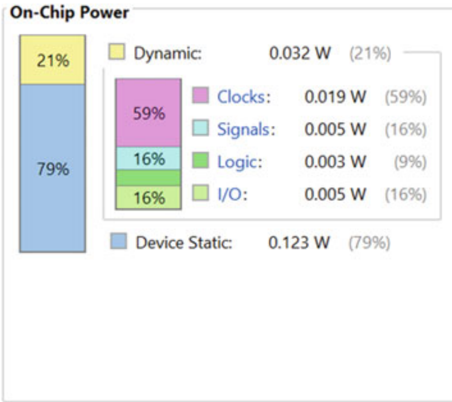
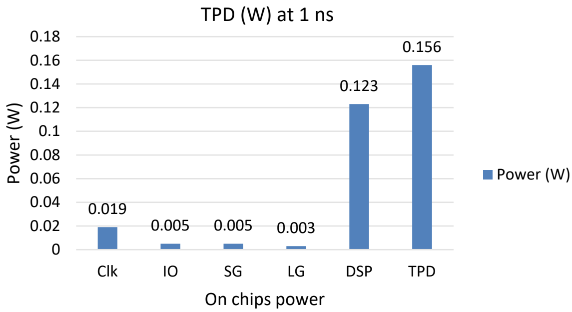


Fig. 6 TPD at 1 ns



consumption is 21% of the TPD, while the DSP consumption is 79% of the TPD. The DDP is the summation of clk, IO, signal (SG), and logic (LG) power. The on chips power dissipation is shown in Fig. 5, and the TPD for the device at 1 ns is shown and described in Fig. 6.

4.2 *Power Analysis for 5 ns*

When the clk frequency is tuned to 5 ns, the TPD of the device becomes 0.13 W. The DSP and DDP are such as 0.123 W and 0.006 W, respectively. The on chips power dissipation is shown in Fig. 7, and the TPD for the device at 1 ns is shown and described in Fig. 8.

Fig. 7 On chips power dissipation at 5 ns

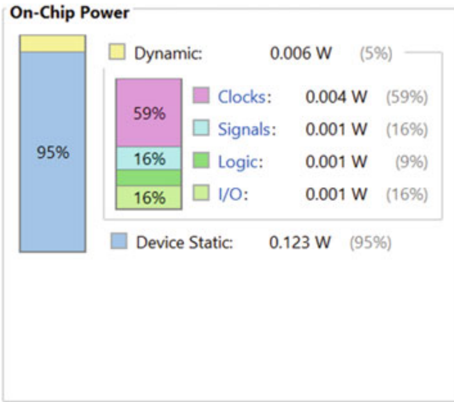
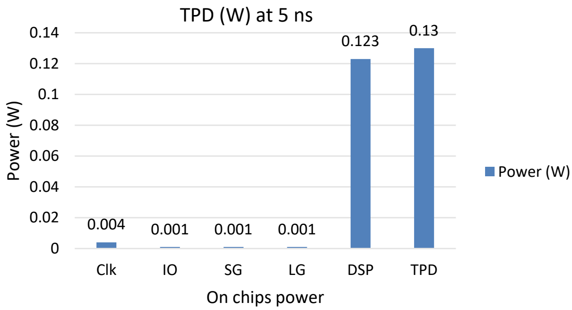


Fig. 8 TPD at 5 ns



4.3 Power Analysis for 10 ns

When the data is encrypted at 10 ns clk pulse, the TPD of the device observed is 0.126 W. The TPD is the sum of DSP (0.123 W) and DDP (0.003 W). The DDP consumption is 3% of the TPD, while the DSP consumption is 97% of the TPD. The DDP is the summation of clk, IO, signal (SG), and logic (LG) power. The on chips power dissipation is shown in Fig. 9, and the TPD for the device at 1 ns is shown and described in Fig. 10.

4.4 Power Analysis for 15 ns

When the clk frequency is tuned to 15 ns, the TPD of the device becomes 0.125 W. The DSP and DDP are such as 0.123 W and 0.002 W, respectively. The on chips power dissipation is shown in Fig. 11, and the TPD for the device at 1 ns is shown and described in Fig. 12.

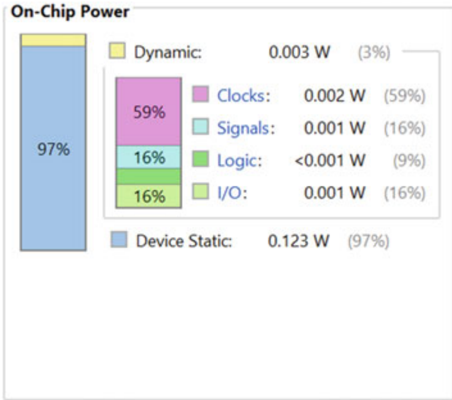


Fig. 9 On chips power dissipation at 10 ns

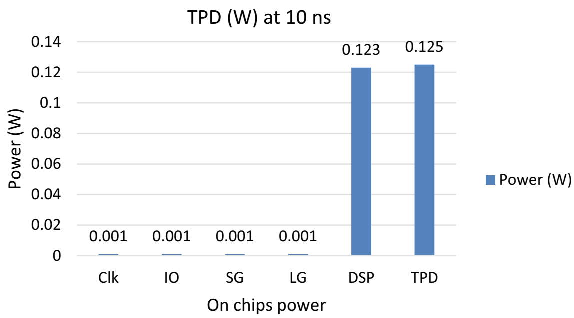


Fig. 10 TPD at 10 ns

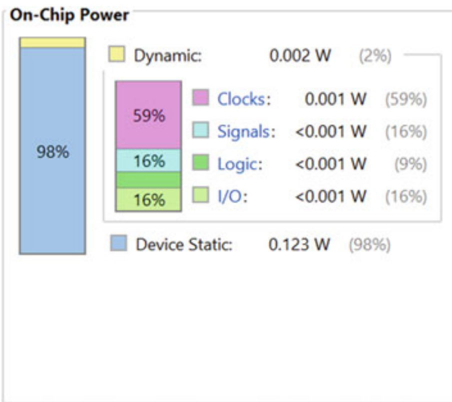


Fig. 11 On chips power dissipation at 15 ns

The power dissipation of the device changes with every clk pulse but after 15 ns the power dissipation gets saturated to 0.125 W. The on chips power dissipation for 18 ns and 20 ns clk pulse is shown in Fig. 13 which is same is TPD at 15 ns.

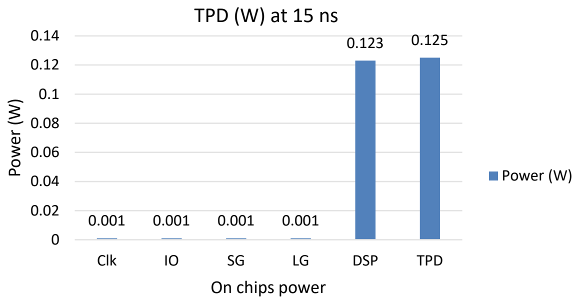


Fig. 12 TPD at 15 ns

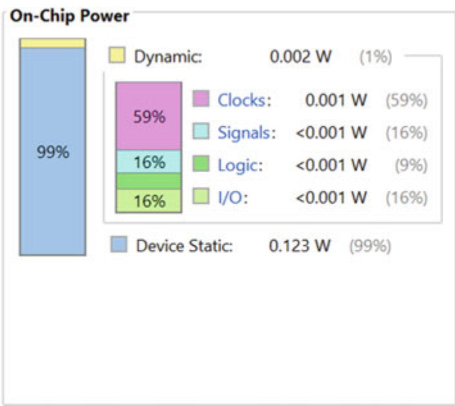


Fig. 13 On chips power dissipation at 18 ns and 20 ns

5 Observation and Discussion

In Sect. 4, the TPD for different clk pulse is calculated for the ECC design on Zynq 7000 board. It is observed that the TPD for the device decreases as the time of the clk pulse gets increased. And after 15 ns, the TPD gets saturated to 0.125 W. The TPD is maximum at 1 ns (0.156 W) and least at 15 ns (0.125 W). The TPD for different clk pulses is shown in Fig. 14.

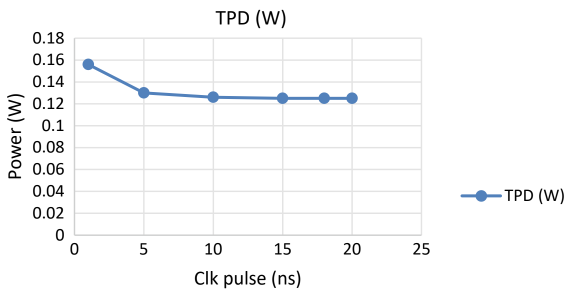


Fig. 14 TPD at different clk pulses

6 Conclusion and Future Scope

Security of data and the ideas of GC are the two most promising factors upon which the globe is concerned most. As there is advancement of technologies being observed on the daily basis the hackers too find new topologies for breaching the security level. The power consumption is also a major factor in people's mind so they are moving toward GC. Therefore, in this proposed work, we have tried to optimize the TPD for the ECC algorithm using the Zynq 7000 FPGA device. In the proposed work, we have tested the data encryption process of ECC design on several different clk pulses. And it has been concluded that the TPD decreases as the clk pulse time increases. The TPD is observed at its max when the data is encrypted at 1 ns and it is at the least at 15 ns. After 15 ns of clk, the TPD gets saturated.

As far as the future scope is concerned the ECC design can also be tested on different other ultra-scale devices with various other power optimization techniques such as clock gating, IO standards, voltage scaling, and so on. Later this design can also be converted into ASIC for the more enhanced communication and better security purpose.

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A Creative Domain of Blockchain Application: NFTs

Urmila Pilania, Pulkit Upadhyay, Rohit Tanwar, and Manoj Kumar

Abstract Blockchain has many applications in the digital world one of which is non-fungible token (NFT). The NFT originated from Ethereum and it is gaining the attention of researchers over the years. Increasing researchers' attention toward NFTs has played a most important role in growing the digital market size. NFT is a creative new art type for artists, manufacturers, and musicians. The digital items can be exhibited, sold, stored, and purchased in virtual galleries through NFT. Blockchain provides permanent evidence of trust, rights, and acquaintances to these digital items. In this paper, the NFT market framework is designed and developed. Smart contracts for the NFT market are written in solidity language.

Keywords Blockchain · Non-fungible token · Ethereum · Web 3.0 · MetaMask · Solidity

1 Introduction

Blockchain is a distributed database of transactions, which is maintained by several computers. In it, records are not handled by a single person but are supervised by several persons. No single person has the right for editing and deletes the information. If some person wants to perform the transaction, it goes to the distributed network for checking the authenticity of the transaction. After checking the authenticity of the transaction, it is linked to the previous transaction to perform a chain of transactions. The complete process is known as the blockchain. In other words, one can say it is a distributed database of encrypted blocks connected to form the particular source of authentication for information. Blockchain has its applications in cryptocurrencies

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such as Bitcoin, Ethereum, Litcoin, and many more. These cryptocurrencies can be used to buy and sell digital assets [1].

Ethereum is a decentralized and distributed network of nodes, the nodes perform the decision-making. It can securely verify and execute the program code known as the smart contract in the NFT market. Smart contract in the NFT market permits users to transfer information with one another without the involvement of a trusted central authority. The records which we are transferring are irreversible, certifiable, and firmly distributed in the network. The transfer of information is visible and editable to all the participants. Users need to create a MetaMask account for the NFT market. The user signs the transactions and then spends ether as the cost of dispensation transactions on the system [2].

2 Related Work

Blockchain has massive applications in business, and it provides the solution to many problems. Also one of the major uses is data privacy like companies cannot use data to sell it to advertisers. In the coming time, blockchain expands itself in many more sectors. In the proposed paper [3], blockchain and its application were explained by the authors. They focused on NFT, how it is booming and beneficial to society. NFT uniquely defines the assets and these are not transferable. NFT could be used to transfer any digital information with its identity. Again in paper [4], the authors discussed NFT in detail including its merits, demerits, and challenges associated with it. NFT initially originated from Ethereum having a unique identity in the form of digital signatures. NFT comes into the market almost one year ago. It is still in the growing phase according to the authors. They discussed the state of the art of NFT in terms of technical components, protocol, and standards used. The author also discussed NFT from a security point of view. In the end, the challenges associated were also discussed by the authors.

In the paper [5], the author discussed the evolution of blockchain and its application in the digital world. They started with the history of blockchain, architecture, working, different tiers of blockchain, types, advantages, and disadvantages of blockchain. Blockchain is growing day by day because of its intrinsic features. In paper [6], ether and Bitcoin pricing was compared by the author. They also found the relationship between NFT users and NFT sell. In the end, it has been concluded that the NFT market depends upon the crypto currency market. In paper [7], the authors proposed an NFT platform for fabric blockchain using hyperledger. As users are very interested in NFT these days so the market was expanded. The authors used hyperledger fabric ERC-721 to reduce the gas charges. It was similar to the Ethereum smart contract. The proposed ERC-721 program was also useful for other applications such as digital artwork.

For the last two years, NFT is getting a lot of attention from users in digital marketing. Many papers have been studied by authors and 14 digital markets were discovered in the last 4 years [8]. Analysis of these papers was done based on NFT sale, NFT trade, NFT wallet, etc. According to this paper, the NFT market was started in 2017 using Bitcoin and Ethereum as cryptocurrencies. The NFT market is still immature and needs a lot of improvements. NFT is non-fungible; by using it digital market was established by many users. They used to sell and purchase digital products using NFT. Using blockchain ownership of the product could be tracked easily. In paper [9], a survey was done by authors to check customers' interest in NFT fashion. From the survey, it has been concluded that people were interested in NFT, they used to sell and purchase digital products. But still, the NFT market was immature and needed lots of improvements. After a literature review of the blockchain or NFT market, lots of issues have been found and these issues are as follows:

- Most of the NFT market still depends on Ethereum, and it does slow confirmation compared to Bitcoin.
- A high gas rate is another issue for NFT users. The smart contract uses computational resources at a large scale resulting in increased gas charges.
- A cryptographic hash is used as a unique ID instead of the duplicate of the original file. This makes the user lose confidence in the NFT due to original file might be misplaced or damaged.
- Users may hide their identities while using the NFT market.
- High power consumption in NFT uploading and transfer.
- Low speed and high gas cost for NFT assets.
- NFTs are taxable so it is another problem among uses.
- The extensibility is also an issue in the NFT market. NFT ecosystems are inaccessible from one another.

3 Problem Statement

Based on the issues listed after the literature review, we have created a framework for the NFT market which is reliable and secure. For the proposed work, NFT market is designed in solidity language and Ethereum is used as a cryptocurrency. It can be efficiently used to sell, purchase, and store digital assets. It also provides the owner of the digital product through blockchain.

4 Preliminary NFT

In the early stage of the Internet, Web 1.0 was used which is the read-only version of the Internet. At that time communication was one-way means the user can only read the information from the website but was not able to update it. Then, Web 2.0 came into existence which provided two-way communications. Many times in Web 2.0 the outcomes displayed are dissimilar from what is requested by the user. Web 2.0 takes more time to generate results and the transformation of results may be of poor quality. In Web 2.0, users can only connect through their email IDs. It is not so much safe from various attacks and fraud resulting in a deficiency of privacy [10, 11]. Web 3.0 is very advanced and user-friendly providing a reliable interface to users. Web 3.0 can understand the perception of information on its own. It is the insolent technology that advances the influence of artificial intelligence and machine learning by making the human interface easy. It has many features such as 3D graphics, stores, and virtual reality devices [12]. In Web 3.0, blockchain provides secure user communications, stores information safely, sells digital products and is also able to purchase securely. Blockchain is open-source software and it works on the concept that most tools will stay exposed to developers [13]. Cryptocurrency work on blockchain, it also provides a record of information carried out. Mining helps to generate a unit of cryptocurrencies using mathematics to solve complex problems and generate coins. Ethereum is the cryptocurrency mainly used in the NFT market [14]. It has lots of applications and many functions some of which are as follows:

- With ethers, one can shop online in the digital market. Some platform also allows taking custody of coins in the digital wallet.
- It deals with smart contracts for shopping and storing ethers. Smart contracts are the type of permission-less program which executes by default once the contract's conditions have been met.
- Ethereum influences digital programs by allowing consumers to play games, invest digitally, transfer money, receive money, track an investment portfolio, and many more.
- NFTs are distinct digital tokens that are useful for evidencing the origin of uncommon assets. NFTs could be used by people for the safety of their work. It also guarantees that their work is distinctive and goes to them. The possession data is noted and preserved on the blockchain system. NFTs are becoming popular in the gaming industry as it permits synchronization between gaming podiums.
- Ethereum is decentralized avoiding control of people over the transmission of digital money or other possessions.

5 Implementation and Result Discussion

Implementation of the proposed NFT market is shown through some figures as follows. First, open the terminal in the repo and then enter the command npx hardhat node as shown in Fig. 1. Hardhat is an environment that allows users to compile, test, and debug Ethereum software. It also helps in creating a smart contract by providing recurring tasks. With this, we can generate private keys for accounts. It will also provide 10,000 ether in it on the dev network. The ethers are added to the MetaMask wallet. Through localhosts, we can create smart contracts. Private and public key is used for authentication purpose in the blockchain. Approval of transactions and ownership of user addresses on the blockchain is done through private keys. Any user who wants to use his/her tokens then also he/she needs to enter a private key. Public keys are used to receive cryptocurrency into their accounts. The public key

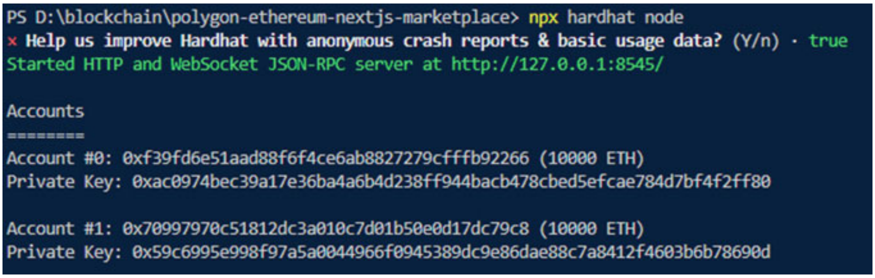

Fig. 1 Generation of private key

is generated by referring private key. Reducing the size of the public key through compression or some other method is converted into a public address.

Using the above-mentioned private key for account 2, we import 10,000 ethers into the MetaMask wallet. MetaMask is an extension to interact with blockchain Ethereum. It permits users to send, receive, and store Ethereum on the blockchain. It provides integrated services by establishing agreements with decentralized applications. MetaMask is a wallet and allows users to do transactions on the blockchain. MetaMask also creates smart contracts. It is completely open-source and has a reliable group at the back to respond fast to new concerns.

Lots of hardware as well as software wallet exists in the market, one can use any wallet either in hardware form or in software form. It provides many wallets and their private keys to use for dev purposes. Around 10,000 ethers are added to the wallet on the dev network that is the localhost in this case. Figure 2 shows ether added to the MetaMask wallet.

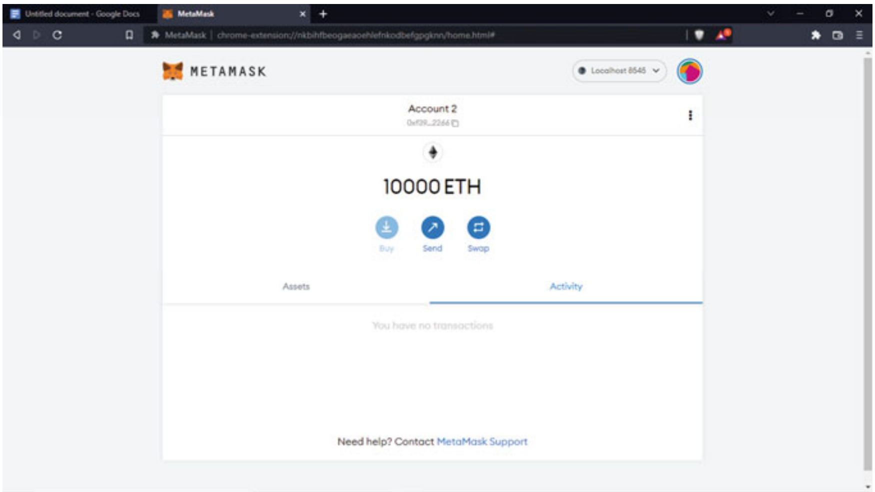

Fig. 2 Dev wallet

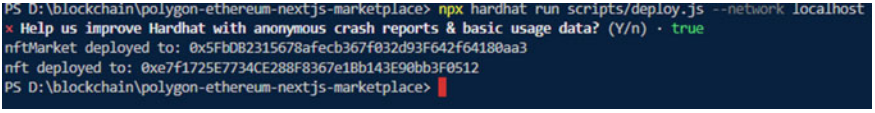

Fig. 3 Smart contract

Figure 3 shows the deployment of a solidity smart contract to run the NFT program. Gavin Wood gave the concept of solidity language in 2014. Solidity is officially released in August, 2015. Wood served as the CTO at Ethereum for two years. His idea was taken forward by Christian Reitwiessner, who led a team of people to develop it. Solidity is the code behind Ethereum—one of the biggest blockchain platforms in the world. Both do have correspondence—like being blockchain platforms with built-in tokens. Bitcoin's currency (Bitcoin) and Ethereum's currency (ether) are two of the most important and broadly traded cryptocurrencies available. The token, ether, was created as a way to pay for those dealings on the platform.

Solidity makes extensive use of concepts from various programming languages. Variables, string manipulation, classes, functions, arithmetic operations, and so forth are all included. While a programmer in a language like C would most likely construct a function like "int main" or "main," solidity works with a "contract" that is created similarly. The solidity programming language resembles C++, C#, and JavaScript in appearance. Python programmers will notice that variables in solidity must have their type defined explicitly, among other peculiarities.

Now we start the NFT program in the localhost. Initially, there are no items to buy, so as a creator we can add NFTs for the people to buy them. The metaverse marketplace is shown in Fig. 4. For adding NFT, we have to pay some gas fees to the nodes from the dev wallet. A blockchain wallet is a digital wallet that provides users the facility of storing cryptocurrency in the form of Bitcoin, ether, Steller, Tehter, and many more. The wallet permit users to transfer digital assets in form of cryptocurrency and also convert cryptocurrency back into the user's local currency. Anyone can use a wallet to hold and use cryptocurrency. A wallet is accessed using private keys and passwords. Whenever the user wants to send or receive cryptocurrency he or she needs to login with their private key.

NFT gas payment is done as shown in Fig. 5. The digital image is uploaded to sell through NFT. Only one or more NFTs can be "mint" (created) for digital artwork. The analogy in the physical world can be a one-time painting for a limited number of editions of printed matter. NFT owners can also claim some ownership. This allows a large number of people to each own a "work" of highly valuable works of art. Art, photography, animation, video, music, cartoon cats, and tweets, all of which can be the foundation of an NFT, and some are quickly appreciated. There are many opportunities in this very new market along with some challenges. The NFT is created in the form of an image as shown in Fig. 6.

It is sold in 100 ethers and MetaMask prompts with a receipt of 100 ethers as shown in Fig. 7. Creating NFTs allows artists and musicians to connect with new audiences and sell their work directly, without the need for agents or dealers. This is

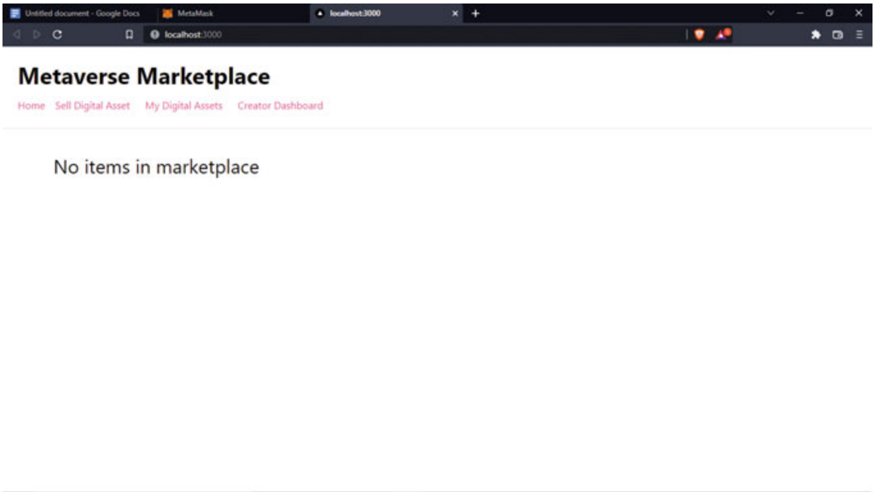

Fig. 4 Metaverse marketplace

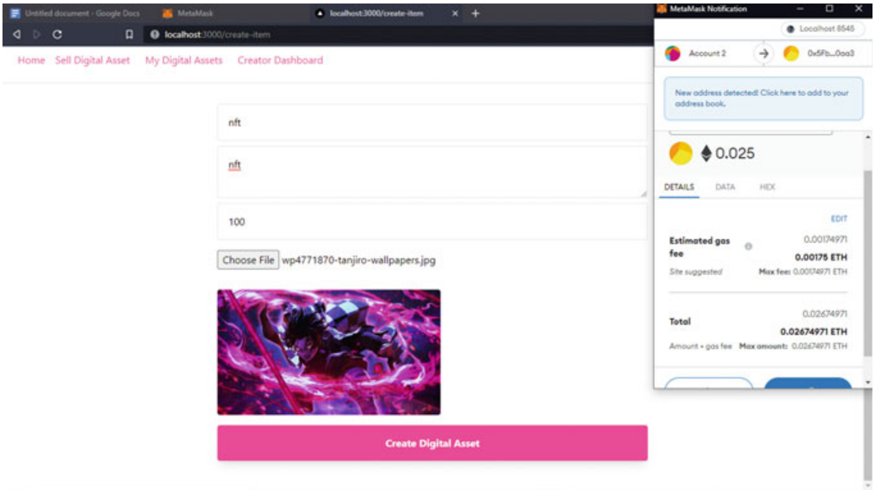

Fig. 5 Payment of gas

an opportunity not only for those who are not yet connected to the industry but also for many who are marginalized in their lifestyles, allowing freedom of expression that is not possible or even legal at home.

Each NFT has a public record of its creation and ownership history, so artists can always see the latest value of their work, but in the real world, it's lost when art is bought and sold. It tends to be even better; creators can choose to automate the royalties of their work, allowing them to regain a certain percentage of the price

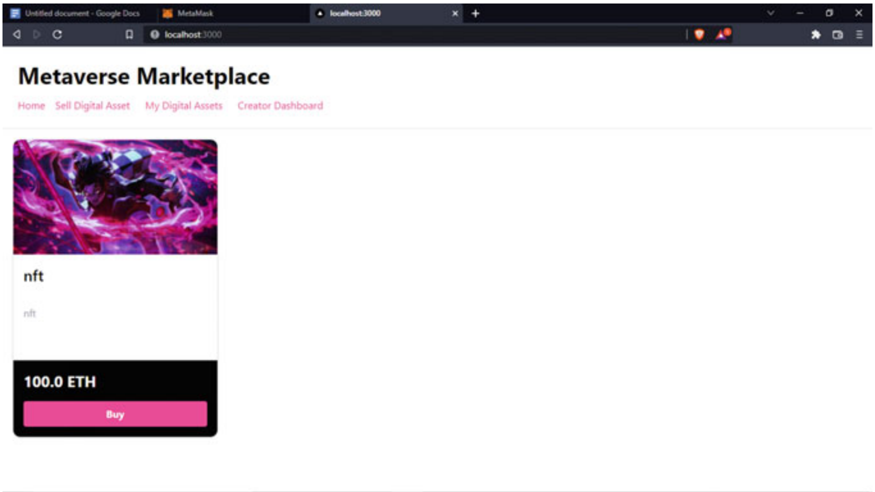

Fig. 6 NFT created

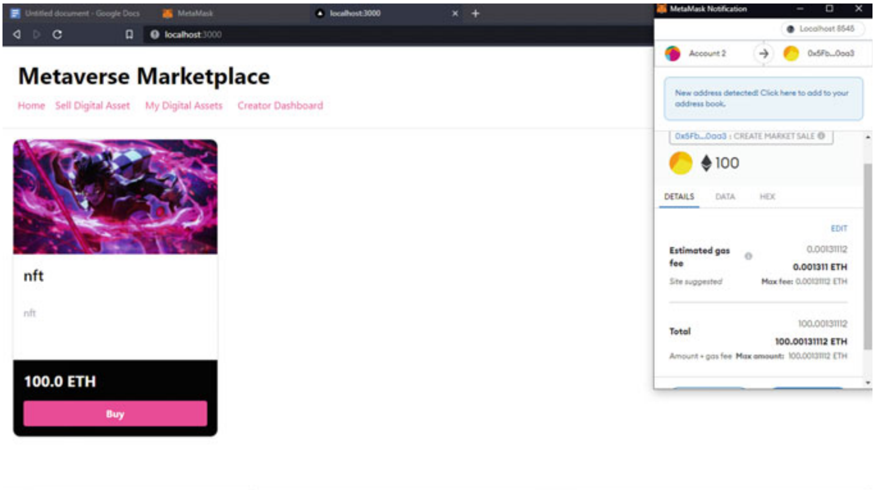

Fig. 7 NFT sold

with each resale. Once someone buys anything from the market it will be moved to his/her assets.

As a creator, if I want to see my collection sales. I can do that from my creator dashboard. I can also check the item created and sold as shown in Fig. 8. The complete interface of the NFT market is shown with the help of some of the above figures. How it creates an account, how we can add ether, how any digital item can be uploaded, how it is sold, everything is explained with the help series of figures.

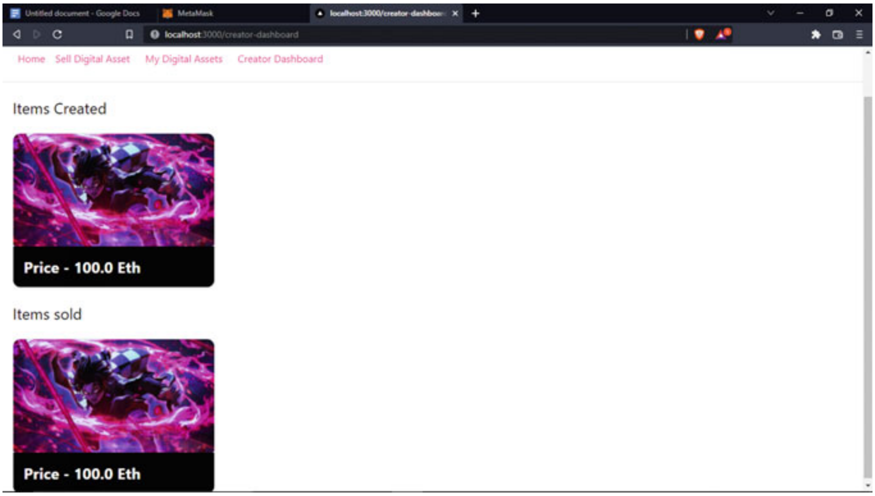

Fig. 8 Dashboard

The proposed paper is a portal for digital creators or artists to monetize their art forms using the advanced technology of NFTs and blockchain. Other creators or people who appreciate the art can purchase the NFTs and add them to their collection. It is easy to use as the user interface is reliable and simple. Also, the data privacy and smoothness are very efficient due to the use of the Ethereum blockchain.

6 Conclusion

The proposed paper helps researchers and academicians to pursue on NFT market. Along with an overview of NFT on the blockchain, we have created a framework for the NFT market which is reliable and secure. In this paper, the NFT market has been designed in solidity language and Ethereum has been used as a cryptocurrency. It can be efficiently used to sell, purchase, and store digital assets. It also provides the owner of the digital product through blockchain. In the future, we will work on the NFT market and its relationship with cryptocurrency. We will expand our proposed work to test different blockchains as each blockchain has its own merits and demerits. Testing parameters for different blockchains include transaction speed, privacy, and decentralization policies.

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Sign Language Recognition Using Machine Learning

Pradnya Borkar and Kiran Godbole

Abstract Communication is vital for humans. It helps to share knowledge and information and develop relations with others. We know that it is hard for people to communicate with people speaking sign language. Therefore, the purpose of this work is to implement a machine learning model for classifying and identifying hand gestures like sign language for translating interactions into written and oral forms. We have developed a machine learning model which will detect hand gestures and translate it to words which will help people to understand sign language.

Keywords Sign language recognition · Convolutional neural network

1 Introduction

Sign language is an important means of communication for humans, which is a gesture-based communication system who are deaf. It's a nonverbal language that hearing-impaired organizations participate in to communicate more successfully with one other and with non-disabled people. It's difficult to communicate with people having hearing and speaking disabilities.

Sign language allows communication with deaf or hard-of-hearing people. Each nation's sign language is distinct. It isn't the same everywhere in the world. The USA has developed American Sign Language and it is used widely in that region. Similarly, British Sign Language was created in the UK. American Sign Language is widely used in most nations, and our system is also based on it. The difficulty of understanding sign language has long been researched. Furthermore, there is no

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universal sign language, and only a few people know how to use it, making it an ineffective mode of communication.

In this paper, we'll discuss the implementation of the machine learning model we have developed to recognize sign language which will help in communication between people with hearing and speaking disabilities and for those person who are not able to recognize sign language.

The work presented in this paper is focused on implementing the machine learning model and its efficiency in recognizing hand gestures. This model mainly focuses on American Sign Language and its recognition. I have used a vision-based method using Python and TensorFlow software library to implement this model.

2 Related Work

Currently, there are many models available that use different techniques to classify and recognize hand gestures. As stated before, many countries have their sign language; hence, there are many models compatible with different languages. Also, the models differ in the technique they use in the gathering of data and classification of the data along with the language they use to implement the model. Existing methods use methods like the method based on glove or vision to recognize hand gestures. However, the glove-based method will require the purchase of additional hardware which will increase the cost of the system and many may not be able to afford such a system making the system impractical. Many models are based on convolutional neural networks. It is very successful in image recognition and classification problems. This is the rationale behind the widespread use of this technology for the recognition of human gestures [1]. Deep CNNs have been used in the field of sign language identification in particular, using input recognition that takes into account more than simply the pixels in the images. The technique is made considerably simpler by creating distinctive depth and motion profiles for each sign language gesture when using cameras that sense depth and contour [2]. The efficiency and accuracy of using CNN are considerable and the model created using this can be scaled depending on the requirement. On the other hand, many developers are using the Leap Motion Controller to develop recognition models with the help of machine learning. It is an optical hand tracking module that records how the hands and fingers of users move. The LMC is frequently used in a variety of industries, including gaming, device control, interactive art, virtual reality, and other ones. The LMC is a portable peripheral device that fits in the palm of your hand, is low cost, and is made specifically to track hand and finger motion with great accuracy in a 3D Cartesian coordinate system [3].

Similar to LMC, RealSense can be used for gesture detection. This technology is a collection of tracking and depth technologies created to offer machines and devices the ability to perceive depth. The RealSense SR300 camera is used to collect depth and colour data. Second, by combining colour and depth information, the generalized Hough transform (GHT) is computed to accurately segment hand gestures in colour images. Last but not least, DC-CNN is built to combine segmented colour images with depth images, and its final output is the prediction of hand gestures [4].

3 Classification of Images and Data Set Collection

To compare the photographs taken while communicating using this method, it is necessary to create a suitable database of the gestures used in the specified language. The data set was created using the Open (OpenCV) package. First, for training purposes, pictures of each ASL symbol were taken. Then take a screenshot of each frame displayed by the other computer's webcam. A blue limited square in each frame designates an area of significance. Applying a Gaussian blur filter will enable you to extract a variety of image attributes.

Fig. 1 ASL alphabet

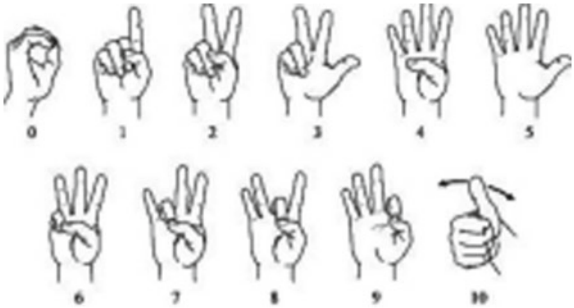


Fig. 2 ASL numbers

We captured each sign, then used background subtraction methods to remove the backgrounds from each image to create our own data set. The data set was first divided into two halves for training and validation, and the validation accuracy displayed a high level. The Figs. 1 and 2 shows the various signs for alphabets and numbers.

4 Proposed Model

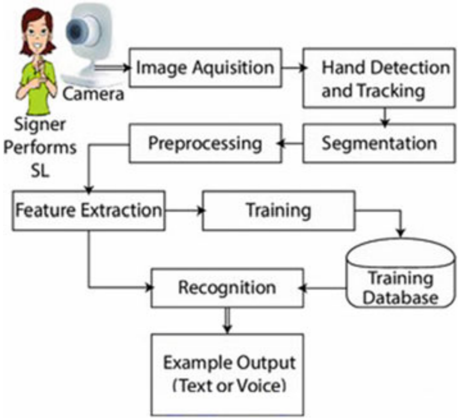
The proposed model focuses on solving the real-life problem of communication through sign language for people who doesn't understand the language. We use transfer learning technique to develop our model. With the help of transfer learning, a model that has been trained on a big data set can be applied to a smaller data set. The general framework for transfer learning for object recognition is shown below: add a pre-trained CNN model that has been through extensive training. Lower convolutional layer parameters (weights) in the model are frozen. Add a custom classifier with several trainable layers to the model. Layers of training data are accessible for the task's classifier. As necessary, adjust the hyper parameters and unfreeze more layers. Python and TensorFlow have been used to implement this model [5, 6].

The model as shown in Fig. 3 will capture live feed from the camera of the device. In this live feed, the model tries to detect patterns of hand gesture. It draws a pattern for user in red lines so that the user can confirm the pattern is getting recognized correctly as shown in below image. The model will preprocess the feed captured through camera and will be compared to training data set present in data set. The proposed system also looks for commonly used phrases in sign language and provides outputs around the same line [7].

5 Result Analysis

The developed model provides desired output as per the goal. The model successfully runs and captures live feed from computer camera. When an American Sign is made

Fig. 3 System architecture

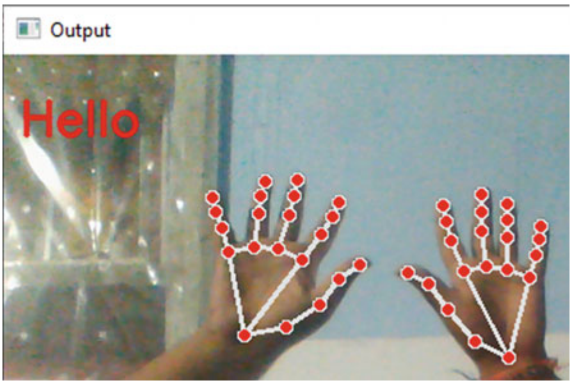


through hand gesture, then the model starts detecting the sign through developed model. Red dots joining the pattern on hand gestures allow user to see the drawn pattern. This also helps the model to detect the sign.

The above images shown in Figs. 4 and 5 show that, the model successfully detects motion of the hand and recognized the sign. It also interprets signs and forms a sentence around it.

The hand movement is recorded by the web camera and inputted to OpenCV and TensorFlow object detection. To determine the hand's boundary, edge detection and skin detection are used. This is then forwarded to data sets for comparison. The model is trained using a data set. It is made up of an input layer, hidden layers, and an output layer. Backpropagation is used for increased accuracy and productivity. It carries out training and verification of the motions that are identified, and human computer interactions like page turning and zooming in and out take place. System Calls or PyAutoGUI are used to communicate with the computer. Figure 6 shows the various hand gesture detected from various hand movements.

Fig. 4 Hand gesture showing hello



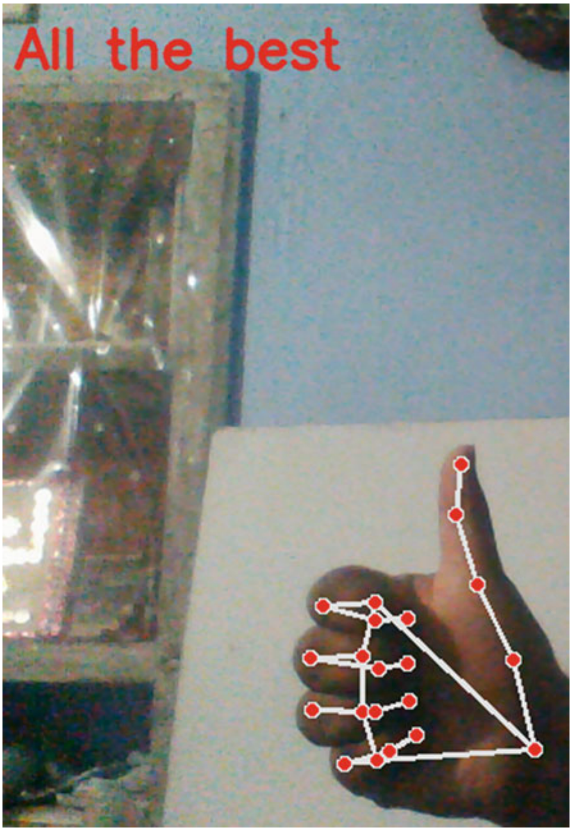


Fig. 5 Hand gesture showing all the best

Fig. 6 Various hand gesture

6 Conclusion

Many scientists and scientific enthusiasts have already researched and applied different techniques for developing recognition technology. Many machine learning models were also created to aid in the effective execution of sign language recognition. Our goal was also to create a machine learning model which will simplify the task to recognize American Sign Language using vision-based technique. To accomplish our goal, Python language and TensorFlow were used. The hardware requirement limits to a working computer to use this model.

The computer camera scans hand gesture in order to classify them. These images get processed through our model. The model uses our algorithm to compare and recognize images with available data set. Furthermore, different algorithms were applied to the same data sets in order to calculate and estimate the accuracy and consistency of the implementations used to illustrate the value, execution, and type of data sets used for the specified algorithm. Therefore, the model accurately recognizes the hand gesture.

The technology serves as a link between normal and impaired persons. It bridges the gap in communication between differently abled and hearing persons. The system translates hand movements into text and then into voice. If a person cannot hear the sound made due to certain circumstances, a text system has been built into the system so that the person may read and understand what the other person is trying to say. Sign language interpreters are used to communicate with people who have speech and hearing impairments. In ordinary life, however, people cannot rely on interpreters because of the high expenses and difficulties in locating qualified interpreters. The system will considerably improve the quality of life for impaired people.

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An IoT-Based Health Monitoring System for Stress Detection in Human Beings

Alen J. James, Andrew Dixen, Naamah Susan Saji, Riya Thomas, S. N. Kumar, and Neenu Rose Antony

Abstract This research work proposes an IoT-based system for stress detection. For stress detection, physiological parameters are acquired and analyzed. Electromyography (EMG) and galvanic skin response are acquired and are used to detect stress. The IoT-based system was designed to transfer data through the Arduino microcontroller. The Arduino Uno processor was employed for the processing of data, biosignal, and physiological parameters are acquired with the aid of dedicated sensors. The statistical analysis of the sensor data was carried out in this research work. The portable system gains its prominence in its usage in industrial and domestic sectors. The system allows for continuous monitoring of stress levels and data transferred through the cloud facilitates disease diagnosis and prediction.

Keywords Electromyogram · IoT · Stress · Biosignal · GSR

1 Introduction

Stress is an intensified state of the human body that arises due to perplexing event or difficult situations facing in life [1]. It affects the physical and mental health of human beings. Universally, a single factor is not responsible for stress, and many factors are there, and it varies among human beings. Stress in the working environment

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is commonly faced by youths and adults. Other sources of stress include marital issues, service pressure, joblessness, health issues, limited support, catastrophic events, jeopardizing working conditions, emotional trauma, financial obligations, casualty, mental ill health, and long work hours. Monitoring the stress level is vital in improving physical and mental health, thereby ensuring healthy living [2]. Stress is responsible for many diseases, and especially abnormalities in cardiac parameters are crucial [3]. The individual undergoing stress may be immunosuppressed, making them defenseless to pathogens [4]. It also impacts work performance and general attitudes in daily life. In [4], stress detection from ECG signals was highlighted, and various machine learning algorithms were employed for the classification of data. Multiple bio-physiological parameters were used for the stress detection in [5], and comparative analysis, data from Wearable Stress and Affect Detection (WESAD) dataset was utilized [3].

The outcome of this research work [3] states that respiratory and heart rates are efficient parameters in distinguishing between normal and stressful conditions [3]. The stress level detection among drivers was highlighted in [6], and data were acquired by using sensors with a minimum of 50 min duration. The skin conductance and heart rate were found to be proficient in stress detection. A dataset comprising multimodal inputs was utilized in [7] for the stress detection, and the classification was carried out by the decision fusion strategy. A wristwatch-based system was proposed in [8] for automatic stress detection, and signal processing and machine learning algorithms are utilized.

The developments in wearable lifestyle equipment have led to unnoticeable, sensor-crammed devices which can ceaselessly check the biosignals to find, decide, or even preclude stress and its inimical consequences. Electrocardiogram (ECG), photoplethysmogram (PPG), surface temperature (ST), electrodermal activity (EDA), electromyogram (EMG), electroencephalogram (EEG), near-infrared spectroscopy (NIRS), and an electrooculogram (EOG) are used to measure the biosignals directly. Facial expressions, head movement patterns, body posture, and speech characteristics provide indirectly measurable biosignals [9]. The paper organization is as follows: Sect. 2 focuses on the materials and methods comprising proposed hardware methodology, GSR, EMG, and pulse rate acquisition. Section 3 highlights the statistical analysis of results with inferences and finally, a conclusion is drawn in Sect. 4.

2 Materials and Methods

The flow diagram of the proposed stress detection system is depicted in Fig. 1. The biosignals and physiological parameters are processed by the Arduino Uno board. The microcontroller has analog and digital pins. A 5 V supply is required to power up the microcontroller, and it can provide power to two sensors at a time; the EMG and GSR sensor are provided power supply through the microcontroller. EMG sensor is connected to the analog pin A0 and the GSR sensor is connected to the analog

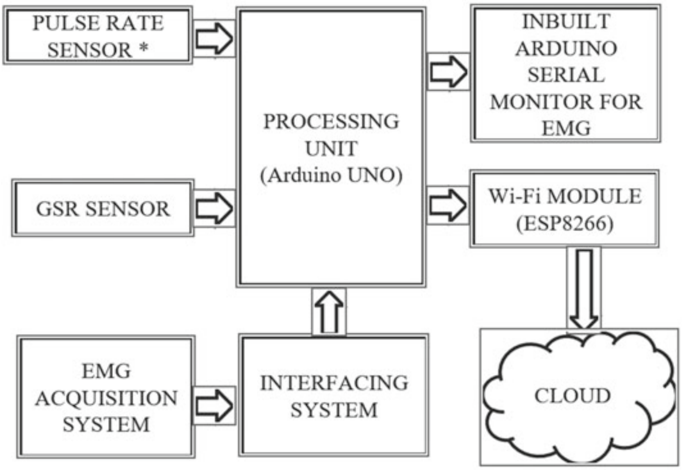

Fig. 1 Flow diagram of the proposed system

pin A1 of the microcontroller. The ESP-01 ESP8266 Wi-Fi module is used for the transfer of data to the cloud and the ThingSpeak IoT cloud platform is employed in this work.

2.1 Acquisition of Galvanic Skin Response (GSR)

People are still unable to measure their stress levels which will bring an impact on their health. Most stress measurement techniques are expensive, and the method used is complicated; hence, Galvanic Skin Response sensor is a feasible method for measurement of stress. As stress is getting common nowadays in this fast-developing world, it helps people to detect their stress level with a simple analysis. GSR sensor is a very economical device and is more user-friendly. The skin conductance is determined and it relies on the sweat generated from the sweat glands in the body. Emotions can influence the sweat glands to secrete more sweat and are related to GSR value. An increase in sweat will cause the value of GSR to decrease which is an indication of stress. The groove sensor is widely used in many real-time applications for the measurement of GSR. GSR groove sensor comprises two electrodes attached to the fingers, usually attached to the middle and index finger. In the relaxed state, less sweat is generated, and the electrical resistance of the skin is high and resulting in low conductive voltage. The stressful condition increases the sweat generated, the electrical resistance of the skin is low, and results in high conductive voltage. A threshold value is required for the analysis of results.

Normal conditions, the GSR value is $>300 \pm 20$ KΩ [3]

Stressful conditions, the GSR value is $<200 \pm 20$ KΩ [3]

The GSR groove sensor system comprises four components: a sensor for estimation of skin resistance, an interfacing circuit to the processor, an embedded processor, and a display module. In this research work, an Arduino UNO board was used, and a serial plotter helps to visualize the GSR values. The GSR groove sensor requires a constant voltage of 3.3 V and can be taken from the Arduino UNO board.

2.2 Acquisition of Electromyogram (EMG)

Electromyography (EMG) reflects the muscle's electrical activity and is generated due to the electrochemical activity of cells in the muscle tissues [1]. The potential generated in a cell under resting conditions is called resting-state potential, and the cell is said to be in a polarized condition. Any stimulus will cause the potential to rise and is called an action potential, the cell is said to be in a depolarized condition. The motor unit is the basic biological unit that reflects muscle activity. The motor unit comprises a neuron and several muscle fibers. Action potentials are generated in the muscle fibers by the excitation of motor neurons. The EMG is used to detect neuromuscular abnormalities. Myoware sensor is used in this research work for the acquisition of EMG signals. The EMG signal value was imported to the excel file as well as it can be stored in the cloud platform. The serial plotter enables visualization of the EMG signals. The Myoware Muscle sensor was manufactured by Advancer Technologies and packaged by Spark fun. EMG coupled with the ECG signal was found to be proficient in the detection of stress [9]. The higher value of EMG in the upper trapezoidal muscle is an indication of stress when compared to the normal condition of the subject [10]. EMG signal was deployed in [11] for the detection of anger, since stress is related to the formation of anger, the high value of EMG is an indication of anger as well as stress.

The EMG threshold values are as follows:

In normal conditions, the EMG range is 0–200 mV.

In stressful conditions, the EMG range is 200–900 mV.

3 Results and Discussion

The IoT implementation was done on an Arduino Uno board. For the analysis of the acquired EMG signal, MATLAB software was used. The GSR and EMG are acquired with the help of respective sensors and are interfaced with the Arduino Uno board. Figure 2 depicts the stress detection system comprising GSR and EMG measurement. The acquired data were transferred to the cloud for analysis. Also, a Microsoft Data Streamer can be used to generate the excel data sheet of the acquired sensor values. The cloud platform strengthens the IoT-based application, and the data can be transferred to any other nodes. In this research work, ten human subjects are considered, and the data are acquired in real time. Tables 1, 2, and 3 depict the subject's physiological parameters obtained using the sensors. The first 20 samples are listed below and in this research work, 100 samples are utilized for statistical analysis.

Table 1 represents the details of the subjects. The experiment was carried out by connecting sensors to all subjects and recording the data.

In this research work, the main focus is to analyze the EMG and GSR signals for stress detection, and hence, the EMG and GSR plot of subject 1 is depicted in Figs. 3 and 4.

Tables 3 and 4 depict the statistical results of EMG and GSR sensor values corresponding to ten subjects. The statistical measures employed for the analysis of EMG signals are as follows:

(a) (b)

Fig. 2 Stress detection system **a** GSR measurement and **b** EMG measurement

Table 1 Details of the subjects

Subject ID	Age	Height (cm)	Weight (kg)	Gender
1	21	178.5	93	Male
2	36	173.5	88	Male
3	37	165	66	Female
4	22	151	45	Female
5	22	157	61	Female
6	41	165	62	Male
7	36	154	55	Female
8	36	170.5	73	Male
9	25	179	75	Male
10	62	170	64	Male

Table 2 First-order statistical measures of EMG signal

SI No.	Mean	Variance	Standard deviation	Standard error of mean
1	191.66	2867.98	53.5536	5.355
2	197.17	2168.72	46.5695	4.656
3	160.83	2417.65	49.1696	4.916
4	124.66	2.18626	1.4786	0.147
5	153.92	2163.15	46.50969	4.650
6	160.91	1397.25	37.37989	3.737
7	109.77	1521.49	39.00631	3.900
8	90.31	2327.22	48.24133	4.824
9	120.89	2357.99	48.55922	4.855
10	103.55	7.58950	2.754906	0.275

Table 3 First-order statistical measures of GSR signal

SI No.	Mean	Variance	Standard deviation	Standard error of mean
1	393.96	655.85	25.60	2.560
2	426.82	0.76	0.87	0.008
3	401.46	48.97	6.99	0.069
4	284.81	295.41	17.18	1.718
5	430.35	10.81	3.28	0.328
6	461.85	7831.09	88.49	8.849
7	433.58	1.5793	1.25	0.125
8	434.43	0.28	0.53	0.053
9	433.79	0.1877	0.43	0.043
10	430.84	94.11	25.60	2.560

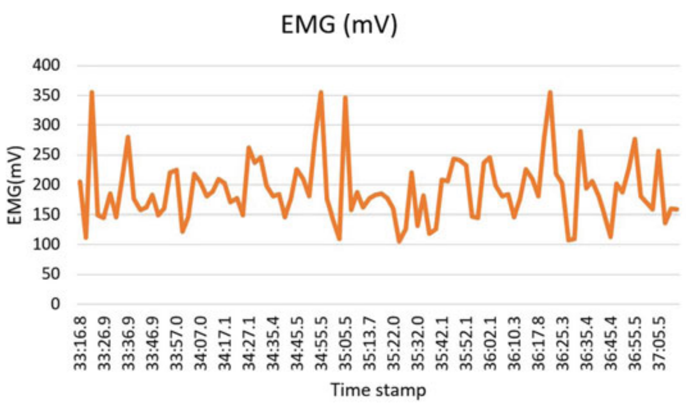

Fig. 3 Graph showing the normal EMG reading of subject 1

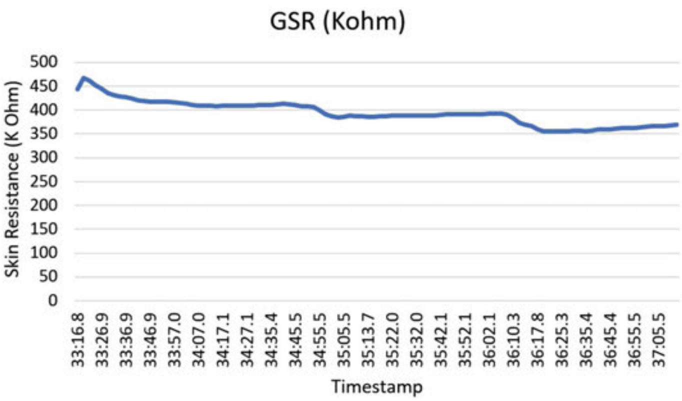

Fig. 4 Graph showing the normal GSR reading of subject 1

Table 4 Inferences from the EMG and GSR sensor data

Subject No	Age	EMG mean (mV)	GSR mean (K-Ω)	Whether the subject is stressed or not
1	21	191.66	393.96	No
2	36	197.17	426.82	No
3	37	160.83	401.46	No
4	22	124.66	284.81	No
5	22	153.92	430.35	No
6	41	160.91	461.85	No
7	36	109.77	433.58	No
8	36	90.31	434.43	No
9	25	120.89	433.79	No
10	62	103.55	430.84	No

RMS value (Root Mean Square): The root mean square (RMS) is defined as the square root of the mean square. RMS was also defined as a continuously varying function in terms of an integral of the squares of the instantaneous values during a cycle.

$$\mathrm{RMS} = \sqrt{\left(\frac{1}{N}\right)\sum_{k=1}^{N}[x_k]^2}; \quad k = 1, 2, 3, \ldots, n \tag{1}$$

N number of samples,
x_k the k-sample.

Absolute Mean Value (AMV): The mean value of samples in a signal is termed the absolute mean value.

$$\text{Mean}(\overline{x}) = \frac{1}{N}\sum_{k=1}^{N}|x_k| \quad (2)$$

Variance Value (VAR): Variance is the expectation of the squared deviation of a random variable from its population mean or sample mean. Variance is a measure of dispersion, meaning it is a measure of how far a set of numbers is spread out from their average value.

$$\sigma_i = E\{x_k\} - E^2\{x_k\} \quad (3)$$

$E\{x_k\}$ the expected value of the signal in the segment i.

Standard Deviation (SD): The standard deviation is a measure of the amount of variation or dispersion of a set of values. The standard deviation of a random variable, sample, statistical population, dataset, or probability distribution is the square root of its variance.

$$\text{SD} = \sqrt{\frac{\sum(x_i - \overline{x})}{n-1}} \quad (4)$$

Standard error of mean (SEM): The standard error of the mean is a method used to evaluate the standard deviation of a sampling distribution. It is also called the standard deviation of the mean and is abbreviated as SEM.

$$\text{SEM} = \frac{\text{SD}}{\sqrt{n}} \quad (5)$$

The final inferences from the experiment are summarized in Table 4. The mean values of EMG and GSR sensor values corresponding to ten subjects are represented in Table 4. The EMG and the GSR sensor values are compared with the threshold values, and inferences are made.

4 Conclusion

This research work proposes an IoT-based portable system for stress detection in human beings. The biosignal and physiological parameters are acquired with the aid of sensors and processed by the Arduino UNO microcontroller. The statistical analysis was performed on the acquired data, and the data were made to transfer through the cloud network for disease diagnosis and prediction. The threshold values comparison of EMG, GSR, and heart rate enables to predict the mental state of a person. The future work will be focusing on the analysis of acquired data with the aid of computer-aided algorithms.

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IoT-Based Driving Pattern Analysis and Engine Sensor Damage Prediction Using Onboard Diagnostics

K. K. Abhinand Krishna, Abhinav Bavos, Ashak Achankunju Thomas, Jerin Joseph, Siju John, and S. N. Kumar

Abstract Car diagnostic tools use sophisticated software to quickly and accurately identify problem areas in a car's engine or elsewhere. The adaptation from mechanical systems to electrical paved the way for much research in the area of vehicle monitoring through a server. Although many studies focus on the tracking of vehicles, fault detection has also gained considerable attention. From our background study, we noticed that most of the systems currently available display the data from OBD and do not perform any functions using that data. We propose a machine learning-based driving pattern analysis and sensor damage prediction system using the data collected from an Onboard Diagnostics (OBD) port. Our system consists of an ELM327 adapter to read data from an OBD port, a mobile application, and a cloud backend. Using the time series data collected, we perform driving pattern analysis and sensor damage detection from the backend server. The smartphone application makes the findings of these analyses visible. The findings can be accessed by the drivers directly via the smartphone app. Drivers are notified of alerts created in the backend as a result of unfavorable conditions.

Keywords ELM 327 · ECU · OBD · LSTM

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1 Introduction

One of the most beneficial technological advances in the automotive industry over the decades has been the computerization of car components, which has benefited both consumers and auto technicians. Car diagnostic tools use sophisticated software to quickly and accurately identify problem areas in a car's engine or elsewhere. Built-in CPUs, microchips, and sensors make this possible. In a modern automobile, there are approximately 70 sensors located throughout the vehicle. In the engines, 15–30 of these sensors are present to keep things working smoothly. OBD is a protocol used to fetch vehicle diagnostics information that is generated from the ECU of a car. A portion of the often utilized sensors incorporates speed, motor rpm, coolant temperature, fuel rate, and oxygen. An OBD-II is the second era of an OBD or OBD I. ELM 327 is the adapter used in the proposed system to read data from OBD. Numerous systems use data from the OBD2 connection to display real-time sensor readings in a human-readable format. Other systems like the in-vehicle data recorder system give drivers feedback on their on-road performance. Despite the fact that some systems use vehicular data analysis, there is no reliable solution for predicting engine sensor failures. The suggested solution employs the OBD2 protocol and a mobile application as a mediation device. To analyze driving patterns and predict engine sensor deterioration, the system employs some sophisticated machine learning techniques. The studies are carried out on both real-time and archived data collected. Since the assessments are time consuming and resource intensive, they are done in the backend. The smartphone application makes the findings of these analyses visible. The findings can be accessed by the drivers directly via the smartphone app. Drivers are notified of alerts created in the backend as a result of unfavorable conditions.

Business Activity Monitor (BAM) is enabled so as to identify the pattern, it should have the ability to predict the undesirable outcomes such as potential failures of sensors. BAM is a primary solution that is intended to provide a real-time summary about business activities and which are capable of collecting, storing, and analyzing data. Drivers can evaluate their driving behavior and changes in the condition of vehicles [1]. The driving behavior (DB) has been classified as safe, aggressive, inattentive, and risky driving behavior. By using neural networks, driving styles can be analyzed by aggregation of data such as rpm, gear shifting, engine speed, vehicle speed, through OBD-II [2]. In [3], a method called MobiDriveScore helps the consumers to assess his\her own driving patterns using their daily routine trips. Through MobiDriveScore, the consumer which is using this can consciously reduce the risk that can occur by his/her driving. The accelerometer and GPS signals within the vehicle are captured using smartphones and for detecting high-risk driving patterns an event detection algorithm is used. Then, the overall average risk factor for each trip is calculated by the risk scores. There are five parameters by which the driving pattern can be calculated which are Risk Computation, Hard Bump, Hard Cornering, Hard Stop, or Acceleration. By these parameters, it is effectively used for the analysis of road vehicle driving patterns [3]. The performance of a driver is evaluated by the following method. Various considered parameters are analyzed and their values are collected frequently when a driver is driving. The Torque app uses a Bluetooth-enabled OBD-II adapter to collect driving data from the car. This OBD-II adaptor serves as a link between your car's OBD-II system and your smartphone. The data is saved as log data in the *.csv format. These logs are filtered before being forwarded to a centralized server, where the information is kept and evaluated in order to provide ratings. The driver can now see his or her scores as well as see a graph of historical performance (Line chart) [4].

The smartphone was utilized in [5] for the collection of automotive data for driving pattern analysis, data were collected from 9 drivers. The OBD II data was utilized in [6] for driving behavior analysis and the regression model was used for the prediction of parameters. A tool was proposed in [7] for collecting OBD and GPS data for vehicle behavior analysis. A low-cost vehicle performance monitoring system was proposed in [8] based on blue tooth technology in Android phones, the OBD collects data from the engine control unit, and through the interface, data is sent to the smartphone through blue tooth. The second generation OBD system was integrated with the cloud network for data storage and transfer in [9], and in [10] a detailed review of driver behavior detection was highlighted.

2 Materials and Methods

2.1 Requirements

The software prerequisites include a smartphone running an Android version greater than pie (Android 9.0). Hardware prerequisites include ELM-327. ELM-327 is a Bluetooth device that provides an easy way to scan a vehicle's Onboard Diagnostics II (OBD-II) system for codes. They can also read PIDs and aid in diagnostics.

Driving pattern analysis. A system that monitors drivers continuously and utilizes the historical data from OBD for allocating an appropriate score thus helps in chastising errant drivers. The data for this analysis is collected from an OBD port using ELM-327. ELM-327 Bluetooth adapter provides an easy way to scan a vehicle's Onboard Diagnostics II (OBD-II) system for fault codes. They can also read PIDs and can help in diagnostics. The ELM-327 microcontroller acts as a bridge between the onboard computer in a car and a PC or handheld device. They communicate with the OBD-II system and relay data through a USB, Wi-Fi, or Bluetooth connection, depending on the implementation. Our approach for driving analysis is to consider harsh parameters that can be analyzed with a regular mobile phone, a car, and an OBD-II adapter. The measured parameters are given as inputs to a smart algorithm that delivers an appropriate score to the driver based on the number of harsh events that occurred (Fig. 1).

In this algorithm, we consider eight harsh events. They are high acceleration count, high deceleration count, high engine speed, low engine speed, high throttle vehicle, low throttle vehicle, high load, and low load.

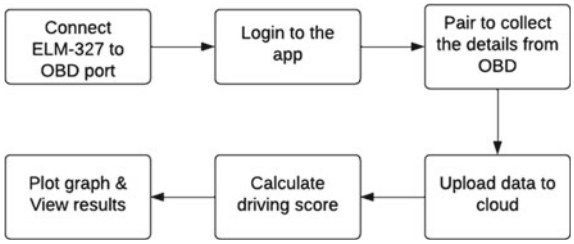


Fig. 1 Block diagram depicting the driving pattern analysis

Each of these events are counted as a harsh event according to the following conditions:

- High acceleration when acceleration greater than 2.74
- High deceleration when deceleration less than −2.74
- High engine speed when engine speed greater than 8
- Low engine speed when engine speed is less than 8
- High throttle value when throttle value greater than 10
- Low throttle value when throttle value less than 0
- High load value when load value greater than 97
- Low load value when load value less than 0.

We then find the total number of harsh events that occurred in a trip. The driving score is then assigned using the formula:

$$\text{score} = (10/(\text{harsh events}/(\text{total distance} * \text{allowed events per km})))/\text{total distance}$$

*Engine sensor damage prediction***.** Engine sensor damage prediction makes use of time series analysis for predictive maintenance. Predictive maintenance is a technique that uses data analysis tools and methods to detect anomalies in your operation and possible defects in equipment so you can fix them before they result in failure. For this purpose, we use a Long Short-Term Memory (LSTM) artificial neural network to make predictions based on time series data. We collect and store readings from different sensors over a long period of time. The reading from previous days is used to predict the readings for the next couple of days. If the predicted values fall beyond the operational range of that sensor, we notify the user regarding the possibility of a failure. We tested out our proposed method on Intake Manifold Pressure Sensor. Manifold absolute pressure sensor reads the total engine load in the intake manifold. The air outside is divided into proper amounts and is then given to each cylinder. The reading is then sent to the control module of the engine from where the amount of fuel to be fed to each cylinder is calculated. From here ignition timing is also determined. A properly functioning MAP sensor is required to maintain engine smoothness, acceleration, emissions, and fuel economy (Fig. 2).

Using Long Short-Term Memory (LSTM), an artificial recurrent neural network used in deep learning to process an entire sequence of data, sensor damage prediction is achieved. The model can learn long-term sequences of collected data, and hence,

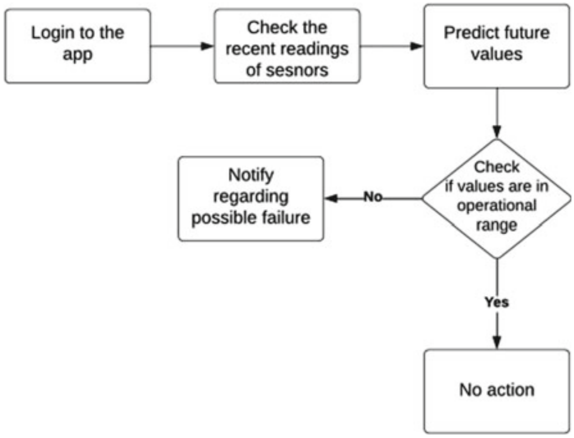


Fig. 2 Block diagram depicting the engine sensor damage prediction

LSTM is a popular method used in time series forecasting. Exploding and vanishing gradient problems that may occur as a result of repeated adjustment of weight are also solved using LSTM. The gradient becomes larger or smaller with repeated epochs and for each adjustment, the network's gradient's ability to compound in each direction becomes easier. Thus, one of the major drawbacks of traditional recurring neural networks, exploding and vanishing gradient problems are solved using LSTM architecture. LSTM neural networks apart from other neural networks contain feedback connections to provide results of previous output as input to the next. This feedback network also enables LSTM to process the time series data without treating each data independently (Fig. 3).

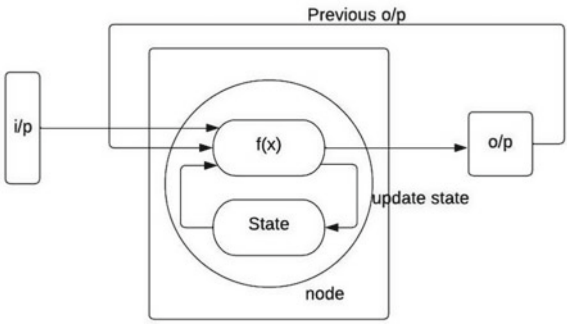


Fig. 3 LSTM model utilized for the engine sensor damage prediction

3 Simulation Results and Discussion

The algorithms are developed in Python and executed on i5 processor. The input data was taken from the public database (www.kaggle.com/datasets/cephasax/obdii-ds3?select=exp2_19drivers_1car_1route.csv). The driving pattern analysis algorithm gives the following output and is depicted in Fig. 4.

From the graph, it can be easily identified that only a few trips got a score 10/10 while the average score is less than 5. Since our approach for giving driving score is based on the concept of harsh events, we can conclude that most of the trips have a high number of harsh events which caused them to have a low score (Fig. 5).

Fig. 4 Score graph

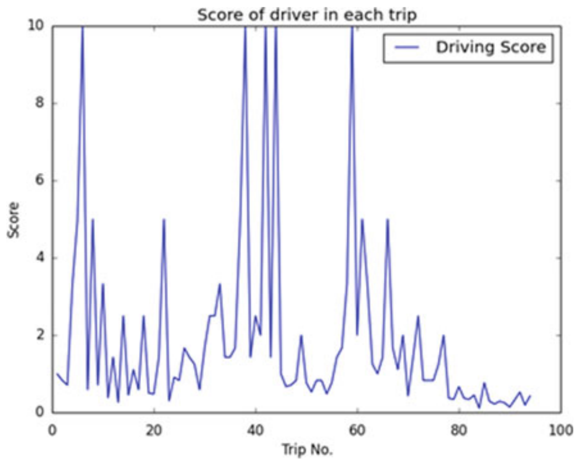


Fig. 5 Harsh acceleration plot

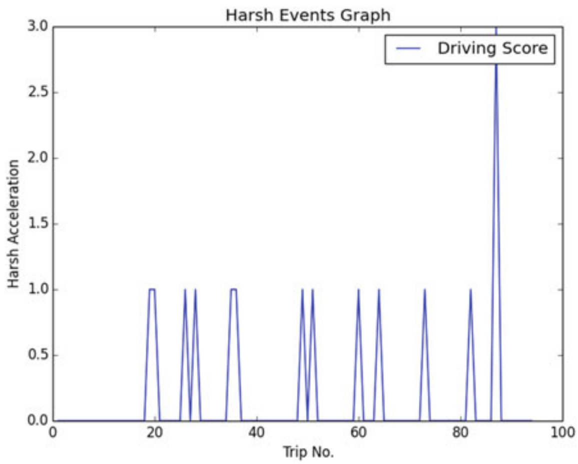
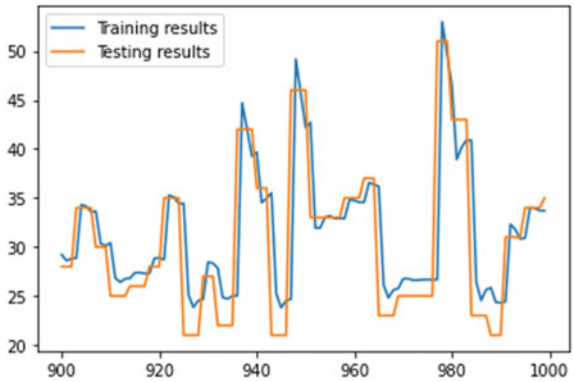


Fig. 6 Training and testing results



The graph above shows the number of harsh event parameters that occurred during each trip. It can be seen that on the 20th trip the harsh acceleration occurred only once and on the 87th trip there are 3 harsh accelerations.

The LSTM model for sensor damage prediction gives the following output and is depicted in Fig. 6.

We trained the model against 1500 rows of data with a mean square error of 8.86. The training was done for 20 epochs. The dataset we used has around 1500 rows, and it was noted that initially the predicted values and actual values have a large difference. But towards the end of the dataset predicted values and actual values show the minimum difference between them. If this pattern follows, we can assume that the sensor values for the next few days will also be predicted with a minimum difference, and hence, the possibility of any malfunction of these sensors can be evaluated.

4 Conclusion

We developed a driving analysis and engine sensor damage prediction using the data obtained from the OBD2 port. The system is able to detect reckless and anomalous driving using collected data from multiple trips and assigns a score to each one of them. Further, the app uses historical sensor values to detect and predict impending sensor failures using the time series prediction method. Additional functionalities of the proposed app include visualizing readings from various vehicular sensors and push notifications from the cloud backend.

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Solving the Element Detecting Problem in Graphs via Quantum Walk Search Algorithm (QWSA)

Sukhpreet Kaur Gill, Gaganpreet Kaur, Gauri Shankar, and Veeramanickam

Abstract Many quantum algorithms rely on quantum walks, which are the quantum equivalent of a conventional Markov chain. This paper will present the review of already existing classical Markov model and exiting quantum walk algorithms such as coined quantum walks and Szegedy quantum walk. Then we show the quantum walk search algorithm (QWSA) formulation to solve the problem of detecting elements in graphs. We implemented the algorithm which will detect the element and as well as marked every detected vertex in any given graph and measurement phase in quantum algorithm done in the computational form. Finally, we implemented it on several specific graphs, i.e. four-dimensional hypercube.

Keywords Quantum algorithms · Quantum walk · Classical Markov chains · Qubits

1 Introduction

In the twentieth century, the specific sort of stochastic procedures, called as random walks, was introduced [1]. From then, it expanded very fast and became a very powerful tool in various research areas such as computer science, economics, physics and many more [2]. During this time, the quantum mechanics came into existence. However, quantum walks, termed as the quantum version of random walks, were proposed after approximately 90 years after the first existence of quantum mechanics [3]. Quantum random walks are integrated into various applications such as quantum

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simulation and quantum algorithm [4]. Different models of quantum walks are there like coined model, Szegedy model, staggered model and Hamiltonian staggered model. These models have their own unique feature to deal with the specific problem. However, in real implementation having various technical problems as similar to quantum computer. Various quantum models of quantum walks are used to design the quantum computation platform universally [5]. As of this powerful applications, various quantum walks models' experimental processes are promoted intensively, for example optical lattices [6], trapped icons and many more.

Additionally, algorithms of quantum walks have been used by author to tackle the spatial search problem [7]. By doing so, author presents this model by implementing it on various graphs like hypercube [8] and grid graph type. Quantum walks models have been used in defining the absorbing time at various random intervals by measuring the walks [9]. Apart from it, various quantum walks computational frameworks are also suitable for solving Hamiltonian cycle problems. Additionally, high quadratic speed can be achieved by using suitable quantum random walk model by measuring quantum escape duration or time. For implementing quantum algorithms to detect or mark the elements in the graph, firstly it is mandatory to search them, for that the Markov chain must be reversible as quantum algorithm can only check if vertices are marked or not [10]. As the procedure of Markov chain if R is the state transitive and there are any two states *a* and *b*, then automorphism1 exists there which actually moves from *a* to *b*. This is equivalent to the definition of vertex transitive, and it puts the symmetry of high degree on Markov chain (naturally, every detected state of R looks the same locally). On the other hand, detection quantum is quite subliminally and understandable [11]; moreover, finding best suitable algorithm requires the proper proof in case detection points are not clear properly. This is mandatory so that rectification in quantum walk models' result should not be equivalent to classical Markov chain model searching. In this paper, we presented the quantum walk search algorithm which will detect the marked vertex or elements in a graph. Overall, we will prove that this selected approach has quadratic speed-up in comparison with the traditional or classical models.

2 Related Work

Szegedy has presented a powerful method of developing quantum equivalent to classical Markov chain, which ultimately leads to the development of new quantum algorithms and models [12] after getting inspired from Ambainis quantum walks methods. Researcher presented that it is easy to find or detect the marked elements or vertex in comparison with classical model at the square root of classical model hitting interval, although marked elements could be searched at same time in the both models. Researcher [13] expanded the Szegedy model larger to extend with ergodic Markov chains and eventually proposed a new algorithm or model in quantum walk models; however, complexity of this proposed model became larger than the classical hitting interval's square root. For instance, in 2D grid graph example, this proposed approach fails to achieve the desire quadratic speed-up. This proposed algorithm achieved the complexity of $\theta(n)$, whereas the complexity of classical hitting interval is $\theta(n \log n)$. In some work, models achieve the complexity of $\theta(\sqrt{n} \log n)$ in case of unique detected vertex [14]. However, this consequence, initially, was obtained by Childs and Goldstone [15] through the implementation of quantum walk method, i.e. continuous-time quantum walk model.

Discussing this point further, it was flaw or further open research question whether it is possible to achieve the high-speed quadratic in graph, i.e. two-dimensional grid. But, author [16] presented an equivalent solution by emerging new technologies. Furthermore, many researchers extended or expanded Tulsi's method to state-transitive reversible classical Markov chain method, and it showed that there is a feasibility to detect the element with the high quadratic speed in comparison with the classical Markov hitting interval. Nonetheless, as discussed earlier, till these all techniques by researchers are not efficient in dealing with multiple detected vertex as state transitivity is in the strong symmetry condition. Currently, a researcher [17] presented a rectification in original algorithm specifically in case of two-dimensional grid with single detected marked element. The rectification is done by substituting amplitude amplification with the traditional search model in the vertex which is in the neighbourhood of final vertex [18]. By doing so, $\sqrt{n} \log n$ speed-up is achieved in comparison with original model and achieved the complexity of $O(\sqrt{n} \log n)$ as mentioned in papers [19].

Furthermore, many applications of quantum walk algorithm are also used in resolving spatial search problems, and many researchers work using other models of quantum walks like continuous-time algorithm for optimizing the spatial search [20]. In this, the system is found to give optimal solution if complexity will be O $\sqrt{n}$. Additionally, traditional attempts for getting the speed-up in comparison with classical algorithms have followed the two sorts of approaches: quantum version of R is combined with the marked vertex reflection to imitate a Grover operation [3, 11], and secondly, without combining do direct implementation of quantum version of R [21]. However, its disadvantage is that such approaches could find or detect the vertex in some limited cases only [6, 18].

3 Quantum Walk Algorithms' Simulation on Qiskit

3.1 Classical Markov Chain

A classical Markov chain is a statistical model usually implemented in various practical situations [22] and contains the features of mathematical Markov property, whilst it has the counterpart of the discrete state and time, it means heuristic dependence on the past data is via the current state, which actually has the all required knowledge or information for the expansion of process. Overall, we can say that the upcoming step probability depends upon the current or present state. For instance, a

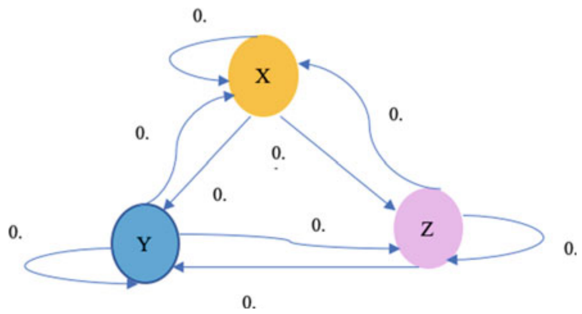


Fig. 1 Probability distribution after time t and by steps R^t

classical Markov chain for transition matrix R reveals the exact moving probability between the given current states. Figure 1 shows the example of classical Markov chain linked with R matrix.

$$R = \begin{matrix} 0.1 & 0.3 & 0.3 \\ 0.1 & 0.1 & 0.2 \\ 0.7 & 0.6 & 0.8 \end{matrix}$$

3.2 Coined Quantum Walk Model

The walker move on the infinite integer line is the basic example of coined model of quantum walk. In this, coin takes decision about the movement of the walker like on the integer line, and it can move to both directions either right or either left. By doing so, the computational basis becomes equivalent to $\{|0\rangle, |1\rangle\}$. The walker will move as per the value such as we move the walker to one specific direction after getting $|0\rangle$ and similarly will move to another direction after we encounter $|1\rangle$. In coined model, there are two quantum positions and two operators. Firstly, the quantum position or state shows the position of the walker in the integer line, and the state of the coin always decides the movement of walker in upcoming steps. Let us suppose the vector $\boldsymbol{S}_{\mathrm{c}}$ represents the state of the coin and vector $\boldsymbol{S}_{\mathrm{p}}$ represents the position state of the coin, then the quantum walk for the whole walker would be $\boldsymbol{S} = \boldsymbol{S}_{\mathrm{c}} \otimes \boldsymbol{S}_{\mathrm{p}}$. Furthermore, it has two operators: coin operator and shift operator. There are numerous coin operators, but the Grover's coin and Hadamard coin operators are the common one. Discussing the Grover's coin algorithm, we implement it for doing experiment for $N = 4$ that can done with 2 qubits. After implementing algorithm on Qiskit, we get the following circuit as shown in Fig. 2.

To put the walker or quantum system into a multiple positions at the same time till the measurement. The Hadamard matrix is given below:

$$H = 1\sqrt{2}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}.$$

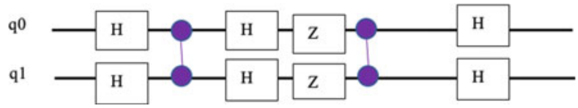


Fig. 2 Circuit design after Grover's algorithm on simulator

On the other hand, Grover's coin operator is as given below:

$$\boldsymbol{G} = \begin{pmatrix} \frac{2}{n} - 1 & \cdots & \frac{2}{n} \\ \vdots & \ddots & \vdots \\ \frac{2}{n} & \cdots & \frac{2}{n} - 1 \end{pmatrix}$$

Figure 3 shows that Grover's operator sometimes behaves differently in comparison with the Hadamard operator since results presented in the figure show that 0 (000) states have much larger probability, which means it does not put all the multiple states at same time till measurement procedure or we can say it does not put the coins states at an equal superposition. Because of this, the coined model of quantum walk algorithm is only suitable in case of regular graphs in which all nodes always have equal or same number of elements in neighbour [2]. Therefore, for non-regular graphs, there is another option which is called as Szegedy quantum walk model.

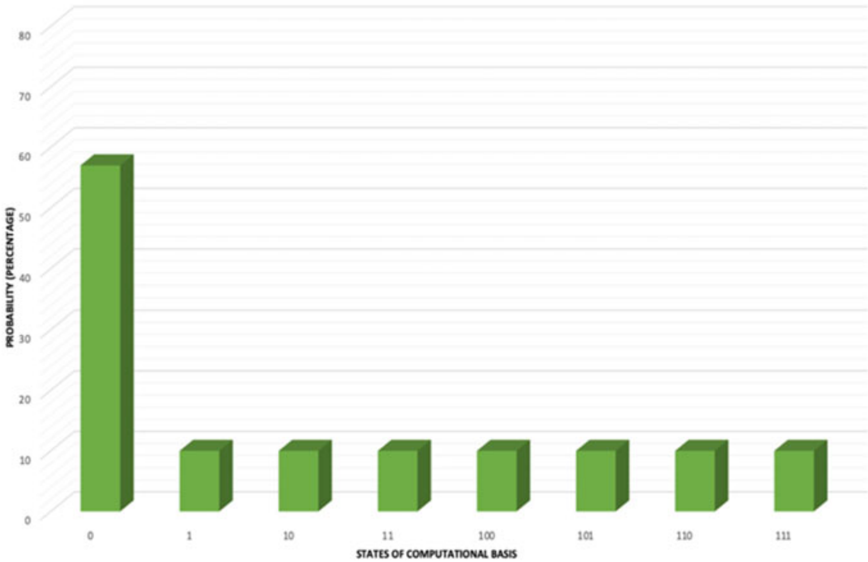


Fig. 3 Plot shows the numerically measured state vector Grover's coin probability distribution

3.3 Szegedy Model

In this model, the walker moves on the edges on the double-cover graph (double graph has the double vertices as of the real graph). The nodes in double-cover graph are connected if and only if they must be connected in real graph. For implementing Szegedy model, take one probability matrix say **R**. For defining unitary operator of discrete-quantum walk, we took the it on Hilbert space (for $\boldsymbol{M}$-vertex graph) as $\boldsymbol{H^M} \otimes \boldsymbol{H^M}$. When we make transition from $\boldsymbol{x}$ to $\boldsymbol{y}$, then let us suppose the probability would be defined as $\boldsymbol{P_{xy.}}$ Before moving the walker, it is required to perform the normalization of states as follows:

$$|\psi\rangle := \sum_{y=1}^{M} \sqrt{P}_{yx}|x, y\rangle, \quad x = 1, \ldots, M$$

The shift operator and projection are defined as, respectively:

$\boldsymbol{S} := \sum_{\boldsymbol{x},\boldsymbol{y}=1}^{\boldsymbol{M}} \left|\boldsymbol{\psi_x}\right\rangle\!\left\langle\boldsymbol{\psi_y}\right| \ldots i$ (shift operator).

$\boldsymbol{\Pi} := \sum_{\boldsymbol{x}=1}^{\boldsymbol{M}} |\boldsymbol{x}, \boldsymbol{y}\rangle\langle\boldsymbol{y}, \boldsymbol{x}| \ \ldots \ ii$ (projection).

From ***i*** and ***ii,*** we can define the quantum walk as following, and in this, $\boldsymbol{2\Pi - 1}$ is termed as reflection operator.

$$\boldsymbol{U} := \boldsymbol{S}(\boldsymbol{2\Pi} - \boldsymbol{1})$$

In this, we concluded that coined walker using Grover's operator is alike Szegedy quantum model.

4 Proposed Algorithm on QASM Simulator: Implementing QWSA on Four-Dimensional Hypercube

Now, we will implement quantum walk search algorithm which will detect the graph elements. The specific steps of this algorithm have been designed to find the accurate result in this work, then that algorithm would be implemented on four-dimensional hypercube. As per algorithm, we will start from a node, and then our walker will move and mark the vertices |*V*| as per algorithmic instructions till all nodes have been marked. In order to store the previous and current nodes or states, registers are used; therefore, two registers are used in the whole searching and element marking process. Some mathematical calculations have been done to define some states and operators working. Firstly, we use the matrix *R to* present the quantum walk model based on Markov chain model and equal superposition over the elements *i's* neighbours. Now, let us suppose that $|i|\,j\rangle$ are the symbols that represent the basis states. Apart from if "i" node is a one marked node, then $|i\rangle|j\rangle$ states are termed as "Good", else they will be termed as "Bad" basis states (BS). The given below equations represent the superpositions over "Good" and "Bad" states (BS), and N represents total number of nodes.

$$\left|\boldsymbol{BS_{good}}\right\rangle = \frac{1}{\sqrt{V}} \sum_{i \in V} |\boldsymbol{i}\rangle|\boldsymbol{R_i}\rangle,$$

$$|\boldsymbol{BS_{bad}}\rangle = \frac{1}{\sqrt{N - |V|}} \sum_{i \notin V} |\boldsymbol{i}\rangle|\boldsymbol{R_i}\rangle$$

Proposed Algorithm on QASM Simulator:
1. Setting initial positions
$\left|\boldsymbol{US_{uniform\,superpositions}}\right\rangle = \frac{1}{\sqrt{N}} \sum_{i} |\boldsymbol{i}\rangle|\boldsymbol{R_i}\rangle = \boldsymbol{Z}$
Where $Z = sin\theta \left|\boldsymbol{BS_{good}}\right\rangle + cos\theta \ \mathrm{I}\boldsymbol{BS_{bad}} >$
2. Repeat process by $\boldsymbol{O}\left(1/\sqrt{\in}\right)\boldsymbol{times}$
• *shift the phase of 'i' if 'i' is in the previous register (implement through* $|\boldsymbol{BS_{bad}}\rangle$ *reflection), else*
circuit will remain unchanged
• *Reflect by* $\mathrm{I}U >$ *it is alike finding unitary that will do the given below mapping:*
$|U\rangle \rightarrow |U\rangle$
$\mathrm{I}|\boldsymbol{\psi}\rangle - \rightarrow |\boldsymbol{\psi}\rangle, \forall|\boldsymbol{\psi}\rangle$, *in the duration of eigenvectors of unitary operator*
Q(R) on R matrix (orthogonal to $|U\rangle$*)*

Now, we implemented the quantum walk search algorithm (QWSA) to detect and mark the set of elements in four-dimensional hypercube in $O\left(1/\sqrt{\in}\right)times$ (as per algorithm step 2). Here, $\in = |V|/N$, in this V is detected and marked nodes and N is the total number of nodes. For detecting and marking elements in four-dimensional hypercube, we have to work as per algorithm like in step-1, apply Hadamard gates to both coin qubits and node qubits. Moving towards step 2 (as per algorithm), we consider $\theta \neq 0$, implement the phase estimation on the hypercube and then perform the marking of all quantum elements (perform it by rotating supporting qubit). At last, the phase estimation process is reversed as shown in Fig. 4.

Before implementing the code for quantum walk, firstly we need to find the inverse of the gate implemented previously as this will be used by us to reverse the phase estimation when required. Apart from it, next we required to use quantum Fourier transform. The quantum Fourier transform on the quantum positions $|X\rangle = \sum_{n}^{N} x_n|n\rangle$, mapping is done to the states of quantum $|Y\rangle \sum_{m}^{N-1} y_m|m\rangle$ as per the formula given below:

Fig. 4 Steps to achieve marked elements in four-dimensional hypercube on simulator

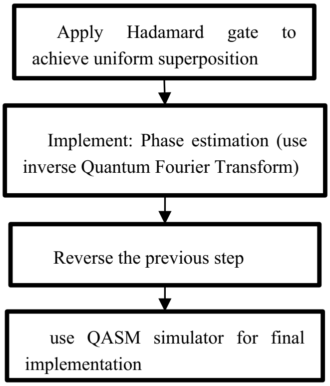
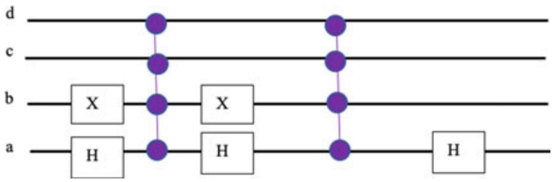


Fig. 5 Circuit design after implementing step 2 of algorithm on simulator



$$y_m = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} x_n \omega_N^{nm}$$

where $\omega_N^{nm} = e^{2\pi i \mathrm{nm/N}}$.

In this, we develop the phase oracle which will detect and mark the positions 1011 and 1110 and result in circuit designing as shown in Fig. 5 as per step 2 of algorithm stated above.

After we will perform the inverse process of phase estimation technique which is mandatory for implementing actual QWSA for four-dimensional hypercube. Finally, we required $O\left(1/\sqrt{\in}\right) times$ looping as per algorithm and calculated the node qubits. Figure 6 is the histogram plot for the marked states in the given graph.

5 Conclusion

In this work, we presented the traditional method for detecting and marking the vertex, and finally, we get the effective and easy method, i.e. quantum walk search algorithm (QWSA), and we concluded that coined walker using Grover's operator is alike Szegedy quantum model. The coined model of quantum walk algorithm is only suitable in case of regular graphs in which all nodes always have equal or same number of elements in neighbour. Furthermore, we proved that this selected approach has quadratic speed-up in comparison with the traditional or classical models.

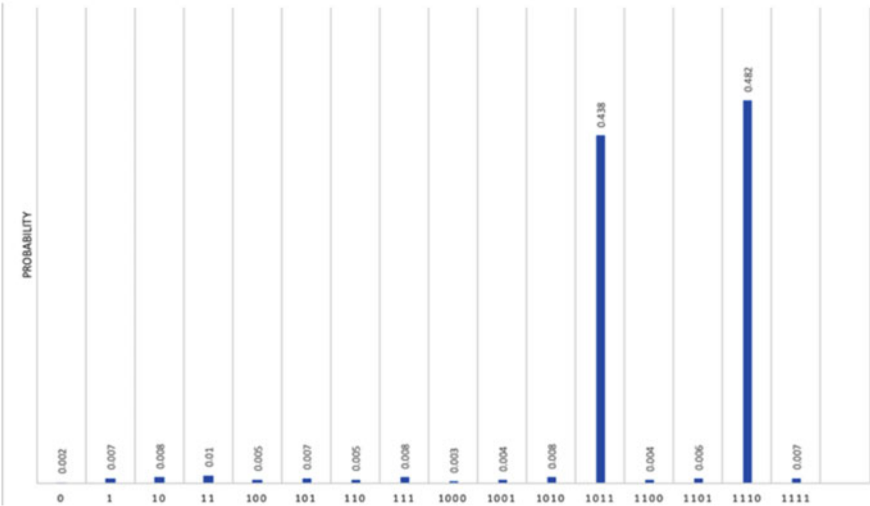


Fig. 6 Probability distribution: Histogram plot for detected and marked positions for 1011 and 1110

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Critical Analysis of Secure Strategies Against Threats on Cloud Platform

Gaganpreet Kaur and Sandeep Kaur

Abstract Cloud computing is one of the popular topics of the current internet world. Cloud computing technology no doubt makes life simple and easier by offering computing, storage space, and many more services on demand over the internet but associated threats cannot be ignored while accessing these services online. Various efforts have been made by both user's end and cloud services provider to cope up with security issues. Various researches provide advanced defense mechanisms like cryptosystem authentication and intrusion detection system for the last 15 years. This study provides a critical analysis of the security strategies along with there's role in circumventing threats. The main contribution of this paper is to make society, cloud users, and research scholars aware of the current scenario of widely used technologies. The critical analysis of prevailing approaches reveals the various used prospects which act as the solution essence against emerging attacks on the cloud, at a glance.

Keywords Threat vulnerabilities · Authorization · Intrusion detection system · Security strategies

1 Introduction

Security is a fundamental facet in the cloud computing environment, due to the significance of information communication and storage on the cloud [1]. Data properties such as confidentiality, integrity, and availability are being compromised due to unauthorized access of confidential and extremely sensitive information. As vulnerabilities of web application decline the interest of users (who intends to use SaaS (Software-as-a-Service) to deploy their web site in the cloud for various purposes

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such as promoting their products), there is urgent requirement to secure applications with strong encryption, authentication, and authorization techniques on the cloud. Though many security strategies have been introduced for the last ten years, still many internal and external threats lead to data leakage, unauthorized access of cloud user accounts, sensitive data disclosure, communication threats, and data integrity [2]. Cloud users require understanding emerging threats, vulnerabilities, and plan possible countermeasures before transferring their computing, storage, and application to remote locations. Emerging threats such as data breaches, DDOS ransomware, cryptojacking, and session hijacking are required to be addressed with the most appropriate solution directives to strengthen the security of the cloud environment [3]. In this paper, general security strategies such as cryptography, authentication is being analyzed along with refined approaches against emerging threats. This section introduces the general concept of used security strategies.

2 General Security Strategies

2.1 Cryptography System

Cryptography is a conversion of readable text into an unreadable form to transfer contents safely by ensuring that only the intended recipient can read. The encryption-decryption technique known as cryptography provides the services of confidentiality, integrity, and nonrepudiation to support information protection. AES, RSA, DES, and SHA are the most popular algorithms [1, 2, 4, 5].

2.2 Authentication/Authorization

Authentication refers to verifying the identity of someone. It is followed the authentication step to determine what the user is permitted to accomplish. Authorization is ascertained by the user identity alone, but sometimes additional attributes such as title and role are also useful [6]. Three main methods used for user authentication are as follows: First, "Token-based authentication: In this technique, tokens such as an identity card, an ATM card, and a smart card are required to authenticate the users. This method is also known as what you a type of authentication has" [6]. Second, "Biometrics-based authentication works on the unique feature of human being such as fingerprints, facial recognition, and scanning. This method is also known as you are a type of method." The use of this technique is very expensive but it is considered the strongest method of verifying the identity of anyone [6]. Third, knowledge-based authentication techniques use text and pictures to verify the identity of someone. It is referred as "what you know" type of technique [6]. It is approved that the loss caused by unauthorized access has increased rapidly in recent years, unauthorized access leads to the leakage of personal information while money damage is also a big issue.

2.3 Intrusion Detection System

An intrusion is a mischievous attempt to affect the confidentiality, integrity, and availability of cloud services [7]. This unlawful act is being performed by bypassing, disabling, or exploring vulnerabilities on the system. Intrusion is one of the important issues among security threats in cloud computing. These are special arrangements to secure user's requests from intruders as cloud service is truly concerned with the users. It is a well-known best security solution to cope with issues on the cloud [7]. Intrusion detection or IDS is mainly used to identify attacks and log the reports. IDS can be hardware, software, and a combination of both that collects data and warns about the detected intrusion. An intrusion detection system minimizes DoS attacks on cloud platform [8]. Basically there are two broad categories: Host-based Intrusion Detection System (HIDS); Network-based Intrusion Detection System (NIDS); and HIDS monitors behavior of a system, while NIDS inspects network traffic to detect intrusion [8, 9]. Hence, application-based IDS monitors a single specific application service or events of application [10] Moreover, cloud-based IDS (CIDS) is deployed within a virtual network to monitor and analyze interactions between VMs and hypervisors. Unlike HIDS and NIDS, CIDS is a hybrid approach of basic IDSs to examine states of software, hardware, and events more robustly [9]. Based on monitoring environment, IDS is classified as (i) hypervisor-based IDs and (ii) distributed IDS (DIDS) [11]. These address scalability (large volume of information from both host systems and networks), heterogeneity (different data formats), and DoS issues on cloud computing platform [12]. Moreover, position of the IDS is an important factor in achieving efficient monitoring. Nowadays, mischievous users are sophisticated and smart enough to track and analyze networks continuously for gaining unauthorized access to sensitive data and information sources. Hence, there is a need to analyze the existing solution strategies against the emerging new attacks. The following section presents the literature review followed by an analysis of each approach of the solution.

3 Literature Review: Analysis of Security Strategy Against Threats on Cloud

3.1 Cryptography Strategies Analysis

ID-Based Cryptography (IBC) addresses the security issues of storing sensitive data in a cloud storage space. It provides not only secrecy for encrypted data but also offers controlled access. Here client act as PKG (Public Key Generator) generates pair of keys to encrypt each data that he intends to store on the cloud to ensure data confidentiality for secure data storage, backup, and sharing flexibility [13]. In 2015, a more efficient framework has been set up by deploying threshold-based cryptography. This threshold cryptography approaches secure cloud transactions and seems quite helpful in implementing cloud security. Another new proposed cryptography algorithm is based on block Cipher symmetric type using X-OR and shifting logical operations. It is beneficial to the applications which require the same procedure of encryption and decryption. In this scheme, any data owner has its own identity, a master key and secret key which are linked to root nodes and delegate nodes, respectively [5]. In 2016, another advanced cryptosystem has been illuminated to boost cloud security. Moreover, advanced techniques such as searchable encryption and secured outsource computation meet the security need of cloud users. Searchable encryption deals with searching as well as conditionally retrieve required encrypted data without having to decrypt all the data whereas homomorphic encryption schemes allow computation on encrypted data for secure outsource computation [14]. Moreover, in 2017, another study deliberates various plans with cryptography for security purposes, especially from the cloud's client perspective. They concentrate on the dangers of PC system security because of the main target of attacker and intrusion to put the system in an anomalous state [15]. To encrypt the image, a lightweight encryption system that utilizes cryptography along with the steganography technique is another attainment in a cryptosystem [16]. In this approach, encrypted images or information are being hidden using the LSB approach of steganography and avoid unauthorized access of users. AES, DES, and RC2 encryption methods ensure the privacy and security of sensitive information for cloud users [1]. Moreover, to protect cloud storage files which are beyond the control of cloud user, ECC (elliptic curve cryptography encryption) provides security and improves performance for accessing and storing mechanisms [17]. Similarly, one more advanced underscoring hybrid approach is a combination of elliptic curve cryptography (ECC) and threshold cryptography [18]. In this approach, Kerberos authentication uses symmetric keys for objects and Kerberos services to create an advanced version of Kerberos authentication protocol to ensure high security. The proposed model is reliable, easy to manage, requires less memory and power, and has a better structure to improve performance. Moreover, another three-step authentication system with automatic cryptography method is used to avoid unauthorized access of outsider attacks and insinuated external attacks. The proposed cryptosystem generates a new key using a previously used key with a hash function to encrypt data or file each time stored in the cloud [19]. The proposed system takes a little bit more time but offers high-level security on cloud computing. In the same year, a new hybrid flower pollination algorithm, based on DNA cryptography along with the nature-inspired FPA algorithm, has been proposed. DNA cryptography plays a vital role in transforming important information into an encrypted form. Further, they recommended nature-inspired and evolutionary methods to produce the best optimal. Exact and heuristic are two types of optimization techniques. Exact strategies work well for finding the optimal solution, but the complex problem requires a high computational cost. In this work, they use flower pollination algorithm in place of genetic algorithm to re-encrypt data.

Nature-inspired algorithms provide better optimal results as compared to the genetic algorithm. In this proposed work, the key is generated using flower pollination algorithm and data is encrypted using the key. The nature-inspired FPA algorithm is used to obtain optimal results in minimum time [20].

Recently proposed, another efficient two-stage cryptography scheme comprises both user authentication and encryption processes to access and store data on cloud safely. In the scheme, file is divided into two parts and encrypted using separate unique key for each part before being transferred to the cloud storage. Hence, division increases the security as well as decreases the encryption time [21]. Logistic chaos model theory is used to generate the keys. This design attains high-security level as it is offering altered security practices along with dissimilar stages. The suggested method decreases the encryption/decryption computation times as compared to other proposed schemes without adding any complication.

3.2 Authentication Protocol Analysis

In 2018, a text-based user authentication technique with a CAPTCHA scheme has been proposed. This technique offers a higher level of security by defeating many challenges that are admitted by both conventional and contemporary authentication methods, but this scheme is being held off by intruder and also vulnerable to phishing, dictionary, and brute force attack (security attacks). Another new text-based authentication scheme generates a new password each time using CAPTCHA to circumvent the DoS attack [22]. A few years ago, it is realized that traditional methods of authentication are not enough to cope with security threats on the cloud platform. Multilevel authentication technique, text-based CAPTCHA, and then hybrid CAPTCHA have been introduced to authorize users in several stages, in which different levels of expertise can be checked and different perception skills can be evaluated for security purposes. This new proposed approach uses hybrid CAPTCHA codes for the creation of advanced multilevel user authentication protocols. In this approach, users require special skills and knowledge for proper authentication [23]. Another proposed framework consists of a nonce, math hash features, id, and password traditional methods, and hash features play a major role to resist replay attacks, forgery attacks, and man-in-middle attacks [23]. Moreover, improvement of the authentication and authorization process is required by modifying existing techniques, using stronger methods such as digital signature and credentials to mitigate the risks of data security and network security on the cloud [24].

3.3 Intrusion Detection System Analysis

To determine whether activities are malicious or legitimate, intrusion detection system (IDS) is considered as the best solution in cloud infrastructure to make users alert [7, 9]. To circumvent the DoS attacks and mischievous happenings, a network intrusion detection system has been incorporated into the cloud framework [25] and classifier snort and decision tree, evaluating the performance and detection efficiency of the proposed framework using NSL-KDD and KDD datasets. Moreover, signature and anomaly-based techniques detect known and unknown attacks. This solution achieves desired objectives such as a higher detection rate with low false positives on reasonable computational cost. Another hypervisor detector anomaly-based detection system improves the accuracy and low false positives of the detection system using a combination of both Fuzzy-C and Artificial Neural Network (FCM-ANN) in the cloud environment. One more collaborative multi-layered NIDS and HIDS system has been proposed to improve the security of cloud computing to detect each incoming packet [26]. Next, the rule-based detection and Fuzzy logic algorithm determine the severity of the attack and monitor system resources and files of the system method collectively to form a trustworthy solution using snort open-source intrusion detection system research [8]. However, this study is not yielding dominant results of false-negative rates and detection rates. To get the more desired result, another enhanced network-based IDPS includes two innovative algorithms: (1) a packet scrutinization technique for sniffing packets; (2) a hybrid grouping model named "NK-RNN" for accessing data in a cloud context [11]. An-other recommended system based on LR-HIDS machine learning methods has three steps: first is preprocessing; second is feature selection; and third is the training and testing of classifiers [27]. Moreover, to perceive the category of every attack, distributed machine learning-based intrusion detection system entails network traffic data collector; preprocessing; and anomaly detection modules [28]. The captured data by the network traffic module is passed to the anomaly detection system and then further coordinated to the central storage server. The structure is tested using the CIDDS-001 public dataset by evaluating on the Google cloud platform and achieves a satisfactory result against DoS attacks with less false-negative rate and more accuracy. However, the authors recommended outliers to produce a better result, as existing IDS are unable to efficiently combine high accuracy with low complexity.

4 Proposed Methodology for Research

To conduct the research, we have comprehensively reviewed many existing research studies. The studies are related latest security strategies that have been introduced to cope with the newly emerging security threats. As online hackers are lurking on the internet and bypassing the security countermeasures, the time demands to know about the different security strategies to make the system secure at all levels. To fulfill this requirement, we attempt to intensely analyze the different security strategies from the latest research studies. We scrutinize the different approaches followed by the research scholars to deal with security and privacy issues and enumerated the compensations of all in abundant strictures.

5 Performance Evaluation Parameters

Each security strategies have aids and costs. Some offer tight security and suffer from low performance and vice versa. The strategies are evaluated on basis of security, cost, and performance parameters. In an authentication system, different factors are evaluated in terms of security and cost. The performance and security of the cryptography system is depending on encryption/decryption time and the complex computation, respectively, of each method. Moreover, accuracy rate, false-positive rate, false-negative rate, and detection rate are the evaluation terms used in intrusion detection systems. Table 1 illustrated the comparison of various recently proposed IDSs. Moreover, Table 2 elucidated the calculation of various cryptography standards. Moreover, Fig. 1 demonstrates the variation of computation time (ms) of standard encryption systems.

6 Performance Comparison

Table 1 depicts the intrusion detection system along with its advantages and limitations, in the tabulated form.

7 Discussion and Future Scope

The traditional methods are vulnerable to many security issues. Online attackers are lurking on the internet to exploit the vulnerabilities of the system. An advanced cryptosystem offers stronger encryption methods to hedge the vulnerabilities. LSB approach of steganography is used to avoid unauthorized access of the user to provide security only, whereas ECC (elliptic curve cryptography encryption) improves performance and security of accessing and storing mechanisms. Moreover, a combination of elliptic curve cryptography (ECC) and threshold cryptography model is reliable, easy to manage and requires less memory, requires less power, and has a better structure to improve performance. However, an incorporated system of encryption and authentication mechanism though takes a little more time but provides high-level security against threats. Multilevel authentication technique, text-based CAPTCHA, and then hybrid CAPTCHA were introduced to authorize users in phases, with varying degrees of competence and perceptive skills to validate identification. To secure a cyber-physical system, HIDS is the best security solution against unknown attacks on cloud environment. It evaluates data regarding actions performed by applications and users that is collected by an operating system within the system, whereas NIDS analyze data collected from each moving network packet to make the administrator aware about the suspicious script. Therefore, cloud IDSs make service more secure and reliable by deploying NIDS at the bottleneck position of the network

Table 1 Intrusion detection system along with its advantages and limitations

Year	Monitoring Type	Detection/Classifier	Data Source	Positioning	Attack covered	Advantages	Limitations	References
2012	NIDS	Signature Based and Anomaly Based	Network traffic	Virtual private network	DoS attack	Low false positives, low false negatives with high detection rate, and economical	Processing cost increases with more partition	[29]
2013	IDSaaS	Signature Based	Network traffic	Public cloud	–	Isaac (under control of cloud consumer, pay peruses), on demand elasticity	Cannot detect new unknown attacks	[12]
2015	KIDS	Anomaly and Misuse detection	User request, data packets	Bottleneck position of the network and hypervisor	DoS, probe, U2R, and R2L	Handles large how of the data packet, secure having quick response then firewall	–	[26]
2016	HIS	Anomaly-Based	Virtual machine	Hypervisor layer of cloud	Unknown attacks, DoS probe, R2L, U2R	High detection accuracy, minimization of the false-negative rate, and large datasets achieve high detection	–	[9]

(continued)

Table 1 (continued)

Year	Monitoring Type	Detection/Classifier	Data Source	Positioning	Attack covered	Advantages	Limitations	References
2016	NIDS	Signature Based	Operating system	Infrastructure layer	DOS	Detect attack at its initial state as IDS is incorporated at the infrastructure layer, detect the known attack	Unable to detect variation of attacks, cannot detect an unknown attack	[8]
2018	HITS	Neural Network, Decision tree, and LDA	Virtual machines	Virtual machines	Probe, DoS, R2L, U2R	High-accuracy detection rate	Require additional computation	[27]
2019	NIDS	NK-RNN Classier	User's packets	Cloudlets	U2R, DDOS, R2L, zero-day attacks and probing	Increases the throughput of the system, furnishes higher detection rate	Cannot detect unknown attacks	[11]
2019	NIDS	Naive Bayes Classier	Central storage server	Edge network components of the cloud provider	Detect types of attacks	High detection performance	–	[30]
2019	NIDS	ABC, Ada Boost	Network traffic	Network traffic data set		High detection and accuracy rate	Cannot detect unknown attacks	[31]
2020	HITS	Signature Based	System behavior	Large data set	Discover both false negative and false positive	False-negative and false-positive rates are very high, High precision and accuracy (reduce the harmful operation and improve the accuracy)	Cannot detect new unknown attacks	[32]

(continued)

Table 1 (continued)

Year	Monitoring Type	Detection/Classifier	Data Source	Positioning	Attack covered	Advantages	Limitations	References
2020	VM-HypIDS	Anomaly Based	Internal, external, and local network traffic	Hypervisor	False negative and false positive	Achieve a high detection rate	–	[33]

Table 2 Security and performance comparison

Cryptography	Encryption time	Decryption time	Key generation time	Security level
RSA	878.022	308.812	617.441	Moderate
ECC	696.593	50.897	9.499	High
DES	284.834583	71.09475	240.56277	Low
TripleDES	3061.36118	289.08841	216.09078	Moderate
Blowfish	1856.11503	137.28842	359.84285	Moderate

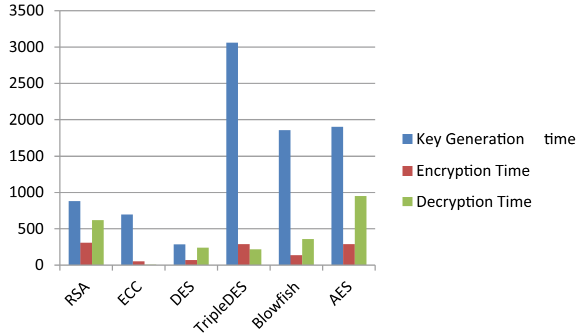

Fig. 1 Computation time (ms) of standard encryption system

and HIDS on the hypervisor. In short, the monitoring mechanism for both network traffic and internal happenings of the hypervisor with features such as high accuracy detection rate and lower false-positive rates at affordable cost is the best solution to tackle DoS and other, unlike security threats. Because of its lower detection rates, anomaly detection can detect attacks with a high false-positive (FP) rate. Signature detection, alternatively, has a low false-positive (FP) rate due to its greater detection rates and the fact that the attack signatures are pre-defined. This study depicts various pioneering authentication, cryptosystem intrusion detection, and integrated approaches to reveal solution essence for evolving suspicions. The critical analysis of prevailing approaches elucidates the various prospects which act as the solution essence to secure the cloud platform.

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Pareto Optimal Solution for Fully Fuzzy Bi-criteria Multi-index Bulk Transportation Problem

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Abstract In the present work, a fuzzy bi-criteria multi-index bulk transportation problem (FBCMIBTP) with all the parameters to be fuzzy is considered. Bulk transportation problem (BTP) extends to form a multi-index BTP (MIBTP). A bi-criteria BTP focuses on minimizing of cost and time with the solutions being a trade-off between the two. Transportation problem with fuzzy parameters is alike the classic transportation problem, the only difference is the objective function minimizes the total fuzzy instead of a crisp transportation cost. BTP comes into existence when the production of commodity at the origin is of more than one type or when the distribution of commodities occurs through varied transportation modes, but any destination's requirement can be satisfied only through one origin although one origin can satisfy the requirements of more than one destination. In actual life, the costs and the values for demands and supply are fuzzy numbers. The optimal solutions that are expected to determine the commodities' value for transportation from an origin to a destination is attained to be fuzzy. A fuzzy cost-time efficient relations on trade-off are considered in the FBCMIBTP, and an algorithm is put forward to obtain the fuzzy cost-time efficient pairs of trade-offs. At first, the algorithm put forward determines the minimum fuzzy cost and corresponding fuzzy time in the considered fuzzy MIBTP, and later the successive fuzzy cost-time efficient pairs of trade-offs are deduced. For clarification of the algorithm put forward, an illustration is formulated by considering triangular fuzzy number.

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Keywords Bi-criteria · Fully fuzzy transportation · Bulk transportation · Triangular fuzzy number · Multi-index

1 Introduction

Classical Transportation Problem (CTP) is a single objective transportation problem. It helps in deducing the transportation schedule to minimize the total cost of transportation; thus, it is used in network flow optimizations. CTP was originally advanced by Hitchcock [1]. Subsequently, numerous authors developed CTP, namely, Koopmans [2], Dantzig [3], Hammer [4], and a few more.

In the actual world, CTP which has a single objective hardly put to use, thus an introduction of bulk transportation problem (BTP). In BTP, the commodities are transported from one origin to various destinations, but a source's requirement is satisfied only through one source. BTP was first introduced by Maio and Roveda [5] in literature with the objective of minimizing transportations' bulk cost. Bhatia [6] and Foulds and Gibbons [7] explored time minimizing BTP. A detailed survey on BTP was done by Singh et al. [8].

Sooner, there was a discovery of multi-index transportation problem (MITP) by Galler and Dwyer [9] and Schell [10]. Transportation problem that has greater than two indices is MITP. Various authors explored distinct approaches for MITP, namely, Junginer [11], Pandian and Anuradha [12], and a few more. Minimization of the cost of multi-index BTP was established by Purusotham and Murthy [13] by the application of Lexi-search method.

A bi-criteria BTP focuses on minimizations of cost and time with the solutions being a trade-off between the two. This was explored by Aneja and Nair [14], Prakash et al. [15], Glickman and Berger [16], and Bhatia [6]. Sooner, there was an introduction of bulk transportation in bi-criteria by Prakash and Ram [17] and Prakash et al. [15]. Singh et al. [18], and Chauhan and Khanna [19] discussed about bi-criteria MIBTP (BCMIBTP). Later, a different approach was developed by Chauhan et al. [20].

The term fuzzy was proposed in 1965 by Zadeh [21]. Bellman and Zadeh [22] introduced decision-making for fuzzy problems.

Zimmermann [23] introduced a method to solve a fuzzy linear programming. A technique to resolve a triangular fuzzy linear programming problem was put forward by Chanas and Kulej [24]. They also advanced a model of linear programming which had supply and demand as fuzzy parameters, and cost coefficients to be crisp. Lai and Hwang [25] evolved the same sample later. Further, Chanas et al. [26] also introduced an optimal solution on the same model.

Chanas and Kuchta [27] put forward the ideas for the optimal solution in problems concerning transportation where the fuzzy coefficients are demonstrated as fuzzy numbers. They established a methodology that attains the solution which is optimal.

Liu and Kao [28] came up with a procedure that obtains the fuzzy objective value for fuzzy transportation problem, such that the quantities of supply and demand are fuzzy numbers along with the cost coefficients basing on the principle of extension which analyzed the problem of transportation with deliverers supply values as well as with the receivers' demand values as fuzzy.

A solution methodology was put forward by Ahlatioglu et al. [29] for procuring transportation problem's all optimal solutions with fuzzy supply and demand values and cost coefficients.

A new algorithm was advanced by Pandian and Natarajan [30] which is known as zero-point method which assists fuzzy transportation problem in finding the fuzzy optimal solution [31–33].

OhEigeartaigh [34] considered and solved the case of triangular fuzzy demands for transportation problems. Later, Kumar and Murugesan [35] advanced an algorithm to obtain optimal solution for triangular fuzzy transportation.

Many researchers namely Mahdavi-Amiri and Nasseri [36], Ebrahimnejad and Nasseri [37], and many more have shown their curiosity in fuzzy optimization cases.

In the paper presented, a process to obtain solution which is efficient is advanced to inspect the fuzzy cost-time relations of trade-off in fuzzy MIBTP. Preliminaries are covered in Sect. 2. Section 3 represents the formulation of problem, and Sect. 4 represents the solution algorithm for the problem considered. Section 5 explains the solution algorithm on the illustration.

2 Preliminaries

Some important definitions are discussed below:

2.1 Membership Function

$\mu_A(x)$ is a notation used for representing the membership function from A to [0, 1], such that the images of each element of set A lies in the interval [0, 1]. The images lying in the interval [0, 1] represents the membership degree.

Full membership is illustrated by $\mu_A(x) = 1$, i.e., x is completely in A. Whereas non-membership is expressed with $\mu_A(x) = 0$, i.e., $x \notin A$. When $0 < \mu_A(x) < 1$, we say x is partly in A.

2.2 Fuzzy Sets

Let A be a fuzzy set in X. A is defined as a mapping

$$A : X \to [0, 1]$$

where, $A(x)$ represents the membership degree of x with respect to the fuzzy set A.

2.3 Fuzzy Numbers

Define a fuzzy set 'B' on real numbers (R). Then 'B' is a fuzzy number if membership function $B : R \rightarrow [0, 1]$ satisfy these characteristics:

- 'B' is convex
- 'B' is said to be normal when $\exists x \in R$, such that $B(x) = 1$
- The support of A, ${}^{0+}A$, should be bounded.

2.4 Triangular Fuzzy Number

A set 'B' is described by triplet (b_1, b_2, b_3). Further, 'B' is defined by $\mu_A(x) : X \rightarrow [0, 1]$, continuous membership function, where

$$\mu_A(x) = \begin{cases} \frac{x-a_1}{a_2-a_1} & \text{if } a_1 \leq x \leq a_2 \\ \frac{a_3-x}{a_3-a_2} & \text{if } a_2 \leq x \leq a_3 \\ 0, & \text{otherwise} \end{cases}$$

Note: The triplet (a_1, a_2, a_3) is such that $a_1 < a_2 < a_3$.

2.5 Arithmetic Operation on Triangular Fuzzy Number

The arithmetic operations used in this paper are:

Let two triangular fuzzy numbers be $P = (p_1, p_2, p_3)$ and $Q = (q_1, q_2, q_3)$, then

- $P \oplus Q = (p_1 + q_1, p_2 + q_2, p_3 + q_3)$
- $k(p_1, p_2, p_3) = (kp_1, kp_2, kp_3)$ if $k \geq 0$
- $k(p_1, p_2, p_3) = (kp_3, kp_2, kp_1)$ if $k \leq 0$
- $P \ominus \mathrm{Q} = (\mathrm{p}_1 - \mathrm{q}_3, \mathrm{p}_2 - \mathrm{q}_2, \mathrm{p}_3 - \mathrm{q}_1)$.

2.6 Ranking of Triangular Fuzzy Number

Define $F(R)$ as fuzzy numbers set on real numbers, then $R : F(R) \rightarrow R$ is defined as a function of ranking, where every fuzzy number is mapped into real line. There is existence of natural structure, i.e.,

(i) $P \prec Q$ iff $R(P) < R(Q)$

(ii) $P \succ Q$ iff $R(P) > R(Q)$.

Let $P = (a, b, c)$ be a triangular fuzzy number then $R(P) = \frac{a+2b+c}{4}$.

2.7 Efficient Fuzzy Cost-Time Pairs

Let C_1 be the least fuzzy cost of FBCMIBTP with T_1 as the corresponding fuzzy time. Consider Y_1 as the fuzzy solution associated with fuzzy pair of cost time $[C_1, T_1]$. Consider $C_2(> C_1)$ be an additional fuzzy cost with $T_2(< T_1)$ as the least fuzzy time with respect to the fuzzy cost C_2. If there does not exist any further fuzzy solution Y for a fuzzy pair of cost-time $[C, T]$ such that $C_1 < C < C_2$ along with $T_2 < T < T_1$, then Y_2 is fuzzy solution associated to fuzzy pair of cost time $[C_2, T_2]$ which is said to be the next efficient fuzzy solution. $[C_2, T_2]$ corresponding to the fuzzy solution, Y_2 is the succeeding solution. Similarly, successive efficient fuzzy pairs of cost time can be procured.

3 Mathematical Formulation of the Problem

Consider a fully fuzzy bi-criteria multi-index BTP with n destinations and l sources. The mathematical model of the problem is given as follows:

$$\text{Min}\left(\sum_{i=1}^{l}\sum_{j=1}^{n}\sum_{k=1}^{q} c_{ijk}y_{ijk} : y_{ijk} = 1, \max\left\{t_{ijk} : y_{ijk} = 1\right\}\right)$$

Subject to

$$\sum_{j=1}^{n}\sum_{k=1}^{q} b_j y_{ijk} \le a_i$$

$$\sum_{i=1}^{l}\sum_{k=1}^{q} y_{ijk} = 1$$

$$y_{ijk} = 1 \ \text{or} \ 0$$

where,

c_{ijk} bulk fuzzy cost for transportation beginning with the ith supplier to the jth receiver employing facility 'k',

y_{ijk} variable for making decision, which is assumed to be either 0 or 1 based on the fulfillment of the demand by the jth receiver from the supplier i employing facility 'k', and

t_{ijk} bulk fuzzy time for transportation beginning with the ith supplier to the jth receiver employing facility 'k',
a_i fuzzy quantity of available amount of the product at the ith supplier and
b_j fuzzy quantity of required amount of the product at the jth receiver.

4 Steps for Solution Procedure

4.1 Step 1

Cancel all the cells, assume (i, j) from FBCMIBTP where fuzzy demand b_j is greater than fuzzy supply a_i.

4.2 Step 2

Proposed method for minimizing fuzzy cost-time method applied:

Take in consideration the 'fuzzy dues' for each column. These 'fuzzy dues' are calculated by applying the technique, balance between minimum fuzzy cost and considered average of two succeeding fuzzy costs in the respective columns. The column with greater fuzzy dues is given preference before other columns for allocation. Thus, the column with most excessive fuzzy dues is selected for allocation first.

*In case of less than three rows, the fuzzy dues are determined by considering difference between two remaining fuzzy costs in respective columns.

4.3 Step 3

The cells (i, j) with the least cost are selected for both the modes of transportation in the determined highest fuzzy dues column. Then allotment is done with the minimum cost between both the modes of transportation. This will be the first allocation of first fuzzy efficient solution of the problem and can be denoted by $Y_{(ijk)}$. Thus, subsequent allocations of all the fuzzy efficient solution can be denoted by '$Y_{(ijk)}$'.

4.4 Step 4

Since $Y_{(ijk)}$ is the obtained fuzzy solution, let $T_{(ijk)}$ be fuzzy time and $C_{(ijk)}$ be the fuzzy cost corresponding to the allocated cell.

4.5 Step 5

Repeating previous steps unless all allocations are completed and no other allocation is possible, we get the first fuzzy efficient solution denoted as Y_1 with the corresponding total fuzzy cost $\left(= \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{k=1}^{p} c_{ijk} y_{ijk} : y_{ijk} = 1\right)$ and the maximum fuzzy time (from all $T_{(ijk)}$) denoted by C_1 and T_1, respectively. Therefore, the first efficient fuzzy cost-time pair of trade-offs for FBCMIBTP is $[C_1, T_1]$.

4.6 Step 6

The subsequent fuzzy cost-time efficient pairs of trade-offs are procured by canceling out the cells from the initial table, where the fuzzy time is exceeding or is same to T_1 for each mode of transportation.

4.7 Step 7

Repeating all the steps to procure the 2nd efficient fuzzy cost-time pair of trade-offs $[C_2, T_2]$. Thus, continuing in similar manner would provide us with subsequent efficient fuzzy cost-time pair of trade-offs until FBCMIBTP eventually is infeasible.

5 Illustration

Considering a FBCMIBTP comprising of 5 receivers and 3 suppliers, fulfillment of demands takes place by 2 transportation modes. The fuzzy availability and fuzzy demands for each source and destination, respectively, are represented in the last column and last row of the table. Two transportation modes, namely P_1 and P_2, are observed.

The top entry in every cell of Table 1 denotes transportation's bulk fuzzy cost (in round brackets), and bottom entry in every cell of Table 1 denotes bulk fuzzy time (in square brackets).

To procure all efficient fuzzy cost-time pair of trade-offs, the new method is used.

Applying the new fuzzy cost-minimizing method and making sure that the requirements at all the destinations are fulfilled by a single source only, the first fuzzy efficient solution is attained. The allocations done for this solution is shown in Table 2, within curly brackets with its associated fuzzy cost and time.

Thus, first efficient fuzzy solution is obtained as $Y_1 = \left\{Y_{(141)}, Y_{(322)}, Y_{(212)}, Y_{(332)}, Y_{(251)}\right\}$ corresponding to $C_1 = (33.4, 41.4, 55.8)$

Table 1 Fuzzy cost and fuzzy time of FBCMIBTP for both the modes of transportation

	Destination							
			$D1$	$D2$	$D3$	$D4$	$D5$	a_i
Sources	$S1$	P_1	(8, 9, 14) [4.2, 6, 7.8]	(6.4, 8, 13.6) [3, 7.5, 10]	(8.6, 12.4, 14.6) [2, 4, 6]	(5.2, 6, 10.8) [1, 3.5, 4]	(6, 7, 12) [2.4, 3.8, 6]	[5, 6.6, 9.8]
		P_2	(6.6, 13, 15.4) [2, 5.6, 6.8]	(8.6, 9, 13.4) [4, 5, 10]	(10, 15, 16) [1.4, 5.8, 7]	(5, 6.8, 13.4) [2.4, 3.8, 6]	(5.2, 6, 10.8) [2, 4, 10]	
	$S2$	P_1	(6, 12, 14) [2, 3, 4]	(8.6, 9, 13.4) [1, 3.5, 8]	(10, 15, 16) [2, 6.5, 9]	(10.6, 14.2, 17) [5, 6.5, 10]	(9.8, 12.6, 13) [3, 5, 7]	[4.6, 9, 9.4]
		P_2	(6.4, 8, 13.6) [2.2, 4, 5.8]	(8, 12.6, 14.8) [3, 5, 7]	(10.6, 13.4, 14.6) [2, 4, 6]	(14, 15, 20) [4.4, 5.3, 9]	(11.2, 13, 14.8) [5, 7.2, 8.6]	
	$S3$	P_1	(5.6, 8, 10.4) [1.8, 6, 6.2]	(4, 5, 10) [4.4, 5.3, 9]	(9, 10, 11) [6, 8, 14]	(8, 9, 14) [2, 3.6, 6.8]	(10.8, 13, 15.2) [7, 8.2, 12.6]	[6, 8, 14]
		P_2	(5, 6.5, 10) [2, 6.5, 9]	(4, 4.8, 6.4) [2.8, 8, 9.2]	(8, 10, 12) [6.8, 7, 11.2]	(9.8, 12.6, 13) [3.8, 4, 8.2]	(9, 10, 15) [4.2, 6, 7.8]	
	b_j		[2, 3, 4]	[3, 5, 7]	[2, 4, 6]	[2, 6.5, 9]	[1, 2.2, 2.6]	

and $T_1 = (6.8, 7, 11.2)$ fuzzy cost and fuzzy time, respectively. Thus, (C_1, T_1) becomes first efficient fuzzy cost-time pair of trade-offs in FBCMIBTP.

Eliminating the cells where fuzzy time is exceeding or is same as (6.8, 7, 11.2) in Table 2 for both forms of transportation, namely P_1 and P_2, to procure the subsequent solution.

Thereafter, all the steps are repeated to get the allocations of second fuzzy efficient solution. The allocations done for this solution is shown in Table 3, within curly brackets with its associated fuzzy cost and time.

Thus, the second fuzzy efficient solution is obtained as $Y_2 = \{Y_{(141)}, Y_{(232)}, Y_{(251)}, Y_{(312)}, Y_{(322)}\}$ corresponding to $C_2 = (34.6, 43.3, 54.8)$ and $T_2 = (2.8, 8, 9.2)$ fuzzy cost and fuzzy time, respectively. Thus, (C_2, T_2) becomes second efficient fuzzy cost-time pair of trade-offs in FBCMIBTP.

Further, cells in which fuzzy time is greater than or equal to (2.8, 8, 9.2) in both forms of transportation, namely P_1 and P_2, are eliminated to procure the subsequent solution.

Table 2 Allocations for the first fuzzy efficient solution

	Destination							
			$D1$	$D2$	$D3$	$D4$	$D5$	a_i
Sources	$S1$	P_1	(8, 9, 14) [4.2, 6, 7.8]	(6.4, 8, 13.6) [3, 7.5, 10]	(8.6, 12.4, 14.6) [2, 4, 6]	(5.2, 6, 10.8) [1, 3.5, 4] {2, 6.5, 9}	(6, 7, 12) [2.4, 3.8, 6]	[5, 6.6, 9.8]
		P_2	(6.6, 13, 15.4) [2, 5.6, 6.8]	(8.6, 9, 13.4) [4, 5, 10]	(10, 15, 16) [1.4, 5.8, 7]	(5, 6.8, 13.4) [2.4, 3.8, 6]	(5.2, 6, 10.8) [2, 4, 10]	
	$S2$	P_1	(6, 12, 14) [2, 3, 4] {2, 3, 4}	(8.6, 9, 13.4) [1, 3.5, 8]	(10, 15, 16) [2, 6.5, 9]	(10.6, 14.2, 17) [5, 6.5, 10]	(9.8, 12.6, 13) [3, 5, 7] {1, 2.2, 2.6}	[4.6, 9, 9.4]
		P_2	(6.4, 8, 13.6) [2.2, 4, 5.8]	(8, 12.6, 14.8) [3, 5, 7]	(10.6, 13.4, 14.6) [2, 4, 6]	(14, 15, 20) [4.4, 5.3, 9]	(11.2, 13, 14.8) [5, 7.2, 8.6]	
	$S3$	P_1	(5.6, 8, 10.4) [1.8, 6, 6.2]	(4, 5, 10) [4.4, 5.3, 9]	(9, 10, 11) [6, 8, 14]	(8, 9, 14) [2, 3.6, 6.8]	(10.8, 13, 15.2) [7, 8.2, 12.6]	[6, 8, 14]
		P_2	(5, 6.5, 10) [2, 6.5, 9]	(4, 4.8, 6.4) [2.8, 8, 9.2] {3, 5, 7}	(8, 10, 12) [6.8, 7, 11.2] {2, 4, 6}	(9.8, 12.6, 13) [3.8, 4, 8.2]	(9, 10, 15) [4.2, 6, 7.8]	
	b_j		[2, 3, 4]	[3, 5, 7]	[2, 4, 6]	[2, 6.5, 9]	[1, 2.2, 2.6]	

Thereafter, all the steps are repeated to get the allocations of third fuzzy efficient solution. The allocations done for this solution is shown in Table 4, within curly brackets with its associated fuzzy cost and time.

So, the third efficient fuzzy solution is $Y_3 = \left\{Y_{(141)}, Y_{(232)}, Y_{(251)}, Y_{(312)}, Y_{(321)}\right\}$ with $C_3 = (34.6, 43.5, 58.4)$ and $T_3 = (2, 6.5, 9)$ fuzzy cost and fuzzy time, respectively. Therefore, (C_3, T_3) is FBCMIBTP's third efficient fuzzy cost-time pair of trade-offs.

Further, cells in which fuzzy time is greater than or equal to (2, 6.5, 9) in both forms of transportation, namely P_1 and P_2, are eliminated to procure the subsequent solution. This matrix is used to obtain the fourth fuzzy efficient solution.

All the steps are repeated to get the allocations for fourth fuzzy efficient solution. The allocations done for this solution is shown in Table 5, within curly brackets with its associated fuzzy cost and time.

Table 3 Allocations for the second fuzzy efficient solution

	Destination							
			$D1$	$D2$	$D3$	$D4$	$D5$	a_i
Sources	$S1$	P_1	(8, 9, 14) [4.2, 6, 7.8]	(6.4, 8, 13.6) [3, 7.5, 10]	(8.6, 12.4, 14.6) [2, 4, 6]	(5.2, 6, 10.8) [1, 3.5, 4] {2, 6.5, 9}	(6, 7, 12) [2.4, 3.8, 6]	[5, 6.6, 9.8]
		P_2	(6.6,13, 15.4) [2, 5.6, 6.8]	(8.6, 9, 13.4) [4, 5, 10]	(10, 15, 16) [1.4, 5.8, 7]	(5, 6.8, 13.4) [2.4, 3.8, 6]	(5.2, 6, 10.8) [2, 4, 10]	
	$S2$	P_1	(6, 12, 14) [2, 3, 4] {2, 3, 4}	(8.69, 13.4) [1, 3.5, 8]	(10, 15, 16) [2, 6.5, 9]	(10.6, 14.2, 17) [5, 6.5, 10]	(9.8, 12.6, 13) [3, 5, 7] {1, 2.2, 2.6}	[4.6, 9, 9.4]
		P_2	(6.4, 8, 13.6) [2.2, 4, 5.8]	(8, 12.6, 14.8) [3, 5, 7]	(10.6, 13.4, 14.6) [2, 4, 6] {2, 4, 6}	(14, 15, 20) [4.4, 5.3, 9]	(11.2, 13, 14.8) [5, 7.2, 8.6]	
	$S3$	P_1	(5.6, 8, 10.4) [1.8, 6, 6.2]	(4, 5, 10) [4.4, 5.3, 9]	–	(8, 9, 14) [2, 3.6, 6.8]	–	[6, 8, 14]
		P_2	(5, 6.5, 10) [2, 6.5, 9] {2, 3, 4}	(4, 4.8, 6.4) [2.8, 8, 9.2] {3, 5, 7}	–	(9.8, 12.6, 13) [3.8, 4, 8.2]	(9, 10, 15) [4.2, 6, 7.8]	
	b_j		[2, 3, 4]	[3, 5, 7]	[2, 4, 6]	[2, 6.5, 9]	[1, 2.2, 2.6]	

FBCMIBTP's last and the fourth fuzzy efficient solution of FBCMIBTP is $Y_4 = \left\{Y_{(341)}, Y_{(221)}, Y_{(152)}, Y_{(131)}, Y_{(311)}\right\}$ and $C_4 = (36.8, 44.4, 66.4)$ and $T_4 = (2, 4, 10)$ fuzzy cost and fuzzy time respectively.

Therefore, (C_4, T_4) is FBCMIBTP's fourth efficient fuzzy cost-time pair of trade-offs.

The process terminates here as there is no further possible solutions.

6 Conclusion

In existing scenario, the industrial sector's cost and time of transportation have prominent control on its profits. To make the most revenue while lowering the costs and

Table 4 Allocations for the third fuzzy efficient solution

	Destination							
			$D1$	$D2$	$D3$	$D4$	$D5$	a_i
Sources	$S1$	P_1	(8, 9, 14) [4.2, 6, 7.8]	–	(8.6, 12.4, 14.6) [2, 4, 6]	(5.2, 6, 10.8) [1, 3.5, 4] {2, 6.5, 9}	(6, 7, 12) [2.4, 3.8, 6]	[5, 6.6, 9.8]
		P_2	(6.6, 13, 15.4) [2, 5.6, 6.8]	(8.6, 9, 13.4) [4, 5, 10]	(10, 15, 16) [1.4, 5.8, 7]	(5, 6.8, 13.4) [2.4, 3.8, 6]	(5.2, 6, 10.8) [2, 4, 10]	
	$S2$	P_1	(6, 12, 14) [2, 3, 4]	(8.6, 9, 13.4) [1, 3.5, 8]	(10, 15, 16) [2, 6.5, 9]	–	(9.8, 12.6, 13) [3, 5, 7] {1, 2.2, 2.6}	[4.6, 9, 9.4]
		P_2	(6.4, 8, 13.6) [2.2, 4, 5.8]	(8, 12.6, 14.8) [3, 5, 7]	(10.6, 13.4, 14.6) [2, 4, 6] {2, 4, 6}	(14, 15, 20) [4.4, 5.3, 9]	–	
	$S3$	P_1	(5.6, 8, 10.4) [1.8, 6, 6.2]	(4, 5, 10) [4.4, 5.3, 9] {3, 5, 7}	–	(8, 9, 14) [2, 3.6, 6.8]	–	[6, 8, 14]
		P_2	(5, 6.5, 10) [2, 6.5, 9] {2, 3, 4}	–	–	(9.8, 12.6, 13) [3.8, 4, 8.2]	(9, 10, 15) [4.2, 6, 7.8]	
	b_j		[2, 3, 4]	[3, 5, 7]	[2, 4, 6]	[2, 6.5, 9]	[1, 2.2, 2.6]	

the time of transportation of the industry is a rather difficult task. Items are typically transported to their receivers by various transportation modes by the industries. They take into consideration the vehicles' availability and the miscellaneous charges, along with various other influences. The algorithm provided is applicable when relations of fuzzy cost-time trade-off are dealt with. Distinctly, it is a beneficiary and useful methodology for procuring the efficient fuzzy cost-time pairs of trade-offs for FBCMIBTP. This is because in a realistic world there can never be any crisp cost or time predictions, whereas fuzzy gives us more opportunity to be flexible. The new method gives us optimal solutions. This happened because in this methodology, more flexibility is provided to decision-makers.

Table 5 Allocations for the fourth fuzzy efficient solution

	Destination							
			$D1$	$D2$	$D3$	$D4$	$D5$	a_i
Sources	$S1$	P_1	–	–	(8.6, 12.4, 14.6) [2, 4, 6] {2, 4, 6}	(5.2, 6, 10.8) [1, 3.5, 4]	(6, 7, 12) [2.4, 3.8, 6]	[5, 6.6, 9.8]
		P_2	(6.6, 13, 15.4) [2, 5.6, 6.8]	–	(10, 15, 16) [1.4, 5.8, 7]	(5, 6.8, 13.4) [2.4, 3.8, 6]	(5.2, 6, 10.8) [2, 4, 10] {1, 2.2, 2.6}	
	$S2$	P_1	(6, 12, 14) [2, 3, 4]	(8.6, 9, 13.4) [1, 3.5, 8] {3, 5, 7}	–	–	(9.8, 12.6, 13) [3, 5, 7]	[4.6, 9, 9.4]
		P_2	(6.4, 8, 13.6) [2.2, 4, 5.8]	(8, 12.6, 14.8) [3, 5, 7]	(10.6, 13.4, 14.6) [2, 4, 6]	–	–	
	$S3$	P_1	(5.6, 8, 10.4) [1.8, 6, 6.2] {2, 3, 4}	(4, 5, 10) [4.4, 5.3, 9]	–	(8, 9, 14) [2, 3.6, 6.8] {2, 6.5, 9}	–	[6, 8, 14]
		P_2	–	–	–	(9.8, 12.6, 13) [3.8, 4, 8.2]	–	
	b_j		[2, 3, 4]	[3, 5, 7]	[2, 4, 6]	[2, 6.5, 9]	[1, 2.2, 2.6]	

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Automatic Candidature Selection by Artificial Natural Language Processing

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Abstract Finding the right person for the job is a daunting task, especially when we have a large number of job applicants. This will reduce the performance of the team looking for a suitable candidate, the process sometimes takes a long time, and the default "Restart Arrangement and Alignment" program can really help the short course of a short shortlist, which can undoubtedly help to select a competitor and a flexible cycle. The proposed model is capable of dealing with a large number of restatements, first combining classes using a different separator and then the expected set of tasks. Now, candidates can be rescheduled using content-based recommendation, using cosine intimacy and using KNN to split resumes close to a set of expected commitments. In this study and proposed work done on the linear support vector classifier with natural language processing and text classification with the help of algorithm and obtained 79.53% accuracy.

Keywords Resume · Natural language processing · Machine leaning · CV · Automated

1 Introduction

Skill purchasing is an important, complex, and tedious skill within the Human Resources department (HR department). We all know that the level of Indian industry has great potential [1–3]. Not only are there an amazing 1,000,000 people entering the job market every month, but there are also huge profits. India is a country with

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a very high number of people who are unemployed or willing to switch to a new job [4]. Obviously, this is an incredibly liquid, huge yet powerful market with many disappointing failures. The most difficult aspect is the lack of a standard design and continuous layout which makes the short submission of the required profiles of the required tasks very troublesome and tedious [5, 6]. Choosing a career person should have background information that will help them understand the function and relevance of the job profile. As there are so many different jobs available in the name, as a result there is a huge demand for one or more jobs, so it is very difficult for the HR department to choose the right candidate for the job profile available, having the option to delete non-functional profiles pre-schedule as it may result in lower investment costs [7]. At present, the problems facing the industry are as follows:

- Differentiating a deserving candidate from the crowd—as India is full of industries and still growing in numbers and it also has many job seekers, it is a difficult job to screen many resumes and get a right person, which ultimately makes the hiring process very slow, and it also costs a huge amount to the company.
- Getting what is required from the resume—the other difficulty faced by the recruiters is that the resumes which they received are not in standard format, like every resume is in different format, so the HR must go through each resume manually and there are chances of mistakes which could lead to losing a deserving candidate.
- Predicting that the candidate will be able to do the job—here the HR has to go through the resume of the candidate and has to match the job description and the content of the resume and decide whether applicant is fit for job.

To solve the problems in selecting a perfect resume for a job role, we build an automated resume screening model by using machine learning. The proposed model's inputs are features absorbed from the applicant's resume, and then it determines the categories. By analyzing job description, the model maps the categorized resume and gives the output which is the most suitable candidate for the job. Our primary commitments are recorded underneath:

1. We fostered a mechanized resume suggestion framework.
2. AI-based categorization techniques are used to filter the most relevant resume.
3. Our experimentation shows that the linear SVM is the best option as compared to the other techniques.

When the uses of forthcoming competitors are gotten, they are exposed to cautious examination by a bunch of devoted screeners. This screening system is vital on the grounds that it straightforwardly influences the nature of the admission and, consequently, the organization benefits. The screeners ordinarily continue as underneath:

(a) Comprehend the necessity for the employment opportunity, as far as the abilities that are obligatory and those that are discretionary however ideal, the experience standards if any, inclination for the area of the up-and-comer and so on. Additionally, note the sort of work that will be proceeded as a feature of the work job.

(b) Glance through every one of the applications and reject the individuals who do not have the base long stretches of involvement, or the abilities needed for the work.
(c) Out of the excess up-and-comers, track down the most ideally equipped counterpart for the work. This requires the enrollment specialist to peruse the resume exhaustively and contrast it and the work profile. Since the quantity of up-and-comers who can be met is restricted, the scout needs to make a general judgment on the competitors.

2 Literature Review

For a particular job role, there are many applications, and out of those applications, many are relevant and many are irrelevant to the given post. As the recruiters want the best candidate among the many candidates [1, 8, 9], it become very difficult to shortlist a particular candidate from a pool of candidates. The process involved in matching a resume with the description of a job is same as that of recommendation model, and the mentioned model was proposed by Varian and Resnick [10]. Nowadays, the recommendation is used more often like on e-commerce websites, on IoT [11], on LMS, news recommendation [12], and in music [13]. Ong et al. [14] proposed a nitty gritty review, and it incorporated the various conventions that were utilized by the analyst in the beyond couple of years for the proposal framework [9, 15, 16]. They were examined how the proposal framework generally utilized progressively applications. Suggested management is usually four types of shared, i.e., filtering, content based, knowledge based, and mixed approach, methods [17]. The author [17] spoke of all kinds of suggestions and guidelines for their full functionality. The author in [18] gave an itemized study of work suggestion administration. They mentioned the key steps opted by many organizations for the recruitment process. How the e-enrollment entry is serving to the association, what component of the applicant might prompt getting chosen, and numerous other pertinent enrollment procedure are clarified. In Malinowski et al. [19], the author used expectation–maximization (EM) algorithm, and it works by utilizing the content of the resume and the requirement for the job provided by organization. The author in [20] used a fuzzy model resume content and job description into consideration. A hybrid classifier is used by the authors of Balaji et al. [21]. They utilized data recovery, manual ascribes, and other for work suggesting process.

There have been a few endeavors to computerize different parts of the enlistment interaction [22]. For instance, [3] proposes utilizing strategies like community sifting to suggest applicants coordinating with a task. Singh et al. [23] portrays a technique that utilizes importance models to connect the jargon split between sets of expectations and resumes. In their technique, related sets of responsibilities are distinguished by coordinating with a given applicant set of working responsibilities with an information base of sets of expectations. Then, at that point, resumes coordinating with those sets of responsibilities are utilized to catch jargon that is not unequivocally referenced in the sets of expectations. These techniques expect the presence of physically named importance rankings. Then again, our technique does not expect the presence of importance rankings for preparing. In [5, 20], community sifting measures are joined with content-based similitude measures for better positioning. Nonetheless, a large portion of these investigations are performed on manufactured information and not on certifiable unstructured continues and sets of responsibilities. There is an assemblage of work that considers individual inclinations and group elements for staffing [11, 24]. In our work, we do not check out joining perspectives, and choices are made exclusively dependent on the expertise match of the possibility to the expected set of responsibilities. There is likewise work zeroing in only on data extraction from resumes [17]. Rather than past work, we portray a whole framework for supporting screeners, utilizing a blend of data separated from resumes and recovery methods to assist the screeners with achieving their errands quicker. Specifically, we show that we can improve recovery execution utilizing data separated from resumes. Likewise, not at all like them we remove insight for every expertise. Our work is unique in relation to that of prior proposed frameworks, as in the greater part of the current framework a task is suggested to the applicant dependent on the CV and its accuracy is low. For further improvisation, we worked on a different model which has two phases: The first is to categorize CVs in classes, and the second is ranking of candidate on the basis of job description and text of the CV.

3 Problem Statement

Today the serious issue being looked across the business is the way to get the right ability, utilizing insignificant assets over the web and in negligible time. As depicted in Chap. 1, the following are the significant difficulties that are needed to be survived, to carry efficiencies to the total interaction.

- Eliminating the irrelevant candidate.
- Getting insights from the resume.
- Acknowledging that the applicant can do the given work or not before onboarding.

The purpose of this project is to give an automated model which can do the above-mentioned work with no human intervention. The model will help the HRs or recruiters to filter the right resume from a heap of resumes; the model will not depend on the format of the resume rather it looks at the content of resume; filters the best candidate from among the others by utilizing features of the CV and the requirement provided by the company [5]. The technique used in this is supervised learning which helps the model to categorize the resumes. The steps used for the classification purpose are as follows:

1. Perform named entity recognition, natural language processing, and characterization of text by using N-gram text utilizing n-grams.

2. The arrangement will give a criticism circle conclusion to change/work on the precision by consolidating the input relating to the inaccurately screened profiles.
3. Use classification based on distance metric.

4 Methodology

The main focus of this research work is to select the right applicant for the bulk of the applications. The modified methodology for this work is shown in Fig. 2. The model presented is divided into two steps (Fig. 1):

(i) Prepare
(ii) Inference and deploy.

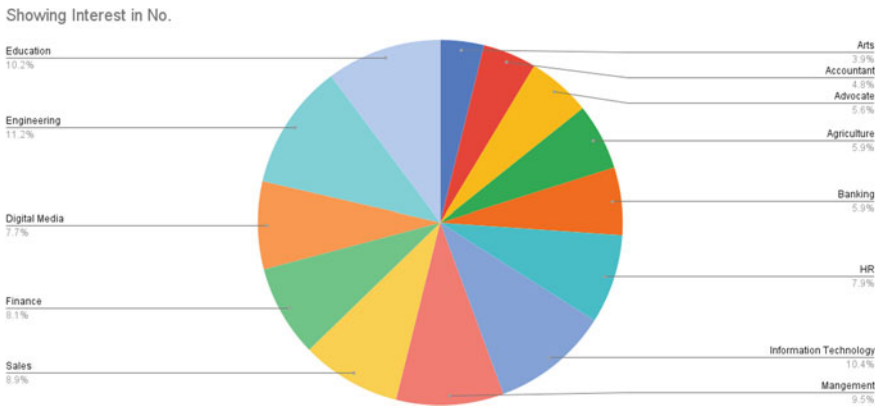

Fig. 1 Distribution of data

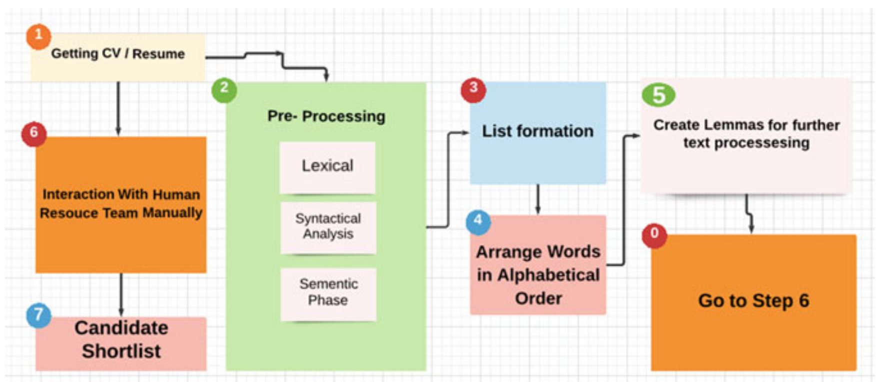

Fig. 2 Methodology

A Dataset Used

We downloaded the dataset from an online portal which is Kaggle. The data is in comma-separated values (CSV) format. It has three columns which are Resume, Category, and ID. Here ID refers to the serial number of the CV, Resume contains the content of the resume, and Category refers to the domain of the candidate.

(a) Preprocessing: Cleansing of dataset is performed in this step and also removal of irrelevant data or character like the extra spaces, special characters, single letters, etc. After performing the preprocessing, we are left with a clean data with no irrelevant characters. Tokenization of the dataset is done by utilizing the NLTK tokenizer [25]. After that stop words removing, lemmatization and stemming. Firstly, the dataset is imported, and then the cleansing is performed on the content of the CV that removed the irrelevant character from the dataset. Information masking was performed as follows:

- String: \x
- String for escape sequence like \b, \a, \n, \t
- Numbers
- Remove all single letter words
- Email addresses
- Stop words were masked
- Lemmatization.

(b) Removing stop words: The stop words, for example, and, the, was, and so on, are regularly showed up in content, and it does not; therefore, we removed these types of words. The process of removing the stop words is as follows:

- Firstly, we tokenize the processed content in single tokens and after that we store these tokens into an array.
- Then for each word, it allocates an array of stop words from the NLTK library.
  (i) We import stop words from the nltk.corpus.
  (ii) Then we fetch the "English stop words".
  (iii) The outcome of the stop words is an array of 181 stop words, and this can be verified by using running a command which is len (one Set Of Stop Words) and print(oneSetOfStopWords).
- Then we check the availability of word in stop word list, and if we found anything in it, then we filter it from the array.
- The above step is looped till the end of the array.
- The outcome of the above operation is an array with no stop words.

B Stemming

It is the process of reducing a word to a base word or root word. It can be a single word or a group of words. For example, if we see words like sending, sent, and send, these words are of different tenses, but they all have a same root which is "send". In the same way if we see another word like play, plays, and playing, here the stem word for these words is "play".

C Lemmatization

The purpose of both stemming and lemmatization is same. The difference between lemmatization and stemming comes when we see the process behind both the techniques. In stemming, the algorithm just chop ending of a word to get a stem or root word, but in lemmatization the algorithm understands the meaning of the word and gives a root word which is known as lemma. If we see the word better, then the stemming technique will not work here as the root word for better is good, but if we use lemmatization, then it will give accurate output. Steps involved in lemmatization are as follows:

- Firstly, text is converted to list which contain words.
- Arrange the words in alphabetical order.
- Lastly make a group of the lemmas and the word forms.

Now we perform feature extraction. We applied TF-IDF to the preprocessed feature extraction dataset [26]. Then we fetched the organized information and performed highlight extraction using TF-IDF. AI-based grouping models or training computations need an appropriately sized mathematical vector to handle them. Machine learning classifiers have not enjoyed content in a long time. Thus, in the preprocessing step, the text is translated into a vector structure of the required equivalent length.

We have used some techniques to get the features, these techniques are term-frequency inverse-document frequency, bags of words, etc. We used bags of words in a way that for every resume, we take the frequency of words into consideration and the order of the occurrence of that word is not taken into consideration. We have also calculated the TF-IDF for every word which is there in the resume, and it is done with the help of scikit-learn:

- Sublinear df is set to true to use logarithmic frequency structures.
- Min df is the lowest occurrence of a word in the set.
- The value 12 is assigned to the norm because the feature vector must have Euclidean units.
- The range of gram is set to $(1, 2)$, and this means that both the bi gram and unigram are taken into consideration.
- To remove irrelevant words, we used stop words which is set to English.

A Inference and Deployment

Here the preprocessed data and the extracted features and the description of the role are compared, and as an output, we get a resume which is suitable for the job role.

5 Experimentation and Analysis

We have built two solutions for the problem: The first one is the classification in which the resumes are categorized with respect to the category of the resume like to which class it belongs. The second one is the recommendation system which compares the description and the content of the CV and returns the resumes which is most suitable for the job role. The output of the model is a list which contains the filtered candidates.

Classification

The classification was finished utilizing four unique models, and they all have different accuracies.

Random Forest (RF) [27]: Random forest is an ML technique which is helpful in solving classification and regression. It works in a way that it merges many classifiers to get a solution for a complex problem, and it has a lot of decision trees.

Multinomial Naïve Bayes (NB) [28]: Naïve Bayes classifier is a group of basic "probabilistic classifiers" in view of Bayes' hypothesis with solid freedom presumptions between the highlights.

Logistic Regression (LR) [24]: Logistic regression is a classification model which is used for linear and binary classification problems.

Linear Support Vector Classifier (linear SVM): It is a supervised ML classifier, and it is defined by an isolating hyperplane which helps to distinguish between the classes. Example of SVM can be a data which has two classes like positive and negative, and then the output of the SVM will be a single straight line between these two classes. Each side of the line represents a class which is positive or negative.

Firstly, we start our experimentation process with random forest. The extracted features which we get from TF-IDF is passed into the random forest classifier to get the prediction, and the random forest attains an accuracy of 37.99%. As it is clearly visible that the result is not satisfactory, we planned to go for another classifier which is Naïve Bayes, and it reached an accuracy of 43.39% which is quite better than the random forest classifier. We can clearly see that the NB missed approximately half of the resumes. Then we utilized SVM, and it gives an accuracy of 79.53%.

We can clearly see in Table 1 that SVM performs the best among the other classifiers, and it gives an accuracy of 79.53%. Since the accuracy of SVM is good, we continue to proceed with it and present an accuracy matric which is shown in Fig. 3.

B Resume Recommendation

Suggestion model is intended to accept position portrayal and CVs as info and give the rundown of resume which are nearest to the given expected set of responsibilities.

Table 1 Result of different experiment

Paper	Author	Classifier	Accuracy
[27]	Breiman, L	Random forest	0.3799
[28]	Rish, I., et al.,	Multinomial Naïve Bayes	0.4339
[24]	Nasrabadi, N. M	Logistic regression	0.6140
Current	–	Linear support vector machine	0.7953

Fig. 3 Accuracy matrix of model

This is finished by utilizing two methodologies: (i) matching the content of the resume with the job description and (ii) K-nearest neighbors.

Resume Recommendation

The proposal model is intended to accept position disclosures and CVs as information and provide their resume list closest to the expected set of tasks. This is eliminated using two methods: (i) matching the contents of the resume with the job description and (ii) K close neighbors. Content-based recommender: Considering this is the circumstance of chronicle resemblance recognizing verification, we have gone with the content-based recommender where job description outfitted by the business is composed with the substance of resumes in the space and the top (*n* being configurable) organizing with resumes are endorsed to the spotter. The model takes the purged continue information and set of working responsibilities and joins the two into a solitary informational index and afterward figures the cosine closeness between the set of working responsibilities and CVs.

1. K-nearest neighbors: In this model, the nearest K neighbor is used to see the CVs closest to the expected order of obligations, with all the considerations, CVs matching next to a given set of performance credits. However, in order to make JD and CVs on the same scale, we have used an open library called "gensim", and this library creates a given text drawing at a given word limit. Therefore in order to achieve JD and CVs on the scale of related words, this library was used to compile JD and CVs, and after that, at that time, k-NN was used to obtain CVs that eagerly planned the JD given. Content-based recommendation: Considering this state of authenticity similarity to authentication history, we are accompanied by a content-based recommendation in which the business description included in the business is combined with the restart space and more (*n* adjustable) redesign edits verified locally. The model takes a continuous refined information and set of work commitments, combines both the information index alone, and then calculates the cosine correlation between the set of work commitments and CVs.
2. K-nearest neighbors–content-based recommender: In this model, the nearest K neighbor is used to see the CVs closest to the expected order of obligations, with all the considerations, CVs matching next to a given set of performance credits.

However, in order to make JD and CVs on the same scale, we have used an open library called "gensim", and this library creates a given text drawing at a given word limit. Therefore in order to achieve JD and CVs on the scale of related words, this library was used to compile JD and CVs, and after that, at that time, KNN was used to obtain CVs that eagerly planned the JD given.

3. Suggestions: Arranged models are generally suitable for primary level 10 review of summaries by the elective agent. This helps scouts to request resumes on an as-needed basis and effectively recognize the resumes that best fit their job structure.

This model will help the enrollment specialist to expedite the selection of profiles while ensuring the validity of the selection system, since they will have the option to review a large number of resumes quickly and with the proper adjustment, which would not have been possible for a human being. Do it continuously. This will help make the hiring process productive and with a lot of confidence in identifying the right skills. Similarly, it will help the explorer reduce the asset spent on recognizing the correct skills that make a bike smart. At the next level, the model positions resume against an expected set of responsibilities as appropriate, making it easy to provide the audience with a list of resumes based on their relevance to the job. The offer made by the model is currently for individual businesses, but it will be further enhanced to target the specific model and industry, which will make it more successful and provide better suggestions.

6 Conclusion

Numerous occupations can be obtained as a result of occupational relationships. Identifying huge newcomer applications in resume pools is a delight for any organization today. The most popular way to submit a beginner resume is passive, extensible, and abusive of resources. To overcome these challenges, we proposed an upgraded AI-based model that recommends reasonable candidates' HR resumes considering a given commitment position. The proposed model proceeded in two steps. First, divide your resume into groups. Second, we propose to act in accordance with a given assignment of work duty and the correspondence of records. The proposed approach properly searches for CV encounters and semantics and provides an accuracy of 78.53% with a linear SVM classifier. Model representations can be updated using important learning models such as convolutional neural networks, recurrent neural networks, or long-term memory. If your industry generates numerous resumes, you can use the proposed approach to generate industry-leading models. Including space experts such as HR masters will help build more accurate models, and analysis of HR competencies will help develop more iterative models.

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Vulnerability Assessment of Cryptocurrency Wallet and Exchange Websites

Saba Khanum, Dishika Bisht, Kirti Kashyap, and Muskan Mehta

Abstract With the great rise in Crypto, the future of blockchain has become susceptible to security threats. These security vulnerabilities allow attackers to compromise sensitive data and manipulate legitimate websites for malware attacks. In this paper, we observe threats and vulnerabilities in blockchain-based websites. By the use of security testing skills and software, we discover severe categories of security vulnerabilities in web applications. To carry out the security testing, we used tools such as, Nmap, Whatweb, and Uniscan, whereas the scans were carried in the OWASP's Zed attack proxy and Nikto tools. After the scanning process, these tools identify the low, medium, high-level risks, and vulnerabilities and configure the overall security analysis for these web applications. This research puts forth the most common vulnerabilities faced by blockchain-based applications and contributes in reducing the attacks and risk in future.

Keywords Vulnerability assessment · Blockchain websites · Risk analysis · Blockchain wallets

1 Introduction

Blockchain technology has transformed the way that we work and live. Crypto currencies are one such popular application of utilizing the blockchain. The great rise in Crypto exchanges and wallets has become susceptible to security threats altogether. The security vulnerabilities allow attackers to compromise sensitive data and manipulate legitimate websites and wallets for malware. Attackers use these vulnerabilities to exploit various cryptocurrency websites. There are many instances where the cryptocurrency websites were attacked for data breach and cyber-attacks, making this technology vulnerable to cyber-attacks even keeping in mind its powerful security factor. The attacks and breaches reported in last one decade is increasing and this

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questions the integrity and security of data put in blockchain applications. Vulnerability assessment is one such way for overcoming this problem. It is a security evaluation procedure which is performed by ethical hackers or security professionals to assess the security strength of cryptocurrency websites. Vulnerability assessment and analysis for cryptocurrency websites signifies the requirement for the critical observation and security check of the web servers, database servers, and access points to eliminate the possibilities of security breaches and exploitation of the investor's assets. The found vulnerabilities can be discovered and prevented by executing vulnerability assessment as it helps to find if any system is open to any vulnerabilities, allocates risk levels to those vulnerabilities, and suggests mitigation.

1.1 Motivation

Blockchain is a large database running over millions of devices and is open to anyone. Crypto currencies are one such popular application of utilizing the blockchain technology. The advantages of blockchain promises a bright endeavour, but at the same time, the breaches happening in last one decade endangers this bright future. It has been observed from grey literature and bibliographic databases that crypto bots, crypto mining and crypto currency breaches are happening all around the world. The motivation behind this research is to predetermine and get exposed to the threats and vulnerabilities in the existing blockchain-based websites.

1.2 Contribution

- This research paper does the scanning of ten blockchain websites and highlight the common vulnerability found. The contribution is as follows.
- Identification of the root cause of the vulnerabilities in websites.
- Prioritizing and analysing the risk and vulnerabilities found in crypto websites by assigning a high- to low-risk score to each vulnerability. The factors included, viz. what data is at risk, severity of an attack, potential damage as a result of the vulnerability, etc.
- Summarization of the characteristics of various attack methods and defence methods.
- Determining the most effective path for mitigation of each vulnerability and attack.

Blockchain technology has transformed the way that we work and live. Crypto currencies are one such popular application of utilizing the blockchain. The great rise in crypto exchanges and wallets has become susceptible to security threats altogether. The security vulnerabilities allow attackers to compromise sensitive data and manipulate legitimate websites and wallets for malware. Attackers use these vulnerabilities to exploit various cryptocurrency websites. There are many instances where the cryptocurrency websites were attacked for data breach and cyber-attacks, making this technology vulnerable to cyber-attacks even keeping in mind its powerful security factor. The attacks and breaches reported in last one decade is increasing and this questions the integrity and security of data put in blockchain applications. Vulnerability assessment is one such way for overcoming this problem. It is a security evaluation procedure which is performed by ethical hackers or security professionals to assess the security strength of cryptocurrency websites. Vulnerability assessment and analysis for cryptocurrency websites signifies the requirement for the critical observation and security check of the web servers, database servers, and access points to eliminate the possibilities of security breaches and exploitation of the investor's assets. The found vulnerabilities can be discovered and prevented by executing vulnerability assessment as it helps to find if any system is open to any vulnerabilities, allocates risk levels to those vulnerabilities, and suggests mitigation.

2 Literature Review

Patel [1] presented the survey to search out the security loopholes in an organization using vulnerability assessment and penetration techniques. Their paper describes the types of vulnerabilities, provides an outline of VAPT, tools used for vulnerability assessment to secure the organization from cyber-attack and also suggests preventive measures against OWASP top ten vulnerabilities'. Devi and Kumar [2] examined the vulnerabilities of web applications using tools like OWASP ZAP, Nikto, and Nmap. They have performed the vulnerability analysis and assessment by using the testing tools such as OWASP Zed Attack Proxy and Nikto scan to find the security loopholes in the web application. Khera et al. [3] discussed the various vulnerability assessment tools for finding vulnerabilities in the system and explained the importance of vulnerability assessment and penetration testing to secure the organization from various cyber-attacks. Shinde and Ardhapurkar [4] examined the various web application vulnerabilities corresponding to attack types. Their paper explains the difference between vulnerability assessment and penetration testing. Vulnerability assessment is the systematic approach to discover the vulnerabilities in the system while penetration testing performs to exploit the vulnerabilities in the system in a same way as an attacker would do and thus it helps to identify many security loopholes in the application. Nagpure and Kurkure [5] proposed the comparative analysis of some vulnerability assessment tools including OWASP Zed Attack Proxy (ZAP), Burp suit, and acunetix. They have also performed the vulnerability assessment and penetration testing in web applications. Vibhandik and Bose [6] introduced the new testing approach for performing the vulnerability assessment by using a combination of Nikto and W3AF tools. They have also explained the importance of selecting the appropriate set of tools for finding the web application vulnerabilities.

2.1 Tools Used for Vulnerability Assessment on Blockchain-Based Websites

The life cycle of the vulnerability assessment tools (VAPT) process examines various VAPT tools for finding vulnerabilities in any system. This research paper does vulnerability assessment on ten cryptocurrency web applications by using a set of VAPT tools. The tools are required to test the security level of an information system to search for security breaches or loopholes. Following are the tools used to scan for the vulnerabilities:

- **Uniscan**: This vulnerability scanning tool uses built-in plugins and modules to perform the scanning. It can be used for information gathering tasks, such as web fingerprinting, server fingerprinting, and Search Engine Dorking including Google, and Bing Dorking.
- **Nikto**: A popular web vulnerability scanner that scans out the website and server for known misconfiguration and security breaches.
- **Nmap**: This is an open-source tool used for host discovery, port scanning, and vulnerability scanning.
- **Whatweb**: Whatweb is a web scanner written in the Ruby language that identifies the architecture and other information about the web application such as web servers, and embedded devices.
- **OWASP ZAP (Zed Attack Proxy)**: This Open Web Application Security Project ZAP scanner actively analyses the risk levels and defines the vulnerabilities in the system.
- **SQL MAP**: This open-source penetration tool defines the vulnerabilities in the SQL databases and manages to sneak out all the available information in the SQL databases.

2.2 Wallets and Exchanges Websites Used for Finding the Vulnerabilities

In order to find the vulnerabilities in blockchain-based applications, the blockchain wallets and blockchain exchanges based web applications are identified and after that scanning and assessment is done using the tools mentioned in Sect. 2.1. Below mentioned table lists the wallet and exchange websites.

3 Methodology

To perform the vulnerability assessment first the VAPT tools are identified (Sect. 2.1) then the target websites are explored (Sect. 2.2). After identification each websites are

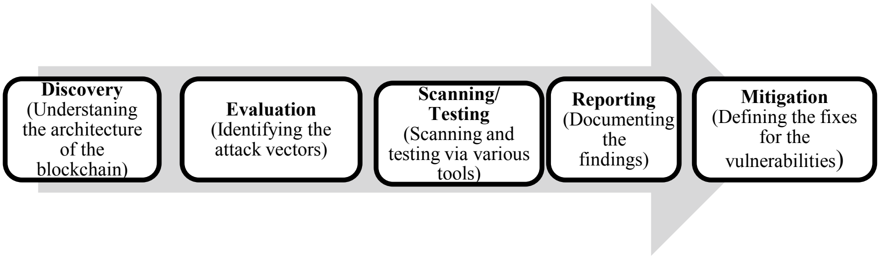

Fig. 1 Process of vulnerability assessment

scanned on all mentioned tools. The process of scanning and assessment is mentioned in this section.

3.1 Method Applied to Do Vulnerability Assessment on Websites

Vulnerability assessments is the technique to locate and report the weaknesses or loopholes in a particular system. This assessment provides a way to resolve and detect security problems and security breaches before they get further exploited beyond repair. It is a systematic analysis of the weaknesses in a system, which evaluates whether this particular system can withhold further security levels and recommends remediation for the same.

Figure 1 describes the steps involved in the process of the vulnerability assessment that helped in the formation of a structure for analysing the security threat assessment. The steps involve the discovery of such websites and having a complete understanding of their architecture, evaluating and identifying the attack vectors by scanning these websites using various tools, reporting and documenting the findings from those scans, and providing mitigation for those vulnerabilities [7].

3.2 Implementation and Analysis

All the required scan is executed on kali linux, identification of the potential vulnerabilities and analysis of the website is done using uniscan, nmap, nikto, and sqlmap. After a complete understanding of Exchange and Wallet, seven well-established crypto websites and three previously hacked Crypto websites scanned for information gathering of the web applications. Identification of all the technologies used by websites such as all javaScript libraries, web servers, and embedded devices are scanned using Whatweb. Comprehension of the security dynamic, triggering the risk level of the vulnerabilities are implemented on zap scan.

Table 1 List of blockchain-based websites

S. No	Blockchain wallets websites and blockchain exchange/websites
1	https://www.atomic.io/
2	https://www.poly.network/#/
3	https://ethereum.org/en/
4	https://www.blockchain.com/
5	https://bitcoin.org/en/
6	https://www.kucoin.com/
7	https://coincheck.com/
8	https://wazirx.com/
9	https://www.binance.com/en
10	https://crypto.com/

Table 2 List the vulnerabilities found through ZAP tool

S. No	ZAP scan listed the common vulnerabilities found across 10 websites
1	CSP: wildcard directive
2	CSP: style-src unsafe inline
3	CSP: script-src unsafe inline
4	X-frame options header not set
5	Absence of anti CSRF tokens
6	Cross domain JavaScript source file inclusion
7	Secure pages include mixed content
8	Cookie without same site attribute
9	Incomplete or no cache control
10	X-content type option header missing

Table 2 shows the vulnerabilities found after scanning the blockchain dependent websites as mentioned in Table 1. It is essential to make note here that no vulnerability is found in the scan of websites using the tools uniscan, nmap, nikto, and sqlmap. But, the websites are prone to attack, viz. XSS Attack, XSSI attack, Data Injection attack, clickjacking attack, CSRF attack, Man in middle attack, cache poisoning attack, file inclusion attack, and MIME sniffing attack [8–10].

3.3 *Mitigation*

- Measures taken for previously hacked websites (https://www.kucoin.com/, https://coincheck.com/). Mitigated security system after the hack, "Server Banner" has changed from "nginx" to "IAS/1.4.2.3-1.17.3" which may suggest a WAF, LOAD

BANNER, or PROXY in the place. A web application firewall protects the web applications by monitoring the traffic between the web application and the Internet.

- Use of Load Balancers and Web Proxy Servers is to distribute client connection requests, provide load balancing and failover across the cluster, and provide security by filtering the LAN addresses from external users.
- The found vulnerabilities are prone to the attacks as described in Fig. 3, thereby by performing proper security auditing and attaining a legal consent from these blockchain companies to penetrate their servers and derive the security threats and remediate those vulnerabilities, these websites can attain an overall security check.

4 Result and Conclusion

In the below given matrices the results obtained after all the scans and assessment is presented. Figure 2 represents the risk matrix of vulnerabilities with respect to the websites in which they were found. There are a total 12 websites seven of which are cryptocurrency exchanges and other five are cryptocurrency wallets. We listed a total 10 vulnerabilities which were found common in all these websites. After that we categorized them in high, medium and low risks as per the results found in ZAP scan. H defines high risk; M defines medium risk; and L defines low risk. According to the results none of the vulnerabilities was found to be at high risk, some of them at medium risk and majority of them at low risk.

Representing the risk levels (M: medium, L: low, H: high) in each cryptocurrency website along with the name of the vulnerabilities. For example, blockchain.com has medium level risk vulnerabilities viz CSP-wildcard directive, CSP-style-src unsafe inline, x-frameoption header not set and low level risk is absence of anti-csrf tokens.

Figure 3 representing the attacks and vulnerabilities found in the cryptocurrency websites. For examples, the websites attacked with MIME sniffing attack and have x-content type option header missing vulnerability are bitcoin, polynetwork, coincheck, ethereum, and atomic.

5 Future Scope

Vulnerability assessment for cryptocurrency is a vast technique in cybersecurity. Blockchain technology is used to store any type of data, which opens up the potential for serious vulnerabilities in any system. Companies require blockchain pen testers to find the vulnerabilities before they're exploited. Understanding the security architecture and being able to perform a VAPT on such webapps allows a first-hand experience in analysing the security frameworks and testing of big blockchain systems. By performing a security audit, we get a detail knowledge of the security

Websites \ Vulnerabilities	CSP : Wildcard Directive	CSP : style-src unsafe inline	CSP :script-src unsafe inline	X-frame option header not set	Absence of Anti-CSRF Tokens	Cross-domain JavaScript source file inclusion	Secure pages include mixed content	Cookie without same site attribute	Incomplete or no cache control	X-content type option header missing
blockchain.com	M	M		M	L					
binance.com	M	M	M			L		L	L	L
crypto.com	M	M	M			L		L	L	L
m.kucoin.com	M	M	M			L		L	L	
coincheck.com					L	L	M	L	L	L
wazirx.com								L	L	
bitcoin.com				M	L	L			L	L
poly.network	M					L			L	L
etherium.com					L				L	L
blockchain.com(wallet)	M	M			L				L	
bitcoin.com(wallet)				M	L	L			L	L
atomic.io	M				L				L	L

Fig. 2 Risk matrix

architecture and can further perform a security audit for small scale companies with the help of open-source tools. In future public, private, and consortium blockchain threats and vulnerabilities can be categorized.

BLOCKCHAIN	BINANCE	CRYPTO	KUCOIN	COINCHECK	WAZIR	BITCOIN	POLYNET WORK	ETHERIUM	BLOCKCHAIN WALLET	BITCOIN WALLET	ATOMIC
BL	BN	CR	KU	CN	WZ	BT	PL	ET	BLW	BTW	AT

Attack vs Vulnerability vs Websites	CSP: Wildcard Directve	CSP: Style-src unsafe inline	CSP:script-isrc unsafe inline	X-Frame option header not set	Absence of Anti-CSRF Tokens	Cross domain javascript source file inclusion	secure pages include mixed content	cookie without same site attribute	incomplte or no cache control	X-content type option header missing	
XSS Attack	BL, BN, CR, KU, PL, BLW, AT	BL, BN, CR, KU, BLW	BN, CR, KU							CN, BT, PL, ET, AT	
XSSI Attack						BN, CR, CN, PL		BN, CR, CN, WZ			
Data Injection Attack	BL, BN, CR, KU, PL, BLW										
Clickjacking Attack				BL, BT, BTW							
CSRF Attack					BL, CN, BT, ET,			BN, CR, CN, WZ			
Man-in-the-middle							CN				
Timing Attack								BN, CR, CN, WZ			
Cache poisoning software attack									WZ, ET,AT		
File inclusion Attack						BN, CR, CN, PL					
MIME Sniffing Attack										BT, PL, CN, ET, AT	

Fig. 3 Attack versus vulnerabilities versus websites matrix

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Greedy Theory Using Improved Performance Prim's Algorithm, Big Bang Speedup of the Bellman–Ford Algorithm

Tejinder Kaur, Vidhu Kiran, Abhinav Ahlawat, and Nandini Verma

Abstract In simple words, it is mainly used to solve a problem in which the best option has to be selected from the available options at each step. An algorithm is designed to find the best solution for a problem. It is used to find the shortest path from the starting point to the target in a weighted graph. A graph in which the distance or value from one point to another is known, that is, the length of the line joining all the points is known in it. Let us say we are trying to find the shortest route from your house to your friend's house and you know the distances between different paths across the city. Now if you consider the different locations as a vertices (point) and the path between them as edges (the line joining the points), we can design a weighted graph. Given a set of cities and the distance between every pair of cities, the problem is to find the shortest possible route that visits every city exactly once and returns to the starting point. It does a blind search, so a lot of time is wasted in processing. It cannot handle negative edges. This leads to the acyclic graph and mostly fails to find the correct shortest path. We need to keep an eye on those vertices which are visited once. Note the difference between the Hamiltonian cycle and the TSP. The problem with the Hamiltonian cycle is if there exists a tour that visits every city once. Here, we know that there exists a Hamiltonian tour (since the graph is complete) and that in fact many such tours exist, the problem is to find a minimum weight Hamiltonian cycle.

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Keywords Path · Shortest · Greedy algorithm · City · Route · Prim's algorithm

1 Introduction

Greedy algorithm is a very simple algorithmic process that makes decisions based on currently available information to solve complex multilevel problems without worrying about the future [1]. It means that while finding a solution to a problem which is divided into several steps by a greedy algorithm, it is thought that—Which is the simplest and easiest-to-implement best solution at the moment? It is not considered, how will this solution affect the next steps in the problem? [2]. The Greedy algorithm is a simple, intuitive, simple-to-use algorithm used in optimization problems. Greed's algorithm always takes the best immediate solution when looking for answers. One of the main reasons for using it is to get the most viable solution right away [3].

Recursive algorithms play a big part in all the programming we do. It is not necessary to use recursion for simple computational problems, but if we define the algorithm recursively, it becomes much easier to write, study and check for errors. Recursive algorithm requires very less line of code as it executes the same procedure over and over again on different data [4]. The following conditions must be fulfilled for the successful implementation of the concept of recursive process: The computer system must have an in built mechanism that supports calling the procedure [4]. There must be conditions within the definition of a recursive procedure, under which, after a finite number of calls, the process terminates [5]. The logic in successive calls should be simple in the sense that each successful argument leads us to the conditions mentioned in the second [6]. What are 'greedy algorithms'? How do you decide which option is optimal? Prim's Algorithm is used to connect all the points of a graph with the help of lines of least weights in which the weights of the lines joining all the points are known [7]. We are starting from point S here, it is chosen as per your wish, and you can start from any other point. After selecting S, we see that 2 points are directly connected to it A and C, out of which weight of S-A is 7 and weight of S-C is 8, so we will choose S-A [8] (Fig. 1).

We have to keep in mind that once we have reached the point, we do not have to repeat it. The points B and C connected to A have A-C's weight of 3 and A-B's weight of 6, so we will choose A-C. The points B and D connected to C have C-B's weight of 4 and C-D's weight of 3, so we will choose C-D. The points B and T attached to D have D-B's weight of 2 and D-T's weight of 4, so we will choose D-B [8] (Fig. 2).

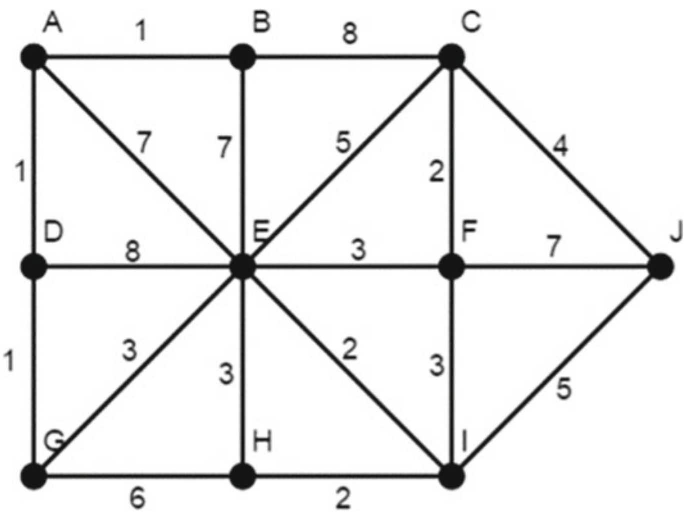

Fig. 1 City location [8]

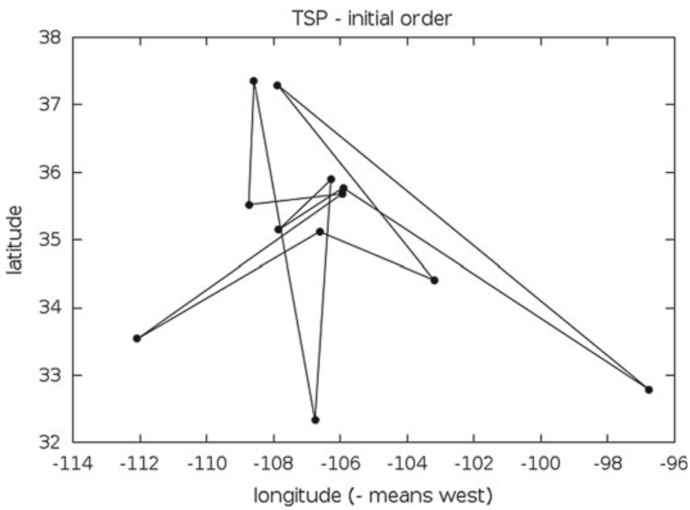

Fig. 2 Iteration performed distances [9]

2 Problem Domains

If there are many lines in a graph, then a lot of time can be wasted in finding the line with the lowest weight.

Converting Prim's Algorithm into a software program becomes very complicated [10].

He is born at the birthplace called Nebula. Then, it becomes young like the Sun, and in the end, it either turns into a black hole or becomes a twinkling lamp in the form of a red star. (There may be other possibilities.) The same thing can be said about the entire universe [9]. Today, science has come to know that the universe is expanding. And this rate of spread is increasing continuously [11]. But there must also be an end to this spread. As it spreads, in what form it will be, till where it will go, science is not able to reach any conclusion about it and is presenting three different theories [12]. According to this view, the universe will gradually cool down as it expands, and at the same time, the speed of its expansion will also slow down. Eventually, it will reach the lowest state of coolness (Absolute Zero). At that time, all the energy that drives the universe will end and everything in it will become stable and will stop in its place. Something like this, after a snow storm in a cold country, everything gets frozen in ice [13]. The second theory is called Big Rip Theory, in which the speed of the expansion of the universe will gradually increase, and due to this, all the bodies of the universe will start breaking apart and finally the basic particles that are scattered apart from each other, i.e., electrons, protons, etc. [12]. The rest will remain. These original particles will then start to annihilate each other, which results in a universe in which nothing will happen. In such a way, many soap bubbles are scattered in the air and these bubbles gradually burst and disappear [14]. This theory was presented in the year 2003 [11].

The third theory is called Big Crunch. According to which there will come a time when the expansion of the universe will stop, and then, it will start shrinking, and eventually, it will reach the same stage where it was before the Big Bang [15]. Then, a new universe will be born through a new Big Bang. The process of expansion, shrinking and formation of new universes will continue in this way. Whatever facts are being received at present, it is being known that the speed of expansion of the universe is increasing continuously [16]. But the science is in the dark about the energy that is doing this work. Maybe at some point, the mood of this energy changes and it starts shrinking the universe [4]. The theory that today's science considers most possible is the theory of Big Freeze or Heat Death. She then believes Big Rip. And the least likely gives to Big Crunch. But in reality what will be the end of the universe depends on the structure of the universe, about which nothing can be said with certainty right now, [7] because this structure is dependent on the matter and energy of the universe. And at present, most of the matter in the universe is dark matter and the energy is dark energy [5].

3 Result

Finally, we will connect B to T. It is very easy to build MST using this. If there are many lines in a graph, then a lot of time can be wasted in finding the line with the lowest weight. Converting Prim's Algorithm into a software program becomes very complicated [14].

The first step involves selecting a starting vertex. In the first step, all the points are connected to the selected vertex, the one whose weight is the least; the construction of the minimum spanning tree has to be started by adding it [1]. If more than one line of equal weight is connected to a point, then we can choose any one we wish. With the MST created so far, the nearest edges with the least weight are to be joined until the minimum spanning tree is formed by joining all the points of the graph [5] (Fig. 3; Table 1).

It means a tree that contains all the edges will find a subset of its edges. Prim's Algorithm shares similarity with shortest first path [3]. This algorithm treats a single tree as nodes and adds a new node to it to form a spanning tree from the given graph. In reality, scientists also know very little about the universe [18]. In relation to the universe, scientists have presented their views on the basis of many speculations and fantasies. If you look at the sky at night, you can see an auspicious band of stars spreading in the sky [4]. Actually, this sky is a small part of the universe. Along with all the stars we can see with our eyes, we, our Earth, planets, satellites, meteorites, comets and the Sun are also part of the vast galaxy [10]. To understand the shape of the galaxy, imagine flat bread whose middle part is slightly inflated [8]. A gigantic

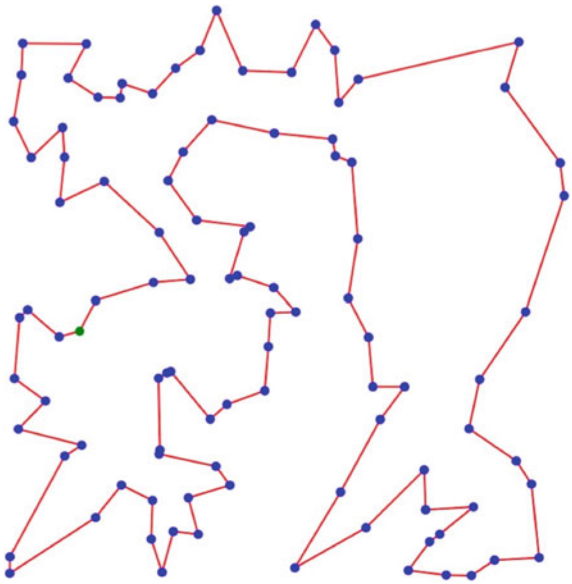

Fig. 3 Elapsed time random distances [17]

Table 1 Findings [2]

Route	Salesman	Iteration	Interval	Measured
500	11	1300	68.2120	27.198565
	24	1400	65.3062	26.888612
	25	1500	53.0329	28.141022

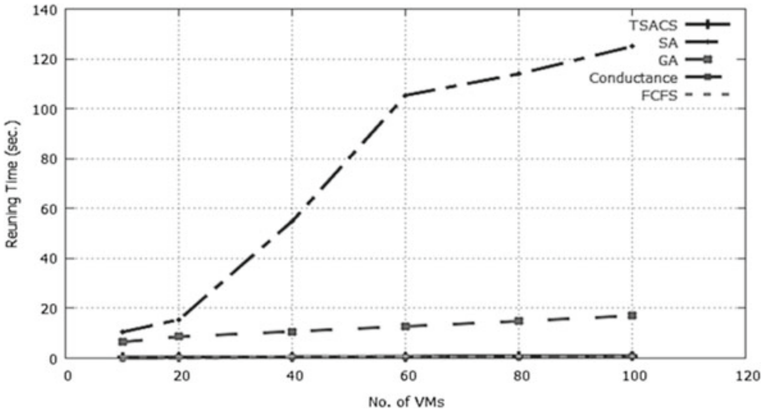

Fig. 4 Best solution history [18]

plan of trillions of stars is called a galactic. The Milky Way is only a galaxy [17] (Fig. 4).

According to world-renowned astronomer Fred Hoyle, the universe is everything. That is, the Earth, Sun, space and all the celestial bodies present in it, galaxies, molecules, atoms, etc., are called the universe as a whole. Encapsulating everything is a special quality of the universe [6].

As we know, the study of the structure, motion, etc., of celestial bodies is called astronomy. Astronomy is also divided into three sub-disciplines, which include astrophysics, astrobiology and astrophysics. The study related to the entire universe is called cosmology or cosmology (Table 2).

Can the entire universe be seen? No, we cannot see the whole universe; it is so infinite that our eyes cannot reach there [2]. The universe is so vast that we cannot even imagine it; it seems to be billions and trillions of kilometers long and wide [17]. The distances of the universe are so much that we cannot express them in kilometers or other common units, so we had to set a special scale—the light year. According to Einstein's theory of relativity, the maximum speed of the entire universe is the speed of light. In fact, the rays of light travel three lakh kilometers in a second [11].

During the entire existence of man on Earth, the Sun has not completed a single orbit around the sky and the Ganges [2]. The curiosity of man was not quenched by observing only some shining objects. Centuries ago, when scientific

Table 2 Findings [11]

Cites			
50	9	200	27 s
Cites			
50	9	200	27 s
	8	405	39 s
	6	301	15 s

and technical knowledge was not available like today, our ancestors made very high level scientific discoveries related to planets and constellations. Among them, the names of astronomers like Aryabhata, Aristotle, Ptolemy, Archimedes, Varahamihira, Pythagoras, Bhaskara, etc., are leading [1]. These astronomers studied and analyzed the motions of the Sun, Earth, Moon and planets; they are factual and accurate even today. On this basis, we can say that astronomy is the oldest branch of science (Fig. 5).

In the early centuries, astronomy also carried the fruits of astrology [8]. But when astrophysics was born in Europe, scientific astrology based on luck and superstition was sidelined from the branch of astronomy [4]. But still, astrology has not been eradicated, and even today, priest-astrologers are the prophets of Kalgyan and auspicious and inauspicious times.

Well, the more science and technological development went on, and the more human curiosity related to celestial objects increased. By the twentieth century, astronomy became very advanced and strong as a branch of science (Table 3).

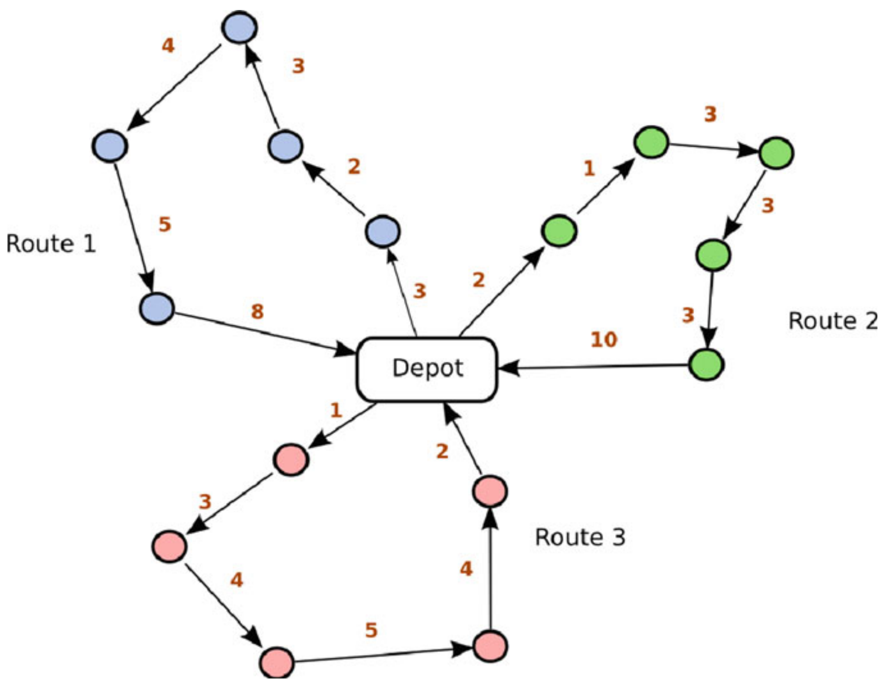

Fig. 5 Route of city [6]

Table 3 Total distances find out using no. of iterations [13]

500	45	948	1333.7763	64.285049
	57	763	1397.8994	81.999712
	53	1000	1353.4148	104.156603

4 Conclusion

Future scope will become efficient for finding out the short path among a number of nodes in this project work. Prim's Algorithm works very fast in graphs that have more edges than vertices.

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Performance Analysis of High-Speed Optical Communication Systems Under the Impact of Four Wave Mixing

Annu and Himanshi Saini

Abstract Among all non-linearities, in particular, FWM (Four Wave Mixing) is a major issue in optical communication. In this paper, an investigation has been done on the impact of FWM on the performance of high-speed optical communication systems. The analysis has been done by comparing different modulation techniques; increasing the number of bits, channels, effective area, sample per bit, length of the fiber; and reducing channel spacing. On the transmitter side, the WDM (Wavelength Division Multiplexing) system has been designed with different techniques, such as RZ (Return to Zero), NRZ (Non-Return to Zero), and On–Off modulation, a range (2–11) of channels, a range (102–17 GHz) of channel spacing, and a range (10–140 bits/s) of bit rate. The channel has been designed with a range (16–112 μm^2) of effective area, and a range (70–200 km) of fiber length. The designed WDM system obtains the best value of Q-factor (Quality-factor) and BER (Bit Error Rate) at a particular point in the abovementioned range of parameters. For a range of channels (2–11), the Q-factor varies from (69.5286–36.5789). The optimized values of all the above mentioned parameters are incorporated and the system attains a Q-factor of 178.849, which is found to be best as compared to other values in the given range of the input parameters. The designed system can be extensively tested in the future for a number of other input parameters so as to implement the system in very high-speed applications.

Keywords FWM · WDM · BER · Q-factor · Fiber length

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1 Introduction

FWM is also identified as four photon mixing. It is the major restrictive factor in the WDM system. In WDM, multiple optical channels with narrow spacing travel through the fiber and merge with one another. These communications in glass can become bulky over the long haul in the fiber [1]. Degradation becomes very severe for large numbers of WDM channels with narrow spacing [2]. This is a third-order non-linear effect in the fibers. The term non-linear means optical signal leaving the fiber at a given wavelength no longer increases linearly with the input power at that wavelength [3, 4]. The reason for FWM is the Kerr effects in which the refractive index changes accordance with optical power. It occurs when the different wavelengths of the optical source are launched within a fiber and due to interference, the generation of the new waves [2]. It causes rigorous cross-talk between the channels propagating through the fiber [5]. It is similar to inter-modulation distortion in an electrical system [2]. FWM has been avoided because it produces new pulses, reduces SNR (Signal to Noise Ratio) ratio, and increases the error rate [3].

2 Literature Survey

Four wave mixing is the demanding research area in which researchers are working for high-speed communication. In this section, investigation has been done on previous implementations with different modulation techniques increasing the number of bits, channels, effective area, sample per bit, length of the fiber, and reducing channel spacing. Jabber et al. [6] have analyzed the line coding performance for 100 GB/s data rate under the influence of FWM. The study has been conducted for Non-Return to Zero (NRZ) and Return to Zero (RZ) formats. It has been found that an effective area of 80 μm^2 RZ modulation introduces a minimum of four waves mixing power up to $-$ 79.5 dBm and received BER is 1.99×10^{-92} at the power of $-$ 5.809 dBm. It has been found that return to zero modulation is the appropriate option for high-speed communication distance and best possible bit error rate. Monika and Kaler [7] have analyzed the performance of FWM in an optical system for the channel spacing between the channels and by varying the number of channels. From the result, it has been observed that when the channel spacing is maximum (50 GHz) with the minimum number of channels (2 input channels), the FWM has been minimum. Mishra et al. [2] have analyzed the design and performance of the FWM effect by varying the number of channels and channel spacing. It is found that the FWM effect reduces with an increase in channel spacing and a decrease in the number of channels. Additionally, it can be reduced by unequal channel spacing. The channel spacing values like 20, 30, 50, 70, 75, 90, and 95 GHz have been used. It has been found that channel spacing 95 GHz has the lowest bit error rate. The system performance is measured by eye opening, bit error rate, Q-factor, and spectrum output. Sangeetha et al. [8] have analyzed fiber non-linearities by varying different parameters in the WDM fiber optic transmission systems. These parameters are fiber length, bit rate, input optical power, center frequency, dispersion coefficient, and booster power that effect on FWM, XPM, and SPM in WDM system. It has been found that four wave mixing is decreased with the increase in the value of dispersion and Q-factor decrease with the increase in the length of fiber in SPM. SRS can be minimized by decreasing input power. The system performance is shown through Q-factor and Eye diagram. Garg et al. [3] have investigated the effect of FWM by varying parameters of optical transmission length from 100 to 450 km and the four wave mixing power 18, − 8, − 28, − 48, and – 58 dBm have been observed. It has been calculated that when the length of fiber increases, four wave mixing effects are almost reduced. Manzoor et al. [5] have proposed three techniques to mitigate FWM in DWDM optical networks. All three proposed systems have great results in the reduction of the four wave mixing effect, but at the cost of system quality. FWM can be mitigated by adjusting the system parameters. The system performance has been analyzed with the help of BER, Q-factor, OSNR (Optical Signal to Noise Ratio), and the received power. It has been calculated that an alternative circular polarizer gives a better system performance (OSNR, Q-factor, and the received power) to suppress the FWM effect.

3 System Setup

Simulation parameters have been shown in Table 1.

Table 1 Simulation parameters

S. No	Name	Value and range	Unit
A	Number of channel	3	Channel
B	Wavelength	1551–1553	nm
C	Input power	0	dBm
D	Frequency range	193.1–193.3	THz
E	Channel spacing	100	GHz
F	Bit rate	10*10^9	Bits/s
G	Bandwidth	20	GHz
H	Fiber length	70	Km
I	Preamplifier gain	20	dB
J	Booster amplifier gain	20	dB
K	Pulse modulator		NRZ
L	Photo detector		PIN
M	Reference wavelength	1550	nm

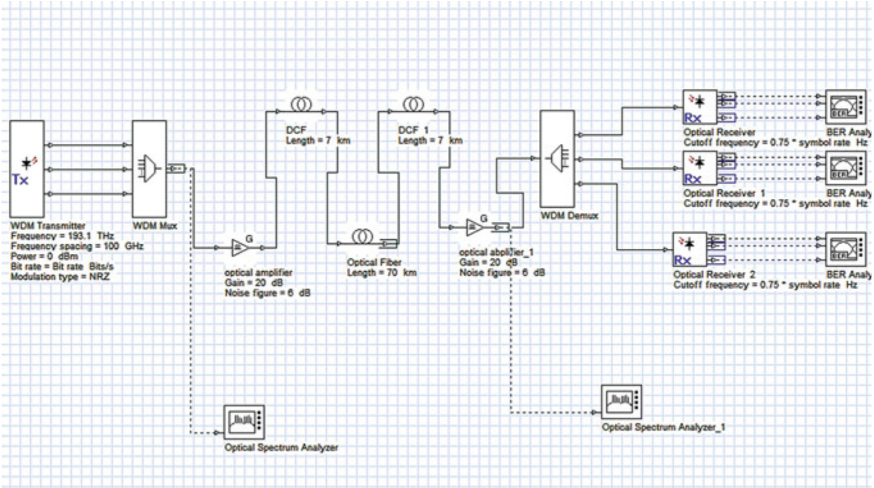


Fig. 1 Three channel WDM system with NRZ modulation

The system is designed with NRZ modulation. In order to investigate the WDM effects on system performance, various parameters such as modulation format, effective area of the fiber, channel spacing, sample per bit, number of channels, bit rate, and length of the fiber have been used. WDM transmitter, WDM MUX, Optical amplifiers, single-mode fibers, DCF (Dispersion Compensating Fiber), WDM DEMUX, Optical receiver, and BER analyzer have been used as shown in Fig. 1 [9].

In the above setup as shown in Fig. 1, the design has been tested with RZ and On–Off modulation format. To analyze the effects of modulation on FWM, a comparison has been shown in Table 2. It is observed that On–Off modulation with PIN (Positive-intrinsic-Negative) detector has a superior performance with a wide and clear eye diagram and the sideband power is also reduced that is clearly seen from spectrum analyzer output. This modulation technique has a maximum Q-factor of 225.474.

The system output of different modulation techniques have been shown in Fig. 2. It has been observed that On–Off modulation shows the best Q-factor because the eye opening and eye height are wider as shown in Fig. 2f. The Spectrum Analyzer output of On–Off modulation has narrowest peak power and smooth waveform (minimum interference noise) as shown in Fig. 2e. Analyzer output has been shown in Fig. 2a–c and eye diagram output has been shown in Fig. 2d–f.

Table 2 Comparison of different modulation techniques with PIN photo detector

Modulation type	Quality-factor
NRZ	63
RZ	91.7922
ON–OFF	225.474

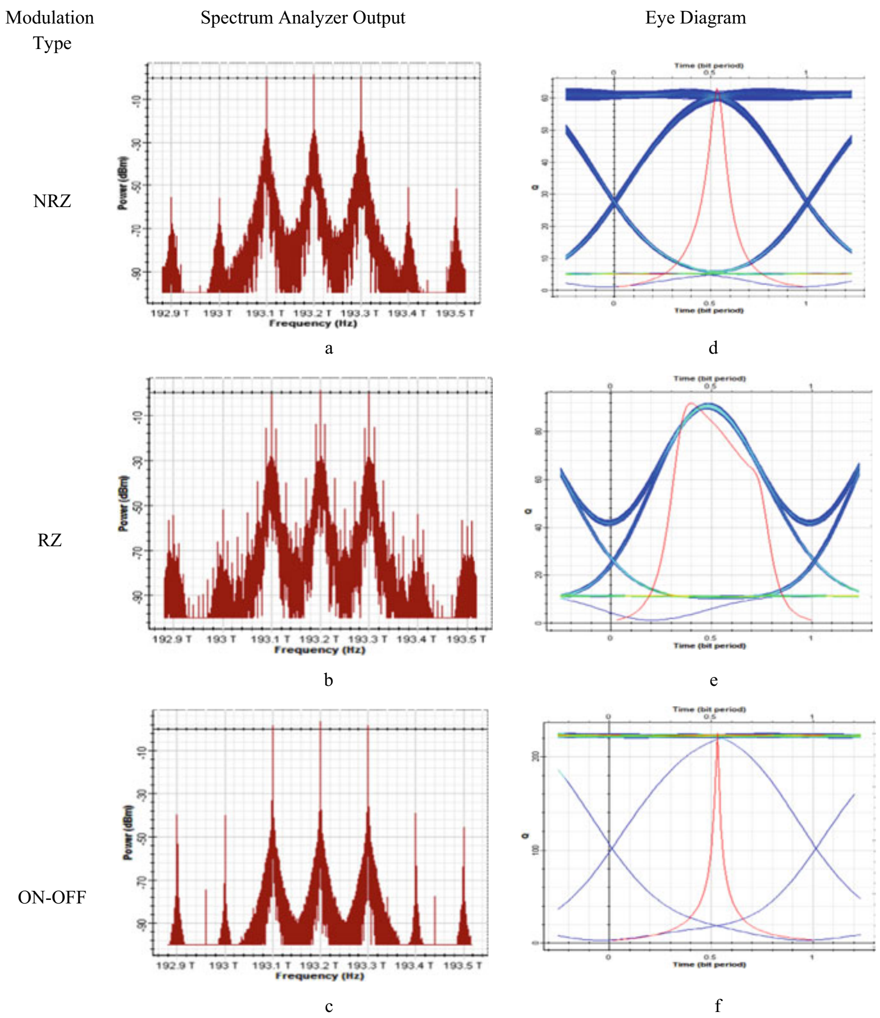


Fig. 2 System analysis with different modulation techniques **a**–**c** spectrum analyzer output and **d**–**f** eye diagram output

Table 3 shows the system performance with APD (Avalanche photodiode) and it is observed that On–Off modulation offers maximum Q-factor. This contains a maximum Q-factor of 205.507. When compared to the results of PIN and APD detectors, it has been concluded that On–Off modulation with a PIN photo detector is the best technique with a maximum Q-factor. It is helpful to reduce four wave mixing and sideband powers also.

As shown in Table 4, the system has been tested for a range of the effective areas. It is analyzed that an increased effective area of fiber mitigates four waves mixing and improves the performance of the system to the area of 80 μm^2. Initially, the

Table 3 Comparison of different modulations with APD photo detector

Modulation type	Q-factor
NRZ	62.7884
RZ	91.1064
ON–OFF	205.507

Table 4 Q-factor at the different effective areas of the fiber with NRZ modulation

Iteration	Effective area of fiber (A_e) μm^2	BER	Q-factor
1	16	7.99031e^{-100}	21.16
2	32	0	39.6567
3	48	0	54.2331
4	64	0	61.4056
5	80	0	63.0883
6	96	0	62.1432
7	112	0	59.9501

eye opening was narrow, but with increased effective area, the eye opening becomes wider.

In Fig. 3, eye diagrams' outputs have been shown for a range of effective area of fiber.

As shown in Table 5, the system is tested for a range of channel spacing. It has been observed that on decreasing in the channel spacing, the interferences among the frequencies increase and the four waves mixing effects are increased [7]. It has been found that channel spacing 85 GHz has maximum Q-factor that improves system performance.

As shown in Table 6, the system is tested for a range of samples per bit. It is observed that when the sample per bit is increased in a particular pattern, the maximum Q-factor of 64.1684 has been obtained at a sample per bit of 16.

In Table 7, the system has been tested for the number of channels. It is observed that when the number of channels are increased, the FWM effects are increased and the performance of the system is degraded which is observed with decreasing Q-factor.

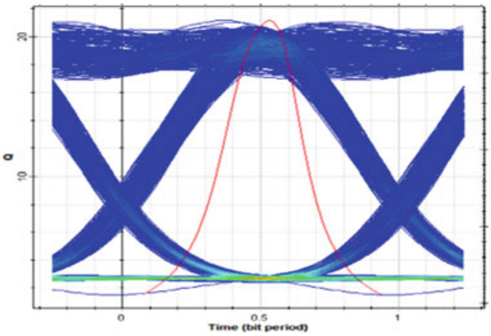
In Table 8, the system is tested for a range of bit rates. It is observed that system performs best at bit rate of 10 Gbps.

In Table 9, the system is analyzed for a range of layout bit rate. It has been observed that the system gets maximum Q-factor at 10 Gbps.

In Table 10, the system is tested for a range of fiber length. It has been observed that 90 km length of single-mode fiber gives maximum Q-factor and minimum BER. When the length of fibers is varied, simultaneously length of DCF (Dispersion Compensating Fiber) is also varied according to Eq. 1 [9].

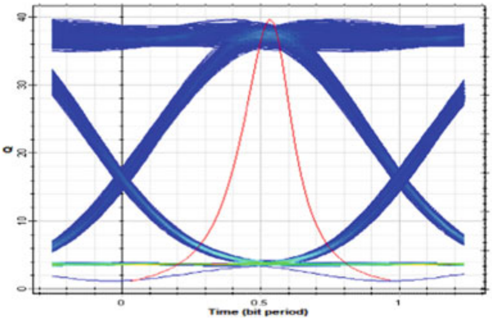
Effective Area of fiber (in μm^2) **Eye diagram output**

16



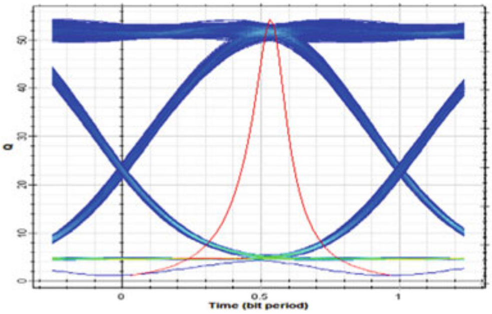
a

32



b

48



c

Fig. 3 Eye diagram at different value of effective area of fiber **a** 16 μm^2 **b** 32 μm^2 **c** 48 μm^2 **d** 64 μm^2 **e** 80 μm^2 **f** 96 μm^2 **g** 112 μm^2

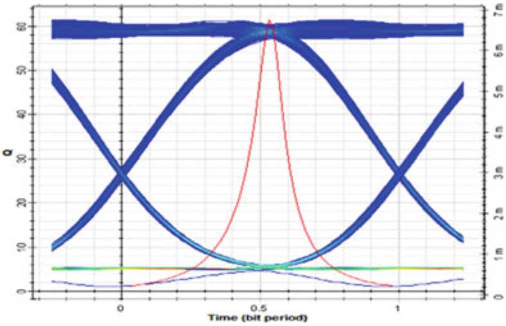
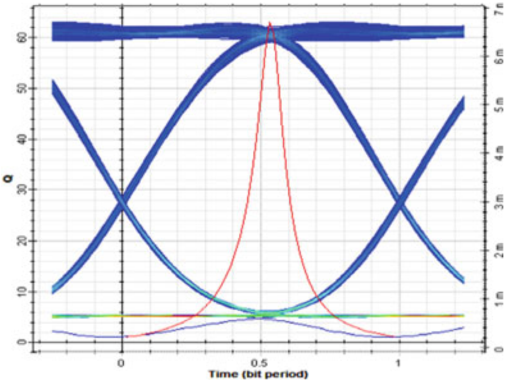
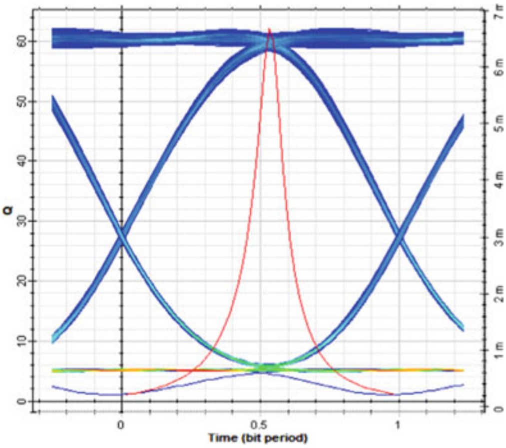
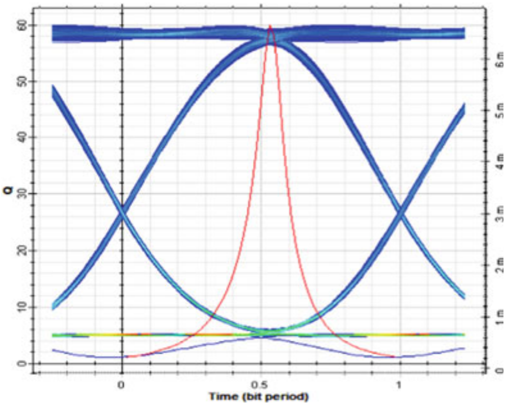
Effective Area of fiber (in μm^2)	Eye diagram output
64	 d
80	 e
96	 f

Fig. 3 (continued)

Effective Area of fiber (in μm^2)	Eye diagram output
112	

g

Fig. 3 (continued)

Table 5 Q-factor by varying channel spacing with NRZ modulation

Iteration	Channel spacing (in GHz)	Q-factor
1	102	70.261
2	85	122.733
3	68	109.579
4	51	107.699
5	34	107.002
6	17	103.103

Table 6 Q-factor by varying sample per bit (layout parameter) with NRZ modulation

Sequence no	Sample per bit	Quality-factor
1	8	63.9814
2	16	64.1684
3	32	63.088
4	64	63.9321
5	128	63.5238
6	256	63.5486
7	512	63.6807
8	1024	63.8362

$$D_{\mathrm{SMF}} \times L_{\mathrm{SMF}} = L_{\mathrm{DCF}} \times -\mathrm{DCF} \tag{1}$$

Here,

D_{SMF} Dispersion of single-mode fiber;

Table 7 Q-factor by varying several channels with NRZ modulation

Sequence no	No. of channels	Quality-factor
1	2	69.5286
2	3	63.0883
3	4	58.6895
4	5	56.5676
5	6	52.528
6	7	51.5879
7	8	47.0857
8	9	44.2223
9	10	44.0059
10	11	36.5789

Table 8 Parameter by varying bit rate with NRZ modulation

Iteration	Bit rate (bits/s)	BER	Quality-factor
1	10	0	63.0883
2	20	$1.58196e^{-012}$	6.95767
3	40	0.00870099	2.36604
4	60	0.0107314	2.27886
5	80	0.000799052	3.15625
6	100	0.00064672	3.14486
7	120	1	0
8	140	1	0

Table 9 Layout parameter by varying bit rate with NRZ modulation

Sequence no	Bit rate (bits/s)	BER	Quality-factor
1	10	0	63.0883
2	20	$8.69574e^{-027}$	10.6384
3	40	$4.9604e^{-006}$	4.40664
4	60	0.00434993	3.32458
5	80	0.000141899	3.62528
6	100	0.00043732	3.32303
7	120	0.000619453	3.21828
8	140	0.000409775	3.34403

L_{SMF} Length of single-mode fiber;
D_{DCF} Dispersion of dispersion compensating fiber;
L_{DCF} Length of dispersion compensating fiber.

The system output of various fiber lengths have been shown in Fig. 4. It has been observed that when the length of the fiber increases, due to the phase matching

Table 10 Q-factor and BER by varying fiber length with NRZ modulation

Sequence no	Fiber length (in km)	BER	Quality-factor
1	70	0	63.0833
2	90	0	78.9192
3	120	0	69.2898
4	140	$1.11303e^{-233}$	32.6186
5	160	$1.00234e^{-020}$	9.26208
6	180	1	0
7	200	1	0

condition of all the beams, the contribution of FWM is increasing. The performance of the system is degraded as observed from the eye diagram. At 70 km length, the eye height and opening are wider and clear. As the length increases, the eye opening becomes narrow and the eye height has been reduced. This results in a degraded Q-factor.

4 WDM System Design

According to the results obtained in this section, the values of input parameters which are selected to design the WDM system are On–Off modulation with a Q-factor of 225.474, channel spacing of 85 GHz with a Q-factor of 122.733, two channels have a Q-factor of 69.5286, an effective area of fiber of 80 μm^2 with a Q-factor of 63.0883, sample per bit of 16 have a Q-factor of 64.1684, bit rate of 10 bits/s with a Q-factor of 63.0883, and fiber length of 90 km with a Q-factor of 78.9192. Q-factor and BER have been obtained to be best with above parameters selection and hence the above system design can be used to optimize the performances of overall communication networks. The following system has been designed with the obtained value as shown in Fig. 5. These parameters have been incorporated in Fig. 5 and obtained Q-factor from Fig. 5 is 178.849 as shown in the eye diagram in Fig. 6.

5 Conclusion

When a high-intensity beam of light traverses through the fiber, the FWM phenomena can be noticed. This effect causes degradation of the input original waves in the form of additional frequency components. In this paper, the parameters with the best value of Q-factor are: On–Off modulation with 225.474 Q-factor, an effective area at 80 μm^2 gives Q-factor of 63.0883, channel spacing at a value of 85 GHz gives maximum Q-factor of 122.733, Q-factor of 63.0883 has been obtained at the value of 10 Gbps rate, the minimum number of channels gives Q-factor of 69.5286,

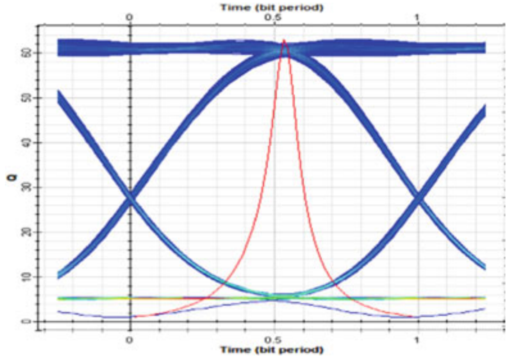
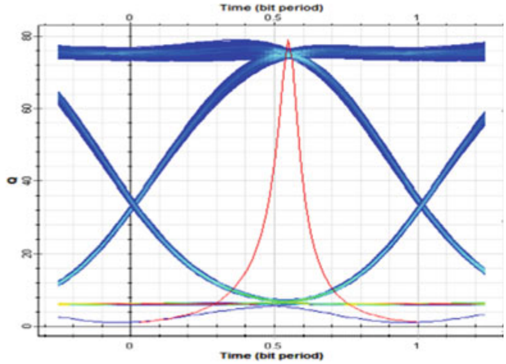
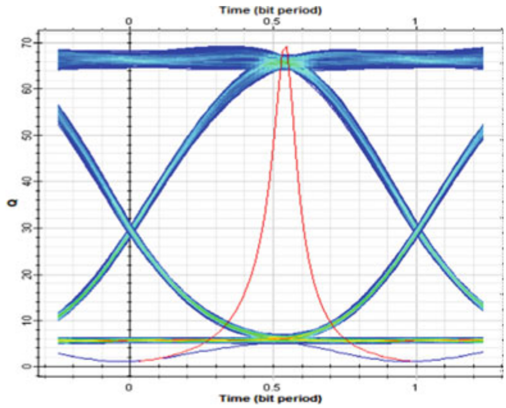
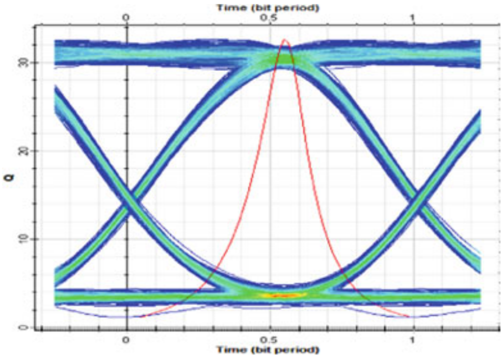
Fiber length (in km)	Eye Diagram Output
70	 a
90	 b
120	 c

Fig. 4 Spectrum analyzer output for different fiber length **a** 70 km **b** 90 km **c** 120 km **d** 140 km **e** 160 km **f** 180 km **g** 200 km

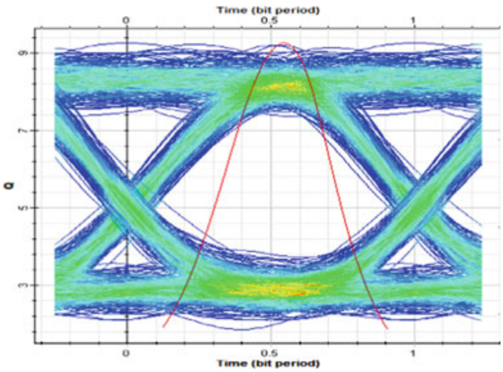
Fiber length (in km) Eye Diagram Output

140



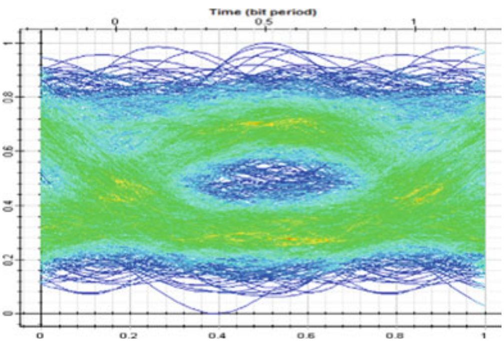
d

160



e

180



f

Fig. 4 (continued)

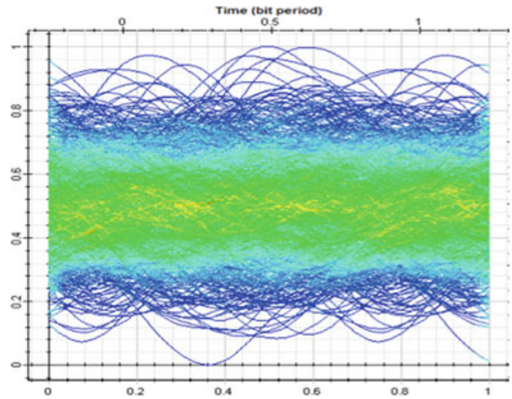
Fiber length (in km)	Eye Diagram Output
200	
	g

Fig. 4 (continued)

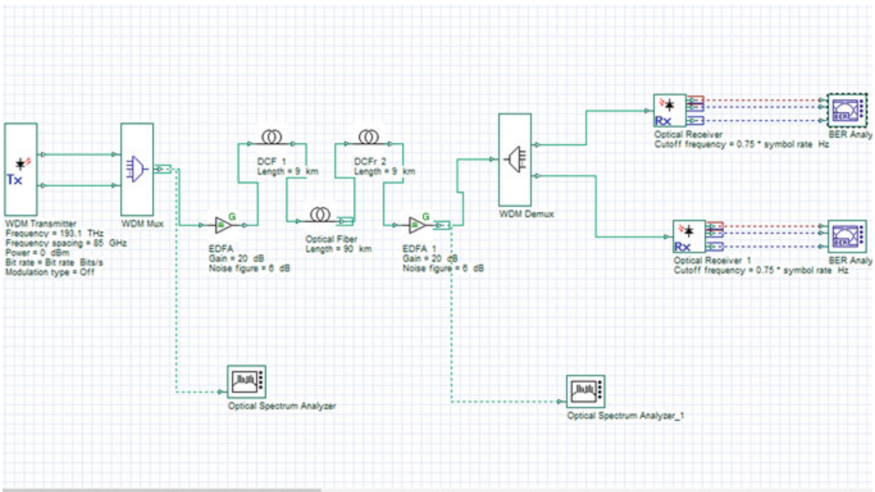
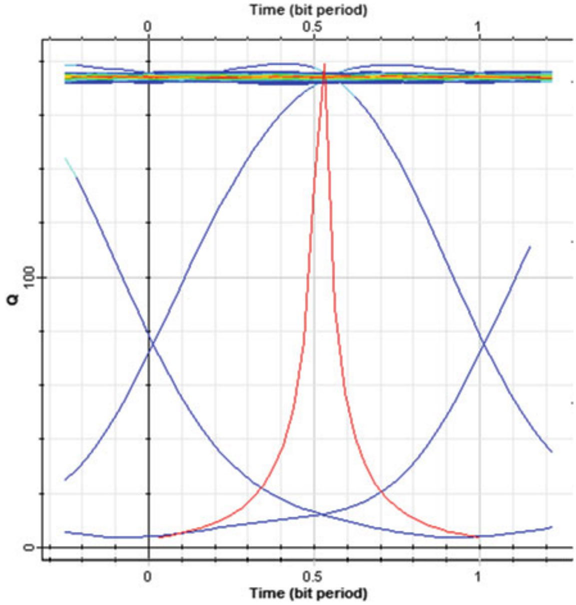


Fig. 5 WDM system setup with On–Off modulation

fiber length at 90 km gives maximum Q-factor of 78.9192. From the above obtained results, a system has been proposed with On–Off keying modulation, effective area of 80 μm^2, channel spacing of 85 GHz, bit rate of 10 Gbps, and the length of the fiber is 90 km. From the channels in range (2–11), the Q-factor varies from 69.5286 to 36.5789. As the number of channels increases, the Q-factor has been reduced. The optimized values of all the abovementioned parameters are incorporated and the system attains a Q-factor of 178.849 which is best among other points in the selected ranges of the input parameters. The range for which the system has been tested has

Fig. 6 Eye diagram at Q-factor of 178.849



been increased and the system design has been optimized at a particular point of input parameters in order to obtain best Q-factor. The designed system testing can be extensively enhanced with more number of performance parameters and observing the impact of these parameters on performance of high-speed communication system.

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Generation and Comparison of Filterless Octuple RoF Upconversion Systems Based on Cascaded and Dual Parallel MZM Configuration

Ajay Kumar, Shelly Singla, and Deepak Kedia

Abstract In this manuscript, Octuple RoF upconversion systems based on dual parallel Mach–Zehnder modulator (MZM) configuration (PMC) and Cascaded MZM configuration (CMC) have been generated and compared. Modulation index and bias points of both MZMs and phase of local oscillator (LO) Radio frequency (RF) are properly optimized for generation of 80 GHz upconverted electrical signal from a 10 GHz RF drive signal. The effect of RF drive signal frequency on optical sideband suppression ratio (OSSR) and RF spurious sideband suppression ratio (RFSSR) is evaluated. Mm-wave signal tunability from 8 to 80 GHz is investigated by applying RF drive signal from 1 to 10 GHz. It is worth to mention here that no optical filter is required in both schemes to obtain mm wave signal of high spectral purity, hence leading to reduction in the system cost and complexity.

Keywords Radio-over-fiber · Octuple · Upconversion · Sideband suppression ratio · Mach–Zehnder modulator

1 Introduction

Millimeter waves are the present and future of high-speed and broadband communication. The current scenario reflects the coexistence of Radio-over-fiber (RoF) and broadband wireless access. Electronic generation of millimeter waves is a challenging task whereas RoF-based upconversion systems accomplish the same with good efficiency. External modulation using MZM is quite a popular and an effective technique for upconversion. Frequency multiplication factor of four, six, eight, ten, twelve, sixteen, eighteen, twenty four have been achieved using various MZM configurations with varying but effective results [1–10].

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In one conventional approach, two cascaded MZMs have been used for generation of Octuple frequency but with the requirement of optical notch filter to suppress undesired harmonics [11]. In [12], frequency multiplication factors of four and eight have been achieved utilizing CMC without requiring optical filter. A filterless approach for Octuple mm wave generation using PMC and modulation index optimization has been presented in [13, 14]. In this paper, we have investigated and compared Octuple upconversion techniques based on PMC and CMC configurations. This paper is arranged as follows. Sections 2 and 3 discusses the principle and simulation details of Octuple frequency upconversion systems. Results are presented and discussed in Sect. 4. Conclusion is presented in Sect. 5.

2 Principle

2.1 Parallel MZM Configuration

Figure 1 reveals the block diagram of PMC to achieve frequency octupling. The light signal from continuous wave (CW) laser diode is injected to parallel combination of two MZMs popularly known as dual parallel MZM configuration. Both MZMs are set at maximum transmission bias (MATB) point. Thus, output of both MZM contains only career and even order sidebands. A phase difference of 90° is maintained between upper and lower arms of each MZM. An additional phase shift of π is provided to lower MZM. This parallel configuration along with the modulation index optimization generate the optical signal where fourth sidebands dominate and career and other even terms are either suppressed or insignificant. Optical signal, thus obtained, is transmitted to photodiode via single-mode fiber. Photodiode produces eight times frequency of original RF signal by beating higher and lower fourth sidebands.

2.2 Cascaded MZM Configuration

Figure 2 depicts the block diagram of CMC for frequency octupling. The optical signal output of continuous wave (CW) laser diode is applied to MZM 1. Output of MZM 1 works as input to MZM 2. Here also, both MZMs are set at MATB point. MATB ensures that odd-order sidebands are diminished. A phase difference of 180° is maintained between upper and lower arms of each MZM. An additional phase shift of π/2 degree is provided to second MZM. This parallel configuration along with careful selection of modulation index generate the optical signal where fourth sidebands dominate career and other even terms. Photodiode produces electrical signal of eight times frequency of local oscillator RF signal.

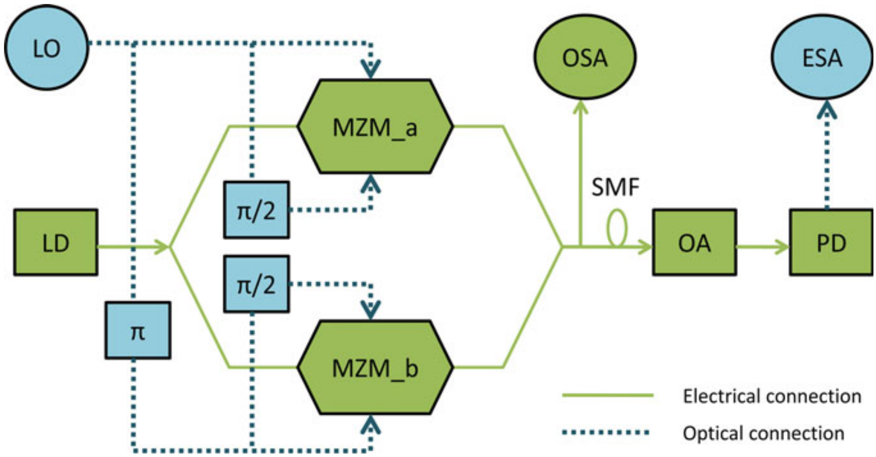

Fig. 1 Block diagram of 8-tuple RoF upconversion using Dual Parallel MZM configuration; LO: local oscillator; LD: laser diode; OA: optical amplifier; PD: Photodetector; SMF: single-mode fiber; OSA: optical spectrum analyzer; ESA: electrical spectrum analyzer

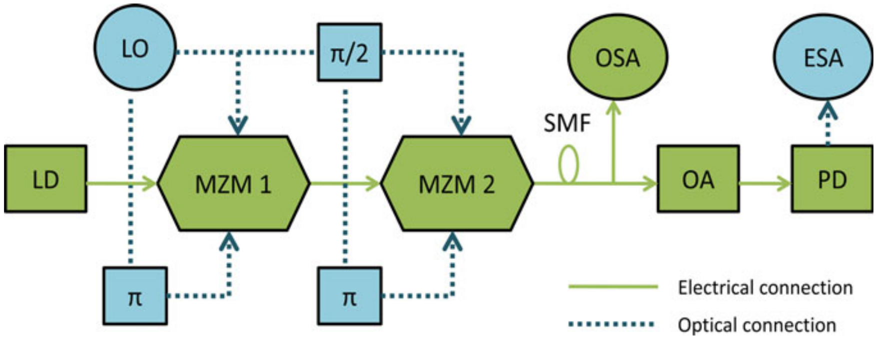

Fig. 2 Block diagram of 8-tuple RoF upconversion using cascaded MZM configuration

3 Simulation Setup

The proposed setup is simulated using software Optisystem v.18. The CW laser with 0 dBm output optical power is operated at 1552.52 nm central wavelength (193.1 THz). Spectral width of laser is 10 MHz. RF source produces a sinusoidal wave of 10 GHz frequency and it is applied to both MZMs. The extinction ratio and insertion loss of each MZM are kept at 30 dB and 2 dB respectively. The switching bias voltage is set at 4 V. The modulation indices of both MZMs are kept at 5.43 for PMC and 3.84 for CMC respectively. The output optical signal is transmitted to photodiode using SMF of 50 km length. Optical amplifier having 21 dB gain and noise Fig. 4 dB amplifies received optical signal. A pin photodiode of 10 nA dark current and 1 A/W responsivity is used to recover the electrical signal.

4 Results and Discussion

Figures 3 and 4 present the optical spectrums of the signal fed at input of SMF. Fourth-order sidebands exhibit quite higher power as compared to other undesired harmonic components. The value of OSSR is 22 dB for both PMC and CMC. Electrical spectrums of signal obtained at output of photo detector, are presented in Figs. 5 and 6. RFSSR for the 80 GHz frequency signal is about 21 dB for both PMC and CMC. However, RF output is – 19 dBm for PMC while it is – 29 dBm for CMC. It is evident from the fact that we are using higher RF voltage, i.e., 6.917 V for PMC and lower RF voltage 4.892 V for CMC.

Frequency tunability of both PMC and CMC has been investigated and results are similar for both configurations. Table 1 reveals that the value of OSSR remains the same with the variation of LO frequency. RFSSR decreases as frequency is increased from 1 to 5 GHz. The value of RFSSR increases with the increase in LO frequency

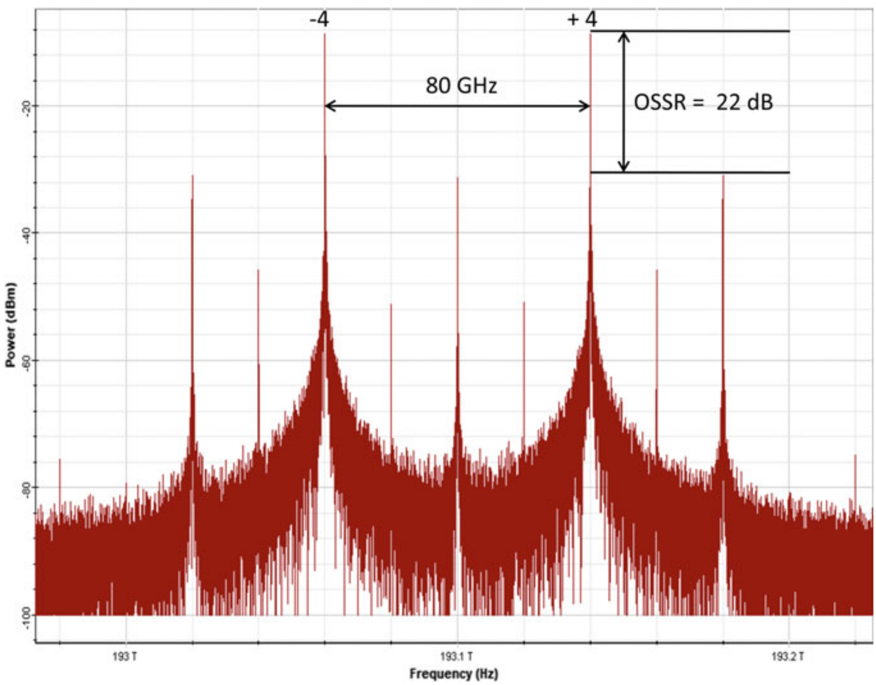

Fig. 3 The optical spectrum of signal at SMF input for PMC

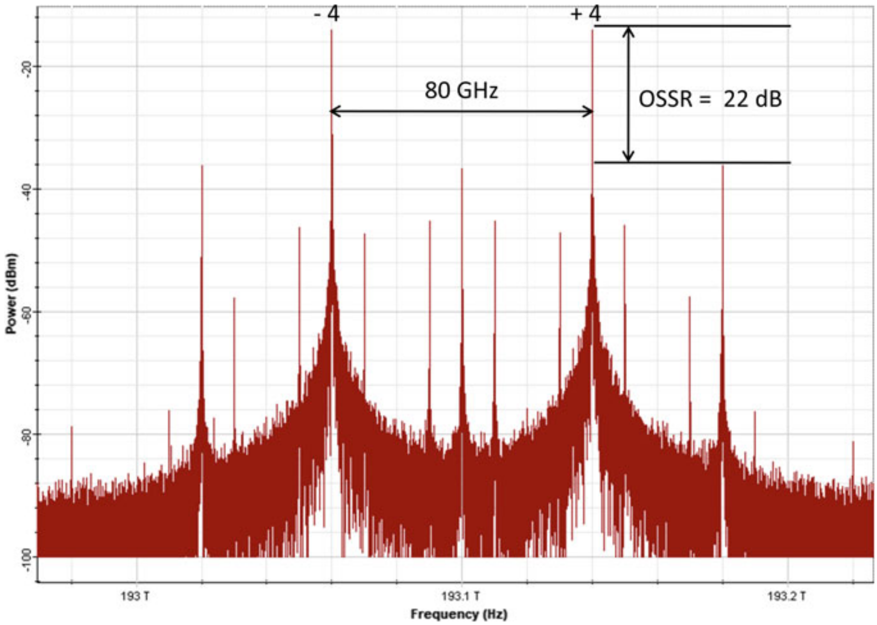

Fig. 4 The optical spectrum of signal at SMF input for CMC

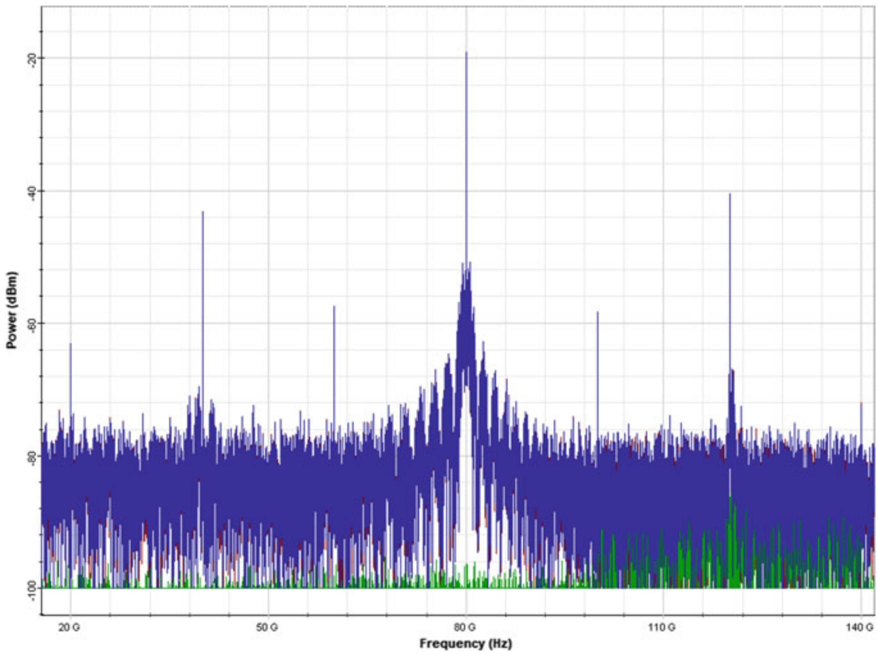

Fig. 5 The electrical spectrum of photodetector output signal for PMC

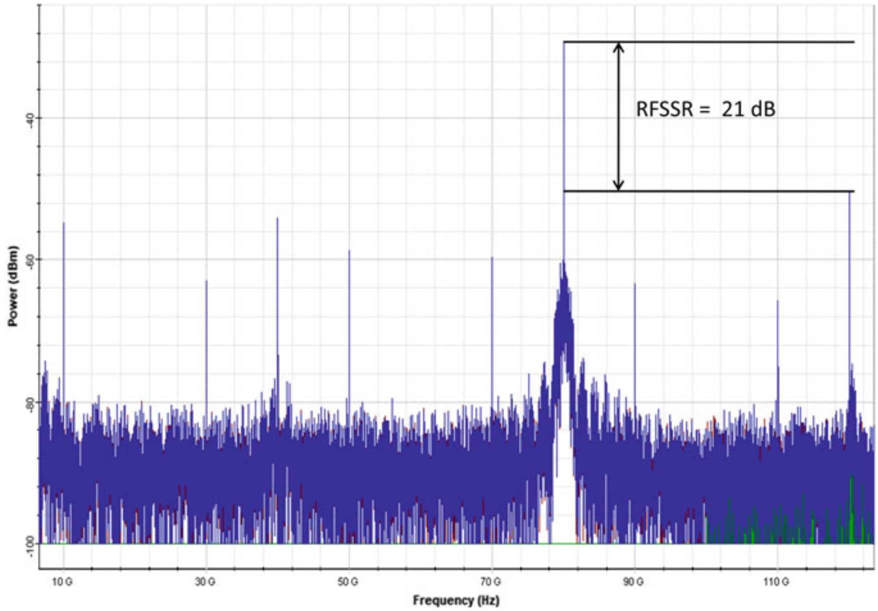

Fig. 6 The electrical spectrum of photodetector output signal for CMC

from 7 to 10 GHz. RF output power experiences no change with the variation in LO frequency and it is – 19 dBm for PMC and – 29 dBm for CMC (Fig. 7).

Table 1 Variation of OSSR and RFSSR with LO frequency

LO frequency (GHz)	Octuple frequency (GHz)	OSSR (dB)	RFSSR (dB)
1	8	22	22
2	16	22	18
3	24	22	16
4	32	22	13
5	40	22	12
6	48	22	19
7	56	22	13
8	64	22	16
9	72	22	17
10	80	22	21

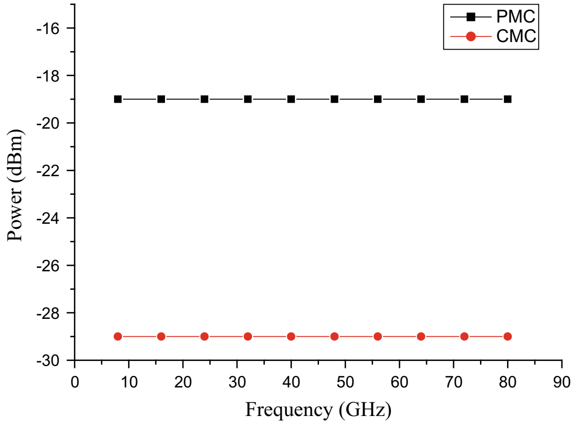

Fig. 7 Frequency response of octupler

5 Conclusion

Filterless photonic generation of mm waves using PMC and CMC are investigated and compared in this paper. Optimization of modulation index and electrical phase shifts has successfully upconverted 10 GHz RF drive signal into 80 GHz mm wave signal for both PMC and CMC. The 22 dB OSSR and 21 dB RFSSR are obtained at 30 dB MZM extinction ratio for both configurations. It is reported that OSSR remains the same with the variation of RF drive signal frequency. Furthermore, from 8 to 80 GHz tunable signal is obtained when RF drive signal from 1 to 10 GHz is applied. Both Octuple configurations have simple structure and are equally efficacious for mm wave communication.

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The Effect of Virtual and Augmented Reality on Well-Being: Perspectives in Mental Health Education

Navreet Kaur

Abstract The paper is an analysis of the impact of metareality on the human mind and its adverse and therapeutic effects on psychological well-being thereof. Metaverse is marked by a blurring of boundaries between the actual physical world and the virtual digital world—a metareality reflected in a three-dimensional, multisensory experience. Based on research evidence, the paper discusses how applications within virtual and augmented reality, such as, the gaming platforms present potential risks and significant safety challenges. There are ethical risks in the metaverse that are related to identity crisis, uninhibited behaviour, and unleashing of sexual and aggressive impulses. At the macro level, the real-time robust mechanisms of this simulated parallel universe impact various societal domains, such as, home, family, religion, and spirituality. The literature review presented highlights the need for digital safety and the prevention of online abuse by launching safe zones and safety tools. However, studies highlight that there are dialectical mechanisms inbuilt in metaverse and these are manifest in its innate therapeutic capacity. Researchers have reported that the imaginal, embodied, and connectivity aspects of this digital reality form the basis for treatment of psychological ailments. The conceptual framework developed will serve as a foundation for researchers interested in studying the link between augmented reality and its effect on the psyche of the human user. The paper has implications for mental health awareness and education which include debunking of associated myths, inculcating of active interest in designing interventions for patient recovery, and for individual growth at the societal level in a digitally transformed world.

Keywords Mental health education · Psychotherapy · Virtual reality · Avatar · E-health · Behaviourally based treatments

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1 Introduction

Artificial intelligence as a technology has enabled machines to simulate human behaviour through sophisticated algorithms, thus making possible the construction of virtual and augmented reality together referred to as 'metaverse' or 'metareality'. This digital transformation, apart from impacting other domains has added a new dimension to all the three areas of mental health education viz. Psycho-education, Treatment, and Support and Advocacy [1]. Psycho-education, the informational part of mental health education, should now incorporate teaching people about the risk factors and symptoms associated with various mental health conditions caused by the adverse impact of virtual reality and its various forms.

Technology has assisted as well as obstructed the progress of mankind. The new innovation 'Meta' or 'Metaverse' is another leap into the ever expanding field of information technology. 'Meta' is a Greek word for 'beyond' and 'verse' is the short form of the word 'universe'. Facebook CEO Zuckerberg has rebranded it as 'Meta' which relates to 3D virtual augmented reality made up of applications enabling individuals to work, play, and travel from one place to another virtually. This virtual 3D reality looks boundaryless—a world of endless possibilities. The vision and mission of the Meta Company is to enable people to connect and businesses to grow by going beyond 2D screens towards profoundly immersive experiences in a materialistic world. "The metaverse will feel like a hybrid of today's online social experiences, sometimes expanded into three dimensions or projected into the physical world. It will let you share immersive experiences with other people even when you can't be together, and do things together you couldn't do in the physical world. It's the next evolution in a long line of social technologies, and it's ushering in a new chapter for our company" [2]. 'Metaverse', typically, is a composite term that includes, Artificial Intelligence (AI), Virtual Reality (VR), Augmented Reality (AR), Blockchain, and the 5th generation mobile network (5G). Researchers [3] have symbolized metareality as Janus—the Roman God of all forms of transition and of beginnings and endings—depicted by two faces looking in opposite directions.

Based on a review of literature, the present study aims to study the significance of mental health education in the context of:

1. The adverse impact of virtual and augmented reality on mental health.
2. The therapeutic applications of virtual and augmented reality.

2 Virtual and Augmented Reality: Impact on Mental Health

Metaverse and its applications are still in the nascent stage. A potent question is whether this wide open digital space is a safe place for a vulnerable demographic like children and adolescents. The effects or pitfalls of the virtual world for both work and recreation, created by augmented reality are much more pronounced as compared to those resulting from social media usage. The element of immersion being far greater in the metaverse, the issues of bullying, harassment, self-esteem, and body image get aggravated [4]. According to Rizzo [5], there is a difference in perceiving and interacting with a digital world through a 3D screen than a flat two-dimensional monitor. The level of realism in this metareality may be 'psychologically assaulting' in some instances. The 3D digital avatars help young users to project a fake version of themselves which may result in an identity crisis. Fictionalizing one's identity makes other people's opinion about the self more important. Talking to CNBC Make It, Clinical Psychologist Mitch Prinstein says that metaverse platforms are creating more loneliness and far more body image concerns due to exposure to dangerous content that's related to suicidality [4].

Companies like Roblox, Epic Games, and VRChat have launched online games that can be played through 3D headsets. Gaming is an apt representation of the metaverse which shows evidence of dangers for young users. In a research study [6], it was found that VRChat—the popular social app in Facebook's VR Metaverse exposes minors to abuse, harassment, racism, and graphic sexual content every 7 min. For instance, recreating of shooting episodes on Roblox and exposing children to these is highly unethical. Despite Zuckerberg's pledge that privacy and safety will be an integral part of Virtual Reality, Facebook Meta's VR policies fail to mitigate these risks. CCDH researchers found that 11 h and 30 min of recordings of user behaviour in VRChat showed 100 potential violations of Facebook's VR policies. Meta was unresponsive to almost half of these violations.

The multimodal character of the metaverse increases the possibility of stranger intrusion manifolds in comparison to social network sites like facebook and instagram wherein only messaging is possible thus limiting unwanted conduct. In virtual space, the stranger will appear closer and more impinging. Haptic gloves, for instance, can increase interconnectedness on the one hand and abuse on the other hand. Virtual groping is a serious side effect of the introduction of the tactile sense in immersive reality. Such incidents have been reported on Horizon Worlds—a virtual reality social media platform [7]. Although the body is not touched in such a case, yet it feels real and generates a feeling of powerlessness because virtual reality space gives an illusion of physical space. It is immersive and real, so the toxic behaviour that occurs in that environment is also real. Furthermore, virtual currencies can proliferate immoral activities online such as kids using their avatars to enter virtual strip clubs in exchange for 'Robux'—a virtual currency. According to a report [8], the decentralized control and independence of cryptocurrency from financial institutions ensures its anonymity making the purchase of Child Sexual Abuse Material (CSAM) in exchange easier.

Researchers [9, 10] uphold the proposition that metaverse has major psychosocial effects and the potential to shake the ethical core of society. Koltko-Rivera [9] talks about three societal domains that are likely to be impacted by metaverse and the observations that follow are based on inferences drawn by him through a comprehensive literature review.

1. Private Experience: He gives a detailed account of how virtual and augmented reality affect various societal and personal domains. His interpretation is largely

based on the Freudian approach to personality and on the nature of the experiential context in which users find themselves. He rightly predicted that the period 2005–2025 will reflect a change in the VR mainframe with a very complex user-virtual technology interface where all sensory modalities will be engaged. The experiential context within which the users function will be a simulation but will appear very close to reality. The research questions raised by the researcher are based on the dialectics of metaverse viz. its negative aftereffects and the opposing positive consequences.

Explaining the private experience of individuals in the virtual environment, [9] takes recourse to Freudian Psychoanalytic theory [11]. Freud talked about two powerful primal impulses: ‘eros’ (the life instinct linked with sexuality and aggression) and ‘thanatos’ (the death instinct). All civilization, he said, has occurred through the suppression, repression, and sublimation of the primal urges of sex and aggression. Socialization is all about taming the Id—the primitive, immoral aspect of the self—often referred to as the “beast in man”. The Id functions on the ‘pleasure principle’ and seeks immediate gratification. Social learning is all about enabling the child to delay gratification of his needs and desires. However, an exposure to the metaverse is about undoing the process of socialization because individuals can unleash their primitive desires and seek instant virtual fulfilment without immediate socio-legal consequences which might make them less inhibited in the real world. The dialectically opposite result could be that of metaverse being cathartic and leading to a more balanced and focused self. However, due to individual differences in personality configurations, there will be differential outcomes. The issues of impulse control are particularly salient in relation to extra-punitive or outwardly directed aggression. In an exhaustive review, [12] found that exposure to virtual violence increased the incidence of immediate as well as long-term harm-inflicting behaviour and so did participation in a violent VR game [13]. However, [14] upholds that the outlets provided by virtual simulation rather purge feelings of aggression, making individuals more peaceful.

The fulfilment of sexual needs in metareality, getting married in virtual scenarios and the realization of sexual fantasies does not involve the risk of sexually transmitted diseases. Calvert [15] found that individuals indulge in safe sex and also learn skills that enhance sexual intimacy. In simulated sex, the partners are imaginary AI characters and not humans and virtual sexual encounters with avatars are likely to lead to positive effects. However, Hyde and DeLamater [16] maintains that learning to develop mature adult sexual relationships may not transfer to the real world. Calvert [15] recognizes the ethical risks of over-exposure to and easy availability of sexual content in metaverse. The immersive sexual activities may particularly reinforce sadism in sexual deviants because of disinhibition and desensitization similar to that seen in consumption of violent pornographic films [17]. Issues of marital infidelity and betrayal may lead to a weakening of familial bonds and a consequent increase in divorce rate and social instability [18].

2. Home and Family: A virtual family life and simulated relationships are likely to shake the very institution of marriage. For a single individual with a virtual extended family and an attractive, caring partner, this arrangement may be ideal for overcoming loneliness and stress. But it is likely that fewer people will marry because of unrealistic expectations from people in the real world which will ultimately affect birth rate. This kind of 'escape from reality' will be beneficial to a limited extent because individuals will fail to deal with the frustrations of real life. The question, however, requires much empirical research.
3. Religion and Spirituality: Metaverse can enable individuals to connect to their faith communities in virtual space, worship their Gods as they come alive, and also incarnate them. Out of the five dimensions of religion and spirituality given by Glock [19], knowledge and ritual are greatly influenced by VR. The holy discourse becomes more enriching because of VR's immersive quality and it gives the freedom to conduct any ritual anywhere, any time, and by anyone. There are two ramifications in this regard: one, spirituality might become more of a private affair lacking in the communal spirit and two, there is a risk of the proliferation of self-proclaimed, pseudo-religious communities of avatars of real world humans or AI constructs which may disrupt the religious foundations of societies.

Metareality has been likened to 'maya'—a Sanskrit word for 'magic' or 'illusion'—and a central concept in Hindu philosophy [20]. The Hindu religion talks of 'maya' as signifying an ephemeral, materialistic, changing world replete with desires of all kinds. In Vedic texts, it denotes a magic show where things are not the way they appear. The digital world personified as 'maya' offers a number of choices but not the choice to escape from it. An individual once caught in this web of desires, metaphorically, is not able to attain 'Nirvana' which in Buddhism is liberation from all sufferings and the quenching of worldly desires.

3 Virtual and Augmented Reality: Therapeutic Applications

Research shows a strong linkage between clinical and health psychology on the one hand, and metaverse on the other hand. The different aspects of virtuality have implications for mental health care, such as in the treatment of depression, chronic pain, phobias, stress-induced ailments, and eating disorders, to name a few. E-health interventions are behaviourally based treatments that are transformed into a digital format and delivered via the internet. Ventura et al. [21] view virtual and augmented reality from three vantage points which help to understand the effectiveness of Information and Communication Technologies (ICTs) used in cybertherapy:

1. VR/AR as an imaginal technology where users feel that they are in the real world when actually they are not.

2. VR/AR as an embodied technology where individuals experience their whole being immersed inside the virtual environment.
3. VR/AR as connectivity technology where geographical boundaries do not matter and people can connect across time and space.

As per [21], the imaginal dimension of metaverse enables mental visualization and imagery which results in the creation of a perceptual experience where sense organs are not actually stimulated by any form of physical energy and is like looking from the mind's eye [22]. VR exposure therapy leads to systematic desensitization and is particularly effective in the treatment of phobias. The harmful flashback-type mental images in PTSD, for example, can be replaced by positive, pleasant images. The patient can come face to face with virtually recreated images leading to a diminishing of negative emotional effects associated with these. Within the systematic desensitization framework, the patient's anxiety is made to increase through confrontation with the aversive stimuli. For example, the feeling of heights in the safe simulated environment, can help to treat acrophobia [23]. An intervention to treat flying phobia designed by Botella et al. [24], includes 3 stages of healing: (1) Pre-flight experience in a living room where the patient can virtually pack, listen to weather news, buy the flight ticket, etc.; (2) Before-flight experience at the airport where the patient can hear boarding announcements and see planes landing and taking off; (3) On-flight experience in the airplane where sitting inside the plane, the patient can experience takeoff and landing in adverse conditions.

The avatars created through augmented reality are descriptive of the embodied aspect of metaverse. These are people's representations in the virtual world through which they can watch themselves and do things that they have never done before [25] including the learning of adaptive behaviours. One application worth mentioning in this context and highlighting the therapeutic effect of AR is about treatment of insect phobia [26]. AR-cockroaches software using computer vision techniques activates the feared virtual environment and cockroaches appear in the hands of the patient. During the exposure session, the therapist can control the number, movement, and size of cockroaches. The main advantage is that this reduces the patient's resistance for therapy since he can see his own body in the safe environment and interact with the feared stimuli [26].

There have been studies where participants could see their own body and a look-alike in virtual space. This technique enabled them to talk to themselves and build self-esteem in the process. In other scenarios, the other body was that of a therapist to whom the patient could communicate his psychological problem and seek solutions. He could also switch positions and look at his mental state through the therapist's perspective. Results showed high level of sense of embodiment [27]. Studies have also shown how changing the perspective, and living experiences from other bodies, can promote empathy, and even compassion and self-compassion in persons with high self-criticism and depression [28] and also reduce racial prejudices through self-identification with a black avatar [29]. Still another study found how participants digitally represented as Superman became pro-social and altruistic [30].

The connectivity dimension of metaverse helps people to share experiences. Computer-mediated communication (CMC) has constructed a simulated social space, called cyberspace [31] which has 2 salient features: interaction and connection. A sense of self and a personal brand can be built based on these features. Online therapy programme was not preferred by people because of a lack of skilled clinician and also geographical distance. The new virtual technologies have helped to overcome these barriers. Videoconferencing, for example, simulates real-life psychotherapy where the clinician does not appear distant and the therapeutic alliance is also not impaired [32]. VR with all its utility features is a step midway between the therapist's office and the real world [33].

4 Conceptual Framework

The conceptual framework derived from the aforementioned studies will serve as a tool for researchers interested in unearthing the psychological phenomena associated with digital reality. Based on empirical evidence, policies and procedures aiming at digital safety and well-being can be devised. It can be seen in Fig. 1 that the three facets of virtual and augmented reality viz. imaginal, embodied, and connectivity lead to both adverse and therapeutic effects and this awareness is crucial to mental health education which encompasses psycho-education, treatment, and support and advocacy.

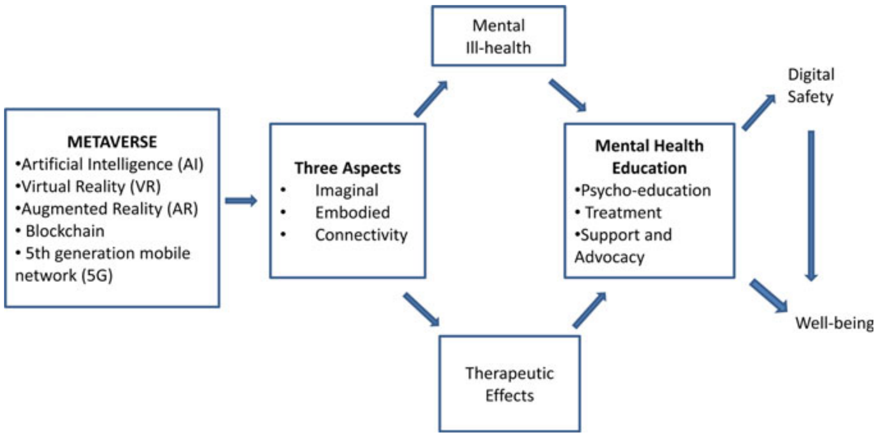

Fig. 1 Conceptual Framework. Source: Author

5 Conclusion

In the end, the issue of digital safety is what needs to be addressed. Tech companies and content creators focus only on the commercial benefits of metaverse. Knowing that it is a double-edged sword, tech companies can build antidotes or solutions into the metaverse products which can, in fact, have a healthy effect on impressionable minds. Strict age verification tools can prevent predators from impersonating as younger users. The presence of content moderators and rapid response to reported violations can deter inappropriate behaviour in virtual space. Regulatory bodies need to incentivize companies that use the metaverse for social progress rather than only for profit. It is the responsibility of tech companies to prioritize the safety of their users over their own incentive to earn a profit. It is critical that metaverse technologies, both software and hardware, have built-in structures and frameworks that ensure safety, privacy, confidentiality and security of the users and their identity. Ecosystems of trust can also be created through policies and regulations. Despite this, safety policies can be difficult to monitor and enforce in virtual spaces. New illnesses have emerged due to the adverse impact of virtual reality and so have new treatments. The associated risk factors have enhanced the importance of mental health education be it in schools, in communities or to health providers or at the workplace.

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Unified Physical Parameters-Based Analytical Drain Current Model of Amorphous-InGaZnO TFTs for Emerging Display Technology

Ashima Sharma, Pydi Ganga Bahubalindruni, Manisha Bharti, and Pedro Barquinha

Abstract In this work, a simple, precise, physical parameters-based model of Amorphous-InGaZnO thin-film transistor is proposed by employing dominant attributes of the device in the specific operating region. The model precisely replicates the measured current–voltage characteristics of any long channel length TFT. In addition, the scope of the model is augmented to replicate the electrical behavior of short channel length TFTs by employing a basic approach that requires a few least-square empirical parameters. For a fixed short channel length TFT, an average error between model outcome and measured device response is found to be less than 3%. The unified model is incorporated in cadence simulator to simulate a 15-stage ring oscillator with long and short channel length TFTs. The simulation response is well accorded with expected device behavior, which further emphasizes the use of the proposed unified model to design oxide TFT-based circuits for a wide application range.

Keywords Unified modeling · Thin-film transistors (TFTs) · Flexible electronics · Optimization · Short channel device · Ring oscillator

1 Introduction

Amorphous-InGaZnO (a-IGZO) thin-film transistor (TFT) technology is a promising aspirant for next-generation flexible and wearable electronics. It offers several benefits such as excellent electrical characteristics, high field-effect mobility, and low

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process temperature for deposition [1, 2]. The innovative display applications necessitate the accurate performance prediction of oxide TFT-based circuits, which require compact a-IGZO models.

In [3–10], several valuable analytical models for a-IGZO TFTs have been presented. However, a unified model replicating the electrical characteristics of long channel (LC) and short channel (SC) length oxide TFTs using a common set of device parameters is still deficient in literature [11, 12]. The reported work in [11] replicated the electrical characteristics of the device with 15 μm of channel length by introducing the impact of the schottky barrier at the source node. Since the anomalies of short channel TFTs are more evident at channel lengths of less than 10 μm [13, 14], the model's applicability in [11] is unspecified. In [12], the model for SC devices is developed by taking the contact voltage drop factor (V_C) at the source node into account. In this, the variation of V_C is noted for applied bias voltages and the deduced trend is applied on LC devices to predict the characteristics of SC TFTs. It is a generalized approach useful for designing oxide TFT-based circuits for any fixed channel length (down to 2 μm).

This work presents a simpler alternative approach to design the circuits (using oxide TFTs) that require any LC and a SC length device. To design an oxide TFT-based circuit which requires a fixed short channel length device, only two additional empirical parameters are extricated from optimization algorithm of least-square curve-fit to compute voltage drop (V_C) of SC device. These parameters reflect the charge injection due to contact junctions and when used along with LC drain current model reproduces accurately the measured response of TFT with a channel length as low as 1.4 μm. It is a simple approach that does not require the computation of a generalized relationship between V_C and input voltage variation. The proposed model can replicate the measured electrical characteristics of LC and SC devices with a common set of parameters with good accuracy.

In this work, an in-house analytical drain current model is employed to reproduce the electrical characteristics of a-IGZO TFT with an actual measured channel length of 18.3 μm. Further, the scope of model is expanded to replicate I–V characteristics of SC device with a measured channel length of 1.4 μm by introducing only two empirical fitting parameters. The channel length of TFTs, i.e., 18.3 μm (LC) and 1.4 μm (SC) used in this work corresponds to the actual measured channel length of the device after fabrication. The model is implemented in cadence virtuoso simulator to predict the response of a ring oscillator with 15 stages using long and short channel length TFTs. As evident from the swift and accurate simulation response, the model accurately predicts the device behavior for different channel lengths and hence is suitable for designing oxide TFT-based circuits with broad range utilization.

2 Amorphous-IGZO TFTs: Device Modeling and Validation

2.1 A Device Modeling for Long Channel TFTs

The transfer characteristic of a-IGZO TFT with staggered bottom gate configuration, partitioned into three regions, is shown in Fig. 1. The values of on-voltage (V_{ON}) and percolation voltage (V_{P}), extracted from the measured transfer linear characteristics of the device, are found to be approximately − 0.5 V and 1.6 V, respectively.

The device fabrication details are specified in [15]. As per the limits of gate to source voltage (V_{GS}), the strong ($V_{\mathrm{GS}} > V_{\mathrm{P}}$) and weak accumulation regions ($V_{\mathrm{ON}} < V_{\mathrm{GS}} < V_{\mathrm{P}}$) are defined where dominant conduction of carriers is through percolation and trap-limited conduction, respectively [16].

The drain-to-source current (I_{DS}) in the regions of weak and strong accumulation [12] reads

$$I_{\mathrm{DS2}} = \frac{W}{L}\mu_{\mathrm{FE}}C_{\mathrm{OX}}\left[\Delta\phi_{\mathrm{SS}}^2 - \Delta\phi_{\mathrm{SD}}^2 + \frac{2\mathrm{KT}_{\mathrm{eff2}}}{q}(\phi_{\mathrm{SS}} - \phi_{\mathrm{SD}})\right] \tag{1}$$

$$I_{\mathrm{DS3}} = \frac{W}{L}\mu_B\frac{A}{B}\left(\frac{C_{\mathrm{OX}}}{\sqrt{4\varepsilon_{\mathrm{IGZO}}N_3\mathrm{KT}_{\mathrm{eff3}}}}\right)^{C-1}\left[\frac{1}{C}\Delta\phi_{\mathrm{SS}}^C - \Delta\phi_{\mathrm{SD}}^C + \frac{1}{qB}\left(\Delta\phi_{\mathrm{SS}}^{C-1} - \Delta\phi_{\mathrm{SD}}^{C-1}\right)\right] \tag{2}$$

$\Delta\phi_{\mathrm{SS}}$ and $\Delta\phi_{\mathrm{SD}}$ are defined as

$$\Delta\phi_{\mathrm{SS}} = V_{\mathrm{GS}} - V_{\mathrm{FB}} - \phi_{\mathrm{S}}(y=0), \quad \Delta\phi_{\mathrm{SD}} = V_{\mathrm{GS}} - V_{\mathrm{FB}} - \phi_{\mathrm{S}}(y=L) \tag{3}$$

Finally, a unified model is given by

$$I_{\mathrm{DS,Total}} = \left(I_{\mathrm{DS2}}^{-1} + I_{\mathrm{DS3}}^{-1}\right)^{-1} \tag{4}$$

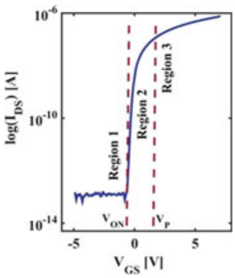

Fig. 1 Linear transfer characteristics ($V_{\mathrm{DS}} = 0.1$ V) of a-IGZO TFT illustrating different operation regions

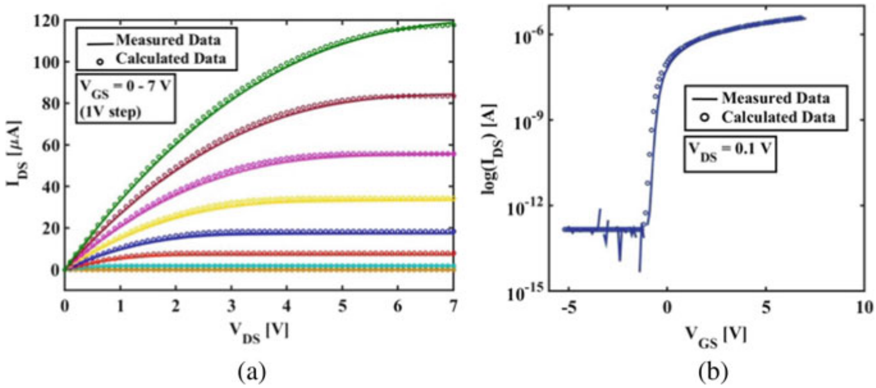

Fig. 2 Model verification of a-IGZO TFT with *L*/*W* of 18.3/20 μm: **a** output and **b** transfer characteristics

The subscripts 2 and 3 represent the regions of weak and strong accumulation, respectively. Here, μ_{FE} and μ_B denote field-effect mobility and conduction band-mobility in regions 2 and 3, respectively. While μ_{FE} follows a universal power law given by $\mu_{FE} = P(V_{GS} - V_{ON})^{\Upsilon}$, with the fitting values of P and Υ [12, 16], value of μ_B is determined from the measured characteristics (transfer) of the device.

Here, C_{OX}, V_{FB}, W, L denotes channel width, length, oxide capacitance, and flat-band voltage of the device, respectively. In the above equations, ϕ_{SS} and ϕ_{SD} represent surface potential at source and drain edge, respectively. Here, N_C corresponds to the effective density of states while $KT_{eff2,3}$ and $N_{2,3}$ denote the characteristics energy and volume density of carriers in regions 2 and 3, respectively. A, B, and C used in the above equations are related to N_C, KT_{eff}, and N.

The key parameters of the TFT with *L*/*W* of 18.3/20 μm are obtained by using the proposed model in (4) in addition to measured *I*–*V* characteristics of the device. The complete model is verified by matching the measured and modeled outcome as shown in Fig. 2. An error (average) between model outcome and measured device response is found to be less than 2.5% and hence, the model is found appropriate for circuit simulations [17].

2.2 Short Channel TFT Modeling and Validation

The anomalies for SC TFTs are more evident for channel lengths of less than 10 μm. A noteworthy decrement in normalized I_{DS} with decreasing L and non-saturated I_{DS} for higher values of V_{DS} is noticed for such devices [11, 13]. Figure 3a shows output characteristics of device with channel length of 1.4 μm using drain current model in (4). The uncorrected plot shows the calculated output response when proposed model is employed for the given device without any additional corrective parameters to account for SC anomalies.

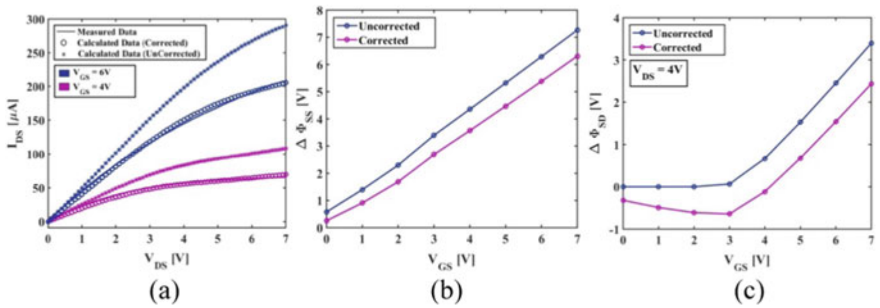

Fig. 3 TFT with L/W of 1.4/20 µm: **a** output characteristics. Change in surface potential: **b** source to source and **c** source to drain with variation in V_{GS} before and after incorporation V_C. Corrected and uncorrected graph represents the device characteristics with and without accommodating for SC anomalies in the model, respectively

As evident from the figure, the SC devices have non-saturated drain current for higher V_{DS}. The reduction in normalized I_{DS} of SC devices is due to potential drop at the source node with V_{GS}. It is taken into account by reducing the surface potential in (3) with an approximated factor of $V_C = \log(V_{GS} + S_1)$, where S_1 is the least-square fitting parameter. The uncorrected and corrected plots in Fig. 3b, c correspond to change in source to source surface potential ($\Delta\phi_{SS}$) and source to drain surface potential ($\Delta\phi_{SD}$) with variation in V_{GS} before and after supplementary parameter (V_C) incorporation in (3), respectively. In addition, the effect of non-saturated I_{DS} with higher V_{DS} is compensated by multiplying a factor of $(1 + \lambda V_{DS})$ in the final drain current model, where λ is an empirical parameter ($\lambda = 0.1948$).

The drain to source I–V characteristics for the short channel device before and after the incorporation of these corrections are shown in Fig. 3a. Table 1 shows the key physical parameters of a-IGZO TFT. Figure 4 shows the complete model validation using proposed model in conjunction with added parameters for TFT with channel L/W of 1.4/20 µm. For the given data set, the percentage error (average) between model outcome and measured device response is found to be < 3%. This approach requires addition of only two fitting parameters to replicate the current–voltage characteristics of any fixed length short channel device. Such a precise model is termed appropriate for circuit simulations [17].

Table 1 Fundamental device parameters of oxide TFT (channel width = 20 µm)

Parameters	Values	Parameters	Values
μ_B (cm^2/vs)	9.1	ϒ	2.4
T_{OX}	180	KT_{eff2} (eV)	0.00195
C_{OX} (nF/cm^2)	130	N_3 (cm^{-3})	2.688×10^{19}
P	0.9	KT_{eff3} (eV)	0.0419
S_1	2.09	N_C (cm^{-3})	9.419×10^{20}

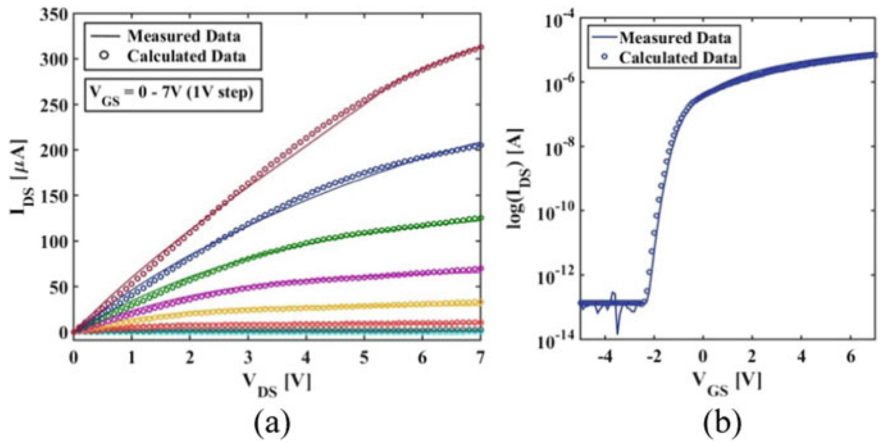

Fig. 4 Model verification of TFT with *L*/*W* of 1.4/20 μm: **a** output and **b** transfer characteristics

3 Results and Discussion

The proposed unified model is incorporated in Cadence virtuoso simulator through Verilog A and its symbol is created for quick instantiation of oxide-based circuits. Due to interpretive and continuous *I*–*V* model, a swift simulation response was achieved without any convergence issues. Figure 5a shows circuit schematic of 15-stage ring oscillator (RO) using pseudo-CMOS bootstrapped inverter for full voltage swings [18]. The RO was simulated using long (length = 18.3 μm) and short channel (length = 1.4 μm) devices with bootstrapping capacitance of 10 pF. The channel length of TFTs, i.e., 18.3 μm (LC) and 1.4 μm (SC) used in this work correspond to the actual measured channel length of the device after fabrication.

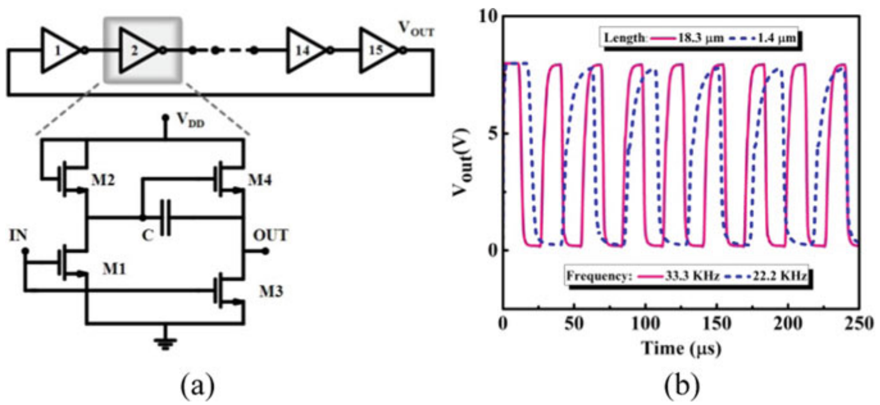

Fig. 5 15-stage ring oscillator (RO): **a** circuit schematic and **b** transient response

Table 2 Performance metrics of long and short channel 15-stage ring oscillator (RO)

RO	Power consumption (mW)	Average propagation delay (μS)	Output voltage swing (V)	PDP (nJ)
$L = 18.3$ μm	5.6	2.1	7.9	11.8
$L = 1.4$ μm	3.6	3.3	7.8	11.9

Both the ROs were simulated using a supply voltage of 8 V while maintaining same aspect ratios. As evident from their transient response, shown in Fig. 5b, the oscillation frequency of long and short channel RO is 33.3 kHz and 22.2 kHz, respectively. The Power consumption, average propagation delay, output voltage swing and power delay product (PDP) of ROs are listed in Table 2.

As discussed in the above section, a supplementary factor (V_C) is employed to precisely replicate measured characteristics of short channel devices (Fig. 4). However, the lower driving capability affects the speed of operation of these devices. Due to this, the RO simulated with channel length of 1.4 μm consumes less power but has higher propagation delay in comparison to RO with channel length of 18.3 μm. The overall PDP of short channel 15-stage RO is 0.84% lower than that of long channel devices. It is to be noted that the simulation response of the circuits is found as expected, i.e., in well correspondence with the device behavior which makes the developed model efficient for circuit simulation of oxide TFTs. The output voltage swing of short and long channel RO is 97.5% and 98.8% of the supply voltage, respectively and can be successfully employed for various applications. The performance metrics of short channel devices can be further improved by surpassing the non-idealities using optimized fabrication techniques to design area efficient devices and compact electronics.

4 Conclusion

In this work, a simple approach is proposed to develop a unified model which predicts the electrical characteristics of any long channel length and a fixed short channel length TFT. It requires only two empirical fitting parameters to combat the anomalies of short channel TFT of length 1.4 μm. For the given data set, the percentage error (average) between model outcome and measured device response is found to be < 3%. A 15-stage ring oscillator circuit with long and short channel length TFTs was simulated using the proposed model. Due to analytical current–voltage equations, the proposed model provided a swift simulation response and accurately predicted the device behavior for different channel lengths. Hence, this model is suitable for simulating circuits for a wide range of applications which need flexible electronics.

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Applying Information and WSN Technologies for Optimizing Complex Farming Ecosystem

Anil Kapil, Anita Venugopal, and Vijay Anant Athavale

Abstract Today, network communication holds a crucial importance of all other types of networks. Of all the advanced network structures, distributed networking system has huge demand. Smart dust network which is one of the categories of distributed networks is the future of distributed networks and has its applications in crucial fields. It is envisioned to blend the features such as ability to sense, compute, and communicate wirelessly. These micro devices can be sprinkled to form a dense network that can monitor real-life processes with high precision results. In this work, we present the characteristics, applications and possibility of using artificial technologies in Smart Dust networks.

Keywords Precision farming · Smart dust · Sensor

1 Introduction

Precision farming is a term used to describe a collection of modern information technologies that are being applied for assisting extensive commercial farm operations [1]. Increased production yields and reduced input costs are the significant outcomes of the automatic real-time agriculture monitoring systems of site-specific management, climate and soil properties using different sensors. This strategy improves the crop production while at the same time cuts labor costs and reduces the amount of waste production. Wireless sensor network (WSN) is gaining huge popularity as this enables intelligence to manage precision agriculture with the aid of real-time

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management tools of agricultural products and atmospheric conditions, among other things. For evaluating large-scale sensor networks, there are reasonable modeling tools available; nevertheless, these techniques fall short of accurately representing the realistic characteristics of wireless communication.

Real-world test-beds bring to light real-world issues and key components of large-scale sensor network implementation that would otherwise be overlooked. It is presented in this research that a WSN test-bed for autonomous and real-time environmental monitoring (REM) of various parameters of farming [2] such as irrigation, soil, and ambient elements that influence agricultural production has been developed and implemented. An easy-to-use graphical user interface is used to illustrate the system design, physical arrangement, sensor node implementation, and software to regulate real-time (RT) surveillance and control of agricultural yields. The report discusses practical difficulties and technical challenges such as sensor integration, sensor placement in an outside setting, energy managing (EM) methods, and real-time rates of power consumption [3].

Visualize, a dust of data gathering sensors, each about the size of a sand particle or even smaller, being swept by a storm and transmitting information about the near stations on the ground beneath them. Consider a network of invisible sensors spread across the smart roadways, city, and all areas of our life, which can be used to detect actual traffic network on roads, available car parking spaces, etc., all virtually in real time, thus improving safety and efficiency. On the other hand, billions of sensitive nano-sensors might be strategically placed across dense areas like forests and other locations such as fire prone locations in order to identify initial occurrence of fire as early as possible. As an alternative, envision a pre-programmed smart dust, triggering alarm signals the minute invisible microcracks in modern turbine blades.

Smart dust is a new technology that will be comprised of small, wireless sensors, also known as MOTES that will be used to collect data. The gadgets are intelligent web-based systems for communication with other processors or sensors that are micro particles mounted at the tip of a pin. In this technology, a mass of programmed interconnected nano-wireless-sensors works together which can be sprinkled in air as particles or can be linked with existing appliances. The data collected is transferred wirelessly to larger computer systems. These sensors have the ability to detect and respond to any variations that occur in elements such as water, temperature, or nutrients used in farm fields and programmed to react against the vulnerability. It offers safe and efficient techniques for food and agriculture organizations [4]. Because they are so weightless, these particles are easily diffused in the environment like an air-borne natural dust particle. Known as smart dust, which implies that it is a system of several tiny smart millimeter-length micro mechanical sensors (MEMS) with the ability to compute, communicate wirelessly using bidirectional technology, and a power supply. These countless microscopic sensors are sprinkled all over the atmosphere, over entire earth, in order to transmit and receive data and information in order to be stored. Smart dust devices have huge applications and have revolutionized the field of military, microbiology, and healthcare [5].

Large number of individual grain-size wireless sensors which are less than a millimeter size with self-processing capability often known as smart dust, are being developed. Smart dust collects and stores information about its surroundings, such as heat, noise, atmospheric pollutants, or vibrations, and then transfers that information to larger processing systems wirelessly.

It is a visualization of future network in which network of trillions of intelligent microscopic sensors continuously senses what is happening in the near geographical region, communicates with one another, and exchanges information. Smart dust is an example of this concept. Smart dust technology may be the supreme of global Internet-of-Things (IoT) gadgets, as they connect a large number of objects together. It has bought revolutionary changes in the field of technology as smart dust have own power supply, and pre-programmed to work without human intervention.

Section 2 of this paper presents smart dust concept. Section 3 mentions applications of smart dust. Section 4 introduces components of smart dust. Section 5 describes risks involved in smart technology. Section 6 presents future neural dust [6, 7].

2 The Inspiration for the Smart Dust Concept

In 1990s, Dr. Kris Pister, an electrical engineer researcher from the University of California, Berkeley, first proposed the concept of 'Smart Dust' in the 1990s as a simple approach to deploy intelligent wireless sensors in a variety of environments. Pister foresaw an era comprising omnipresent devices with the ability to sense and detect all that could be measured in the surroundings at the time of his research. He immediately thought of applying this technology in analyzing environmental attributes like weather variations (mentioned in paper, Emerging challenges: Mobile networking for 'Smart Dust' in 2000), and he continued to think about environmental applications.

However, it should come as no surprise that the military was the driving force behind the development of smart dust, as well as the source of funding. During the Smart Dust Project [8] in 1992, DARPA provided funding for Pister's study (Fig. 1).

3 Application Areas of Smart Dust

The following are the application areas for smart dust: Smart dust networks are comprised of nodes (referred to as 'motes') with built-in power supply that can sense the surroundings and based on the findings process, compute and generate results, communicate wirelessly with other processors and with a volume less than millimeters, making them ideal for use in space-constrained environments [9] (Fig. 2).

Micro-electromechanical systems, sometimes known as MEMS, are used to create smart dust. MEMS are comprised of mechanical components such as actuators, levers, sensors, gears, pistons, etc., integrated along with electrical components such

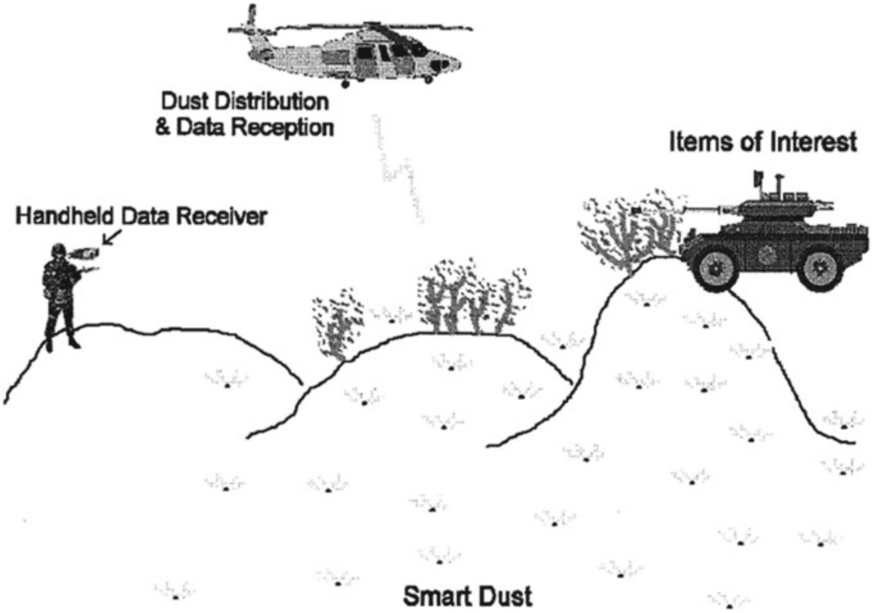

Fig. 1 Illustration of smart dust sensor network applied in the battle ground, as represented in the grant project proposal

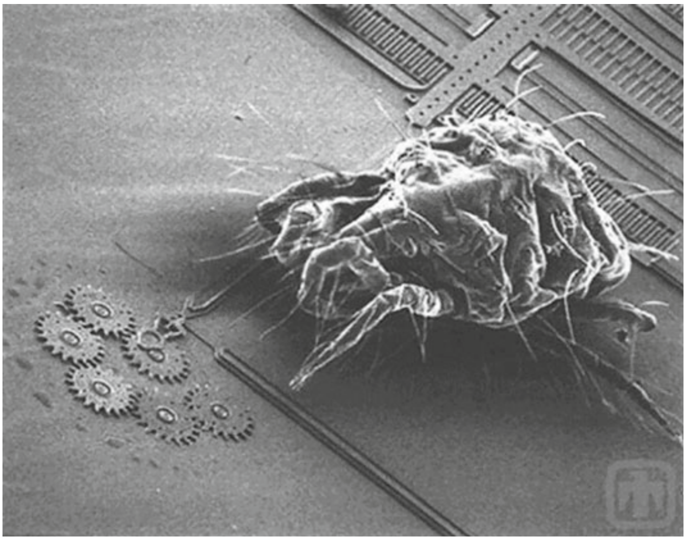

Fig. 2 Mite, barely 1 mm in size

as resistors, condensers, inductors, etc., onto a micro silicon chip using IC technology in order to accomplish their functions. As fabrication methods progress, this will reduce much further in size, eventually reaching the level of nano-electromechanical systems (abbreviated as NEMS).

MEMS are tiny integrated devices or systems that combine mechanical and electrical components. MEMS has been identified as one of the most promising technologies for the twenty-first century and has the potential to revolutionize both industrial and consumer products by combining silicon-based microelectronics with micromachining technology. Its techniques and microsystem-based devices have the potential to dramatically effect all of our lives and the way we live. Microsensors detect changes in the system's environment by measuring mechanical, thermal, magnetic, chemical, or electromagnetic information or phenomena. Microelectronics process this information and signal the micro actuators to react and create some form of changes to the environment. Mechanical microstructures, microsensors, micro-actuators, and microelectronics are all integrated onto the same silicon chip.

Motes are fabricated using the phenomena of silicon-based technology and are capable of remaining suspended in an environment comparable to that of dust for extended periods of time (hence the name). Because of the wide variety of implications, it is hard to limit comprehensive brilliance of smart dust in a piece of writing. As a result, we'll just list a few of the most important ones below.

3.1 Agriculture

Agriculture involves the continuous monitoring of a crop's nutritional requirements, as well as its watering, fertilizing, and pest management requirements. Having access to this essential information can assist in increasing the quantity and yield of crops for farmers. It can assess soil health, limitations and can analyze factors like pH in soil, nutritional balance, fertility level, weed invasions, etc., which are crucial information to the plant's growth and development.

3.2 Industries

A regular inspection is required to make up to date the critical equipments, so that they always give the desired results. Identifying and monitoring the actual condition of asset and associated components to know the weaknesses and deterioration of the asset and determine the type of maintenance required that might help to avoid a complete failure of the system.

3.3 Environment

Chemical and biological environmental monitoring with the purpose of identifying potential health and safety hazards (water, air, soil).

3.4 Infrastructure

Infrastructures like private or public building constructions, highways, connectivities like bridges or tunnels, pipelines handling gas, water, or drainage systems, electrical channels, telephone, network-communication systems. and other urban infrastructure will all be monitored as part of the larger notion of a smart city, as will bridges and tunnels. For example, during the construction process, smart dust could already be incorporated into the concrete.

3.5 Inventory Management

Smart dust aids at inventory management of products production or product shelve life during transportation via vessel or vehicles ensuring accurate and effective inventory control.

3.6 Transportation

Smart dust is used in the transportation sector to convey perishable commodities because these materials require regular monitoring. When transporting perishable goods, it is necessary to monitor specific characteristics such as temperature, humidity, and aeration on a continual basis. Likewise, intelligent dust can be used to monitor and manage the conditions required for safe transportation of animals, such as temperature, air quality, and humidity levels.

3.7 Military

It facilitates access to activities in inaccessible or remote locations. It can also be used to detect the presence of poisonous gases or harmful compounds and to assist in the implementation of appropriate measures.

3.8 Space Exploration

Weather and seismic activities focusing on planet structure and moon of our solar system is part of space exploration. New excavation techniques are investigated by researchers envisioning at building an entirely different concept of building a space telescope using the concept of smart dust by reshaping it with an aperture consisting of swarms of particles emitted from a cylindrical pressured container, controlled by a laser. The second phase of the astronomical orbiting rainbows project is funded by NASA's Innovative Advanced Concepts (IAC) program, which aims to integrate space-optics with smart dust, or self-oriented robotic technology, in an effort to create a more powerful and efficient spacecraft.

4 Current Implications of Smart Dust

4.1 Oil Tankers

In North Atlantic, an oil tanker, Loch Rannoch of size more than 800 feet had installed a total of 160 wireless mote sensors on it. The sensors are designed to detect and predict equipment breakdown onboard by measuring engine vibrations. In addition, several other projects are also implementing smart dust technology sensor networks.

4.2 Wildlife

Great Duck Island (USA) is home to a wireless network more than 100 mote sensors monitoring the micro-climatic conditions in and around nesting burrows of sea birds for the past several years. With the exploration of environmental monitoring (EM) kit, it is hoped that researchers will be able to research wildlife and ecosystems in an un-intrusive and less interruptive mode.

4.3 Bridges

A swarm of wireless motes has been deployed on the Golden Gate Bridge in San Francisco USA to analyze the vibrations and other structural strains that can occur due to hurricane or earthquakes as part of a proactive maintenance.

4.4 Trees

IN California, USA, a group of scientists in their case study reveals installing more than 100 motes to monitor remotely the native conditions required for the good growth of one of the world's tallest redwood trees which is more than 65 m tall.

4.5 Markets

As part of security initiative, cargo and shipping containers in Florida of the United States department of Homeland proposes to test the deployment of motes to ensure security for international trade.

5 Components of a Smart Dust Mote

At basic level, a mote consists of four types of classes which are as follows:

- sensors,
- circuits,
- communication, and
- power supply.

The conceptual mode of a wireless sensor node will look as follows (Fig. 3).
A sample model of a wireless sensor node consists of 3D-printed:

- A cube—with a number of printed sensors and the antenna.

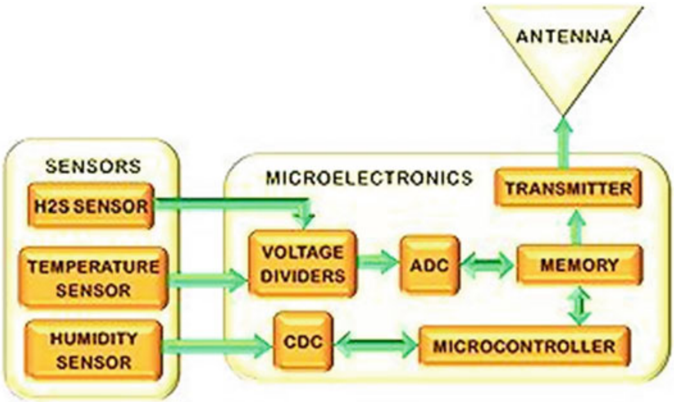

Fig. 3 Sample of wireless sensor node (circuit board)

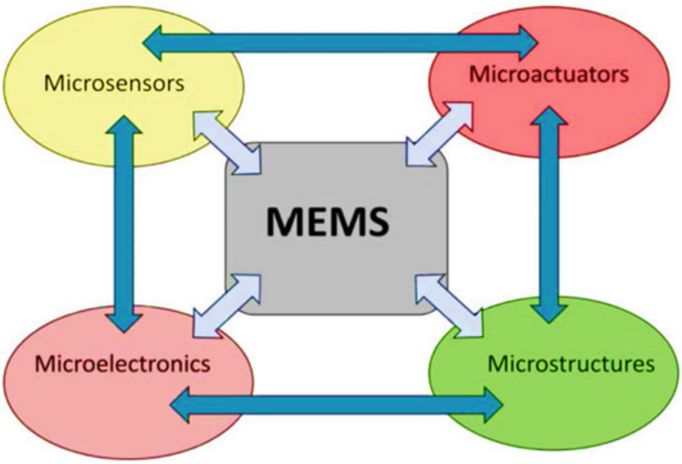

Fig. 4 Functional cube

- A circuit board—with tiny electronic components all bound together [10] in one unit.

Complete set of sensors also called MEMS or NEMS is comprised of a single sensor or sometimes more than one sensor with the ability to act as the primary mote sensor that can detect and quantify attributes like movement, heat, weight, noise, brightness, magnetic pull, etc.

- Circuits (microcontroller)—acts as a platform to interact with the sensors. It helps to process the data and store it.
- Communication—mainly includes 3D antenna with transmitter that emits radiations to the surroundings. This way it successfully establishes communication in all direction.
- Power supply board—that supplies power for the entire unit where it is installed. Power can be supplied using solar energy cell or thin sheet of capacitor that serves as battery (Fig. 4).

6 Risks and Concerns for the Smart Dust

The use of smart dust would be associated with a number of dangers, including.

6.1 Data Security

Several of those who have qualms about the real-life consequences of smart dust express worry on privacy of individuals. Smart dust is tiny and so microscopic that it may remain undetectable to the naked eye and, as a result, will be extremely difficult to detect and identify. These wireless sensors are programmable and can save and transfer information and hence people have begun to do several experiments to solve or monitor tasks. Fearfully, it leads to data hacking as you will have no clue about who all can gather or steal the data from the cloud and use/misuse the data or information. One has to be careful about negative use of smart dust especially when it falls in the hands of wrong people; it's easy to let your imagination run wild when it comes to the potential for privacy violations.

6.2 Control

Once billions of smart dust devices have been spread throughout a large area, it will be challenging to gather or capture these microscopic sensors back after the task. Since these are programmed particles which are in large mass with small size, these programmed particles can be collected and pre-programmed and manipulated to serve differently by destructive people causing damage to individual, corporation, or government. Hence, it becomes a mandatory to maintain control over the use of such sensors.

6.3 Cost

The cost of installing the new technology of smart dust systems is comparatively high as it demands the use of wireless communication through satellites and other hardware and software requirements necessary for its smooth functioning and installation. As a result, it is limited to researchers or specified authorities unless and until it is made affordable for common use.

6.4 Pollution

There is high ecological risk using smart dust unless and until these motes are made completely biodegradable. These devices serve only for single time use. It may pose threat to the environment if the clouds of sensors are left unattended after use. It will pollute the natural resources like soil, air, water where they are used.

6.5 Health

Since these smart particles are suspended in the air as dust, there are high risks of danger of inhaling or consuming these engineered products. Nano particles may even penetrate through skin and have toxicological effects and hence one must be conscious of the hazards this technology may pose to species.

6.6 Legal

The lack of information protection is one of the major concerns of this technology. Smart sensors can collect specific data and can transmit the data to other people and devices. This may lead to security breach as the data can be hacked by unauthorized parties where information can be used for illegal purposes. It may also reveal the identity of the authorized individual who has installed the device. It is trackable and as a result, it can pose threat to privacy destruction and damage to the person.

6.7 Future Neural Dust

Research is carried out in developing millimeter-size safe wireless devices that can be embedded in human nerve system. These man-friendly sensors have the ability to detect nerve impulses and muscle responses in human body. In this technology, ultrasound source is coupled with power generator to communicate with the sensors. This device can be implanted in human brains and can be initiated by just using ultrasound and does not require power supply or wires. It is basically consisting of three components:

- Electrode pair—used to measure nerve signals,
- Transistor—used to amplify the signal, and
- Piezo-electric—used to convert the mechanical power that is generated externally in the form of ultrasound radiations into electrical form and same time recording the activities of nerves.

Researchers have elaborated the possibility of implanting these Implantable Integrated Chips into human cells.

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Unraveling a New Age of Travel in Blockchain Based Metaverse

Shivinder Nijjer, Jashandeep Singh, Pankaj Sharma, Meenakshi Malhotra, and Rajit Verma

Abstract Recently, there is an upsurge in tourism and hospitality sector using the VR technology with major players like Airbnb and Hilton using it as an instrument of advertisement. Blockchain based networks have opened newer avenues for electronic business and authentication and identity modeling. The article attempts to elucidate how blockchain and metaverse will transform the travel and tourism—and enlist the facilitators and inhibitors of this paradigm change. The article will also shed light on supporting technologies in metaverse and how it will extend the space of virtual tourism.

Keywords Metaverse · Tourism · Virtual reality · Augmented reality · Blockchain · NFT · 5G

1 Introduction

A post-reality universe, called Metaverse, is a multiuser environment merging 'physical-reality' and 'digital-virtuality'. The basis of metaverse is the convergence of various technologies enabling multisensory interactions with digital objects, virtual environments, and people. It may be called as a combination of virtual reality and augmented reality. Therefore, metaverse is an interconnected web of social network immersive environments in persistent multiuser platforms [1].

Virtual reality (VR) and augmented reality (AR) is an interactive and simulation-based environment which uses the three-dimensional technology. Individual can interact in this environment with others, hence having a real-life experience in the 3D

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space. Users can access VR through computers, smartphones, and a head-mounted display (HMD). HMD is touted as the best device to access a 360-degree view as it senses the rotational movement of the user's head. With the reduced price and the entry of companies like Samsung, HTC, Google, the HMD is becoming affordable [2].

VR technologies also infiltrated the tourism sector. The pandemic may have resulted in adoption of VR apps as by using VR apps, individuals are experiencing global destinations to overcome depression and loneliness. Applying VR technology, various countries are projecting their prime destination sites in the form of VR trips [3]. For example, India VR Tours provides a virtual trip to the prominent destination sites of India. According to Statista [4], the global market for virtual environments (augmented and virtual reality) is expected to grow from $16.8 billion in 2019 to $250 billion in 2028.

The COVID-19 restrictions have forced the customers to stay at home and experience the indirect way of visiting a destination with the application of VR technology [5]. COVID-19 has brought unprecedented challenges to the tourism and hospitality industry. The current pandemic has resulted in strict restrictions that brought international and domestic tourism to a halt [6]. International traveling was declined by 81% in July 2020 compared to the same period in the previous year. Coupled with social distancing, COVID-19 restrictions also resulted in the emotional well-being of individuals [7]. The loneliness and uncertain future resulted in a 74% drop in overall well-being. Travel and tourism-related activities act as stress-busters for tourists [8].

Recently, there is an upsurge in tourism and hospitality sector using the VR technology with major players like Airbnb and Hilton using it as an instrument of advertisement. However, during the pandemic, it became very relevant for the tourism sector to use virtual reality more than an advertising tool. The new social distancing norms imposed in this pandemic has further influenced the tourists to opt for the touchless travel [9]. The statistics related to the internet searches proved the rise of VR tours in the pandemic phase. There is a rise of 488% in the search for virtual reality tours on the internet from February 2020 to March 2020. At the same time, the search for VR Tours got three or four times increase in the United Kingdom and the United States of America [10]. This article attempts to elucidate how blockchain and metaverse will transform the travel and tourism—and enlist the facilitators and inhibitors of this paradigm change.

2 About Blockchain

A blockchain or distributed ledger technologies (DLT) is a shared and distributed database that holds a constantly expanding record of transactions in their chronological order [11]. It is a ledger that contains digital transactions, data records, and executables [12]. All the transactions are accumulated into larger formations (i.e., blocks), which have a time stamp [13] and they are cryptographically linked to previous blocks [14]. These links form a chain of records which defines the chronological order of events, therefore, it is called a blockchain. Blockchains were initially created for smooth distributed transactions by eliminating central management [15].

Blockchain technology primarily has four features, namely, decentralization, traceability, immutability, and currency properties [14]. Decentralization is the mathematical process of data storage, data verification, maintenance, and transmission on blockchains [16] over a distributed system structure without any help of the centralized organizations [17]. Traceability means that every transaction can be tracked back by observing the blocks by the cryptographic hash function, since it is arranged chronologically [14]. Immutability exists because all the transactions are stored in blocks with one hash key linking to the previous block and another key to the next block, as blockchain is a shared public ledger stored on thousands of nodes which continue to sync in real time [12]. Cryptocurrency property in blockchain technology is point-to-point transactions, without any third-party intervention or supervision [18]. The variety of other activities like, government activities [19], educational activities [20], and financial activities [21] can make use of these non-financial activities which have a property of currency [14].

Blockchain technology is not limited to finance area (cryptocurrency, bonds, stocks, loans, etc.) now. It has been applied to other sectors such as government, culture, art, health, etc., and tourism is not an exception. TUI Travel PLC, a British leisure travel group adopted blockchain technology in its bookings, reservations, and payment systems [22] and huge amounts of money are being invested in promising start-up ventures [23]. Companies like CheapAir, Expedia, One Shot Hotels, and Webjet are also encouraging blockchain for payments [24]. However, researchers [25] found that the blockchain travel consumers are still in the early stages and they lack general awareness [26].

3 About Metaverse

Metaverse is simply an immersive experience based on personalization enabled by supporting technologies like AR and VR primarily [1, 2]. While these technologies twin real world, also called as the digital twin, Blockchain enables financial or economic exchanges across this virtual world. This term was first coined in a novel 'Snow Crash' launched in the year 1982. The proliferation of metaverse differs by different countries owing to difference in their policies and economic factors. Researchers enlist three major features of metaverse viz. it is multi-technology, a new social form and is a virtual world. Since metaverse attempts to recreate reality, it is based on several supporting technologies for its construction. Without the advancements in any of the underlying technologies, development of a metaverse would not have been possible at all. Metaverse will include development of newer forms of economic systems, cultural systems, and legal systems, necessitated by virtual world.

Virtual world will also become advanced and extended because the supporting technologies exist which break the continuum of time and space offering an immersive experience [27].

This technology, due to convergence of multiple technologies, has fetched interest and application in multiple industrial sectors. Education especially marred by pandemic has switched to remote learning [28], however 2D learning induces isolation and emotional detachment leading to learning loss. This remote learning has been enhanced by metaverse offering immersive experience to learners and feedback cues from the system provide a sense of realism [29]. Besides authors also note that this may overcome cultural barriers through digital representations of class participants and promote global learning. Digital twins created by metaverse enable planning of smart cities and infrastructure before implementing it in real. The possibility of providing a secure and authentic residential experience through blockchain based smart cities are predicted and managed using their digital twins (metaverse) [30].

Digital artifacts in museums are also reaping profits from adopting this technology while remote assistance for medical care and medicines and patient monitoring is also done more effectively through metaverse. Liu and Oh provide an example of digital transformation of products in China and how it is enhancing virtual tourism and fetching higher profits [31]. The use of metaverse and related technologies for better gaming experience is done by the leading gaming companies like Rodblox and Minecraft [32]. Prior works also elucidate the application of metaverse in remote work management by providing a new form of employee interaction and online meeting spaces which do not replicate the fatigue experienced in 2D meeting space [33].

3.1 Supporting Technologies

5G. When an overlap is to be created between actual and mirror world, which is seamless and ubiquitous, it requires very powerful internet services with no lag, latency, and jitter. The existing 4G communication technologies can barely afford AR and VR applications. They do not have the capacity to deliver the sense of realism in virtual environments. Although 5G networks have the features of low latency and high bandwidth, it can support haptic mobile devices, but may not be effectively scalable. Still in the present state, 5G technologies are a must to develop machine to machine interactions which offer a ubiquitous and seamless experience. One possible solution offered is development and use of tactile network which is redefining the bone of internet to suffer from lesser latency issues [34]. Additionally, these technologies are based on quantum communication promising security.

AI (Artificial Intelligence) refers to equipping machines with the ability to learn from experience through deployment of theories, technologies, and algorithms in order to deliver work and perform tasks mimicking human brains. AI will enable tourist segmentation, clustering, identification, besides aiding in creation of digital twins to first verify the implementation of plans in reality [3].

Augmented reality (AR) *points to the use of positioning tactics and AI techniques of recognition and classification based on inputs received from multiple sensors, GPS, and dimensional data to place digital or virtual objects in the real world. Ultimately this information is displayed on user's screen which maybe VR headset, enabling real-time two-way interaction between physical and virtual space.*

Virtual Reality (VR) *is more focused on offering an immersive experience, which is hyper spatiotemporal providing the users with a sense of realism as if they are in the real world. It is an extension and advancement of the current 2D virtual systems enabled by 5G and Web 3.0. When both AR and VR are combined, they provide surreal experience presenting a mirror world which is a recreation of the actual world. This combination is mixed reality (MR) and is the key enabler of metaverse* [2].

Blockchain and NFT (Non Fungible tokens) are the key pillars of digital currency. Blockchain through its features of immutability, disintermediation, decentralization, and so on is a building block for emergence of newer form of economic exchanges. DAPPs (Decentralized application) markets are proliferating owing to token economy enabled by blockchain. Based on smart contracts, NFT is a cryptocurrency based token distinct from coins, as they are unique and provides a sense of ownership. NFTs are the reason for making economic exchanges possible across metaverse and blockchain networks [35].

IoT and HCI (Human Computer Interaction), as illustrated in the discussion ahead, since metaverse relies immensely on multimodal sensor inputs, exchanges between the machines and human user interface, it is heavily invested in IoT and technologies which make human computer interaction smooth [36].

Computer Vision falls under the purview of AI, yet it needs special mention as identity of individuals in a digital virtual world is through their avatars which have become realistic and human-like owing to computer vision technologies. Without this simple air gestures, finger pointing would never have been achieved. Also, without advancements in computer vision technologies, users in metaverse or virtual world would appear as sedentary [27].

4 Shift in Virtual Tourism

Virtual tourism is an amalgamation of virtual reality with tourism. It aims to enhance tourism experience by immersing virtual components. Generally, till date virtual tourism has been seen as an added attraction and a source of entertainment for visitors to a tourist spot, however, metaverse enabled tourism will take it a step ahead and let tourists experience a destination from the comfort of their homes. Virtual tourism can help to promote sustainable tourism by reducing unnecessary greenhouse gas emissions from transportation and enhance 'virtual accessibility' especially for the elderly and disabled with limited mobility [37]. As Cenni and Vásquez [38] note in their work that online tourism products find acceptance among consumers if they are educational, entertaining, allow social interaction and virtual escape, and allow connect between closed ones of an individual. This is what is being offered by the metaverse. We enlist the user-centric features which will be a key requirement for enabling success of travel and tourism in metaverse. It has to move beyond solely depending on AR, VR to mixed reality.

4.1 Immersive Experience

Unless virtual tourism gives an authentic and empathetic personal experience, it cannot compete against physical tourism. Metaverse will take it a different dimension through 'Immersive experience' which refers to the perception of a user of being teleported to an alternate world which mirrors the reality. Virtual reality (VR), augmented reality (AR), and multisensory applications impart an immersive experience to the metaverse [1]. This enables the user to develop social interactions and perceive depth, sound, and feel as in real world. This fidelity is enabled by stereoscopic displays. While VR replicates the real physical space using multisensory equipment, AR embeds virtual elements into physical environment seeming like a layer of projected artifacts [39]. Using camera sensors on a VR headset, AR can be integrated into virtual space as well. To provide immersive experience, using 3D, spatial or binaural audio techniques, the system allows spatial distribution of sound cues with user identifying the directions. Handheld motion controllers provide the feel of grabbing or touching an object. Haptic body suits allow activation of entire body to perceive touch and feel the virtual environment as real. This is an edge over 2D experience since 2D occurs in isolation causing fatigue and emotional disconnect among users.

4.2 Identity Management and Avatars

In metaverse, tourists will be concerned about the way they look and how would they identify themselves. Blockchain based metaverse allows for unique identity creation across the system requiring no proof for access of services, as access is authenticated by Blockchain. Several techniques have been developed to manage consumer identity over Blockchain network-like IAD (Institutional Analysis and Development) framework [40], Known Traveller Digital Identity System [36], Smart Authentication Service, to name a few. Avatar is a Sanskrit word which is a representation of an individual in the virtual world. Development in Avatars allow them to be interactive to the extent of gaze, facial expressions, and gestures, such that users feel an immersive experience or social presence of the individual [41]. This will provide a realization of actual travel in the virtual space to the user. Besides Avatar's reactions and gestures should change dynamics of audience involvement such that the metaverse is able to offer a social and communicative dimension [42]. Computer vision is a major technology which goes into the development of Avatars to make it as close to reality as possible. Avatar capabilities such as free-hand interactions, object pointing, mid-air pointing are enabled by computer vision which consumes computational resources very heavily, and without which the traveler would appear to be sedentary in the metaverse [34].

4.3 Economic Exchanges

Blockchain networks allow development of their own currencies and transactions across the network occurs through the same. Any innovation does not proliferate until it inculcates a financial aspect. Blockchain based networks will allow for economic changes through token economy [43]. Tokenization of transactions across blockchain based metaverse will generate revenue, profits, aid in development of reward and loyalty programs fetching investments and garnering interest from different stakeholders. As Im and Lee [44] note that non-fungible tokens (NFT) allow users to gain ownership of things in virtual space such as purchase of goods, properties, and so on. This is a key requirement for travel sector as well and will lead to creation of new business models. Government across the globe have developed policies to aid in effective functioning of a blockchain based economy [27]. Although a lot of work needs to be done to regulate cryptocurrency and digital exchanges over a blockchain based network which is decentralized, the future looks promising [45]. Therefore, tourists can use the metaverse to conduct transactions to avail services similar to real world. Metaverse commerce is also an emerging scape for user to user and business to user trading on this platform. The main emphasis will be on interoperability as the system will allow for exchange to occur globally across national boundaries and hence demands for a rigorous regulation framework.

4.4 Interactive Content and Web 3.0

Enabled by Web 3.0 which is a collection of technologies centered at building interactive customer experience, metaverse will provide an interactive storytelling like experience to tourists. While 2D experience does not provide real-time interaction, Web 3.0 will enable the same. Just as tourists can move back and forth across a tourist spot, 3D models in metaverse will enable tourist avatars to interactively walk inside a spot and explore it to as real-time granularity as possible [46]. Museums are already providing this experience to users through special AR headsets, motion controllers, and beacons and head mounts [47]. Few researchers [48] also highlight the importance of interaction and storytelling in the world of tourism by emphasizing that liveliness of the 3D models, vibe, lighting, graphics and sound, emotional connect, size and travel-like exploration, opportunity to interact and escape are all key components of delivering a real feel in virtual tourism. Details and sensory experience are part of this experience and are enabled by Web 3.0. Metaverse will be able to overcome the demarcation between real and virtual spaces using AR and virtualization and use of avatars, location based interactive webpages [29]. A comparison of metaverse with theaters note that digital representations are far more metamorphic to the living reality providing possibilities of 'unprecedented experiences' [42]. Further, the interactive experience should provide constant interconnection or perception of a virtual presence. Feedback cues are very vital to the perception of real interactions in a digital world such as auditory or visual or haptic [34]. Although the user interacts using devices and interfaces, the perception gained from metaverse should be a sense of realism which is enabled by providing feedback cues. These, at present, are enabled by multimodals where ongoing works are also focusing on developing the sense of smell, other than visual, auditory, or haptic which are in place. One powerful example is of Google Maps which provides real-time directions and Google Lens which identifies places by looking at pictures of places. Besides this, metaverse participants can also offer their feedback to answer tourist questions while AR-based shopping will enable users to view how product would like in their actual house in 3D model in the metaverse before making an actual purchase.

4.5 Personalized Recommendations

As Mark Zuckerberg notes in his announcement video on Meta, that by integrating numerous experiences of a consumer over a single space, firms will be able to collect massive data with more accuracy as all aspects of metaverse are digitized. This will allow better exploration of individual traits and preferences, which will enable the firms to build tailored recommendations to the lowest level of granularity and achieve the goal of marketing which is an individualized recommendation. User and IoT interactions will offer deeper and individualized consumer insights such as which type of tourist spot users prefer, how they like to spend their day, favorite genre of music, budgetary experiences, and so on. This can change the world of tourism shopping by suggesting places to visit and how product would fit in user home. This may also sense if user's body is sending urgent signals to use washrooms while guiding the location of actual restroom.

5 How Metaverse Fulfills This?

Mixed reality has the goal of bringing senses to the virtual presence and recreates empathetic physical spaces in mirrored world. Metaverse can combine immersion with interaction in 3D virtual worlds, thereby building identity construction, presence, and co-presence [1]. Metaverse requires that the shift from digital to real world and back should be ubiquitous which necessitates the shift to mobile technologies. Lee and others [34] outline various technologies which allow seamless interaction with digital entities such as ActiTouch which is a surface worn on human arm which allows taps to traverse into meta-reality for enabling human perception of interaction among digital entities. In other words, this is remote social touch. Instead of using multiple sensors on human body to enable this touch perception, research is also focusing on developments of textile material which are digital and therefore, act as user interfaces, for example, Pocket Thumb and ARCord. Taps on the material acts as motion positioning and clubbed with AR may generate menus for performing certain tasks or enable movement of avatars in the metaverse.

Some existing notable examples of metaverse and metaverse-like technological products are listed here: Amazon offering BR shopping experience, Roblox with advanced virtual experience in gaming, Epic Games 3D modeling platform Skethfab, Disney investing in building a theme park metaverse, Snapchat's custom avatars, digital artwork on display by Decentraland, 'ifLand' by SK Telecomns in South Korea which allows cartoon avatars of users to conduct meetings on the virtual space, Urbanbase which is a 3D real estate project, MetaDubai which is a collaborative blockchain and metaverse based economic marketplace effectively running.

Specifically in the tourism [49], Boeing company has invested in metaverse to create a digital twin of its planes and offer virtual plane experience to users. Metaverse facilitates executive travel in the parallel world by enabling virtual meetings, conference rooms through avatars. LynKey is a tourism project selling virtual properties through NFT exchanges. Sam is also a NFT-enabled metaverse in the space of smart luggage. Color Star Technologies have also developed a metaverse for virtual ticketing while a few global singers have used the metaverse to conduct their concerts where millions of people joined in to view the avatar of the singer performing. However, the framework for the blockchain based Metaverse in tourism is presented in Fig. 1.

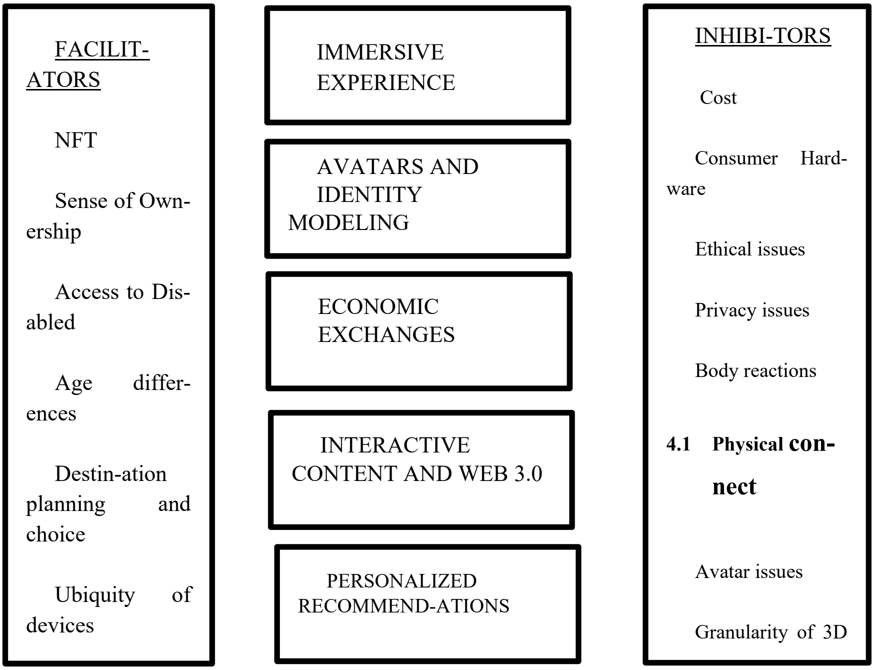

Fig. 1 Framework for Blockchain based Metaverse in tourism Source: The authors have adopted the farmework form various sources

6 Facilitators and Inhibitors

6.1 Facilitators of Blockchain Based Tourism Metaverse

NFT and sense of ownership—In contrast, NFT is unique which cannot be exchanged like-for-like (equivalently, non-fungible), making it suitable for identifying something or someone in a unique way. To be specific, by using NFTs on smart contracts (in Ethereu), a creator can easily prove the existence and ownership of digital assets in the form of videos, images, arts, event tickets, etc. [50]. Furthermore, the creator can also earn royalties each time of a successful trade on any NFT market or by peer-to-peer exchanging. Full-history tradability, deep liquidity, and convenient interoperability enable NFT to become a promising intellectual property (IP)-protection solution. Although, in essence, NFTs represent little more than code, but the codes to a buyer have ascribed value when considering its comparative scarcity as a digital object. It well secures selling prices of these IP-related products that may have seemed unthinkable for non-fungible virtual assets [51].

Opens new avenues for disabled—This possibility of extended virtual tourism would be most beneficial for disabled. They cannot visit the tourist places but metaverse will enable real sensory experience which empathizes and replicates the actual travel experience. With enhancements in computer vision and multi-sensory perceptions, even blinds can perceive through their sense of touch and smell and experience any destination [1]. Globally also, the expense and burden of travel can be reduced by adopting metaverse.

Age differences in perception—This is a facilitating factor because of two main reasons: One, younger age groups are already tech-savvy and proficient in use of Internet and technological innovations; and Two, they have already developed an addiction or liking of 2D virtual world and stay glued to their mobile devices for hours on end. Therefore, it is opined that the younger age groups would be willing to experience the meta-reality through metaverse. Gen Z tourists are willing to explore mixed reality based cultural heritage explorations and will benefit from this transformative experience [48].

Privacy mechanisms using Avatar—Users may clone avatars which are identical looking and confuse about the real identity of the user. Metaverse also allows for creation of multiple disguise suitable to event inside the metaverse. Teleporting the avatar to another location inside the universe and using a bot to mimic it will also protect avatar from any attacks. Metaverse features also allow avatars to become invisible for some time or lock certain locations of the metaverse as private or restricted access areas. Besides, metaverse may also offer private zones which are completely locked out for general uses [34].

Assistance in travel planning and destination choice—Google Earth uses interactive content display providing directions in real time while Google Lens identifies to the utmost accuracy any destination from the images. Using this feature, travelers can explore a tourist spot in metaverse before visiting it in real to understand if the experience matches with their desires and also aid in developing a travel itinerary. Virtual rooms on metaverse of accommodation providers may offer real-time feedback to the guest, basis which they can make a choice of booking it. Besides this, blockchain verified review and rating system will add credibility to the reviews and feedback provided by participants in the metaverse and help the tourists build a better-informed destination choice. Using predictive analytics and personalized recommendations, travel itinerary or planning of journey can also be done both virtually and physically [52].

Ubiquity of devices—Although right now metaverse can only be accessed through specially designed equipments such as AR/VR headsets, haptic suits, arm wear, digital textile products, research is focusing on development of technologies equipping smart devices such as our phones capable of delivering this beyond real experience. However, this would require the devices to have extremely long battery life, 5G/6G enabled, lots of sensors. But if this ubiquity is achieved such that experiencing the metaverse is just a touch away and using the common handheld devices, it would soon become the new reality [1].

6.2 *Inhibitors of Blockchain Based Tourism Metaverse*

Cost and equipment—Researchers assess in their research work how workload perception is affected by information overload created by AR and VR technologies. Their findings suggest that the resources and cost of operating XR-mediated realities are different and higher than physical reality. Besides all these technologies are resource exhaustive and cost intensive. Right now majority of the firms in this space are in the investment stage and believe that it will not be before a decade that these metaverse products reap any profits or revenues for the investments. This is a major inhibitor for different industrial sectors as well who will not be willing to innovate in this area unless cost goes down [53].

Consumer hardware—Just like Lee and others [34] outline that various technological gadgets are required which are exhaustive on computational resources to exist as a digital entity in metaverse, this is also an inhibitor. For example, digital textile material, AR headsets, haptic suits, arms equipped with sensors are a few hardware requirements from the consumer end to experience this parallel reality. These are not only costly but also power exhaustive while also posing health constraints as discussed ahead. It would be exhaustive for consumers to carry and store numerous devices required to enable human computer interaction in the metaverse, which will definitely inhibit the tourist experience.

Ethical issues emerge from unauthorized use or fact manipulation. Since the metaverse is purely digital and the data is collected and controlled by a third party, it may be put to any use. Besides, personalized recommendations restrict the view and exposure of the users inducing bias or microscopic thought process which may lead to distorted perception of real world. This can lead to riots as well. Also, some places might be restricted to access, but 3D models may enable virtual experience which may translate to unethical access in real world and damage to property such as through organization of terror attacks [54].

Privacy issues arise because all stakeholders or participants of blockchain based metaverse have access to the distributed ledger and other information details of all users across the network. Assume that a user trades his personal data in exchange for a token, but how the one gaining data utilizes the personal data is questionable and poses significant privacy risks [55].

Nausea and other bodily reactions—Mystakidis [1] notes that while using AR headsets or body suits, users may be distracted from real world to such an extent that it may lead to accidents. Besides this, continuous use of these technologies can reportedly cause physical well-being issues such as experiencing nausea and also psychological problems due to information overload enhanced multi-fold by metaverse which is purely digital networking. VR technologies also have been associated with motion sickness, fatigue, dizziness which limit the exposure time of users to these technologies. This is highly important in tourism sector as user seeks to spend considerable time traveling a tourist spot, but the technologies in the present state do not allow spending a longer time span.

Human physical connect—2D media such as social networking sites have proven to be very addictive and promoting mental isolation and emotional disconnect. It is a major concern that when experiences in metaverse are going to be immersive and real world-like, it may lead to manifold increase in addiction, social isolation, ultimately leading to neglect of body and social circle. This may also lead to increase in toxic behavior like bullying, aggressions, grieving, and anxiety to name a few [56]. Since the experiences will be recreation of reality and targeted at offering parallel experience to real world, violent scenes may induce real trauma and play with the psychology of the people. Tourism is one sector which requires actual physical connect and till the time advancements in multisensory perceptions do not mimic the empathetic physical spatial to the finest extent potential, this will continue to serve as a major inhibitor for leisure travel.

Accuracy and granularity of 3D models—AR/VR is limited by narrow field of view (FOV) which limits the user experience, and task performance. Besides, the user will experience only what has been inculcated in the design of virtual space, which may not match with user expectations. 360-degree photography already exists, but the limitation is still the same that if the photograph skips some aspect of the destination which majority of users are really interested in, it will limit the derivation of satisfaction from the same [57].

7 Conclusion

Although experts project that looking at current state of metaverse technologies, it is too early to predict any clear leader, they also assert at the same time that there will be different metaverse catering to different needs of the society, for example, even in tourism for different tourist categories, metaverses can be emerged. However, if one examines the seven rules of metaverse, the rules begin with existence of only one metaverse, which is accessible by all, efficiently networked and collectively controlled. Looking at the facilitators and inhibitors, the future of extended and augmented virtual tourism looks promising.

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MRI and SPECT Brain Image Analysis Using Image Fusion

V. Kalpana, V. Vijaya Kishore, and R. V. S. Satyanarayana

Abstract The undecimated discrete wavelet transform domain is used for fusing (UDWT). Medical image fusion aims in the direction of coalescing several images out of multifarious sources as an individual representation that may be utilized for better diagnosis. The discrete wavelet transform is used in the majority of state-of-the-art picture fusion algorithms (DWT). When DWT is employed for picture fusion, there is a small blurring. This blurring is greatly decreased when utilizing UDWT. In UDWT, there is no decimation step. As a result, wavelet coefficients for each site are generated, allowing for better recognition of dominating characteristics. It is a multi-resolution decomposition that is not orthogonal. The maximum selection rule employed en routes merging of low-frequency sub-bands in the UDWT domain, whereas modified spatial selection rule is utilized to combine high-frequency sub-bands. In this project, the recommended approach is implemented using the Python tool. The proposed method's superiority is displayed and justified. Various quality measures, include peak signal-to-noise ratio (PSNR), entropy, correlation coefficient, global consistency error (GCE) and mean square error (MSE), are employed to evaluate the performance of fused images.

Keywords Image fusion · Undecimated discrete wavelet transform · Correlation coefficient · Global consistency error · Mean square error · Peak signal-to-noise ratio · Entropy first keyword · Second keyword · Third keyword

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1 Introduction

1.1 Image Fusion

Image fusion is a technique for integrating several input photos as a keen individual output entity with the aim of brief overview of the scenario than input images alone. Image fusion used to improve image quality while also reducing unpredictability and redundancy, making it easier to diagnose medical concerns. Multi-sensor image fusion, in the computerized version, is the process of fusing significant features of manifold descriptions information as a solitary picture. With the comparison towards input image, fused illustrations will have more data. Image fusion's main objective is to produce an image that is more detailed for human perception and more adaptable for further vision processing.

1.2 Fusion Categories

Different fusion categories are shown in Fig. 1. Depending on the type of images to be merged, fusion may be divided into the following categories.

(a) Multi-view fusion
(b) Multi-temporal fusion
(c) Multi-focus fusion
(d) Multi-modality fusion.

Multi-view Fusion: The targeted images have the same sensory modality and are sent simultaneously, the same moment, yet under different conditions. The fusion principal aims in this category, the method is to group all of the relevant information into separate categories. In the merged picture, there are a number of different factors to consider.

Multi-temporal Fusion: The main objective of the fusion procedure at any instance will spot the dissimilarities of the image over time by subtracting two or more photos. Although the photographs that need combination be from identical processes and affianced during distinct phases.

Multi-focus Fusion: The basic target in this method produces amalgamated picture by integrating as much details from the various modalities as is feasible while preserving the overall meaning of the images. The pictures for synthesis are collected from various techniques.

Multi-modality Fusion: Multi-modality fusion is the process of integrating many images gathered by screening techniques to produce a composite image with a wealth of information that may be applied in medical settings.

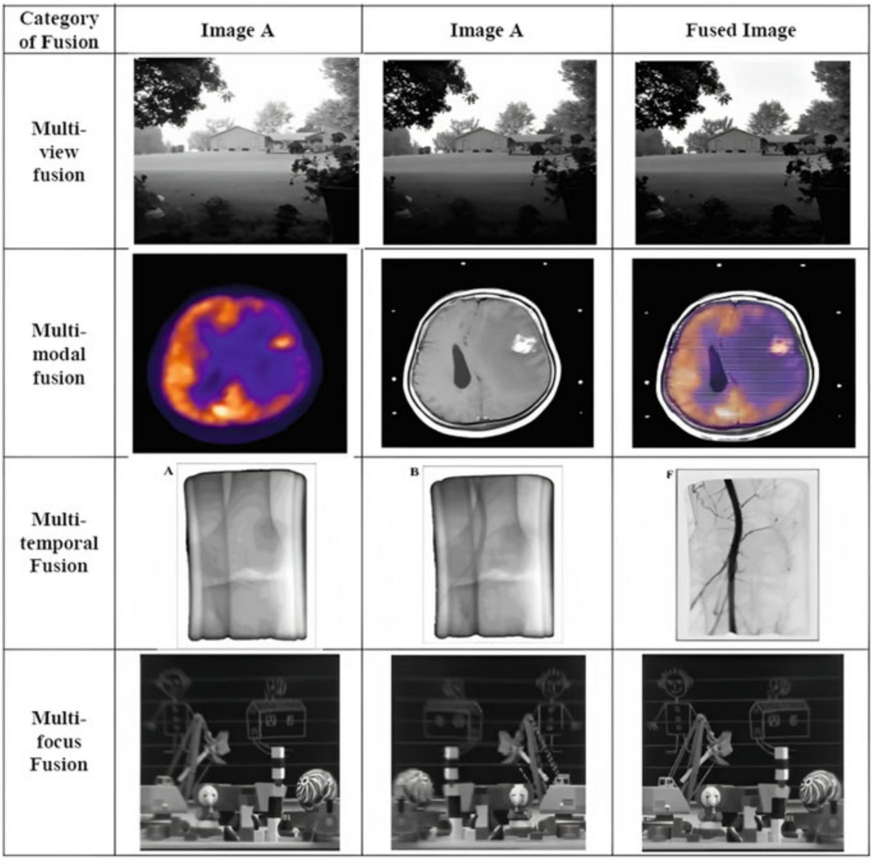


Fig. 1 Different fusion categories

1.3 Medical Images Used for Fusion

1.3.1 Magnetic Resonance Imaging (MRI)

The structure and function of the body are examined utilizing non-invasive imaging equipment, which does not expose users to potentially harmful ionizing radiation. It is characteristically drawn for analysing health disorders and to track the succession and also to categorize unusual and unique developments. Using strong magnets and its powerful field effect, magnetic resonance imaging (MRI) causes the body's protons to align with the magnetic field. Protons get initiated and start to swirl with a balance while the RF energy is throbbed on a patient. The formed pressure due to the proton realignment with magnetic field strength triggers the MRI sensors to distinguish the fluctuations even after the RF field switch over. The amount of liberated force and proton position to a different restoration varies depending on the surroundings and compound composition based on molecular reactions. Based on magnetic characteristics, physicians may discriminate various tissue kinds.

Soft tissues and other non-bony bodily components are particularly well adapted to MRI scanning. MRI scanning is different to computed tomography since it does not use X-rays, which produce dangerous ionizing radiation. Because MRI does not utilize X-rays, it can see the muscles, ligaments and tendons as well as the brain, spinal cord and nerves far more clearly than traditional CT and X-rays. MRI is commonly utilized to image shoulder disorders and knee. MRI can discriminate among grey and white matter in the brain and also identifies aneurysms and other abnormalities. While repeated illustrations are needed in support of conclusion or treatment, especially in the brain, MRI is the imaging modality of choice as it does not apply X-rays or even former types of emission.

1.3.2 Single Photon Emission Computed Tomography (SPECT)

SPECT is a sort of fusion (nuclear) imaging with the aim of utilizing radioactive compounds (fluorine-18, technetium-99, iodine-123, xenon-133 and thallium-201) and specific gamma cameras to examine how well inside organs are operating. The procedure makes a 3D scan of the "insides" from various angles and offers information on how different areas of the body operate, allowing any issues to be readily identified.

A nuclear imaging examination called a SPECT coalesce computed tomography (CT) with an irradiated tracery. Treatment centre will be able to monitor in what way blood reaches tissues and body parts using the tracery. Tracer is infused keenly on the bloodstream prior to the SPECT examination. The radio-tagged tracer releases gamma emission that a CT machine can sense. The gamma ray's info is congregated by the computer and flaunted on the CT cavilling segments. A three-dimensional representation of the patient's brain is produced by reassembling these cross-sections. Some of the radioisotopes used in SPECT include fluorine-18, technetium-99, iodine-123, xenon-133 and thallium-201. As the listed radioactive natural element forms pass through the patient's body, the scanner will detect them. The type of tracer used is dictated by the doctor's objectives. In order to assess how the tumour metabolizes radio-labelled glucose, or fluorodeoxy glucose (FDG), during a tumour examination (Figs. 2 and 3).

2 Literature Review

A technique called "image fusion" combines many medical imaging process and procedures, counting X-rays, magnetic resonance imaging (MRI), positron emission tomography (PET), magnetic resonance angiography (MRA), computed tomography (CT) and single photon emission computed tomography (SPECT) is becoming increasingly important in modern medicine and health care. Over the last ten years,

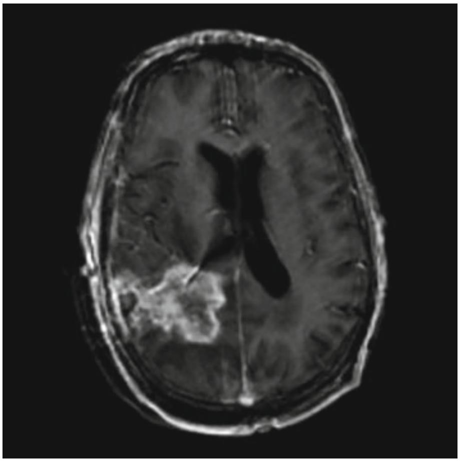


Fig. 2 MRI image of brain

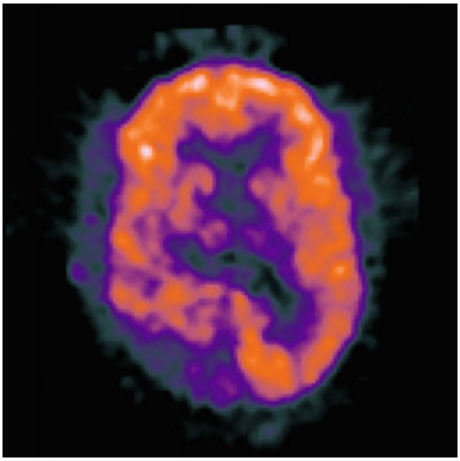


Fig. 3 SPECT image of brain

medical data processing and analysis research has exploded. Since the MR image may offer information on both healthy and sick soft tissue, the SPECT image can only provide information on blood flow to tissues and organs and cannot identify biological changes. Combining SPECT and MRI provides a wealth of information that is useful for diagnosis. The development of new algorithms in image processing has offered substantial impetus for new techniques obtaining information from images in depth. The general goal of computer-assisted diagnostic systems is to allow for early detection, illness monitoring and improved treatment. Medical pictures from several modalities give more data, which is combined for improved analysis. The fusion of multimodal medical pictures creates a single composite image that may be relied on for better analysis and diagnosis.

In medical image processing, the most important research issue is to extract maximum information by fusing multimodal images. In extracting the detail information from images, the advancement of developing new algorithms has provided major impetus for new algorithms in signal and image processing [1]. Pixel averaging [2], gradient pyramid [3], Laplacian pyramid [4], contrast pyramid [5], ratio-of-low-pass pyramid [6], morphological pyramid [7], ripplet transform [8] and the DWT method [9–11] are some of the existing research methodologies. The fusion of medical images in many combinations assists in utilizing medical image fusion for medicinal diagnostics and examination. There is a tremendous progress in the fields of deep learning, artificial intelligence and bio-inspired optimization techniques. Effective utilization of these techniques can be used to further improve the efficiency of image fusion algorithms [12]. A thorough survey of medical image fusion techniques is referred in [13]. The application of wavelet transforms like discrete wavelet transform (DWT), double density discrete wavelet transforms (DDDWT) are compared [14]. The time varying characteristics of the 1D signal are extracted by wavelet transform [15].

Using pixel-by-pixel average of two photos is the simplest method of picture fusion, but it has drawbacks like less contrast. All pyramid-based decomposition techniques do not account for spatial orientation selectivity, which causes blocking effects and unattractive edges in the fused picture. The other method of multiresolution fusion technique is the wavelet-based method which uses discrete wavelet transform (DWT) in the fusion where DWT preserves different frequency information in stable form and allows good localization in time and frequency domain. The main disadvantage of DWT is that it lacks shift invariance, which results in a significant change in the wavelet coefficients of the picture when the input image is changed slightly. In medical imaging analysis, it is important to know and preserve the exact location of this information and it is happened with a wavelet called undecimated discrete wavelet transform [16]. In medical images, acquiring the most information out of multimodal images by fusing them together is the most important area of research in medical image processing. Pixel averaging, gradient pyramid, contrast pyramid, Laplacian pyramid, morphological pyramid, ripplet transform, ratio-of-low-pass pyramid and DWT technique are some of the existing research methodologies. Using pixel-by-pixel average of two photos is the simplest method of picture fusion, but it has drawbacks like less contrast. All pyramid-based decomposition techniques do not account for spatial orientation selectivity, which causes blocking effects and unattractive edges in the fused picture. Discrete wavelet transform (DWT) is used in the wavelet-based approach of multi-resolution fusion to keep varied frequency information steadily. The main disadvantage of DWT is that it lacks shift invariance, which results in a significant change in the wavelet coefficients of the picture when the input image is changed slightly.

3 Proposed Method

The proposed technique fuses MRI and SPECT images to provide a fused image that has more information than the individual modality image (MRI and SPECT images). Both MRI and SPECT images are fused using image fusion. Image fusion is a method for integrating many input photos as an extracted individual representation which portrays the objects except all the other key images could do on their own. Image fusion is used to improve image quality while also reducing unpredictability and redundancy, making it easier to diagnose medical concerns. This section introduces a novel method for combining components from high-frequency sub-bands (HFSs) and low-frequency sub-bands (LFSs) into a single medical image. Major goal of this research is to fuse medical photos by considering the features of the images.

3.1 Undecimated Discrete Wavelet Transform

Mallat's method [17], known as the discrete wavelet transform (DWT), is supported by orthogonal decomposition of the picture to a wavelet basis directed to remove duplication of data in the pyramid at every plane of declaration. As a result, undecimated discrete wavelet transform (UDWT) avoids picture decimation, which is used in applications of image processing including texture classification [18], denoising [19–21], pattern recognition and fusion. The "a trous" (with holes) method may be used to discretize UDWT [22].

Some interesting properties of UDWT are: The wavelet decomposition's assessment may be tracked from level to level. At each level of decomposition, a separate wavelet coefficient plane is generated. Each location's wavelet coefficients are generated, allowing for a more accurate detection of the dominating feature. It is simple to implement. A non-orthogonal multi-resolution decomposition known as the "a trous" wavelet transform divides information into low-frequency components and high-frequency components (detail coefficients). In this separation, a low-pass filter is associated with the scale function is employed to generate the following series of scale-based signal approximations:

$$a_j(k) = \sum_n h(n) a_{j-1}(k + n2^{j-1}), \quad j = 1, \ldots, N \tag{1}$$

where j is the scale index and the N number of scales and $a_0(k)$ is the original discrete signal $s(k)$.

The following filtering process is applied to a high-pass filter connected to the wavelet function to produce the wavelet coefficients (2).

$$w_j(k) = \sum_n g(n) a_{j-1}(k + n2^{j-1}) \tag{2}$$

Two dual filters are used to complete flawless data reconstruction, and they must meet the quadrature mirror filter requirement.

$$\sum_n hr(n)h(l-n) + gr(n)g(l-n) = \delta(l) \tag{3}$$

where $\delta(l)$ is the Dirac function. Considering $hr(n)$ and $gr(n)$ filters as equal to Dirac function ($hr(n) = gr(n) = \delta(n)$). $g(n)$ is deduced from (3) as

$$g(n) = \delta(n) - h(n) \tag{4}$$

As a result, the wavelet coefficients are generated by simply comparing the differences of two consecutive approximations (5).

$$w_j(k) = a_{j-1}(k) - a_j(k) \tag{5}$$

This method generates the sequence via successive convolutions with a filter created from an auxiliary function called the scaling function (6). The following are the creations of the series of approximations:

$$A_1 = F(I), A_2 = F(A_1), A_3 = F(A_2) \tag{6}$$

where F represents a scale function. It is common practice to characterize the scale function using a $B3$ cubic spline function, which causes a convolution with a mask of (7) [20] 5×5

$$\frac{1}{256}\begin{bmatrix} 1 & 4 & 6 & 4 & 1 \\ 4 & 16 & 24 & 16 & 4 \\ 6 & 24 & 36 & 24 & 6 \\ 4 & 16 & 24 & 16 & 4 \\ 1 & 4 & 6 & 4 & 1 \end{bmatrix} \tag{7}$$

As previously stated, the difference between two consecutive approximations A_{j-1} and A_j is used to compute the wavelet planes.

$$d_j = A_{j-1} - A, \quad j = 1, \ldots, n \tag{8}$$

where $A_0 = I$, the reconstruction Formula (9) is

$$I = \sum_{j=1}^{J} d_j + A_J \tag{9}$$

3.2 Low-Frequency Sub-bands Fusing Using Maximum Selection Rule

The LFSs coefficients fused utilizing maximum selection technique. The frequency coefficients with the highest absolute value are chosen as fused coefficients using this fusion rule which is shown in Eq. (10).

$$\mathrm{LFS}_F = \begin{cases} \mathrm{LFS}_i^X & \text{if } \mathrm{LFS}_i^X \geq \mathrm{LFS}_i^Y \\ \mathrm{LFS}_i^Y & \text{otherwise} \end{cases} \tag{10}$$

where X image and Y image are two inputs and F represents the fused coefficient image. LFSF is the fused LFS image, $\mathrm{LFS}_i{}^x$ and $\mathrm{LFS}_i{}^y$ are the low-frequency sub-bands of ith region of LFS image for X and Y images, respectively.

3.3 High-Frequency Sub-bands Fusing Using Modified Spatial Frequency

The Eskicioglu et al. [23] suggested spatial frequency (SF) is determined using row and column frequency. The greater the SF [24, 25], the more detailed distinctions and textural changes are seen, reflecting the overall activity level of a picture. The suggested image fusion approach makes use of a modified version of SF. Three frequencies make up modified spatial frequency (MSF): diagonal frequency (DF), column frequency (CF) and row frequency (RF). The MSF is specified for a $m \times n$ image F as

$$\mathrm{MSF} = \sqrt{(\mathrm{RF})^2 + (\mathrm{CF})^2 + (\mathrm{DF})^2} \tag{11}$$

where

$$\mathrm{RF} = \sqrt{\frac{1}{mn}\sum_{i=1}^{m}\sum_{j=2}^{n}[F(i,j) - F(i,j-1)]^2} \tag{12}$$

$$\mathrm{CF} = \sqrt{\frac{1}{mn}\sum_{i=2}^{m}\sum_{j=1}^{n}[F(i,j) - F(i-1,j)]^2} \tag{13}$$

$$\mathrm{DF} = P + Q \tag{14}$$

where

$$P = \sqrt{\frac{1}{mn}\sum_{i=2}^{m}\sum_{j=1}^{n}[F(i, j) - F(i-1, j-1)]^2} \tag{15}$$

$$Q = \sqrt{\frac{1}{mn}\sum_{i=2}^{m}\sum_{j=2}^{n}[F(i-1, j) - F(i, j-1)]^2} \tag{16}$$

3.4 Algorithm

The suggested medical image fusion method's schematic diagram is given away in Fig. 4. The subsequent order is used to complete the fusion process: The source medical images X and image Y separated using UDWT at level 1 to obtain $\mathrm{LFS_s}$ and HFSs. The LFSs coefficients are fused to get fused LFS by means of the maximum assortment imperatives as explained in Sect. 3.2. The coefficients of HFSs of two source images are segmented into several regions. The modified spatial frequency of the appropriate areas of the segmented HFSs of the two input images is calculated as explained in Sect. 3.3. To determine which source picture should be utilized to create the fused HFS image, make a comparison between the changed spatial frequency of the respective areas of input images.

$$\mathrm{HFS}_F = \begin{cases} \mathrm{HFS}_i^X \ \text{if} \ \mathrm{MSF}_i^X > \mathrm{MSF}_i^Y \\ \mathrm{HFS}_i^Y \ \text{otherwise} \end{cases} \tag{17}$$

where HFS_F is the fused HFS image, $\mathrm{MSF}_i{}^X$ and $\mathrm{MSF}_i{}^Y$ are the modified spatial frequencies of the ith region of HFS image for X and Y images, correspondingly. Final fused medical likeness is formed by doing converse undecimated discrete wavelet transform on the fused LFSs and HFSs.

3.5 Evaluation Metrics [26]

PSNR

The (PSNR) peak signal-to-noise ratio [12, 27] refers to the relation among the highest attainable control of an image and the maximum influence of degrading noise to facilitate the quality representation of the picture. It is essential to make comparisons of an ideal, clean image with the greatest amount of potential power in order to determine its PSNR. The efficiency of compressors, filters and other equipment is frequently assessed using PSNR. The efficiency of the compression or filtering strategy increases with the PSNR value.

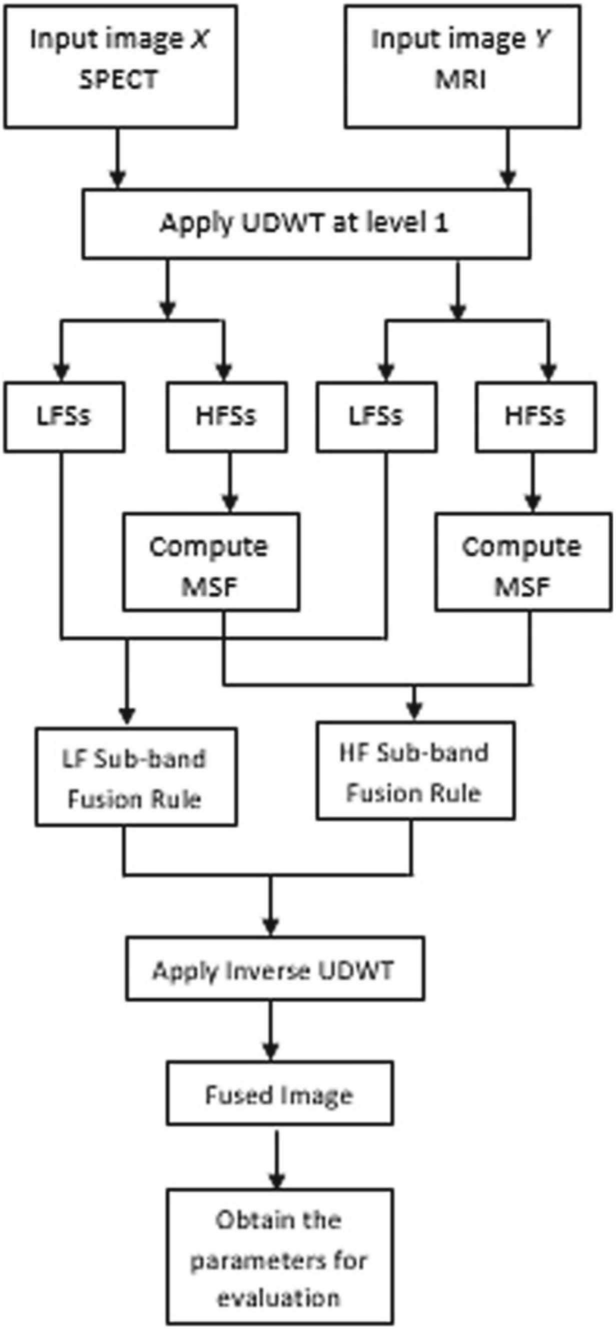


Fig. 4 Algorithm representation diagram of image fusion process

$$\mathrm{PSNR} = 10\log_{10}\left[\frac{L^2}{\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(O(i,j)-D(i,j))^2}\right] \quad (18)$$

The highest possible intensity levels are represented by L (least intensity level is assumed to be 0). Here, O denotes the original image's data. Where the matrix data of the degraded image represented by D. M signifies number of pixels in a row, and image's index for that row is denoted by i. N stands for number of pixel columns in the picture, whereas the index of that column is denoted by j.

Mean Square Error (MSE)

The image quality is measured using the MSE [23] method. The quality and RMSE (root mean squared error) are inversely related. The RMSE number decreases as the eminence of the amalgamated representation increases. It is delineated as follows:

$$\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(O(i,j)-D(i,j))^2 \quad (19)$$

where O denotes the original image's matrix data. Where D symbolizes the matrix information of the corrupted illustration. M describes the number of pixels in a row and i denotes image's index for that row. N denotes the number of pixel columns in picture, whereas the index of that column is denoted by j.

Entropy (EN)

Entropy is a statistical computation [23] that describes the order in the image. It is a metric indicating how much information is included in a picture. The amount of information included in the fused picture determines the entropy value. Because it tracks how many times a picture has changed, the entropy of an image reveals its degree of unpredictability. When coding pictures, using the entropy is advantageous since it reduces the average coding length in a pixel to a fraction of prior values, allowing operators to operate without affecting the image's data quality. As a result, it is linked to the quantity of data in the image.

$$H(X) = H(p_1, \ldots, p_n) = -\sum_{i=0}^{n} p_i \log_2 p_i \quad (20)$$

Global Consistency Error (GCE) [20]

GCE is a test that determines how well a segmentation algorithm resembles human behaviour. They are made such that when comparing two separate segmentations, the error value should be very tiny, if one is a refinement of the other. They define refinement as the consistency of segmentations with one segmentation having a higher level of detail than the other. The reason is because, in general, humans do not construct similar segmentations of the same sight. The range of GCE measurements is [0, 1], with values closer to zero indicating better segmentation.

Correlation Coefficient [19, 27, 28]

The correlation coefficient (r) is a summary metric that expresses the degree to which two images are statistically related. The correlation coefficient is adjusted to be between 0 and 1 at all times. When the correlation coefficient is close to 0, it suggests there is minimal association between the variables, and the further away from 0 or closer to 1, the stronger the relationship between the two images. Correlation coefficient 0: No correlation. The images do not have a relationship with each other. Correlation coefficient 1: Perfect correlation.

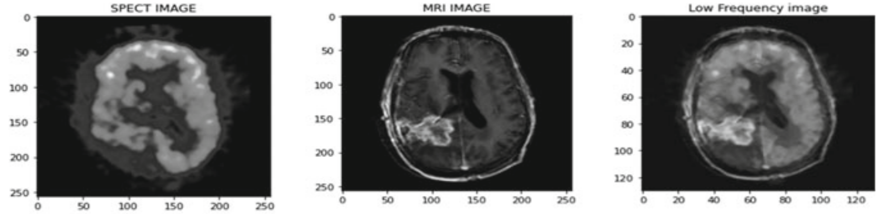
4 Results and Discussions

Image fusion is a technique by fusing several input images to form one output image that can represent an image with greater accuracy than the majority of the other input photos alone. By enhancing picture quality and lowering uncertainty and redundancy, image fusion is a technology that makes it simpler to identify medical problems. Figure 5a SPECT image provides information about how brain is functioning but no soft tissues information, while MRI image as shown in Fig. 5b provides clear soft tissues information but no bone information and brain functioning. Hence, when the two images are fused both brain functioning and soft tissues information can be seen in the output fused image Fig. 5e.

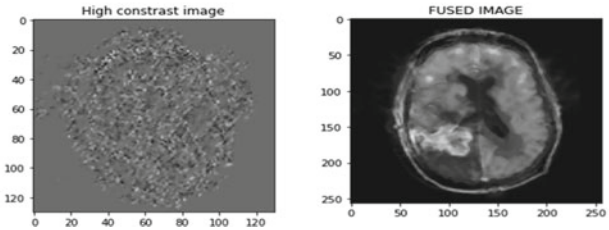
Maximum selection rule is applied to combine the low-frequency sub-bands (LFSs) coefficients of two input images, and the output image of low-frequency sub-bands coefficient is shown in Fig. 5c. Modified spatial frequency is employed to coalesce the HFSs high-frequency sub-bands of two input descriptions to give image shown in Fig. 5d. Final fused medical image shown in Fig. 5e is produced by performing inverse undecimated discrete wavelet transform on the fused LFSs and HFSs. Parameters computed between fused image shown in Fig. 5e with respect to SPECT image shown in Fig. 5a and MRI image shown in Fig. 5b are mean square error (MSE), peak signal-to-noise ratio (PSNR), entropy, global consistency error (GCE) and correlation coefficient. These parameter values were presented in Tables 1 and 2, respectively.

5 Conclusions

For merging medical images, an approach based on UDWT and changed spatial frequency was implemented in this paper. Medical image fusion is significant in many clinical applications because it can offer more accurate information than a single picture. Some of the drawbacks of pixel-level fusion techniques, such as fading



(a) SPECT Image (b) MRI Image (c) Low Frequency Sub band Fused Image



(d) High Frequency Sub band Fused Image (e) Fused Image

Fig. 5 Output images of set 1 image

Table 1 Output image evaluation metrics with respect to SPECT image of set 1

Method	Image type	MSE	PSNR	ENTROPY	GCE	Correlation coefficient
Proposed method	MRI-SPECT	476.2509	21.3524	10.7896	0.1433	0.9096

Table.2. Output image evaluation metrics with respect to SPECT image of set 2

Method	Image type	MSE	PSNR	ENTROPY	GCE	Correlation coefficient
Proposed method	MRI-SPECT	512.3542	21.0351	10.7896	0.1262	0.9096

effects eliminated. This study demonstrates how to use UDWT for medical picture fusion in three phases. UDWT decomposes the medical pictures to be fused into sub-images in the first step. In the second step, the low-frequency band coefficients fused utilizing utmost assortment criterion, where the high-frequency band coefficients are amalgamated by means of modified spatial frequency. In the last stage, the composite coefficients are employed to generate the fused picture using the inverse UDWT. By merging LFSs with HFSs, the suggested technique can improve diagnostic decisions. It contains details of the soft and hard tissues. The suggested approach is able to present soft and hard tissues in fusion image and is closer to tissues in MRI and

SPECT images. According to the evaluation metrics GCE is least, the MSE is the smallest, and the correlation coefficient is the closest to one.

6 Future Scope

Highly rated medical institutes in India, such as AIIMS Delhi, PGIMER Chandigarh and a number of other private and government medical colleges, utilize expensive medical image fusion tools purchased from outside. As a result, these tools are becoming extremely unaffordable for small clinics or hospitals, particularly in rural regions. As a result, there is a critical need for low-cost indigenous equipment in these locations to supplement the demand for this high-priced equipment. Furthermore, the design of these computer-assisted instruments may make this technology cheap to those in rural regions of the country.

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Discrete Wavelet Transform-Based Image Fusion in Remote Sensing

Richa, Karamjit Kaur, Priti Singh, and Swati Juneja

Abstract Image fusion is the process of gathering all information from different multiple images and their inclusion into few new images. These single images are more informative than other single source images. In this paper, we have determined the various systematic literature reviews on the basis of author's review and conclusion analysis. The images fusions with wavelet transform state that first input images to be fused decomposition by forward wavelet transform images. The wavelet transform decomposes images into low–high frequency sub-band images. The performances of two more images of image fusion on wavelet transform are briefly described for comparison. To evaluate the fusion result, matrix-based mutual information MI is presented for measuring fusion effect.

Keywords Image fusion · Image registration · Multiple-source imagery

1 Introduction

Picture mix is a synergistic instrument that serves to unite distinctive source imagery. The musing is to get two photos of a comparative article under two unmistakable acquisition conditions, and to arrange these two pictures to get a more exact arrive at assessment of sign levels. Picture blend of different sensors in a fantasy system could through and through diminish human/machine screw up in area and affirmation of articles by virtue of the natural overabundance and extended consideration disillusionment [1].

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The essential mark of image mix (IF) is gathering necessary, similarly as peaceful monotonous information from various pictures to make a merged picture, to giving more complete and exact portrayal. In the space of clinical imaging, joining of different technique pictures of same scene gives such endless advantages and it may very well be a blend of picture taken at different objective and power and by different systems helps specialist/radiologists to easily separate or recognize the features or anomalies that may not be consistently clear in single picture. Another advantage of picture mix is that it diminishes the limit cost by taking care of simply the single merged picture, as opposed to the different philosophy pictures. This paper presents execution of a bit of the image mix techniques using preliminary data. The image blends strategies used in wavelet change.

2 Image Fusion Methods

Picture mix is a synergistic instrument that serves to combine different source imagery. This assessment is orchestrated to make picture mix techniques for pictures gained with single and different modalities. There are every now and again a couple of issues that should be overseen before the blend can be performed [2]. A huge segment of the photos from various source are slanted. Picture enlistment is routinely used as a groundwork advance in picture mix. In this paper, image fusion graphical UI is made and execution occasions of mix methods in a part of the applications are presented. The mix results show that the mix reduces the obscurity and improves the constancy of flaw distinguishing proof in both visual and emotional appraisals. The results moreover show that image mix gives an effective system to engage assessment and examination of such data [3].

There are various strategies that have been created to perform picture combination [4]. Some notable picture combination strategies are recorded underneath:

- Power tone immersion (IHS) change-based mix.
- Principal part assessment (PCA)-based blend.
- Multi scale change-based blend.
- High-pass detaching procedure.
- Pyramid strategy.
- Wavelet transform.

3 Wavelet Transform

The wavelet changes of a picture expecting multiple recurrent channels and the source picture are first multi-wavelet decay, the measure of sub-picture and the change space, and fuse formation, resulting in the combined all-in-all joined picture created by the change. Of late, wavelet change has pulled in cognizant idea, it not just in math has laid out another branch, is ideal blend of utilitarian assessment, Fourier appraisal, mathematical evaluation, yet moreover in arranging applications, like sign dealing with, picture preparing, plan assertion, talk attestation and blend correspondingly as different nonlinear science, have a colossal impact [5].

Wavelet evaluation is another breakthrough in time-scale evaluation and multiresolution evaluation, with staggering restricted highlights in both the time and area; yet additionally as a result of the slowly fine reality step on the high rehash, it can zero in on appraisal of the discretionary subtleties like, this brand name is centering wavelet change the properties of wavelet change, it was hailed as a numerical enhancing point of convergence [6]. The wavelet debilitating of the picture is a multi-scale, multi-target disintegrating of the picture, because wavelet is non-excess, the picture information after wavelet decay by complete won't expand; simultaneously wavelet breaking down has heading and using this brand name may for the trademark eye to various direction of the unimaginable recurring areas with various goal of the visual qualities; the joined picture has improved impact in picture mix.

4 Image Fusion Algorithm

Various computations have been made for picture blend to improve the trust worthiness and the show of testing. Picture blend methodology can be disengaged into two social affairs: spatial region mix procedure and transform space mix. Spatial region blend methodology clearly oversees pixels of data pictures.

Wavelet based Methods—Wavelet methodologies are also a way to deal with separate pictures into confined scale unequivocal signs. Wavelet changes are immediate and square vital changes whose premise limits are called wavelets. Discrete Wavelet Transform—Once the imagery has been broken down by wavelet modification, a composite multi-scale portrayal is created using a decision of the striking wavelet coefficients in the typical wavelet-based mix [7]. The choice can be made between a region-based most significant energy or a restriction of incomparable qualities. On the composite wavelet representation, the last stage is an opposite discrete wavelet change.

- This design is a MATLAB image fusion sensor that uses function-based procedures and code to evaluate matrix plot results.
- First, we create function user-defined images fusion.
- Various image-related process.
- Matrix-plotted graph generated.
- Sample good-man interface.
- Save operation for images' fusion.

Comparative Study Focuses on Comparing

(a) Standard deviation (σ)
(b) Entropy (H)
(c) Spatial frequency (SF)

(d) Fusion mutual information (FMI)
(e) Fusion quality index (FQI)
(f) Fusion similarity metric (FSM), etc.

Image Fusion Parameters with Reference Image

(a) Peak signal to noise Ratio
(b) Mutual Information
(c) Correlation Coefficient
(d) Structural similarity index measure (SSIM)
(e) Universal quality index (UQI)

In view of three boundaries to be specific edge strength, combination factor and combination evenness. The entropy and combination quality list share the way that they can be viably utilized for intertwining multi-see pictures [8].

5 Related Work

A precise writing survey (SLR) distinguishes, chooses, and fundamentally evaluates research to address an obviously formed inquiry that image blend is a broadly discussed subject for improving the information substance of pictures. The essential objective of picture mix computation is to join information from various photos of a scene. The eventual outcome of picture blend is another image which is more workable for human and machine insight for extra picture planning errands like division, feature extraction, and article affirmation. This paper explores the opportunity of using the specific wavelet approach in picture blend and de-noising. These estimations are considered on cutting edge amplifying instrument pictures [9]. The procedure uses a general change-based picture enlistment followed by wavelet mix. By then, the least squares support vector machine-based repeat band decision for picture de-noising can be combined to diminish the arti-real factors [10]. The spaces are to intensify objective, decrease arti-real factors, and darken the last super picture. To accelerate the entire errands, it is proposed to offload the image taking care of estimations to a gear stage as such the presentation can be improved. FPGAs give an astounding stage in executing steady picture dealing with applications, since natural parallelism of the designing can be abused unequivocally. Picture taking care of endeavors executed on FPGAs can be up to 2 critical degrees faster than a similar application on a comprehensively valuable PC.

In [11] image blend is the headway of amalgamating in any event two images of essential brand name to outline a lone picture which secures all of the crucial features of interesting picture. It consists of various fusion format of images which is converted into a single image blend with which wavelet change is inspected with its advantages and blames.

In [12] this paper talks about the picture mix subject to wavelet change and assessment of picture blend significant head, technique, and benefit. The fundamental goal of picture mix is to harden data from different pictures of an equivalent scene dependent upon a specific assessment; the postponed outcome of picture blend is another outcome which can be more legitimate for human and machine. This current day's picture mix progression has been generally applied in different fields including far off recognizing, automata certification, PC vision, and clinical picture managing. This report plans and fathoms the procedure for picture calculation which depends upon wavelet change.

According to [13] picture blend construes consolidating a totally clear picture with a ton of photographs of a similar scene and under relative imaging conditions with various center communities. To get a reasonable picture that contains all important things around there, the multi-center picture mix calculation is proposed dependent upon wavelet change. First thing, the multi-center pictures were disintegrated by wavelet change. Similarly, the wavelet coefficients of the approximant and detail sub-pictures are consolidated freely dependent upon the mix rule. At last, the interweaved picture was gotten by utilizing the opposite wavelet change. Among them, for the low-rehash and high-rehash coefficients, we present a mix rule subject to the weighted degrees and the weighted point with the improved edge exposure administrator. The fundamental results address that the proposed calculation is astounding for holding the arranged pictures.

The general need of an image merging measure is to save all considerable and important information from the source pictures, while at the same time it should not present any bowing in resultant interlaced picture. Execution measures are used significantly for measuring the expected benefits of blend and are besides used to differentiate the results obtained and different estimations.

Standard deviation: It portrays the degree of dissipating between the value of each pixel and the ordinary worth of picture. When in doubt, the more conspicuous the standard deviation regard, the more dispersive the transport of overall greyscale will be, the more imperative picture contrast it will present.

Entropy: The acclaimed creator of information theory, Shannon, suggested that the possibility of entropy can address how much information is contained in signals. It is in a like manner comprehensively used to show the ordinary proportion of information of pictures in picture-getting ready field. For an image, grayscale worth of every pixel can be considered as shared self-sufficient.

In [14] research in the field of picture combination has made extraordinary accomplishments, picture combination technique in the use of different sorts, identifies with the field is increasingly more generally and profoundly. However, all in all, the examination on picture combination innovation isn't yet full grown, and there are numerous issues and urgencies due to an assortment of picture kinds of variety and distinction; in combination, calculation plan of picture needs to consider the genuine picture-registering velocity and capacity limit, as how to plan the picture arrangement of pictures of explicit plan of a continuous, dependable, steady, commonsense combination calculation which is one of the exploration areas of interest and troubles. Partners ought to likewise attempt to run other combination calculation on MATLAB stage.

In [15] the theoretical combination of pictures is the way toward consolidating at least two pictures into a solitary picture holding significant highlights from each. Combination is a significant procedure inside numerous dissimilar fields like far off detecting, advanced mechanics, and clinical applications. Wavelet-based combination procedures have been sensibly powerful in joining perceptually significant picture highlights. Shift invariance of the wavelet change is significant in guaranteeing vigorous sub-band combination. In this manner, picture combination is presently presented.

In different applications, picture combination assumes a significant part [16]. Picture combination is only consolidating at least two pictures into a solitary picture by removing significant highlights from every one of the pictures. The combination of pictures is regularly needed to meld pictures that are caught from instrument. Complex wavelet-based combination strategies have been utilized in consolidating perceptually significant highlights. A tale picture combination method dependent on double tree complex wavelet change is introduced in this paper. Double tree CWT is an augmentation to discrete wavelet change (DWT). Our methodology depends on an inclination space strategy that jam significant neighborhood perceptual highlights which evades numerous issues, for example, ghosting, associating, and haloing.

6 Performance Matrices

Picture combination plans to blend at least two pictures to create another picture that is superior to the first ones. A picture combination framework takes as an info at least two source pictures and delivers one melded picture as a yield. Picture combination execution measures rely basically upon assessing the measure of data moved from both source pictures into the subsequent melded picture [17, 18].

The diverse picture mix limits reference picture for assessment performs and measure examination dependent on MATLAB assessment given under:

If X and Y are completely free, then they are two unpredictable variables. It employs cross entropy between joint movement XY and the best-case assignment of being completely random variables as follows**:**

$$I.(X.X) = \sum Px.y(X.Y)\log_2 \frac{p.XY(x.y)}{PX.(x).P.Y(y)} \tag{1}$$

It is symmetric and reaches 0 if X and Y are completely independent, with $p\ XY$ (x, y) 14 $p\ X(x)\ p\ Y(y)$ resulting in

$$(XY) = \sum P(XY).\log_2 \frac{P(XY).(x, y)}{PX(x).PY(y)} = 0$$

Problem with Image Fusion:

To estimate the joint information between source pictures x, y, and the fused image F, utilize the mutual information measure as follows:

$$M(XY) = I.F(X) + I.F(Y)$$
$$I.(X.X) = H.(X)$$

where $H(X)$ denotes the variable image fusion entropy $(x.y)$

$$\mathrm{NMI}(XY) = \frac{I(XY).(x, y)}{\mathrm{MAX}\, H(x).H(y)} = 0$$

where $H(X)$, and $H(Y)$ are the entropies of X and Y, respectively.

$$\mathrm{NMI}(XY) = \frac{I(XY)}{D}$$
$$M(XY) = 2\frac{[I(F.X)]}{H.(F).H(X)} + \frac{[I(F.X)]}{H.(F).H(Y)}$$

As $H(X)$ $2H(Y)$ increases, the results reveal that MI records fundamentally higher contrasts.

- Classic basic information (MI) is unequal in its treatment of the source image with the highest entropy. Three picture-blend calculations on enlisted source pictures with visual and infrared information were tested in the experiments.
- That praiseworthy shared information (MI) is uneven toward the source picture with the most raised entropy.
- The results show that MI records on a very basic level higher differences as $H(X) - H(Y)$ increases
- Results show how the misstep between using model shared information and the normalized structure increases as the differentiation between entropies of source pictures increases [19].

This design is a MATLAB image employing wavelet transform-based fusion, which can handle a wide range of images.

Specific requirements include:

- Format picture process is allowed for selection.
- Fused in different categories.
- Single images convert into one more source full.
- Images fusion in different ways (Fig. 1).

Where the entropies of X, Y, and F are $H(X)$, $H(Y)$, and $H(F)$, respectively.

Fig. 1 Image right side. Image left side

Fig. 2 Fused image

Table 1 Comparison and result analysis

Fusion rules	Entropy	Mutual information	Avg. gradient	PSNR	Running time (s)
1. Low frequency	6.7	6.30	4.60	68	1.5
2. High frequency	6.75	6.35	4.65	68.5	1.6
3. NSCT	6.78	6.38	4.7	69.0	1.65
4. Proposed method	6.80	6.40	4.8	70	1.657

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A Deep Learning Model for Early Prediction of Pneumonia Using VGG19 and Neural Networks

Shagun Sharma and Kalpna Guleria

Abstract Pneumonia is a disease that can be caused by bacteria, viruses, and fungi. According to WHO, pneumonia is responsible for 22% of all deaths of children under the age of 1–5 years which is one of the main causes of increased mortality rate. Congestion, gray hepatization, red hepatization, and resolution are the stages of this disease. If the disease is not detected in time, it can progress to a fatal stage. The chest X-ray image is used to diagnose pneumonia, but it requires the presence of experienced radiologists. Pneumonia, COVID-19, cancer, and various other diseases can be identified using X-ray images. If the disease is incorrectly identified, severe difficulties may arise. A deep learning-based model called VGG19 is used to address this issue, which classifies pneumonia from normal lungs. A chest X-ray dataset containing 5856 images was used in this study to classify pneumonia from normal lungs. The outcomes have been demonstrated as accuracy, precision, recall, F1-score, and receiver operating characteristics with the values of 93%, 0.931, 0.93, 0.931, and 0.973, respectively. Furthermore, for validating the proposed model, the performance parameters are compared to the existing work, which results that the proposed model outperforms the other models. In future, this work could be used in hospitals and medical applications.

Keywords Machine learning · Deep learning · Pneumonia · Convolutional neural network · VGG19 · Support vector machine

1 Introduction

Greeks and ancient Romans have been using the terms: pleurisy, peripneumonia, and peripleumoniacon, to define a disease which is identified as pneumonia [1]. In the

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nineteenth century, a researcher named "Laennec" differentiated "pneumonia" from "pleurisy", and later on, lobar pneumonia and bronchopneumonia were identified as distinct disease entities by another researcher named "Rokitansky". Pneumonia is an inflammation of the lower respiratory tract. Fever, cough with mucus, breathing issue, and chest pain are all indications of pneumonia [2]. It is among the most common causes of mortality in old age and children all over the globe. It is a disease caused by bacteria, viruses, or other microorganisms. Pneumonia causes inflammation in the lungs that can be fatal if not treated quickly [3].

The kind of organism producing the chest infection and overall health state determine how serious pneumonia is if it occurs [2]. Children between the ages of 1 and 5, older than 65, and patients with health issues such as diabetes, heart failure, weak immune systems because of HIV/AIDS, and people who have cancer are at higher risk of pneumonia. When pneumonia affects a person, the alveoli, or mini sacs inside the chest, become congested with fluid and pus, which cause difficulty in breathing and limit the oxygen exchange process. There are various kinds of pneumonia, which are divided into four categories: viral, bacterial, mycoplasma, and some other pneumonia. Furthermore, pneumonia can be classified as hospital-acquired, and community-acquired pneumonia, which occurs in weak immunity patients, such as those with HIV infection.

In the U.S. alone, there are currently over 1 million pneumonia cases in hospitals, with roughly 50,000 mortality [1]. Each year, approximately 450 million patients acquire pneumonia globally, of which almost 4 million people die due to severe infection. Chest X-ray (CXR) images are presently identified as the best and most widely used technique for diagnosing pneumonia, and it plays a significant and pivotal role in the everyday medical care of patients suffering from pneumonia.

The advancement and growth of computerized systems, particularly artificial intelligence and its various branches namely machine learning (ML) and deep learning (DL), have improved the accuracy of disease identification and classification, as well as the precision and quality of medical diagnosis. The pneumonia diagnosis and categorization have drawn the interest of researchers, who have developed a variety of ML and DL algorithms for accurate pneumonia prediction [4]. On the other hand, detecting pneumonia in the CXR images is a challenging task if there is no availability of expert radiologists. For diagnosing pneumonia, the radiologists search for white-colored patches and determine whether the patient is having pneumonia or not. Nevertheless, due to the limited color distribution of CXR (grayscale), it comprises shades of white and black, making it difficult to determine whether the pneumonia is developed in the chest or not.

Hence, it has been found that there should be some method which can identify the presence of pneumonia in the CXR images based on the previous data. The ML and DL have taken place, as they can be used for accurate classification of other diseases like cancer, lung diseases, and many more.

In this research work, the DL-based convolutional neural network (CNN) model with VGG19 feature extractor has been used for diagnosing and classifying pneumonia. The VGG19 is responsible for extracting the features from CXR images. Apart from this, a deep study about pre-existing ML and DL models for the identification of pneumonia is also done.

This article is structured as follows:

Section 2 tabulates the state-of-the-art models which have been used to diagnose and predict pneumonia. Section 3 shows the methodology of the CNN, support vector machine (SVM), K-nearest neighbor (KNN), and decision tree (DT) classifiers with the visual geometry group19 (VGG19) feature extraction model. Section 4 describes the results of the proposed classification model in the form of receiver operating characteristics (ROC), accuracy, F1-score, precision, and recall. Furthermore, the conclusion of the proposed work is described in Sect. 5.

2 State-of-the-Art

There are various ML and DL models utilized for various prediction purposes [5, 6]. In this section, various DL and ML models are listed based on their performance results in pneumonia prediction as illustrated in Table. 1.

Rajpurkar et al. [7] have developed a 121-layered CheXNet model for the prediction of pneumonia in CXR images. The dataset namely ChestX-ray14 contains 100,000 images of 14 different diseases. The results have been identified in the form of F1-score and compared with the real-time average radiologist F1-score value (0.387) which is quite lower than the proposed CheXNet model. Sirazitdinov et al. [8] have presented an ensemble model for the prediction of pneumonia. The dataset was named as pneumonia detection challenge dataset containing 26,684 images. The input image size has been taken as 512 * 512 and batch size of 8 and developed the model using Adam optimizer by giving the learning rate as 0.001. The ratio of training and testing has been kept as 75:25. Rahimzadeh and Attar [9] have developed a DCNN model by combining the XceptionNet and ResNet50V2 model which identifies the prediction results in the form of accuracy. In this work, the authors have used two CXR datasets containing 14,871 images collected from the RSNA pneumonia detection challenge and 180 images of the COVID-19 CXR. Ieracitano et al. [10] have a CNN model for the prediction of pneumonia using a CXR dataset containing 121 images. The model has been used for the extraction of features from CXR images and fuzzy images. Lastly, the proposed model was compared with existing models. Kundu et al. [11] have ensembled three CNN architectures i.e., ResNet-18, DenseNet-121, and GoogleNet, for the prediction of pneumonia which resulted in the performance in the form of the accuracy of 87.02% for the RSNA CXR dataset. Jain et al. [12] have used various pre-trained models for predicting COVID-19 viral, bacterial pneumonia, and tuberculosis using a CXR dataset. As per the results, the DenseNet, visual geometry group16 (VGG16) and VGG19 have been identified as the best performing models among all the models having higher accuracy, specificity, and sensitivity. Ahmad et al. [13] have used a DCNN model for the extraction of features from the lung disease dataset containing 2465 images collected from BIMCV. The results have been identified in the form of the area under

Table 1 Existing state of art for pneumonia diagnosis and prediction

Reference	Year	Model	Dataset	Accuracy	Future scope
[8]	2019	Ensemble model containing RetinaNet and Mask RCNN	Pneumonia detection challenge dataset containing 26,684 images	Precision—0.288 Recall—0.284 F1-score—0.286	The dataset can be augmented to increase the images and performance result of the experiment
[13]	2022	Deep CNN model	Lung disease dataset containing 2465 images collected from BIMCV	AUC—0.98	In future, the dataset can be increased through which the performance of the proposed model can also be increased
[7]	2017	ChexNet model	ChestX-ray14 dataset containing 100,000 images of 14 diseases	F1-score—0.435	NA
[14]	2018	CNN model for the development of CAD system	CXR images containing 158,323 images collected from NIH, Indiana University and Mount Sinai Hospital	AUC—0.931	NA
[9]	2020	DCNN model	Two chest X-ray datasets containing 14,871 images were collected from RSNA pneumonia detection challenge and 180 images of COVID-19 CXR	91.4%	For the future, the dataset can be increased and the performance may be analyzed for the proposed model
[10]	2022	ConNNet model	CXR dataset containing 121 images	Up to 81% accuracy	The dataset is very small for the DL model (ConvNet)

(continued)

Table 1 (continued)

Reference	Year	Model	Dataset	Accuracy	Future scope
[15]	2021	U-Net and Inf-Net model	CXR and CT scan images containing 123 and 100 images, respectively	NA	The dataset needs to be increased for better performance
[11]	2021	An ensemble of ResNet-18, DenseNet-121 and GoogleNet models	RSNA and Kermany's dataset has chest X-ray images	87.02% accuracy for the RSNA dataset	For the future purpose, various data augmentation techniques can be applied to increase the dataset
[12]	2022	Pre-trained VGG16, VGG19, Xception, DenseNet, Nasnet Mobile, InveptionV3, ResNet	CXR dataset consisting of 18,603 CXR images collected from Kaggle	VGG19—92.67%	In future, the model can be used in real-time applications which may lead to saving time and can lower the medical work and load

the curve (AUC) and defined the level of health issues in patients. Zech et al. [14] have introduced a CNN-based model for the prediction of pneumonia and identified that the proposed model may overstate the real-life pneumonia prediction performance. Zhang [15] have used various AI-based models for the prediction of pneumonia and resulted that Inf-Net models may perform better by doing a deep survey of the existing models.

3 Material and Methods

This section consists of the methodology used for research along with the details of the dataset used to perform the experiment.

3.1 Dataset

The dataset is collected from Kaggle [16] containing 5856 CXR images. This dataset is having three directories namely train, test, and validation. The train directory contains the CXR of pneumonia and normal lungs, in which initially the CXR in the pneumonia were 3875 and normal were 1341. The test directory was also divided into two sub-folders as pneumonia and normal consisting of 390 and 234 CXR images. The validation folder was also divided into two sub-folders consisting of 8 CXR for normal and 8 CXR for pneumonia.

In this study, the validation process has not been carried out, hence the 4 CXR of pneumonia from the validation set has been added to the sub-folder pneumonia of train and the test 4 CXR has been added to sub-folder pneumonia from the test folder. The remaining 8 CXR of the normal sub-folder of the validation set have been added to the normal sub-folder of train and test.

During the development of this dataset, all the images from Guangzhou Women and Children's Medical Center in Guangzhou of children patients aged under 1–5 have been chosen. Overall CXR imaging has been done as part of the regular medical treatment provided to patients. Before using these CXRs, all of them have gone through a quality check process and then the selection of the best radiographs has been done.

3.2 Proposed Methodology

The proposed method is divided into various phases including image importing, image embedding, data sampler, and finally testing phase.

- Image importing: It is the first widget that is used in image analysis to import images. It creates class values from directories and loads the images from the selected folder.
- Image embedding: Image embedding receives images to read and either upload them or locally analyzes them. A feature map is generated for every image using DL models. It provides an improved data table with more columns including descriptive information about images.
- Data table: The data table is used to store the images in the form of a table consisting of all the information about CXR images i.e., category, height, width, and size along with the path of the image.

For classifying the CXR images, a pre-trained model based on CNN with VGG19 feature extraction has been used.

VGG19—It is a variation of the VGG model which contains 19 layers in total [17] i.e., 16 convolutional, 5 pooling, and 3 fully connected, along with 1 softmax layer. There are numerous VGG variants, including VGG16, VGG11, and others. The VGG19 network contains 19.6 billion floating-point operations per second [18]. AlexNet is a model which was released in 2012 and enhanced the working performance of conventional CNN. VGG has been found as the successor to the AlexNet model. However, it has been developed by a different organization at Oxford University and named visual geometry group (VGG). It takes some concepts from its precedents and builds on them while using deep CNN layers to increase the performance results. The framework of the proposed model is shown in Fig. 1.

This model takes the input of size 224 * 224, and the matrix size becomes 224 * 224 * 3. The kernel size is taken as 3 * 3 with a stride value of 1 due to which it is possible to cover all the notions of the CXR image. The image padding is used to keep the resolution of the image preserved. The max-pooling is performed using 2 * 2 pixel while the stride size has been taken as 2. For introducing the non-linearity in the model, a ReLu activation has been used which can increase the prediction performance and decrease the computational time much better as compared to the sigmoid function. Afterward, three fully connected layers are used in the framework, in which for the first two layers the output is of size 4096 while the output for the third layer is of size 1000. Finally, the softmax layer was used which takes input from the final fully connected layer and gives output to the output layer. This layer uses a softmax function to classify and results in the outcome in the form of binary class classification. In the proposed model, there are various parameters used such as optimizer, learning rate, number of neurons, etc. The proposed model has been implemented in the Orange 3.311 simulator. The number of neurons was taken as 100, while the Adam optimizer is taken for optimizing the model. The learning rate is kept as 0.0001, while the model has been trained and tested on 200 iterations.

4 Performance Evaluation

There are various performance parameters which have been used for identifying the performance outcome of the proposed model including AUC, classification accuracy, F1-score, precision, and recall. The training of the proposed model is done using 5224 CXR images, while for the testing process 632 CXR images have been used.

The AUC, accuracy, F1-score, precision, and recall of the proposed model are identified as 0.992, 96.4%, 0.964, 0.964, and 0.964 for training dataset while 0.973, 93%, 0.931, 0.931, and 0.93 for testing dataset, respectively. The confusion matrix of the test performance evaluation is illustrated in Fig. 2.

The ROC is used to show the relationship between precision and recall. It can also be utilized to see the performance of binary class classification. It graphically represents the performance outcome of an algorithm. It identifies a threshold value which suits the problem under consideration. The ROC curve for the neural network model with VGG19 feature extractor is shown in Fig. 3.

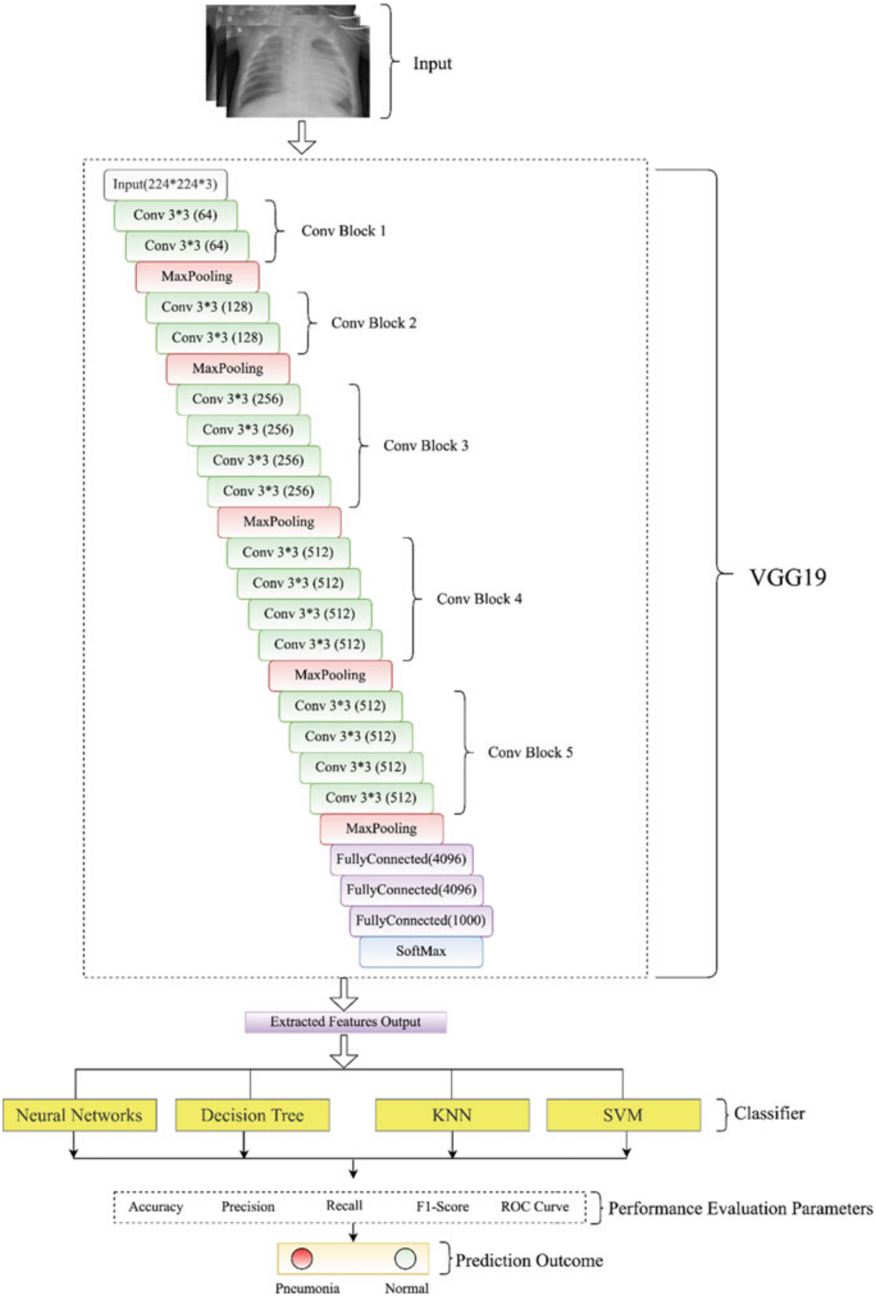

Fig. 1 The architecture of the proposed model

Actual \ Predicted	NORMAL	PNEUMONIA	Σ
NORMAL	220	18	238
PNEUMONIA	26	368	394
Σ	246	386	632

Fig. 2 Confusion matrix for testing dataset

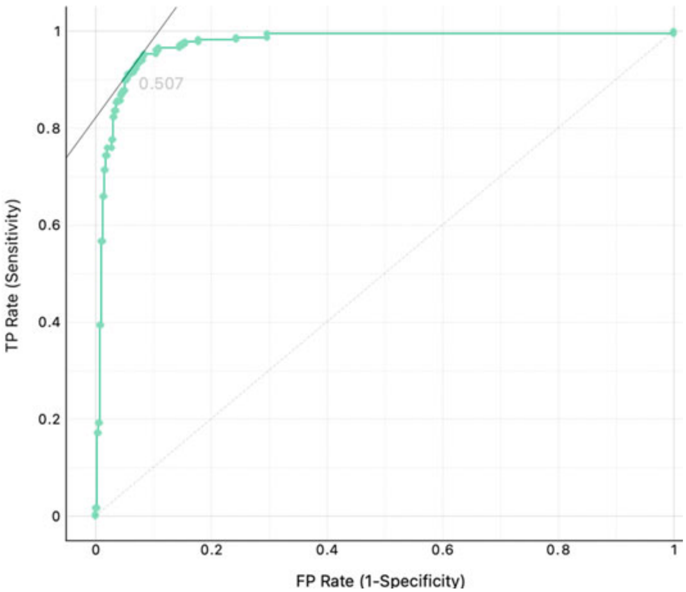

Fig. 3 ROC curve of proposed model neural network with VGG19

4.1 Comparative Analysis of the Performance of Neural Network Model with Other ML and DL Models

This section presents various ML models namely SVM, DT, and KNN in comparison to the neural network model using VGG19 feature extractor. Various ML techniques such as SVM, DT, and KNN have been trained on the same CXR dataset and the performance has been measured, with respect to the accuracy, AUC, precision, recall, and F1-score.

Figure 4 shows the ROC curve of the SVM model with VGG19 feature extractor for the CXR dataset. The threshold value for this model has been identified as 0.492

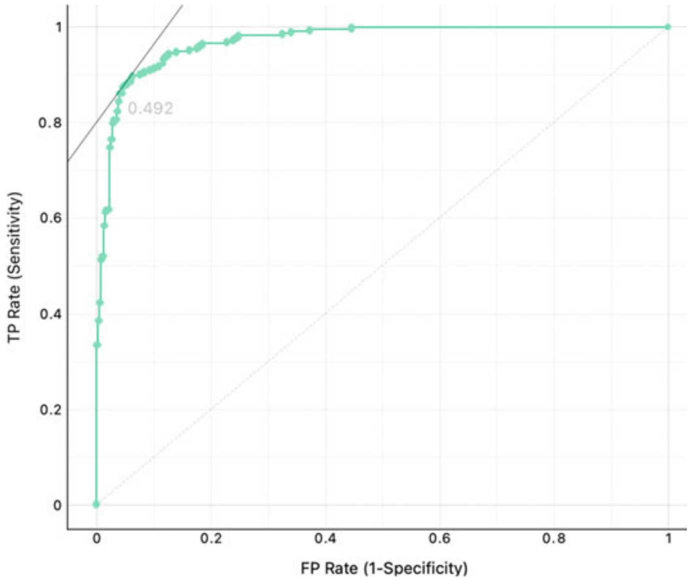

Fig. 4 ROC curve of SVM with VGG19

which is quite less as compared to the neural network model using the VGG19 feature extractor.

Figure 5 shows the ROC curve of the KNN with VGG19 feature extractor for the CXR dataset. The threshold value for this model has been identified as 0.600.

Figure 6 shows the ROC curve of the DT model with VGG19 feature extractor for the CXR dataset. The threshold value for this model has been identified as 0.500. This value of ROC is lesser as compared to the proposed neural network model using VGG19. This shows the high performance of the proposed model in terms of ROC value.

This paper has identified the value of accuracy, precision, recall, and F1-score for SVM, KNN, and DT with VGG19 as (91.5%, 0.915, 0.915, 0.914), (90.7%, 0.907, 0.907, 0.907), and (87.7%, 0.877, 0.877, and 0.877), respectively. The below illustrations show the comparison of the accuracy of the neural network, SVM, KNN, and DT models using VGG19.

Figure 7 shows the illustration of the comparison of the proposed model NN with VGG19, SVM with VGG19, KNN with VGG19, and DT with VGG19 models. The accuracy of the model identifies that the proposed model performs better as compared to other models because of the highest accuracy of 93%.

Figure 8 shows the precision of various models which are taken into consideration for the study. This identifies that the proposed CNN model shows better performance in the case of the precision parameter when compared to the other classification models.

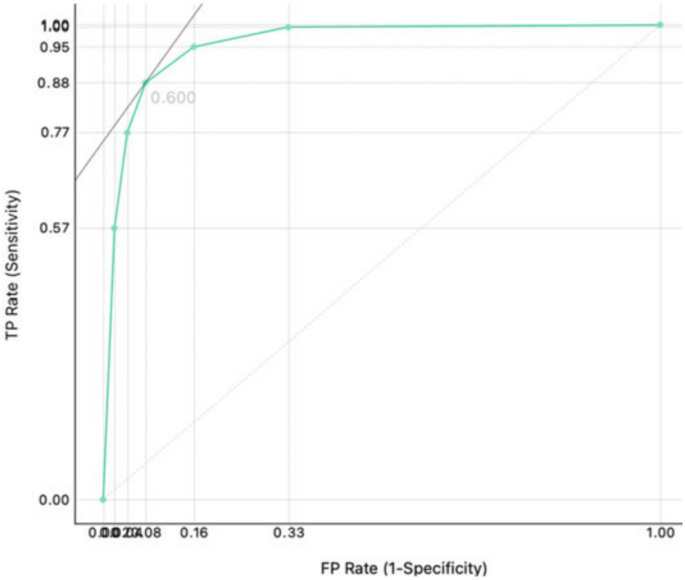

Fig. 5 ROC curve of KNN with VGG19

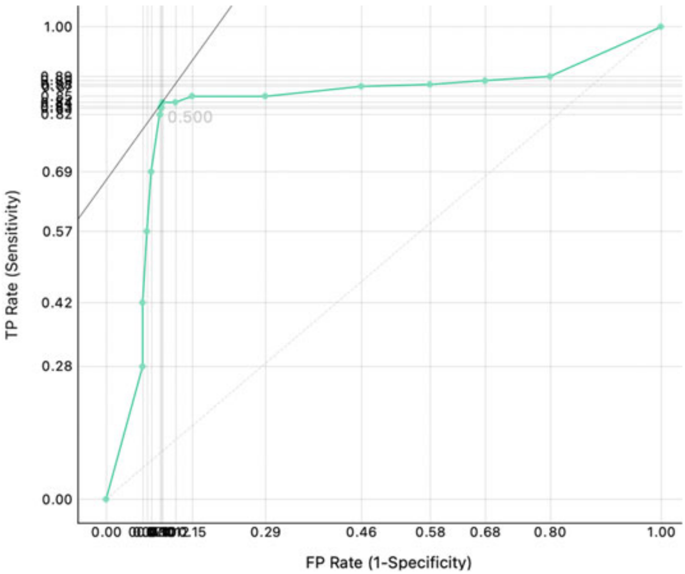

Fig. 6 ROC curve of DT with VGG19

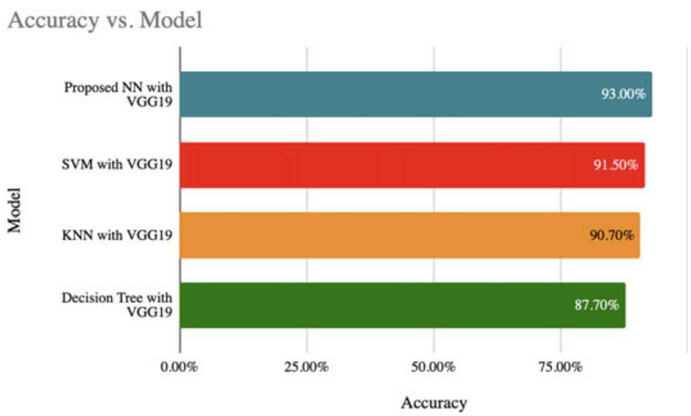

Fig. 7 Accuracy comparison of various models with the proposed model (NN with VGG19)

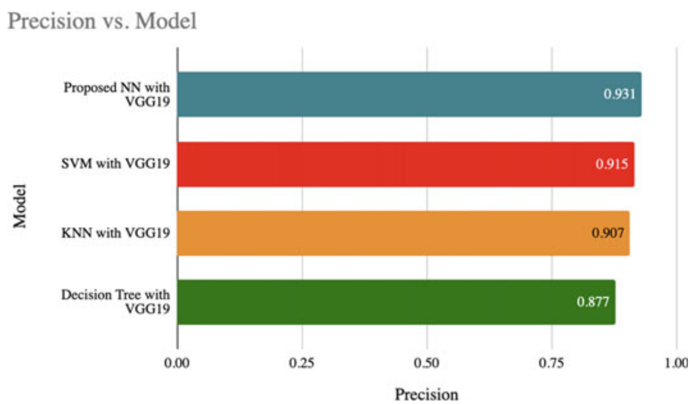

Fig. 8 Precision comparison of various models with the proposed model (NN with VGG19)

The recall is a parameter which is used to identify the performance of the ML and DL models. Hence, the parameter in this work shown in Fig. 9 is high for the proposed CNN model as compared to other models, which results it as the best model.

F1-score identifies the relationship between precision and recall. The value of the F1-score as shown in Fig. 10 is identified as higher than other models which results, in the proposed CNN model as the best fit model for the CXR dataset.

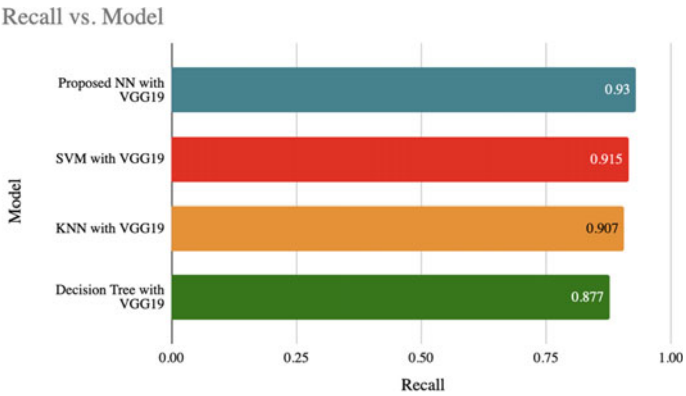

Fig. 9 Recall comparison of various models with the proposed model (NN with VGG19)

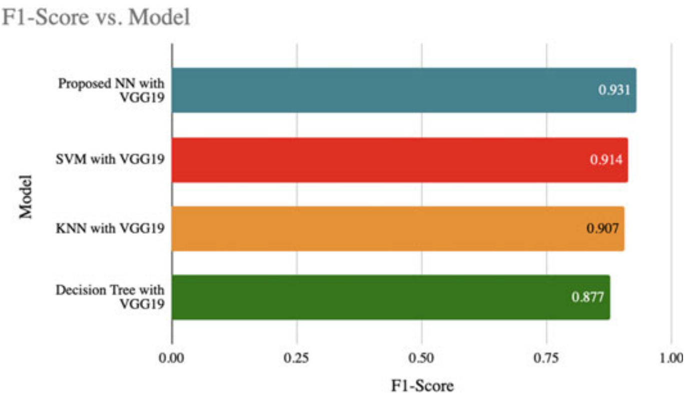

Fig. 10 F1-score comparison of various models with the proposed model (NN with VGG19)

4.2 *Comparative Analysis of Proposed Model with State-of-the-Art Models*

This subsection of the paper identifies how the proposed model is better as compared to other existing models introduced in the state of the art. Pneumonia detection and prediction via the CXR images have been found as the subject of several research.

As the studies shown in Section II are evaluated for multiple types of datasets, hence the comparison is not suitable with each state-of-the-art model. In the present study, the binary classification has been done which can be compared with the model presented by Kundu et al. [11], who have used two datasets for classifying the presence of pneumonia. The results of the first dataset i.e., RSNA have been identified in the form of accuracy as 87.02%. While comparing these results, it has been identified that the accuracy of the proposed model is quite high i.e., 93%. Hence, the model can be validated due to high-performance results for the prediction of pneumonia.

Ieracitano et al. [10] have used a CovNNet model to identify the prediction of pneumonia and resulted in the accuracy of prediction up to 81%. In a comparison with the proposed model, the accuracy has been found to be very high as compared to the CovNNet model. Jain et al. [12] have used a VGG19 model for the prediction of pneumonia and achieved an accuracy of 92.67% while in the proposed VGG19 it has been found quite high, which validates the proposed model. Rahimzadeh and Attar [9] have proposed a model namely DCNN, which achieved 91.4% accuracy and the dataset was also imbalanced, hence the proposed model can be taken as the superior model as compared to the DCNN model.

Figure 11 illustrates the accuracy comparison of the proposed model with the existing works. F1-score is a value which sums up the performance of the model by using precision and recall parameters i.e., higher the value of the F1-score better the performance will be. Figure 12 depicts the F1-score comparison of the proposed work with the existing models.

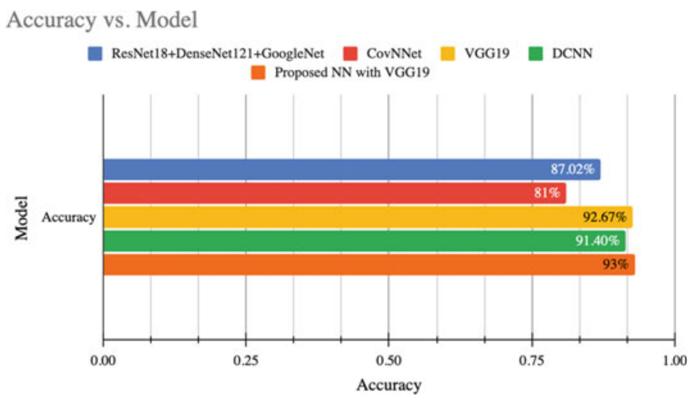

Fig. 11 Accuracy comparison of the proposed model (NN with VGG19) existing models

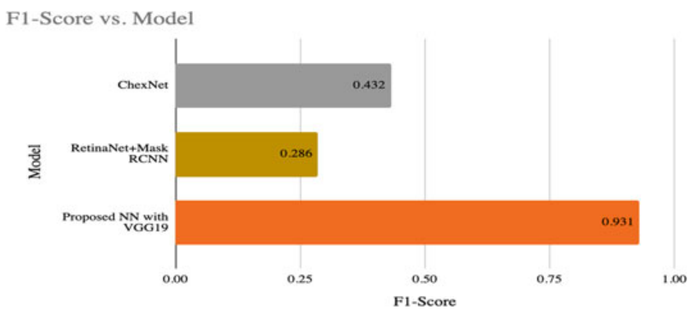

Fig. 12 F1-score comparison of the proposed model (NN with VGG19) with existing models

Sirazitdinova et al. [8] have proposed an ensemble RetinaNet + Mask RCNN model which has resulted the F1-score of 0.286, which is quite less than the proposed model. Hence, the proposed model can be called a better model than the model presented in [8]. In comparison to the model presented by Rajpurkar et al. [7] i.e., ChexNet, the F1-score of the ChexNet and the proposed model is found i.e., 0.435 and 0.931 resulting in the proposed one as a better model.

5 Conclusion

Pneumonia is an upper respiratory tract infection which primarily affects the breathing system and lungs. During the breathing process, small sacs in the lungs called alveoli fill with oxygen. When the alveoli get clogged with fluid and pus pneumonia gets appeared. Pneumonia is one of the main causes of an increase in the mortality rate of children worldwide. The illness may advance to a deadly stage if it is not identified on time. Hence, it is required to decrease the mortality rate caused by pneumonia. There are various ways of pneumonia detection and prediction such as CXR and CT scan images. In this paper, the CXR dataset containing 5856 images is used to predict pneumonia and the results of the prediction using the proposed model have been shown in the form of ROC, accuracy, precision, recall, and F1-score as 0.973, 93%, 0.931, 0.93 and 0.931, respectively. Finally, these results are compared with the existing works, and it has been concluded that the proposed model outperforms the other models. Furthermore, this work can be helpful for identifying the best prediction model for pneumonia and in future, the datasets can be increased to enhance the performance of the predictive models.

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KDS: Keyless Data Security for Wireless Sensor Networks

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Abstract Wireless Sensor Networks (WSNs) are becoming more popular and are also used in a variety of mission-critical applications. Security in these applications plays a significant role. However, these networks are constrained by a number of factors including limited computation capabilities, energy and storage capacity, unreliable communication, vulnerability to physical capturing and unsupervised activities. The main challenge is to retain security in the network despite these constraints. For secure transmission, key management plays a vital role. But re-keying is necessary when the node is compromised or after a specified number of rounds. So key refreshing increases communication overheads in the network which degrades the network performance. To overcome this problem, a Keyless Data Security (KDS) scheme for WSNs is proposed which eliminates the requirement for key management in the network during data transmission. Simulation results prove that the proposed scheme provides better performance without increasing communication overheads in the network.

Keywords Data partitioning · Key management · Wireless sensor networks

1 Introduction

Security becomes one of the major problems in WSNs [1]. During network setup in WSNs, the most important requirement is to establish cryptographic keys for future use. Key management is the mechanism in which pre-allocation of secret keys

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to every node is done by which only authorized node can interact with each other [2, 3]. Key management schemes are categorized as static and dynamic methods. In static key management schemes, once the key pre-allocation is done, the keys remain constant during the entire network's lifetime so it guarantees low level of security. In dynamic scheme, regeneration of keys is possible when necessary during the entire network's lifetime and is more secure.

1.1 Problems in Different Types of Key Management Schemes

A high level of security is required to transmit sensitive information over a network [4, 5]. A number of security-critical applications rely on different key management methods to operate. As sensor nodes (SNs) are randomly deployed in unsupervised and inaccessible areas, physical tampering is a major risk [6]. If a single key is used in the network and if this key is compromised by any single SN, the whole network is compromised. If multiple keys are used, then large numbers of keys are required to be managed and refreshed. The WSN must be capable to survive with the compromise of some of the SNs in the network. It is important to find out how many compromised SNs it takes to compromise the security of the entire network. And when any SN is compromised, these security-critical applications also demand a high level of fault tolerance. This is a challenging task as there are many rigid requirements to implement key management and the resources available to execute such methods are highly constrained due to which many highly secured approaches become infeasible to execute. A proper balance between requirements and the number of resources of WSNs decides which key management scheme should be used.

2 Related Work

In [2], authors outline a survey and also summarized critical issues related to different key management schemes highlighted by different researchers such as discovering compromised SNs in the network, making SNs tamperproof without communication overheads and minimizing the bootstrapping time required for WSN. The authors highlight that there is no one-size-fits-all approach to key management for all applications.

Shaik et al. [7] presented a detailed overview of different key management schemes along with the pros and cons of each scheme. The authors also published a table comparing each scheme based on different networks with varied parameters.

Ozdemir et al. [8] proposed a single network-wide key management approach in which a solo key is pre-loaded in the memory of all SNs. Each SN uses this solo key to encrypt and decrypt data, so there is no need to carry out additional key discovery and key exchange processes. All of the SNs send data using the same key that they already have. But this scheme has a major loophole that the compromise of any single SN will compromise the entire network.

For a network of n SNs, $(n - 1)$ pair-wise keys are required to be stored in every SNs memory so that each SN can communicate with all the other SNs that are in its communication range. Since each SN has a unique pair of keys for communication with every other SN, this scheme is not scalable and the communication overheads of this scheme are very high as compared to a single network-wide approach. Authors in [9] proposed a key establishment scheme for WSNs that enables both inter- and intra-cluster communication. The goal is to reduce delay, storage and communication overheads while establishing pair-wise keys for these communications.

The major problem with the pair-wise key establishment scheme is that it requires each SN in the network to hold $(n - 1)$ key pairs. A solution to overcome this problem is to use a centralized Key Distribution Centre (KDC) approach. The role of BS in this scheme is to supply session keys for communication between any two SNs. This key is saved in the SN memory and acts as an authentication entity for the SN. When compared to pair-wise key setup, this approach uses fewer keys, but the drawback of trusted BS is that it is not scalable and the BS is readily attacked.

In [10], the authors proposed a model in which the network is divided into zones, each with its own intrusion detection system (IDS) and KDC to detect the activity within its zone and communicate with its KDC. The authors tried to reduce the computation and communication overhead of the already overloaded BS by separating the IDS work of the BS with a separate entity in each zone.

In [11], the author proposed various random key pre-distribution methods. Two nodes can communicate with each other only if they have shared key. The drawback of this scheme is that the two neighbouring nodes cannot communicate with each other if they do not share common key and encryption keys of those nodes will be easily revealed which are captured by the attacker.

Erfani et al. [12] proposed a dynamic key management approach that included key pre-distribution and dynamic key establishment techniques. It ensures that any two SNs communicating can share a common key. Each SN memory stores the pre-distributed keys and dynamic keys independently. When a node in its radio range tries to interact with another node, it uses either the common pre-distributed key or the dynamic key. If the communicating SNs do not share a common key, they will compute a dynamic key for safe communication. This approach is more scalable and provides better resilience. This scheme, on the other hand, may not work well for high-mobility WSNs.

In all the above schemes, a lot of keys are required to be managed to broadcast the data packets securely to the BS over the network which increases complexity, communication overhead, energy consumption, time delay, etc.

3 Proposed Work

In some schemes, the keys are pre-loaded in the SNs prior to network deployment. Re-keying is necessary after a specified time interval so that it does not become stale. To establish security priorities such as integrity, confidentiality and authenticity between the connections established between arbitrary SN endpoints, the SNs require the existence of appropriate cryptographic keys at the end points. In a hierarchical scheme, the job of CH is to collect data from all cluster members, so keys are required to be shared between CH and each cluster member for communication. To transmit sensitive data aggregated by the CH to BS, another key is required which can only be shared between the CH and BS. But as SNs are resource constraints, the role of CH changes periodically, so every time new keys are required to be shared between the new CH and its cluster members and between the new CH and the BS which increases communication overhead. The unicast keys are required for SN-SN, SN-CH or CH-BS communication. The broadcast keys are required either by the CH to send messages to its cluster members or by the BS to broadcast a message to all SNs in the network. In other schemes, the keys are required to be refreshed due to changes in topology, the keys are updated periodically or on-demand, or the keys need to be refreshed after key revocation.

A large number of keys are required to be effectively and efficiently managed in different key management schemes for secure data transmission in WSNs which increases complexities, communication overhead, computation overhead and energy consumption. Instead of adopting different key management schemes that share many keys between SNs for secure data transmission, a KDS scheme is presented which eliminates the requirement for key management in the network.

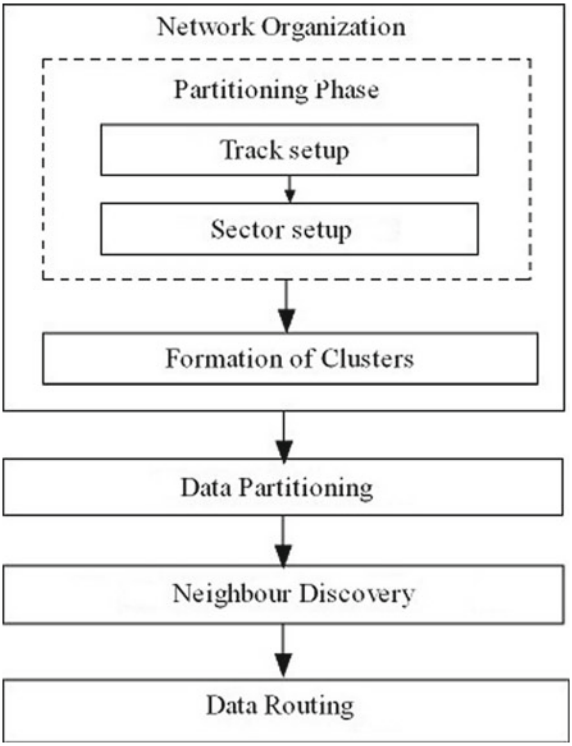
This scheme works as follows: First, the network is partitioned into tracks and sectors. After then, the data packet D of each SN is divided into n overlapping segments such that D cannot be reconstructed from less than k segments. Three neighbours of each SN are selected in the direction of BS only. The segments are transmitted through the selected neighbours in such a way that no more than $(k - 1)$ segments of any SN are collected in a single place, except BS. After receiving k segments of SNs, the BS reconstructs the original packet D.

The flow diagram of proposed scheme is shown in Fig. 1. The model is divided into 4 stages:

- Network Organization
- Data Partitioning
- Neighbour Discovery
- Routing.

A. *Network Organization*: During this phase, the BS organizes the network by dividing the network into concentric circles known as tracks. Tracks are further divided into sectors. The clusters are the regions under the curved strip formed by the intersection of tracks and sectors. All the computations required for the construction should be done in the beginning by the BS.

Fig. 1 KDS scheme



B. *Data Partitioning*: During data partitioning, data packet (D) of each SN is divided into n number of overlapping segments $S_1,\ldots,S_n$ such that:

- D can be easily reconstructed from any k segments where k is the threshold value $1 \leq k \leq n$, i.e. the minimum number of segments required to reconstruct D.
- Even comprehensive knowledge of $(k-1)$ or fewer segments of D provides no information about D and renders D absolutely unpredictable.

As shown in Fig. 2, the data packet D is divided into n number of overlapping segments which are further divided into three groups in such a way that each group contains less than $(k-1)$ number of segments. During data transmission, if any segment is lost, the BS can easily reconstruct D with the help of any k segments.

Algorithm 1 shows how D is partitioned into n number of segments S_1, S_2, S_3, $\ldots S_n$. First randomly choose $(k-1)$ integers. These integers are used to generate a polynomial of a degree $(k-1)$ as given in Eq. 1.

$$f(x) = a_0 + a_1 x + a_2 x^2 + \cdots + a_{k-1} x^{k-1} \tag{1}$$

After then, the next step is to partition D into n segments using Eq. 2.

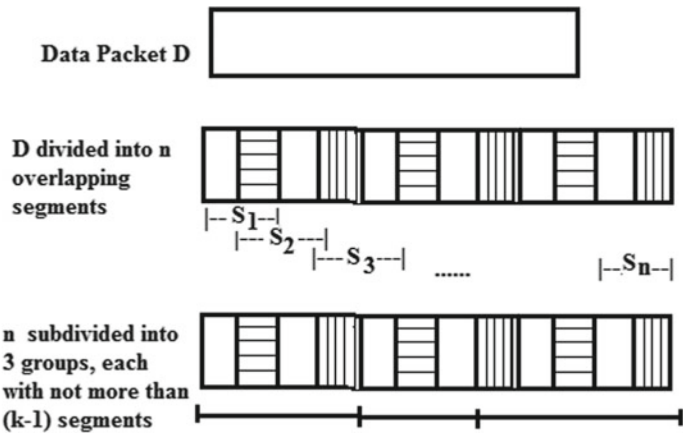


Fig. 2 Data partitioning

$$S_i = f(x_i) \quad \text{where } i = 1 \ldots n \tag{2}$$

Equation 2 gives the desired number of segments of D.

Algorithm 1: Data Segmentation

Input: Data packet (D), total number of segments (n), number of segments required to reconstruct D is denoted with (k).
Output: n segments of D: $S = \{S_1, S_2, S_3, \ldots S_n\}$
Procedure: Data_Seg (D, *n*, *k*)

i Input k such that
  a) k should not be zero or less than zero.
  b) k should not be greater than n.
ii Initialize $(k - 1)$ random integer numbers $(a_1, a_{2,\ldots} a_{k-1})$
iii Set $a_0 = \text{D}$
iv Generate a polynomial of degree $(k - 1)$.

$$f(x) = a_0 + a_1 x + a_2 x^2 + \cdots + a_{k-1} x^{k-1}$$

v for (each x_i, $1 \le i \le n$)

{
  Compute $S_i = f(x_i)$
}

vi return $S = \{S_1, S_2, S_3, \ldots S_n\}$

These n segments $\{S_1,S_2,S_3,\ldots S_n\}$ are then partitioned into three groups comprising no more than $(k - 1)$ segments. These groups of segments are subsequently delivered to selected nodes to transmit data to the BS.

Algorithm 2 shows how D is reconstructed from any k-out-of-n segments by using Lagrange interpolation polynomial. The formula for the basis polynomials is defined in Eq. 3.

$$l_i(x) := \prod_{\substack{0 \le m \le k \\ m \ne i}} \frac{x - x_m}{x_i - x_m}$$

$$= \frac{x - x_0}{x_i - x_0} \cdots \frac{x - x_{i-1}}{x_i - x_{i-1}} \frac{x - x_{i+1}}{x_i - x_{i+1}} \cdots \frac{x - x_k}{x_i - x_k} \quad \text{where } 0 \le i \le k \tag{3}$$

For k segments, the interpolation polynomial in the Lagrange form is a linear combination of Lagrange basis polynomials which is given in Eq. 4.

$$L(x) := \sum_{i=0}^{k} y_i l_i(x) \tag{4}$$

Algorithm 2: Data Reconstruction

Input: Total segments (n), k number of segments required to reconstruct D.
Output: D.
Procedure: Data_Rec (n, k)

i Start
ii if ($n < k$)
  insufficient segments of information for reconstruction
iii Select any k segments from n.
iv Compute Lagrange interpolated polynomial using Eq. 4
v D is the free coefficient after solving the Eq. 4.
vi end

The data packet D of every SN is first divided into n segments for transmission and then BS reconstructs D from any k segments, as shown in Fig. 3.

C. *Neighbour Discovery*: As each SN has limited resources available so it is necessary to lower down transmission power and energy consumption to prolong network lifetime. Neighbour Discovery is the major component of communication. Instead of directly sending data to BS, each node finds its three neighbours in the direction of BS in such a way that.

- One neighbour is selected from the same sector in which the node resides.

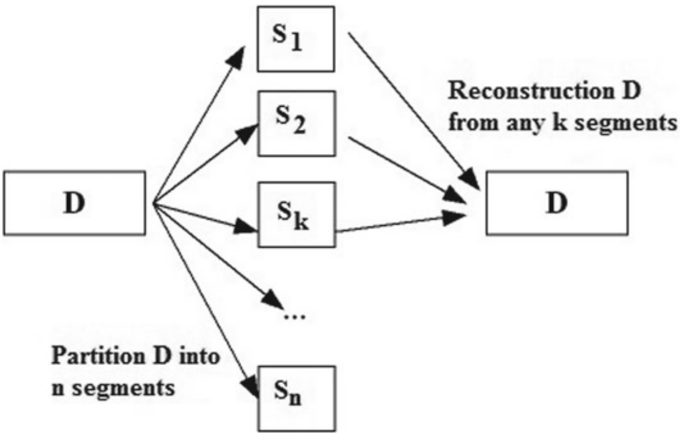


Fig. 3 Data partition and reconstruction

- The other two neighbours are selected from the right and the left adjacent sectors to transmit data to BS.

D. *Data Routing Phase*: It is used to transmit the data of each SN to the BS securely.

Track Model:

If the network is divided into tracks only and the SNs are randomly deployed. The information D of each node is partitioned into three groups which should not contain more than $(k - 1)$ number of segments. Every SN in the network finds its three neighbours in the direction of BS to transmit segments of D. Each neighbour selected of a particular SN is allowed to send only $(k - 1)$ or fewer segments of that SN only. When the SNs start transmitting the segments to BS through different routes with the help of selected neighbours, there is a high risk of collecting more than k number of segments of single SN at one place which make that SN compromised. So, in this case data of all the SNs is revealed except those SNs which are present nearest to BS. As the SNs instead of sending packets through neighbours, these nodes send data directly to BS. So to overcome this problem, the presented model partitions the network into circular tracks and triangular sectors.

For data transmission, the sensitive information D of each SN is divided into three groups such that:

- The neighbour selected from left adjacent sector is used to transmit $(k - 1)$ or less segments of D to BS.
- Similarly, $(k - 1)$ or less segments of D are transmitted through the neighbour selected from the right adjacent sector.
- And the remaining segments are transmitted via neighbour selected from the same sector in which the node resides.

During data transmission, the SN transmits its own information D with the help of neighbours selected from same sector and from left and right adjacent sectors, but restricted to send data received from other neighbouring nodes within same sector only. As a result, the information D of each SN is transmitted in such a way that no k or more than k number of segments of every SN can be collected on the single node. In this way, the original information D can never be reconstructed by any intermediate node. Only BS is allowed to receive any number of segments and can reconstruct D. Before attempting to reconstruct D, the BS must check that it has received enough segments (i.e. that it has received at least k segments), otherwise the retrieved information will be of no use.

Algorithm 3 shows the complete working of KDS scheme which defines how the data is securely transmitted over the network without any key requirement.

Algorithm 3: KDS

Input: Data packet (D), total number of segments (n), number of segments required to reconstruct D is denoted with (k).
Output: (i) $S = \{S_1, S_2, S_3, \ldots S_n\}$ (ii) Reconstructed D
Procedure: KDS (D, *k*, *n*)

i Clusters are formed by dividing the network into tracks and sectors.
ii Call Data_Seg (D, n, k) to divide D into n segments.
iii Find three neighbours of each SN in the direction of BS such that

- First neighbour is selected from the same sector in which the node resides.
- Second and third neighbours are selected from the next and previous sector respectively in which the node belongs.

iv For every SN, neighbours selected from step 3 is used to transmit $(k - 1)$ or fewer segments of D to BS.
v Data_Rec (n, k)
vi end

4 Simulation Results

- **Symmetric Key**: It relies on a shared key between two parties. The number of keys required to transmit data of p number of nodes is $p(p - 1)/2$. After encryption, the number of communication required to transmit encrypted data of each SN is p. So the number of communication required to transit encrypted data in this scheme is $p + (p\ (p - 1)/2)$.
- **KDS**: In this scheme, no key is required to encrypt or decrypt data. After data partitioning phase, the partition data is transmitted by three selected nearest neighbours. So to transmit data packet D of p number of SNs, $3p$ communications are required.

During key updation and data transfer, Fig. 4 compares the communication overhead of symmetric key distribution scheme with KDS. As KDS scheme eliminates the need for key management, there is no need to exchange keys between communicating nodes for data transmission. As a result, as compared to symmetric key distribution scheme, the number of communication overheads in this scheme is quite low.

The required simulation parameters are given in Table 1.

Figure 5 compares the number of uncompromised packets received by track model and KDS at BS after 200 rounds. In the KDS scheme, compromised nodes in the network are unable to compromise data, resulting in the BS successfully receiving uncompromised data packets, as opposed to other model in which data packets are more likely to be compromised before reaching the BS.

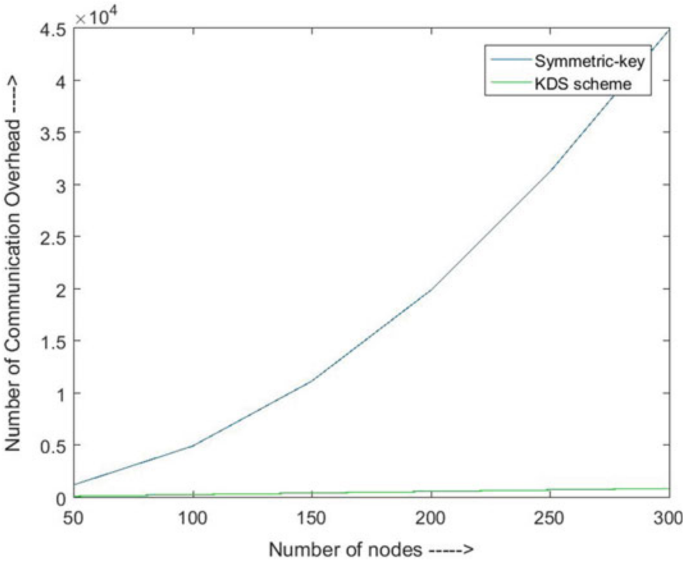


Fig. 4 Communication overhead comparison of symmetric key distribution scheme with KDS during key updation and data transmission

Table 1 Simulation parameters

Parameter name	Value
Network area	1000×1000 m^2
E_{elec}	50×10^(-9) Joules/bit
E_{amp}	100×10^(-12) Joules/bit/m^2
EDA	50×10^($\times$ 9) Joules/bit
No of rounds	200

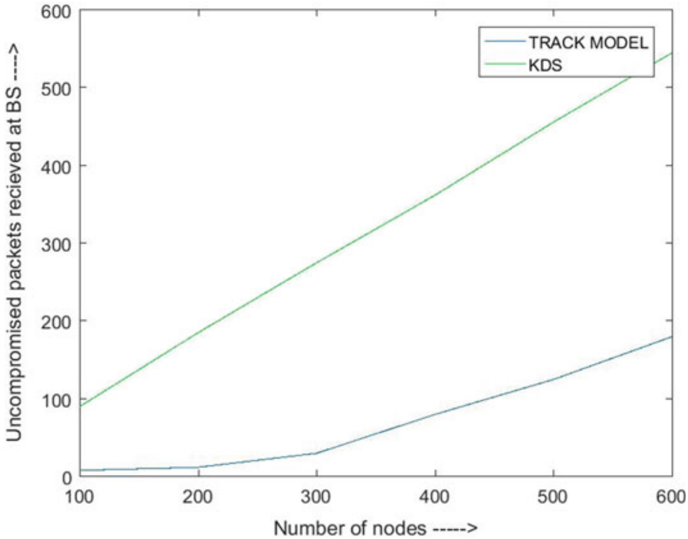


Fig. 5 Number of uncompromised packets received at BS comparison between track model and KDS

5 Conclusion and Future Scope

The proposed KDS scheme overcomes the problem of key management by reducing number of communication overheads in the network. As in this scheme, there is no chance that more than k segments of data packets collect at single place so compromised nodes in the network will not be able to compromise the data using KDS scheme. Comparison graphs show the proposed KDS scheme is secure and more efficient in prolonging network lifetime. The KDS scheme provides security only on static clusters. So in future, one can extend this work and develop a security framework for dynamic clusters where the size and composition of cluster members varied.

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Smart Industrial Scanner for Implementation of Relevant Data Parsing from Prescriptions Using SSWF Algorithm

Jephin V. Jose, Sherin Eliyas, Sathish Kumar, and Angeline Benitta

Abstract Scanners have a wide range of functions. When it comes to an embedded system that converts scanned documents into meaningful data, there is seemingly a void in the industry. Data that can be mined from prescriptions are invaluable and any approach to make meaningful sense of such data is always a beneficial. Such approaches not only push the bounds of how much creative programming can achieve, but also how much it means to the people who can benefit from such innovations. We implement one such innovative approach to convert medicine data within a prescription to make meaningful sense of the data that resides within the prescriptions. We propose a device for converting a medical prescription into a standardized format. To achieve this, we implemented a HP Ink Tank 410 scanner connected to a Raspberry Pi 4 running Ubuntu, we propose a revised algorithm for detecting and parsing related medicinal information from a prescription. This algorithm guarantees a reduction in processing time and improve improves performance.

Keywords Medicinal data · Improved processing · Improved performance · Prescription digitization

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The original version of this chapter was revised: The second author's name has been changed to "Sherin Eliyas". The correction to this chapter is available at https://doi.org/10.1007/978-981-19-7982-8_57

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1 Introduction

With the advent of advanced techniques in the field of deep learning and innovative strategies to convert any handwriting into text has provided us with an advantage of making innovations to such techniques that will improve the efficiency of these algorithms as well as come up with solutions to issues that plague the healthcare industry. In Fig. 1, the growth of digital medical industry demands the need for digitized health data and there is a need for efficient methods for generating such data.

The medical industry generates an enormous amount of data, but unfortunately they require highly specialized set of tools to parse them and convert them into meaningful information. Developing such specialized tools require immense research. Although there are a lot of studies being conducted to find novel approaches to equipping the medical industry with advanced technologies that has the potential to improve lives of many people, which include the use of robotics to improved healthcare service providers, they tend to focus on standardizing the formats and services the industry offers. The need for technology to parse information from previously unstandardized forms of data can be very valuable in studying a patient's previous medical history and much more. These kinds of data combined with the modern infrastructure of advanced healthcare ecosystems can lead to many use cases where such technologies can be implemented. The techniques required for such innovations can be formulated by simply studying and researching the current drawbacks in the industry and can be implemented to provide useful services. We propose a similar strategy for parsing relative information into a standardized format for digitizing data contained in prescriptions.

A HP Ink Tank 410 scanner is capable of scanning images at 1200dpi. This scanner is connected to a Raspberry Pi Ubuntu and is connected via USB and CUPS. HP Ink Tank 410 scanner is set to scan the images at 400dpi as this is seemingly a good

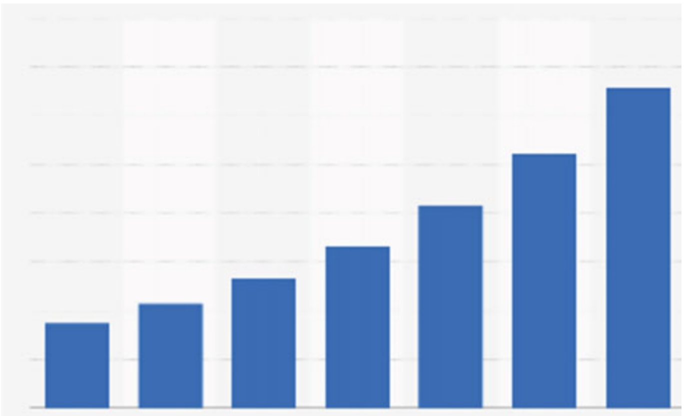


Fig. 1 Growth of digital health market

tradeoff between the image qualities and file size. The Raspberry Pi uses PyCharm as the preferred IDE for development.

1.1 Algorithm Description

Selective sliding window filtering (SSWF) algorithm is an improvement on C-Cube algorithm and 3-step filtering algorithm. The algorithm comprises of 4 steps that can be used to efficiently provide with the required data that can be parsed from the prescription. This technique is novel in the sense that it utilizes the vertices data that in Fig. 2 Google Vision API returns along with the text OCR conversion and uses it to the advantage of filtering out the irrelevant data from the text that is parsed from the API.


```
"boundingBox": {
  "vertices": [
    {
      "x": 250,
      "y": 63
    },
    {
      "x": 267,
      "y": 62
    },
    {
      "x": 268,
      "y": 70
    },
    {
      "x": 251,
      "y": 71
```


Fig. 2 Response from Google Vision API

The algorithm selectively searches for the relevant words in the data and then searches for information relevant to the newly found piece of data. This approach, however, is scalable and can be implemented in a wide array of use cases that struggle from parsing niche categories of data.

The algorithm then proceeds to rank the similarities of the relevant data with an internal dataset. The data can be used to implement the keyword search as search for a large dataset consisting of the data that can be parsed. The parsed information is then stored in a structured format of key, value pairs and can then be used to make meaningful sense of the data and perform analysis on the data acquired.

1.2 Datasets

The algorithm is tuned to efficiently use as little data as required to perform the searches. This algorithm uses two different datasets. The first one for the initial search and the second one for finally searching the relative information relevant with respect to the data gathered from the first dataset. An efficient approach to data collection and processing was of high priority as the use case demands highly efficient performance figures in terms of usability and scalability. This prompted the use of innovative strategies to minimize the amount of times the algorithm interacts with the datasets. These are described in detail later on. Data was collected in house and from external sources like WHO and so on. Data that was collected was done after immense research implementing state-of-the-art techniques for processing, cleaning and collecting only the data that will be required for the most general use case.

1.3 Environment

Choosing the most efficient and user friendly platforms and frameworks was key in choosing the runtime environment for implementing the algorithm. The system is implemented using Python, Flask, Numpy, Pandas and Google Cloud Vision API Library. This was implemented in a REST architecture utilizing all the advantages of a REST API. This consists of, but not limited to faster performance, quick integration and flexibility. Python was chosen as the standard language due to the immense community support and the vast amount of libraries and frameworks that can be utilized. Flask was chosen as a quick and efficient way of implement a REST API for dealing with the request from the client system that consists of the Base64 encoded prescription. Pandas stands as the unparalleled data storage and processing framework for such data heavy tasks as it is highly efficient in dealing with big data and can be utilized for easy manipulation, cleaning and pre-processing of the dataset. Numpy was chosen to provide the algorithm with the arbitrary math operations to make the functionalities possible.

1.4 Test Hardware

We implemented the scanner using a HP Ink Tank 410 scanner at 400dpi, coupled with a very minimally powerful Raspberry Pi 4. This combination of devices can efficiently convert scanned data into a well-structured format.

2 Literature Review

While only the words that contain the names of the medicine are of interest, as they are mixed with other irrelevant words extracted from the prescription, it is non-trivial to isolate them [1]. Artificial intelligence and ingenious solutions have enabled us to automate different elements of the screening process and present metrics for evaluating the performance of the automated process [2]. The usage of extended MNIST has been explored and the results support the efficiency of proposed model to identify the poor legibility of handwriting and transform it into readable correct text recognition [3]. In order to recognize doctors' handwriting with higher accuracy, more medical words and associate recognized terms with prescriptions will be dealt with by using a larger medical term corpus. The proposed doctors' handwriting recognition system will make it possible to reduce medical errors and save medical cost and ensure healthy living [4]. People face problems in collecting all the documents including debts and receipts. In the current COVID like pandemic situations, it is even worse if one needs to visit a hospital to collect documents [5]. The results indicate that major hospitals are, at present, using AI-enabled systems to augment medical staff in patient diagnosis and treatment activities for a wide range of diseases. In addition, AI systems are making an impact on improving the efficiency of nursing and managerial activities of hospitals [6]. Scientists seek various possibilities using computer technologies, especially artificial intelligence (AI) enhanced methods, for healthcare services and medical diagnoses [7]. The image data contains a lot of redundant information; how to use the effective information in the image to transform the image style becomes very important [8]. The upsurge and flourishing of text mining paved the way for a new beginning in the area of information extraction (IE) and information retrieval (IR). As the term suggests, it is to mine relevant information from the text document. The text document could be un-structured or semi-structured. There exist different approaches and methods for text mining and most of these techniques are computational linguistics with Python library related functions [9]. Since the handwriting of physicians is hard to peruse out, the proposed system simplifies the process of comprehending such handwriting by the methods for handwriting recognition utilizing the OCR techniques [10]. Raspberry Pi (RPi) is a credit-sized mini-computer with great capabilities similar to a PC. In this study, it is used as a remote enrollment node. The application of Raspberry Pi and cloud computing has given a new direction of research into the field of Internet-of-Things (IOT) [11]. In the pre-processing step, the system digitizes a paper-made document into a grayscale image using an optical scanner and converts the grayscale image into a binary image. Furthermore, the regions containing text are located and each image is segmented from the word. Then, a smoothing and normalization processing is applied for eliminating noise and variation of size, slant and rotation before performing the recognition. The recognition methods consist of feature extraction and classification [12].

3 Modules

The system consists of six modules. Modules are categorized based on the amount of tasks each module performs and by the frequency of their operations.

3.1 Module 1

Module 1 consists of input data management. This module takes in the input and converts the data into an image file that is temporarily stored in the local storage. The image is stored according to the content type that is mentioned in the Base64 code. Python Base64 library is used for this purpose.

3.2 Module 2

Module 2 consists of the Google Vision API environment setup and sending the data to the Google Vision API. The environment setup consists of authentication, data conversion, response management and response parsing.

The response from the Google Vision API consists of a JSON-like syntax where each word detected consists of its description, vertices for the bounding box in Fig. 3 that encapsulates the word and so on.

3.3 Module 3

Module 3 consists of a text parsing component that scans the document containing texts against the dataset containing keywords. These keywords consists of carefully designed words that corresponds to the different combinations of the dosages of medicines. As they are key to finding relevant medicine information. These keywords also consist of different words/combination of characters and numbers that correspond to the dosage, i.e., the digit 5 may also be returned by the Google Vision API as the letter S in the English alphabet. This is done mainly to account for the errors that

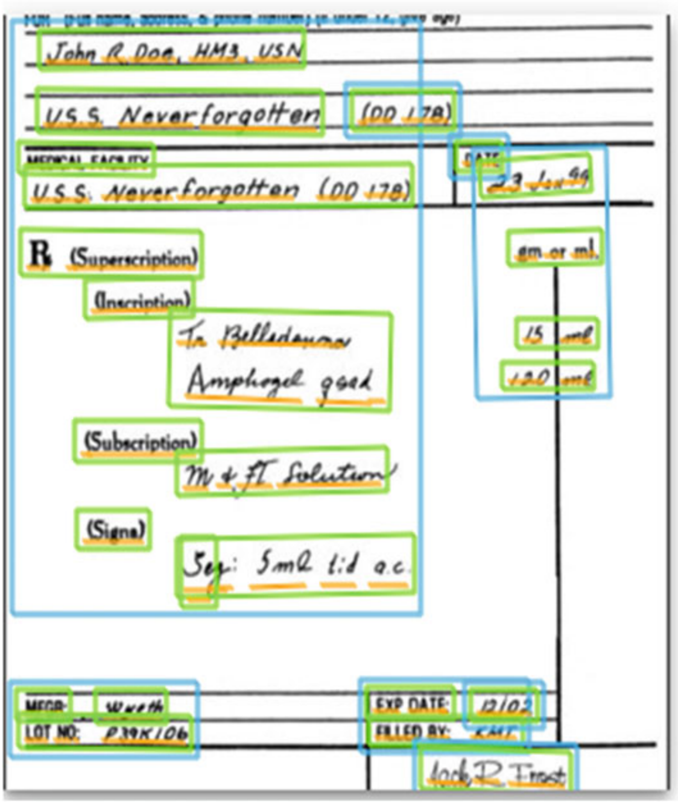


Fig. 3 Bounding boxes created by OCR

Google Vision API may return. These are mostly due to the handwriting of doctors being very complex.

This module hence scans the document for words returning a fuzzy match percentage of above 98 for every word in the keyword dataset. This then returns a candidate dosage that is accurate enough for the algorithm to do the rest of the processing.

3.4 Module 4

Module 4 consists of the second layer of the data parsing architecture. This is, however, the most complex and crucial component of the algorithm. This component is key to finding the relevant information from the medical prescription. As the candidate word that was returned in module 3 also contains relative position of the word in the document by means of the vertices of the bounding box which encapsulates the word, this can be used to our advantage in parsing the words in the immediate vicinity of the currently found word. This section of the algorithm searches for words in the immediate vicinity of the candidate word and returns a list of potential medicines.

3.5 Module 5

Module 5 consists of checking the list of words returned by module 4 and checks them against the second dataset in the architecture. This datasets consist of names of medicines currently in circulation at the time of performing this task. Every potential word in the list returned by the module 4 is checked against the dataset and are then ranked according to their fuzzy match score which is tuned to be above 85. The word that has the maximum score is selected as the name of the medicine.

3.6 Module 6

Module 6 consists of the data matching component of the architecture. The words found to be the name of the dosage and the name of the medicine are paired together to form a key value pair of data. This data can be utilized for efficiently processing the data and can be useful for a wide number of operations.

4 Our Approach

Our approach for creating a very efficient and scalable data parsing utilizes our novel selective sliding window filtering (SSWF) algorithm for parsing relative data contained within a medical prescription. This approach consists of two different datasets that can be used to find the accurate words that are found in the datasets.

4.1 Data Collection

Data collection for the datasets have been carried out keeping the possible biases in mind, this includes methods of determining the most common keywords that can be present within a prescription. It has also been taken to account that certain words can be mislabeled in the output of the OCR and a Rosetta Stone like dataset consisting of possible errors that can be captured by the OCR has been included in the dataset that consists of the different variations to a keyword and its actual correct representation added as key value pairs. This dataset is very crucial in finding the correct word in the document [13]. We are currently only focusing on the dosage information of every medicine to avoid the biases that can be caused by other common words in the document like tablets, syrup, etc., and are currently not considering any such words. We are only detecting words that correspond to the dosage information of a particular medicine. Dosage words include words like 10 mg, 25 ml and so on.

4.2 Selective Sliding Window Filtering (SSWF) Algorithm

The selective sliding window filtering (SSWF) algorithm stands for the approach taken for finding words in the immediate vicinity of the detected dosage words in the prescription document. This approach is motivated by the need for a highly efficient architecture for parsing information from the document [14]. This works by first using the detected dosage words and extracting its bounding box vertices returned by the Google Vision API.

4.3 Priorities

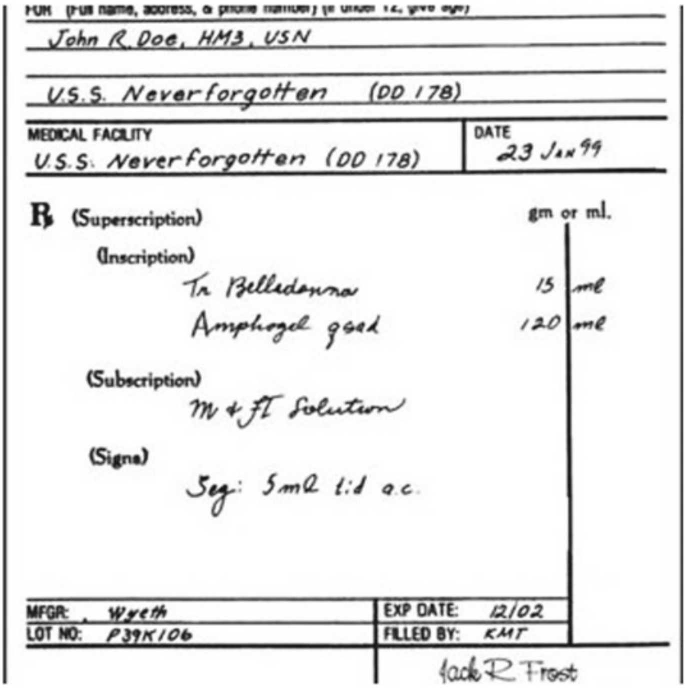
The priorities of this algorithm have been decided after immense research and are tuned to efficiently return the word in the immediate vicinity of the dosage word. This is done in three different directions, left, top and bottom. These directions are chosen as they are the most common places a medicine name is seen with respect to the dosage information [15]. However, the most common direction in a prescription is toward the left of the dosage information, e.g. Ranitidine 150 mg in Fig. 4. So this is the default location for search.

If a medicine name is not found in this direction, the algorithm then checks in the direction corresponding to the top of the dosage word. Same followed by the direction corresponding to the relative bottom of the dosage information.

4.4 Proposed Method

The search for a word in the immediate vicinity of the dosage word consists of extracting the vertices and setting a new bounding box through which all words falling within them is detected. The new bounding box is decided with respect to the vertices of the dosage word. If $[x, y]$ vertices of the dosage word that correspond to the bottom left, bottom right, top right and top left are assigned as A, B, C and D. And $[x, y]$ vertices of the new box that correspond to the bottom left, bottom right, top right and top left are assigned as W, X, Y and Z. In the case of searching toward left of the dosage word, the vertices are assigned to the new box are set as

$$W = A[x] - \text{decrement value of } x,\ A[y] - \text{decrement value of } v$$



FOR (Full name, address, & phone number) (If under 12, give age)
John R. Doe, HM3, USN
U.S.S. Neverforgotten (DD 178)

MEDICAL FACILITY
U.S.S. Neverforgotten (DD 178)

DATE
23 Jan 99

℞ (Superscription) gm or ml.

(Inscription)

Tr Belladonna 15 ml

Amphogel qsad 120 ml

(Subscription)

M + ft Solution

(Signa)

Sig: 5ml t.i.d a.c.

MFGR:	Wyeth	EXP DATE:	12/02
LOT NO:	P39K106	FILLED BY:	KMT

Jack R Frost

Fig. 4 Medicine name to the left of dosage words

$$X = A[x, y]$$

$$Y = D[x]\text{—decrement value of } x,\ D[y]\text{—decrement value of } v$$

$$Z = D[x, y]$$

Here, decrement value of x, decrement value of y are constants that allow the system to move the search window every time it does not return a value.

Here, the solid blue line refers to the bounding box created by the OCR and the dotted green line refers to the box created by the algorithm in Fig. 5 to look for potential medicine names.

The values are set globally independently for each direction. These values have been tuned to fit the widest use cases and to reduce errors while searching for words.

The resulting list of words is checked with an external dataset consisting of medicine names in Fig. 6. This is then fuzzy matched with each of the resulting words. If an accurate match is found that satisfies the threshold set, it will return the name of the medicine. This word is then paired with its respective dosage word and then returned as a key, value pair.

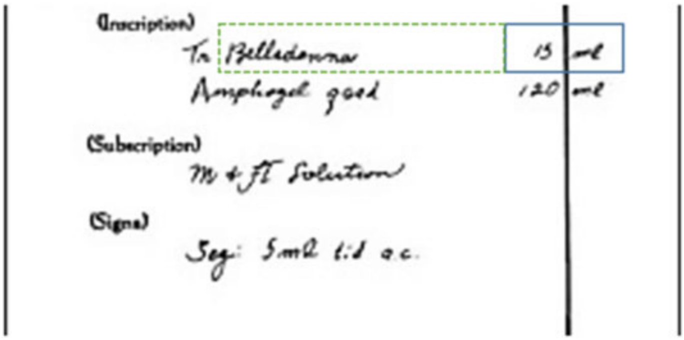
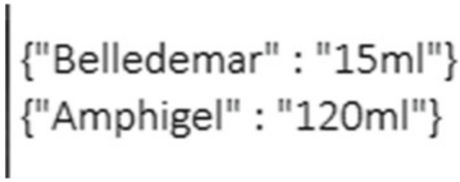


Fig. 5 SSWF algorithm searching for words

Fig. 6 Medicine data in key, value pair



We have also a check for supplicates at this step to account for any duplicates that might be detected by the algorithm. Hence, duplicate key, value pairs are removed from the final result.

5 Conclusion

In this paper, an efficient and scalable algorithm is proposed for innovatively search for medicine names in a prescription and return their details along with their dosage information using a HP Ink Tank 410 scanner and a Raspberry Pi 4. The devices are connected via USB and CUPS and is simple to implement. This algorithm innovatively searches for potential words in three different directions relative to the keyword first detected. This method not only works on printed prescriptions but also works efficiently on handwritten prescriptions. The future revisions of this algorithm can be potentially improved upon with a more accurate OCR system that has trained exclusively on prescriptions. Such a system can alleviate the need for correcting errors in the OCR text and hence reducing the complexity of the algorithm and further improving performance. One more aspect of a better result out of this algorithm would be the reality of a structured prescription format that is standardized. This would be beneficial in resolving some of the major issues that were noted in research.

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Optimizing Water Quality Parameters Using Machine Learning Algorithms

Avinash Sharma, Anand Kumar Gupta, Dharminder Yadav, and Tarkeshwar Barua

Abstract Water is the necessity of life; without water, human being not survives, but people are polluting the water. Water pollution is the major problem today and affects the groundwater quality. The main causes of water pollution are industries' waste product disposal, urbanization, crowded population, wastewater, sewage waste, and harmful chemicals' released by industries. There is an urgent need to resolve this issue in order for us to have safe drinking water. This article proposes a suitable classification model for classifying water quality that is based on machine learning algorithms and can be used to classify water quality. An evaluation and comparison of the performance of various classification models, visualizations, comparisons, and algorithms were carried out in order to identify the significant features that contributed to classifying the water quality of groundwater in Ambala, Haryana. Three models, each with its own set of algorithms, were tested, and their results were compared to each other as well. According to the results, the random forest algorithm was the best classification model out of the five models tested, with the highest accuracy of 82.67% compared to the other models. Overall, wastewater is hazardous to our health, and using scientific models to solve this problem is an absolute must.

Keywords Water · Machine learning · SVM · Naive Bayes · Random forest · Bagging · Boosting

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1 Introduction

Historically, natural sources of freshwater such as groundwater and surface water have been the least expensive and most generally available sources of freshwater. Although these resources are more likely to be polluted, this is due to a variety of causes such as human activity, industrial activity, and commercial activity, as well as natural processes. In addition to this, inadequate sanitary infrastructure and a lack of public knowledge both have a significant role in the pollution of drinking water [1]. Drinking water quality decline has far-reaching consequences that have an unfavorable influence on human health as well as the environment and infrastructure.

According to the United Nations (UN), waterborne illnesses claim the lives of more than 1.5 million people every year, a figure that is far higher than the total toll of deaths from accidents, crimes, and terrorism [2]. Because of this, it is critical to develop unique ways and procedures for assessing water quality and forecasting future changes in water quality over the coming years.

Freshwater supplies account for just 2% of the world's total water resources, and they are becoming increasingly contaminated as a result of human activities. According to the World Health Organization (WHO), the drinking of polluted water has resulted in 30% of all fatalities globally. The research, which is designed to examine the water quality, compares projected results with observed data using a machine learning algorithm to determine the quality of the water. A map describing the relationship between observed data and changes in quality measures may be created using data collected from water quality monitoring systems, and this map can then be used to anticipate future water quality. The typical method of analyzing water quality samples in a laboratory needs a significant amount of time and work, and it is also inefficient in some instances.

For the analysis and monitoring of water quality, as well as for time series analysis, many approaches have been developed and tested in various settings [3]. A wide number of technologies are used, including statistical techniques, visual modeling, analytical algorithms, prediction algorithms, and decision-making algorithms. AI techniques such as Bayesian networks (BN), artificial neural networks (ANN) [3], neuro-fuzzy inference [4], support vector regression (SVR) [5], decision support system (DSS), and auto-regressive moving average (ARMA) [6] may be used in the analysis and prediction of data, among other things. However, because of the nonlinear nature of water quality data, such as that shown in this study, mapping input–output data and predicting future water quality are extremely difficult [7].

This work aims to solve this issue by proposing a model based on machine learning techniques that can be used to predict water quality by using existing water quality information. There are nine specified water quality metrics that have been employed in this study, and they are as follows: ph, hardness, solids, chloramines, sulfate, conductivity, organic carbon, trihalomethanes, and turbidity. In this research, the ultimate objective is to build efficient models for predicting the values of water quality metrics based on the current values of those parameters.

2 Materials and Methods

In this study, the goal is to forecast water quality components using artificial intelligence (AI) approaches such as machine learning (ML), support vector machine (SVM), and neural networks. The examined data and region are therefore introduced in the first section of this section, and then the ranges of measured water quality components are reported in the second section.

2.1 Dataset

The dataset utilized in this study was compiled from several historical sites around the country of India. Over the year 2000–2018, it contains 3276 samples collected from various Indian states during that time period. pH, hardness, solids, chloramines, and sulfate are among the major factors in the dataset, which also includes organic carbon and trihalomethanes. The dataset also contains nine other significant parameters, including turbidity and organic_carbon. The Indian government gathered information in order to assure the quality of the drinking water that was provided. This dataset was taken from Kaggle, which can be found at https://www.kaggle.com/about/. Parameter of water defines as below.

1. **pH level**: pH of water lies in the range of 0–14. Carbon dioxide, bicarbonate, and carbonate are all components of the carbon dioxide–bicarbonate–carbonate equilibrium system, which governs the pH of water in most natural waterways. When carbon dioxide concentrations raise, the pH drops, and when they fall, the pH rises. It is important to note that temperature has an impact on equilibria and pH. When you raise the temperature of pure water by 25 °C, you see a pH reduction of roughly 0.45. Most drinking water has a pH from 6.5 to 8.5, which is the most common range. Because of acid rain or the higher pH in limestone locations, natural waters might have a lower pH.
2. **Hardness of Water**: It shows the capacity of water to precipitate soap in milligram per liter. The quantity of calcium and magnesium dissolved in the water is the simplest way to measure water hardness. Calcium and magnesium are the primary dissolved minerals in hard water. Soap may have left a film on your hands after washing; however, this is due to the hardness of your water.
3. **TDS/Solids**: Total dissolved solids in ppm. TDS is an abbreviation for total dissolved solids (TDS). Calcium, magnesium, chlorides, sulfates, and bicarbonates are just a few examples of the inorganic salts that make up TDS.
4. **Chloramines**: It is the amount of chloramines in ppm. Disinfectants for drinking water, such as chloramines, can be generated when ammonia and chlorine are combined in a process known as ammonium hypochlorite treatment (AHP). Since the 1930s, water treatment facilities have relied on chloramines.

5. **Sulfate**: Almost all natural water contains sulfate (SO_4). These chemicals are often formed by the breakdown of sulfite ore, or by the decomposition of industrial waste. Rain contains a significant amount of dissolved sulfate. When paired with calcium and magnesium, the two most frequent hardness elements, water with high sulfate concentrations can have a laxative effect. It measures amount of sulfates dissolved in mg/L.
6. **Conductivity**: The capacity of water to conduct electricity is measured by its conductivity. Inorganic substances such as salts and other dissolved salts are conductors of electricity; hence, saltiness raises electrical conductivity. The electrical conductivity of oil and other organic substances in water is low because they are poor electrical conductors. The higher the water's conductivity, the more it is influenced by its temperature. Electrical conductivity of water is measured in μS/cm.
7. **Organic_carbon**: The organic pollutants come from rain runoff. Organic pollutants from domestic and industrial wastewaters vary. Industrial organic pollutants might reach waterways due to spills or leaks. Some pollutants may not be entirely eliminated by treatment, posing a threat to drinking water supplies. It is vital to know a river's organic composition. Organic carbon is measured in ppm.
8. **Trihalomethanes**: Trihalomethanes (THMs) are formed when chlorine used to disinfect water reacts with organic materials in the water. THMs have been linked to cancer and poor reproductive outcomes at high doses.
9. **Turbidity**: Turbidity is a liquid's relative clarity. It is an optical property of water that measures how much light is dispersed by materials in the water when a light is flashed through it. The turbidity increases with dispersed light intensity. Algae, dissolved colored organic compounds (DOCs), plankton, and other microscopic creatures generate turbidity in water.
10. **Potability**: It indicates if water is safe for human consumption. Potable—1 and Not potable—0

Figure 1 depicts the working methodology. Data contains lot of anomalies; some of the parameter values have null value. Most important factor is that effects the analysis of water data, so firstly, we remove the null value or replace the null value with the row mean or column mean value, then normalize the value by using the Z-score normalization. Figure 2 shows the null value contained by the dataset and visualization by using Missingno. Missingno is a great Python module that helps you understand the existence and distribution of missing data in a Panda's data frame.

Figure 3 represents the feature distribution between potability and non-potability data. Dataset contains that 61% of water is not fit for human use and 39% of water is usable to human. It shows that most of the water is not used for drinking purpose. Figure 4 displays heatmap among the nine parameters of water, left image manifests potability of water, and right heatmap image conveys the relationship between the potability and non-potability of water.

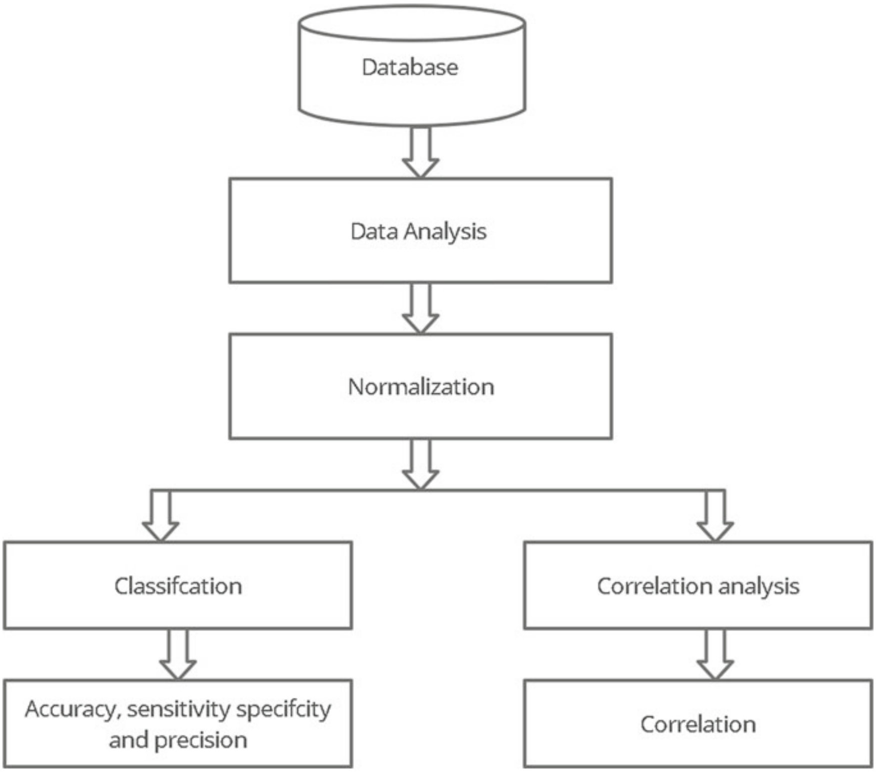

Fig. 1 Framework of the proposed methodology

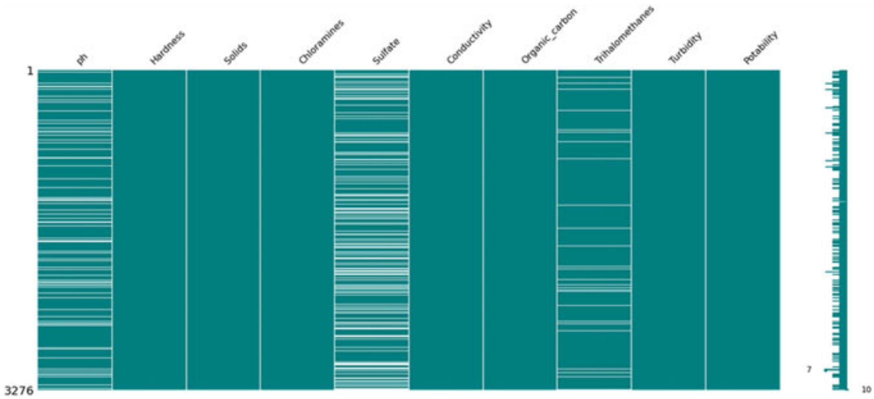

Fig. 2 Parameter containing the null value and visualization using Missingno

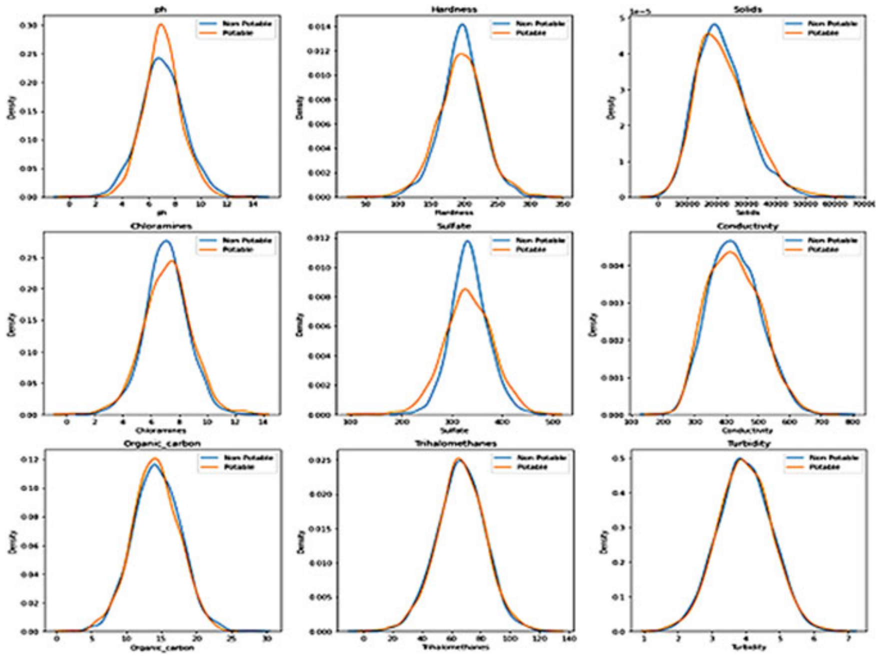

Fig. 3 Distribution of feature in potability and non-potability

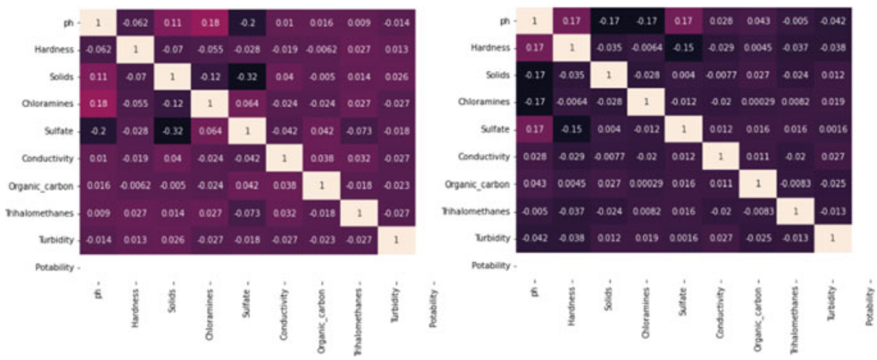

Fig. 4 Manifests the heatmap of water data

2.2 Data Processing

Processing data is critical to improving data quality. The WQI was derived using the dataset's most important parameters. The WQI scores were then used to classify water samples. The *Z*-score approach has been used to improve data normalization accuracy.

The TDS levels appear to have some inaccuracies because their average readings are on average 40 times higher than the safe drinking water guideline. Water samples with acidic and basic pH levels are about equal in quantity in the dataset. Over 92% of the data were deemed unusable. Chloramine levels were found to be safe in just 2% of the water tests. Sulfate levels were found to be safe in just 1.8% of the water samples. About 90.6% of the water samples tested showed carbon levels that were greater than the normal carbon levels in drinking water (10 ppm). On the other hand, trihalomethane levels in 76.6% of water samples were low enough to be considered safe for human consumption. About 90.4% of the water samples tested were safe to drink in terms of turbidity. Feature correlation coefficients were quite low. A combination of random forest and XGBoost was the most effective method for training the model. Voting classifier on stratified K-folded samples produced an accuracy rate of more than 64% in the ensemble technique.

3 Result and Discussion

The dataset was separated into 75% training subsets and 25% testing subsets in order to validate the generated model. The SVM, KNN, logistic regression (LR), decision tree classifier (DTC), GaussianNB (GNB), stochastic gradient descent (SGDC), perceptron (Perc), nearest centroid (NC), ridge classifier (Ridge), BernoulliNB (BNB), random forest classifier (RF), AdaBoost classifier (ADA), gradient boosting classifier (XGB), passive aggressive classifier (PAC), and Naive Bayes were used for the water quality classification prediction. Figure 5 depicts the accuracy of distinct machine learning algorithm.

We selected the best five baseline models and adjusted their hyperparameters. Random forest and XGBoost stood out from the rest; therefore, I went with those two as my final models. Accuracy of the random forest is the highest followed by LightGBM, SVM, and bagging. The model precision, recall, and $F1$-score are 0.81, 0.71, and 0.75, respectively. Figure 6 represents the true positive, false positive rate, and confusion matrix of the algorithm. SVM algorithm with different learning rate and kernel improves the accuracy of the model but not beats the random forest accuracy.

4 Conclusion

Water quality modeling and prediction are critical for environmental protection. To predict future water quality, powerful artificial intelligence algorithms can be employed to create a model. The sophisticated artificial intelligence algorithms' neural network models were employed to forecast the WQI in this proposed technique. To categorize the WQI data, machine learning methods such as SVM, KNN, LR, DTC, GNB, SGDC, Perc, NC, Ridge, BNB, RF, ADA, XGB, PAC, and Naive

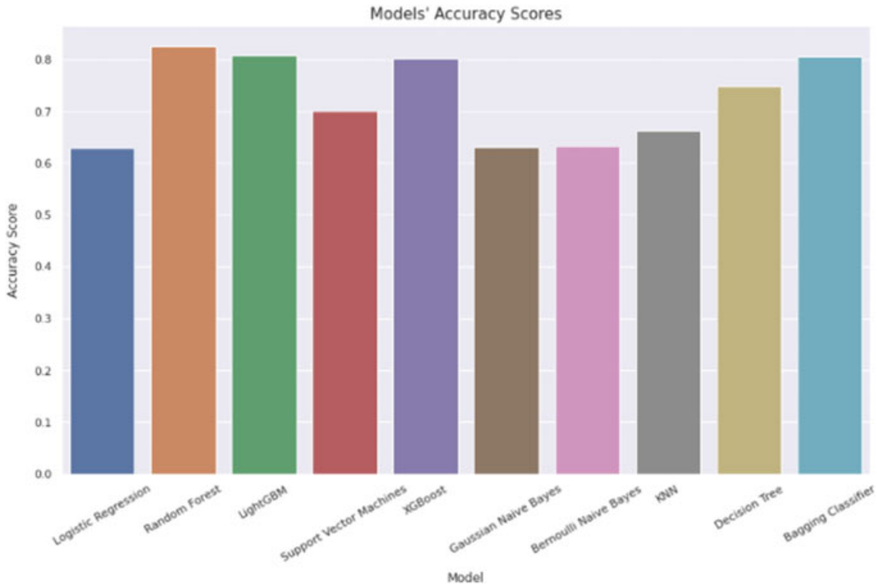

Fig. 5 Accuracy of non-identical machine learning algorithm

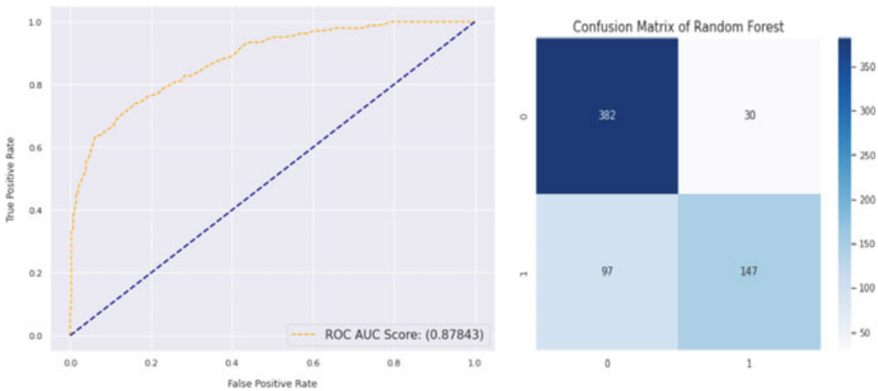

Fig. 6 True positive, false positive rate, and confusion matrix

Bayes were employed. Some statistical factors were used to verify and investigate the proposed models. When compared accuracy of machine learning algorithms, the random forest method predicted the WQC with the best accuracy. Following an examination of the robustness and effectiveness of the suggested model for predicting the WQI, the generated models will be utilized in the future work to forecast water quality in various parts of India for other types of water.

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Approximate Arithmetic Circuit for Error-Resilient Application

Garima Thakur, Shruti Jain, and Harsh Sohal

Abstract The approximate computing is a viable way of lowering the amount of energy. This energy is wasted due to complex designs. This paper proposes an effective approximate multiplier by using an exact multiplier and speculative Han-Carlson parallel-prefix adder. This optimization cuts down on power consumption as well as hardware overhead. Even though this method lowers the precision to some degree, the multiplier is still much more precise than is required for use in practical applications like image processing. An exact error compensation module that is effective and efficient is also designed to enhance the precision of the proposed approximate multiplier. As a result, authors developed a satisfactory solution that strikes a balance between precision and hardware metrics. The design that is implemented offers a significant improvement over its competitors in terms of the trade-offs between the performance characteristics and the precision. The proposed approximate multiplier shows 74.76, 44.41, 34.24, and 53.80% PSNR improvement in comparison with different state-of-the-art work.

Keywords Approximate computing · Arithmetic circuit · VIVADO · System generator · Error-resilient application

1 Introduction

The emergence of imprecise computing ushered in a new chapter for the design of high-performance circuits and systems that use less energy [1, 2]. The approximate circuits have a broad variety of error-tolerant applications, including image processing, machine learning, and many more [3–5]. In error-resilient applications, users often have to choose between precision, power, and speed. Components in digital circuits that multiply and add are known to use a significant amount of resources [6]. One of these strategies that are often used even though it exhibits in less accurate results is known as approximate computation [7].

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Energy dissipation has emerged as one of the most vital concerns in the area of integrated circuits because computing blocks are used in so many different applications [8]. It is vital to restrict the amount of money spent on design and execution, as well as the amount of energy that is lost, to bring about a revolution in deep learning, image processing, mobile, and multimedia error-tolerant applications that can tolerate small amount of loss in accuracy [9, 10]. As a consequence of this, approximate computing may be used successfully in various applications resulting in large decrease in the expenses of design and implementation as well as energy consumption. On the other hand, the quality of the findings is still respectable [11]. Therefore, accurate complex calculations are not reasonable in many applications, considering the increased complexity of integrated circuits and the importance of reducing power dissipation, particularly in battery-operated electronic devices [12].

Multiplier is one of the mathematical building blocks that is utilized to solve complex calculations and used in various applications as a basic module. An effective approximation multiplier design may increase the performance of digital systems as well as their energy efficiency [13]. This is because multipliers are often positioned on the critical path of digital systems. The process of multiplication typically consists of three stages: the formation of partial products (PPs) via the use of an array of AND gates, the reduction of partial products, and the calculation of the final output through the use of a ripple carry adder [14]. When considering these three steps, the second stage is the most important and requires the greatest force. Therefore, simplifying this phase may considerably improve the multiplier's overall performance while reducing the amount of energy usage [15, 16].

In this research article, the authors proposed an efficient approximate multiplier. The proposed design incorporates an exact multiplier and a speculative Han-Carlson parallel-prefix adder [17], which helps in simplifying the circuit. It also lowers the complexity by conserving energy and area/space. The proposed approximate multiplier strikes an appropriate compromise between the efficiency and precision of the error-resilient applications. In this paper, the validation of the approximate multiplier is done in an image processing application for image blending. The quality of image is evaluated in terms of PSNR and MSE.

The paper is continued as follows: The methodology for the implementation of the approximate multiplier is shown in Sect. 2. Section 3 shows the simulation results of the proposed design for variable bit width. The conclusion and future work are drawn in Sect. 4.

2 Methodology

The arithmetic circuits such as multipliers play a fundamental/basic role in various applications (image/signal processing). The implementation of an efficient multiplier increases the performance of such applications. In this article, the approximate multiplier is proposed by using the exact multiplier and speculative Han-Carlson (Sp_HaCa) adder as shown in Fig. 1.

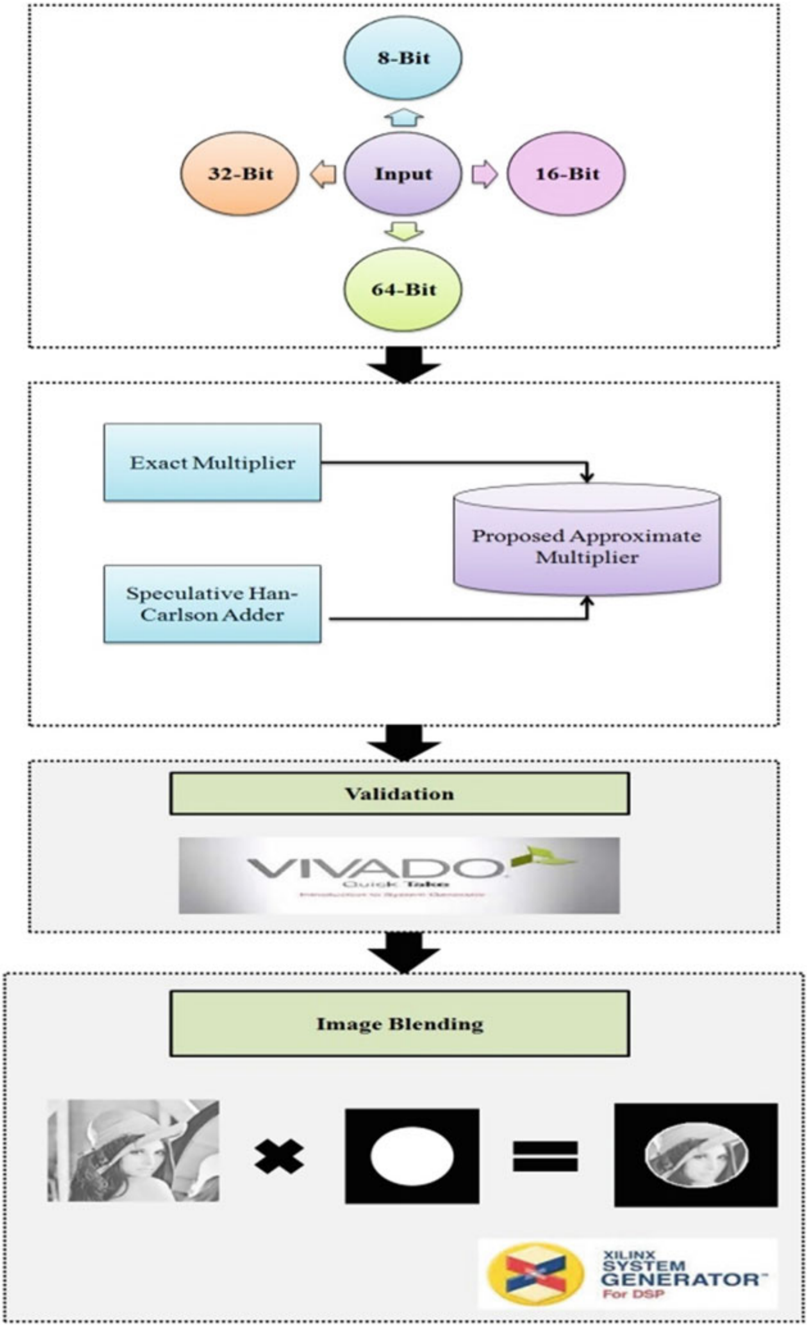


Fig. 1 Proposed methodology for implementation of approximate multiplier

Authors used the Sp_HaCa adder circuit which is proposed by Thakur et al. [17]. After the implementation of the approximate multiplier, it is further validated in the error-resilient application. Using approximate multipliers is the best way to achieve energy efficiency in computing, particularly in applications that have a fundamental capacity to tolerate error. All the simulations of arithmetic circuits were done in VIVADO 2018.3, and validation of the error-resilient application is done using Xilinx system generator.

Figure 2 illustrates the design of a generalized approximate multiplier that consumes less power. Both speculative Han-Carlson parallel-prefix adder and an exact/accurate multiplier are used in the implementation of the design. The results are computed for a variety of various operand widths. The implementation of a $2n \times 2n$ approximate multiplier involves the use of four $n \times n$ exact/precise multipliers in conjunction with four n-bit suggested speculative Han-Carlson adders.

In Fig. 2, four $n \times n$ exact multipliers are used for the generation of the partial products, and the final addition of partial products is done by using four Sp_HaCa adders. Algorithm shows the implementation of the proposed approximate multiplier.

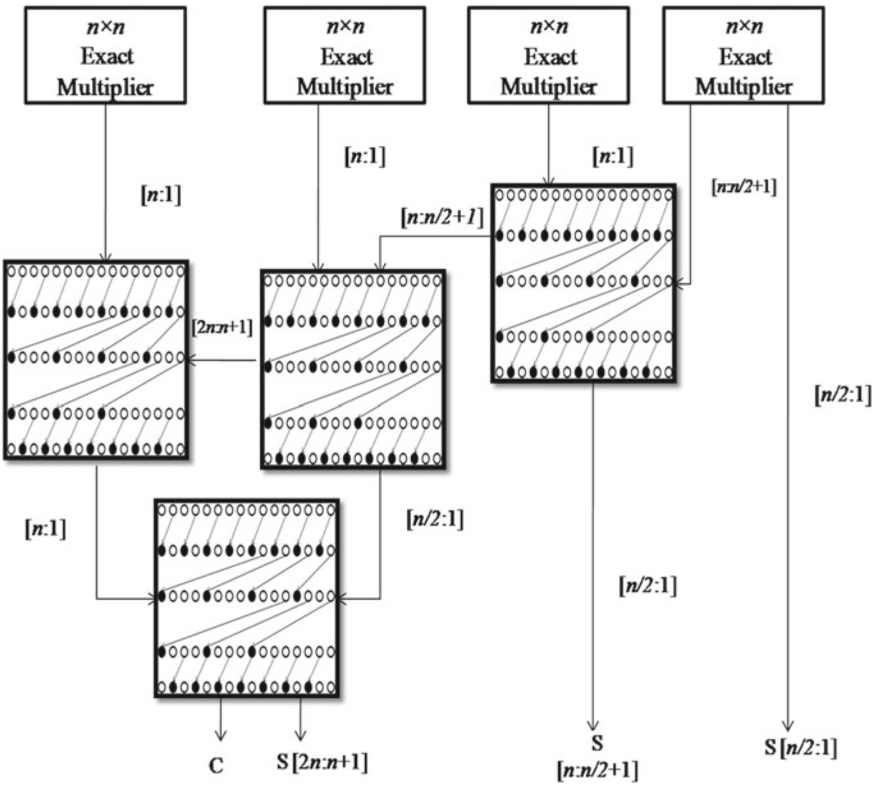


Fig. 2 Generalized diagram of the proposed approximate multiplier

Algorithm The proposed approximate multiplier design (A_pM)

Input: A, B: n-Bit operands

Output: $Prod$: $2n$ - Bit operands the approximate product

Exact Multiplier (E_M)

$x1 \longleftarrow$ E_M ($A[n/2:1], B[n/2:1], P1[n:1]$)

$x2 \longleftarrow$ E_M ($A[n:n/2+1], B[n/2:1], P2[n:1]$)

$x3 \longleftarrow$ E_M ($A[n/2:1], B[n:n/2+1], P3[n:1]$)

$x4 \longleftarrow$ E_M ($A[n:n/2+1], B[n:n/2+1], P4[n:1]$)

Speculative Han Carlson adder (Sp_HaCa)

Generate, $g_{iprev} = a_i \cdot b_i$

Propagate, $p_{iprev} = a_i \oplus b_i$

$$\tilde{c}_i = \begin{cases} g_{[i:0]} & for: i \leq K \\ g_{[i:i-K+1]} & for: i > K, i\ odd \\ g_{[i:i-K]} & for: i > K, i\ even \end{cases}$$

$$\tilde{s}_i = p_i \oplus \tilde{c}_{i-1}$$

Where $\tilde{c}_{i-1}$ is the approximated carry for i-1 bit input.

Approximate Multiplier (A_pM)

$k3[n/2:1] \longleftarrow P1[n:n/2+1]$

$k3[n:n/2+1] \longleftarrow n$'b0

$x8 \longleftarrow$ Sp_HaCa ($k3[n:1], P2[n:1], P8[n:1], c4$)

$k4[n/2:1] \longleftarrow P8[n:n/2+1]$

$k4[n/2+1] \longleftarrow c4$

$k4[n:n/2+2] \longleftarrow (n/2-1)$'b0

$x9 \longleftarrow$ Sp_HaCa ($k4[n:1], P3[n:1], P9[n:1], c5$)

$k5[n/2:1] \longleftarrow P9[n:n/2+1]$

$k5[n/2+1] \longleftarrow c5$

$k5[n:n/2+2] \longleftarrow (n/2-1)$'b0

$x10 \longleftarrow$ Sp_HaCa ($k5[n:1], P4[n:1], P10[n:1], c6$)

$k6[n/2:1] \longleftarrow P9[n/2:1]$

$k6[n:n/2+1] \longleftarrow (n/2)$'b0

$x11 \longleftarrow$ Sp_HaCa ($k6[n:1], P10[n:1], P11[n:1], c7$)

$Prod\,[n/2:1] \longleftarrow P1[n/2:1]$

$Prod\,[n:n/2+1] \longleftarrow P8[n/2:1]$

$Prod\,[2n:n+1] \longleftarrow P11[n:1]$

The algorithm shows how the computation is carried out for the implementation of the outcome of the approximate multiplier.

3 Results and Discussion

Approximate arithmetic circuits such as multipliers play a vital role in error-resilient applications. In such applications, an approximate arithmetic circuit increases the performance by compromising little loss in accuracy. In this paper, an approximate multiplier (A_pM) is proposed and implementation is done in VIVADO 2018.3 using varying bit width (8-bit, 16-bit, 32-bit, and 64-bit) and the validation is done in Xilinx system generator for 16-bit width. Table 1 gives the results of the approximate multiplier for variable bit width in terms of cell usage, area, and power consumed.

Table 1 shows that if the size of the bit increases the consumption of power also increases when compared to the previous bit. The size of the multiplier is selected, according to the requirement of the application. In this paper, 16-bit width approximate multiplier selected for error-resilient application. Figures 3 and 4 show the graph of the proposed approximate multiplier in terms of area utilization and power consumption, respectively.

Area (cells) and power (W) of approximate multiplier increase exponentially with the size of the circuit. The approximate multiplier is further validated in an error-resilient application.

Error-Resilient Application

Image multiplication is a technique that is used extensively in image processing applications to assess the quality of approximation multipliers in applications that take place in the real world. In Xilinx system generator, the output image/picture for the multiplication algorithm is computed by multiplying two images pixel-by-pixel to produce the product. The block diagram for the blending of images is shown in Fig. 5.

Authors have successfully blended two images using proposed approximate multiplier design circuits. Table 2 shows the comparison of the state-of-the-art technique with the proposed designs regarding the quality of images in terms of PSNR and MSE.

The proposed approximate multiplier shows 74.76%, 44.41%, 34.24%, 53.80% PSNR improvement in comparison with [2, 4–6], respectively.

Table 1 Results of proposed approximate multiplier for the variable operand

Proposed approximate multiplier design (A_pM)	Cell usage			Area	Power (W)		
	LUT	IBUF	OBUF	Cells	Dynamic	Static	Total on-chip power
8-bit	116	16	17	149	12.899	0.345	13.244
16-bit	555	32	32	619	38.602	1.147	39.749
32-bit	2420	64	64	2548	130.224	4.554	134.779
64-bit	9875	128	128	10,131	484.422	4.554	488.978

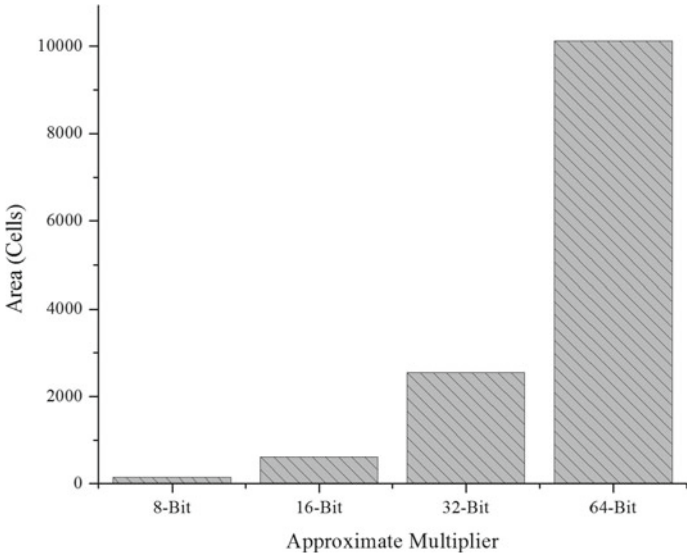


Fig. 3 Approximate multiplier area (cells) graph for variable bit width

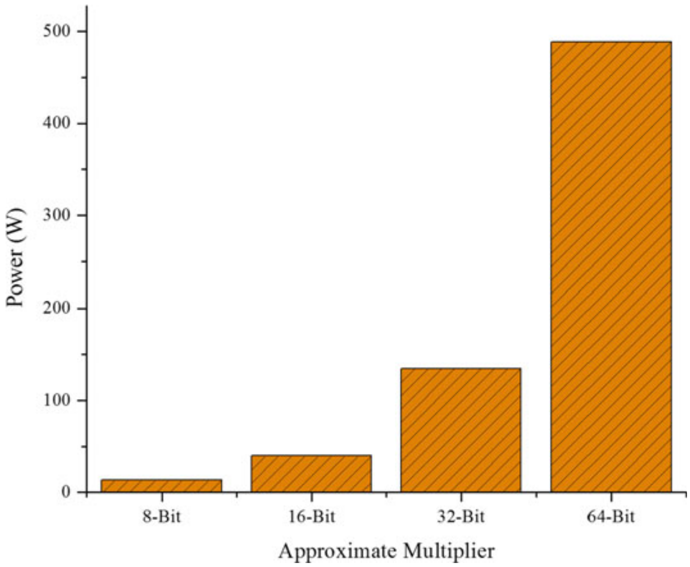


Fig. 4 Approximate multiplier power (W) graph for variable bit width

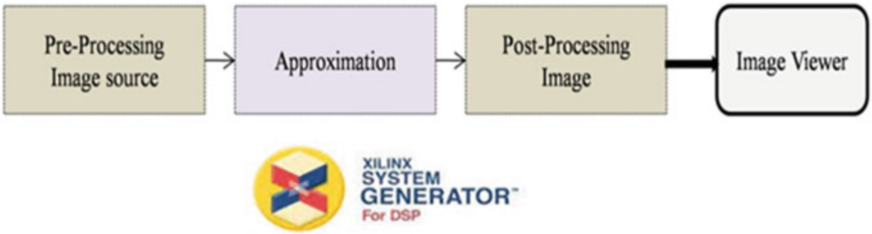
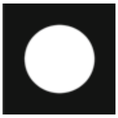
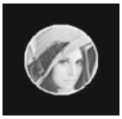
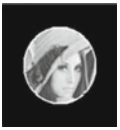
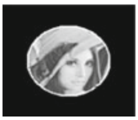
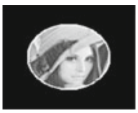


Fig. 5 Block diagram representation of image blending

4 Conclusion

In this paper, circuit design is proposed to optimize the power using an approximate multiplier. The proposed approximate multiplier is implemented with the help of an exact multiplier and parallel-prefix adder. The exact multiplier helps in maintaining the accuracy of the circuit and the parallel-prefix adder helps in increasing the performance. All the simulations are done using VIVADO software and MATLAB. The proposed multiplier is further validated in the error-resilient application. The proposed approximate multiplier shows a remarkable percentage improvement in PSNR in comparison with state-of-the-art work. In the future, the complexity of the circuit may be decreased further by using optimized modules on the behalf of the exact multiplier.

Table 2 Comparison of state-of-the-art technique with the proposed design

		PSNR (dB)	MSE
Input image 1		–	–
Input image 2		–	–
Output image using exact multiplier		–	–
[2]		9.78	6840.41
[4]		21.54	456.12
[5]		25.48	184.11
[6]		17.9	1037.72
Proposed approximated multiplier design (A_pM)		38.75	8.67

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Development of a New Technique to Improve Security of Data in Remote Patient Monitoring System in Health Care

Shivanshu Bansal and Chander Diwaker

Abstract New emerging technologies in today's world play a vital role in each and every sector. In health sector, also a lot of research work is going on to transform the traditional health sector into a digital health sector with the help of these new technologies. And the biggest step toward this transformation in health care is remote patient monitoring (RPM). Remote patient monitoring (RPM) is the most powerful tool to observe the patients effectively at any time. RPM allows the healthcare providers to get the real-time monitoring of the patients with the help of sensors, wearable devices, smart phones, etc. Data is a new fuel of twenty-first century, with the implementation of different new technologies in various fields the legitimate concern of data security and privacy of the users is also arise which has to be resolved for maintain the trust of the users. And this research acknowledges this concern seriously and efficiently. The objective of this research is to enhance the security of the data of patients with the help of RSA by preventing the malicious data infusion in wireless sensor networks (WSNs) used in remote patient monitoring architecture, to maintain the integrity and authenticity of data by en-route filtering using RSA and to enhance the efficiency of overall system by minimum use of energy with the help of AODV protocol. The proposed enhance security mechanism is simulated using NS2 simulator. This research work provides a path to move a step further in transforming the health sector when dealing with the legitimate concern of data protection simultaneously.

Keywords Wireless sensor networks · Malicious data infusion · Cryptography · RSA · AODV en-route filtering · NS2 simulator · Remote patient monitoring

1 Introduction

Remote patient monitoring (RPM) is the most powerful tool to observe the patients effectively at any time. RPM allows the healthcare providers to get the real-time

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monitoring of the patients with the help of sensors, wearable devices, smart phones, etc. With the help of this new emerging technology of RPM, the time and cost of the patients are reduced significantly and it also enhances the quality of the health care. As RPM model is used significantly to reduce the burden on the existing healthcare infrastructure it works on various latest technologies and advance devices to process and gather the information of the patients remotely. One of the main components of the RPM model is wireless sensor networks (WSNs).

WSNs consist of the network of various small sensors which are used to collect the information and transfer it to the common location. There are wide applicability's of the WSNs in various critical and important fields like defense surveillance, monitoring of various environmental activities, remote patient monitoring (RPM), etc. [1]. Wireless sensor networks consist of various units which are known as sensor nodes and this sensor node consists of different parts like radio transceiver which helps in the communication with different sensor nodes, microcontroller which is used to handle all the computational issues and one battery unit as shown in Fig. 1. Sensor nodes may be varying in size and in cost also. Every node has the different function to perform like processing of data, storing of data, acquiring of data, etc. Mainly, WSNs consist of independent nodes which are actually responsible for the functioning and infrastructure building of the wireless sensor networks.

In RPM, WSNs, wireless sensor networks consist of various small units which are known as sensor nodes and this sensor node consists of different parts like radio transceiver which helps in the communication with different sensor nodes, microcontroller which is used to handle all the computational issues and one battery unit as shown in Fig. 1. Sensor nodes may be varying in size and in cost also. Every node has the different function to perform like processing of data, storing of data, acquiring of data, etc. Mainly, WSNs consist of independent nodes which are actually responsible for the functioning and infrastructure building of the wireless sensor networks. In RPM, WSNs or WBNs help to monitor the patients, collect the data related to the health and transfer it to the central location where doctor examines the data and diagnose the patient effectively. It is a quite effective and efficient system for the

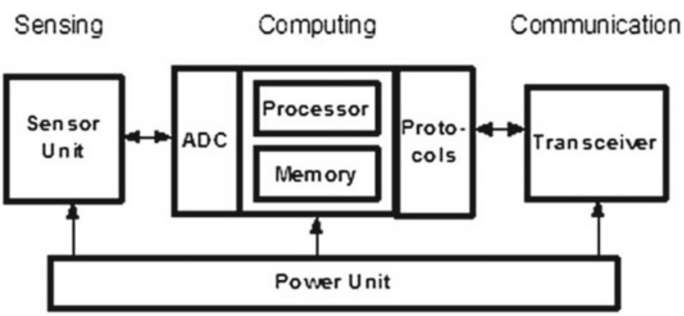

Fig. 1 Architecture of sensor node in WSNs

patient monitoring but on the other hand, there is some serious concern related to the security of the data as well as high energy consumption while using WSNs [2, 3].

2 Problem Formulation and Solutions

2.1 Problem Formulation

WSNs are a part of various applications models which are used in various critical sectors like defense while doing surveillance on border, intrusion detection and health in remote patient monitoring. These applications demand the high level of security in the communication phase with the low level of energy consumption which is some sort of tricky task. There are some problems related to WSNs in RPM model which are needed to be address.

- Malicious data infusion in WSNs in which the unsecured nodes infuse the false data in WSNs which will further deteriorate the decision taking function of the system.
- High usage of the energy due to high processing capacity of various security techniques and the false infusion of data.
- Increase the chances of DOS attack due to high false data insertion.

These are the various issues which should be addressed while implementing the RPM model based on WSNs. So, that the privacy and security of the data has to be maintained and effective and proper use of the RPM will achieve without any trust issues.

2.2 Objective

As based on the above problem formulations which are quite serious concerns related to the security of the data in RPM and the efficiency of the RPM model. The following objectives have to be accomplished to achieve the secure and effective WSNs-based RPM system:

- To prevent the malicious data infusion in WSNs by enhancing the security based on RSA algorithm and routing methods.
- To maintain the integrity and security of data and to increase the authenticity of nodes and sender.
- To attain the minimal energy consumption while enhancing security in the communication phase.

2.3 DFD for Purposed Solution

Data flow diagram (DFD) is basically a pictorial representation of flow of process in the particular architecture. In the proposed schema, DFD shown in Fig. 2 represents the objectives and their solutions to implement the security framework in the remote patient monitoring. DFD simplifies the understanding of the process and workflow of implementation in the proposed system.

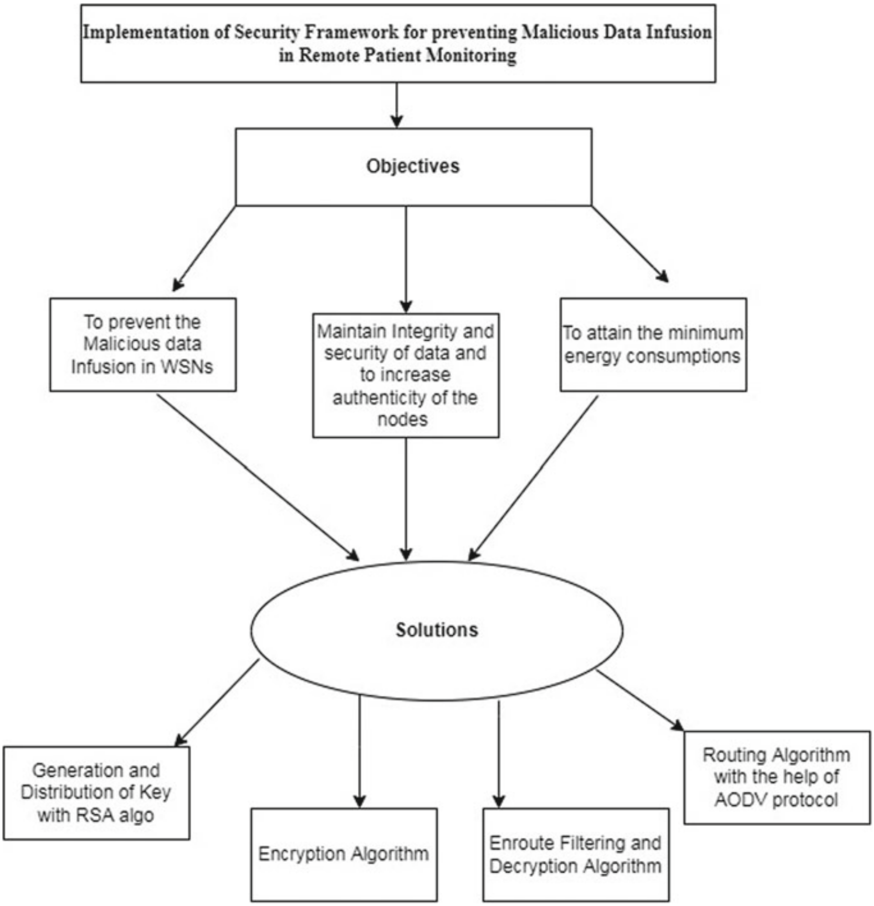

Fig. 2 Data flow diagram for proposed solution

2.4 Implementation

The objectives sighted above will going to be achieve with the help of different algorithms in the implementation module. This particular implementation section is bifurcated into four major parts as discuss:

- Generation and distribution of a key with the help of RSA algorithm
- Encryption module for encrypting the data
- En-route filtering for decrypt the encrypted data
- Routing to transmit the package at right destination

The main module is divided into these four parts and the input to this main module is the script which consists of all the information related to the nodes which are going to be used in the implementation, about the communication section between the different nodes, about the deployment scheme of different nodes, and last but not the least about the routing protocol to transfer the package of data to the safe destination. With the help of these four major parts, security enhancement has to be achieved with the minimal energy consumption in the proposed schema [1].

2.4.1 Key Generation and Distribution

The first part of the proposed model is the generation and distribution of key. It is considered as one of the most important module because it will help to achieve the confidentiality and authenticity of the data which is one of the main objectives of implementation.

Cryptography is the highly efficient technique to achieve the high level security and to prevent the infusion of malicious data in wireless sensor networks (WSNs) in remote patient monitoring. In this technique, only the authenticate users are eligible to see the content of the any message sent.

RSA algorithm has been used in this to achieve the authenticity of the data. RSA algorithm is an asynchronous cryptographic algorithm consists of two keys [4].

- Public key
- Private key

Private key has been used to encrypt the data so that the data cannot be compromised before reaching on the defined destination.

Public key is used to decrypt the encrypted data, so that only the authenticate user can able to access the relevant data. Creation of the pair of keys is the first step toward the implementation of this module. Once this will achieve the public key has to be accessible to all the nodes present in between and to the destination so that the decryption of the text will easily be done [5].

Algorithm
Step 1: Select two large prime numbers r and s randomly.
Step 2: Get $p = r*s$.

Step 3: Euler quotient function of p, $y = (r - 1)\ (s - 1)$.
Step 4: Select public key, a in such manner that a selected public key should be less than p and a and y are relatable and prime.
Step 5: Select private key, b in a manner that b is divisible by y and the remainder will 1 ($b = a$ inverse mod y).

2.4.2 Encryption of Data

This particular step is used for the encryption of the data which are further sent to the destination for the sinking of the data from where it is to processed and get the desire results. The sender of the data will encrypt the data in this section with the help of the private key which is achieved by the key distribution and generating task. After the encryption of data has been done the result obtained in the ciphertext is transmit toward the destination. Basically, encryption is to secure the data from the unauthenticated users [6].

Algorithm
Step 1: Provided the input private key (b) and data (D).
Step 2: D is divided into number d in a manner that $d < f$ with the help of the padding scheme.
Step 3: Calculate the ciphertext t as

$$d = t^b \bmod f.$$

2.4.3 En-route Filtering and Decryption of Data

This is the third part of the implementation phase. En-route filtering is the technique which is worked on the unsecured nodes and it is commonly used in the system desired for data transmission. In this technique, intermediate nodes present in the functioning of data transmission are used to carry out the task of data authentication and verification unlike in another techniques or traditional scheme in which the destination nodes are performing the task of verification and authentication of data. The main purpose of using en-route filtering here is to increase the efficiency of the results because the method of en-route filtering is energy efficient as compared to other methods as well helpful in prevent the malicious data entry [7].

In this method, basically, the main performing task is of decryption. The encrypted data in the ciphertext form is taken as the input and with the help of the public key the decryption has to be performed on the received encrypted message. If the decryption is achieved successfully, then it is the indication that the sender is authenticate as there is no malicious infusion by any other unauthenticated user. Since all the process is going accordingly from receiving of the ciphertext to the decryption of the message it means the confidentiality of the system is also verified. If the received encrypted message is not decrypt accordingly, then it is the indication that some malicious data have been transmitted by malicious node. Hence, the message will be dropped [8].

Algorithm
Step 1: Take ciphertext (t) and public key (a) as input.
Step 2: Calculate t^a
Step 3: Calculate $t^a \bmod f$.
Step 4: Calculated result is original text d.

2.4.4 Routing

In this module, the data packet is transmit to the right destination with the help of AODV protocol. AODV protocol [9–11] further takes up the process with the help of route discovery technique. When the final route has been selected for sending the data packet, the route reply phase comes to an end by completing the entry in the routing table. Once all this process is completed and the route is finalized, then the packet will sent to the right destination [12–14].

Algorithm
Step 1: A ROUTE DISCOVER message has been forwarded by the AODV protocol to the present nodes in the network.
Step 2: ROUTE DISCOVER message flooded by nodes in the network and at least one message will reach at the destination.
Step 3: A ROUTE REPLY message has been prepared by the destination node and resend it to the sender.
Step 4: Those intermediate nodes which received the ROUTE REPLY will update the routing table with the new entries.
Step 5: After the ROUTE REPLY message received by the sender, the routing table will update and packet will ready to transmit.
Step 6: Packet is transmitted to the right destination through all the calculations.

2.5 Simulation and Results of the Proposed Schema

For completing the task of the simulation in the defined schema, there is a need of network simulator. In the proposed system, network simulator NS2 has been chosen as a simulator. NS2 is the advanced simulator used to simulate test protocols and network on it. Different simulating protocols like TCP, FTP, UDP, HTTP, etc., has supported by NS2 simulator. NS2 is coded in the C++ programming language, and all the implementation has been done on C++ only. So, simulation in this proposed system has been carried out by the NS2 simulator. To check out the performance of the system algorithm of preventing false data injection and algorithm of dynamic source routing has been simulated.

2.5.1 Results

Different parameters are used to analyze the performance of the proposed solution based on NS2 simulation. Parameters under consideration are encryption and decryption of the data, throughput value, packet delivery ratio, energy consumption. Mentioned parameters are discussed below.

Encryption and Decryption of the Data

Cryptography is the highly efficient technique to achieve the high level security and to prevent the infusion of malicious data in wireless sensor networks (WSNs) in remote patient monitoring. In this technique, only the authenticate users are eligible to see the content of the any message sent [5]. In the proposed system, RSA algorithm is used to achieve the cryptography and enhance the security in the proposed solution. Public key and private key have been generated and distributed to encrypt and decrypt the messages. So, that the authenticity of the system has maintained and the data of the users will remain safe and secure [15]. The implementation result of the RSA algorithm is shown in Fig. 3.

Throughput

Throughput in any network can be defined as the total number of the valid messages reached to the right destination in the per unit time over any communication medium. It is represented by the unit bits per second or bps. The medium over which the messages are delivered can be wired, wireless, physical or logical, etc. In some situations or in some techniques, the throughput can also be defined as the number of data packets per second. If the packet drop is less it means the system is working in the efficient manner, more appropriately and throughput value is better because there is no congestion of the data at the destination point. Result obtained in Fig. 4

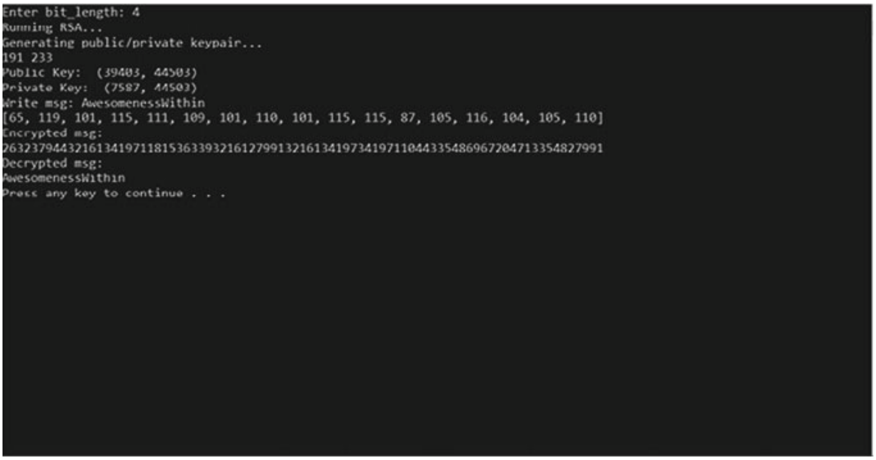

Fig. 3 Encryption and decryption using RSA

clearly shows the high value of throughput as compared to the traditionally used BECAN-based method as packet drop is less [16].

Packet Delivery Ratio

Packet delivery ratio is defined as the ratio of packets reached at the destination point to the number of packets sent from the receiver end. The attached result in Fig. 5 illustrates the delivery ratio of the packets, i.e., number of packets delivered to the destination. In the defined system, the packet delivery ratio is high because the packet drop count is less due to use of AODV protocol as compared to the traditional BECAN method [13, 14].

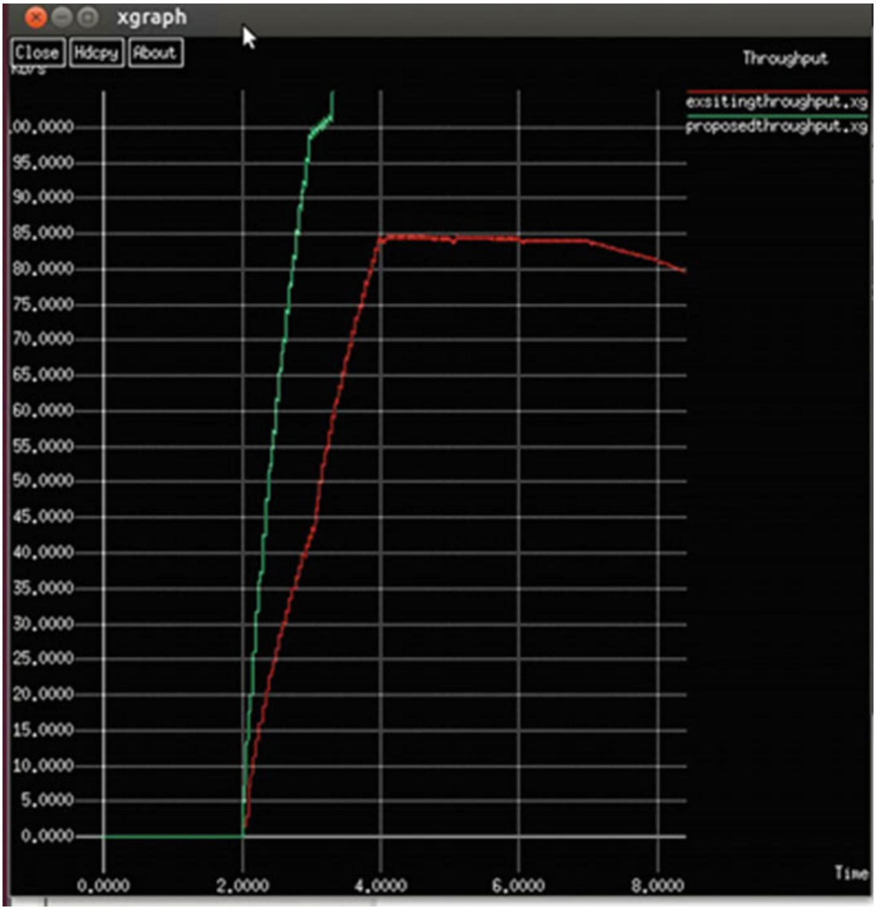

Fig. 4 Throughput, time versus bits received in kbps

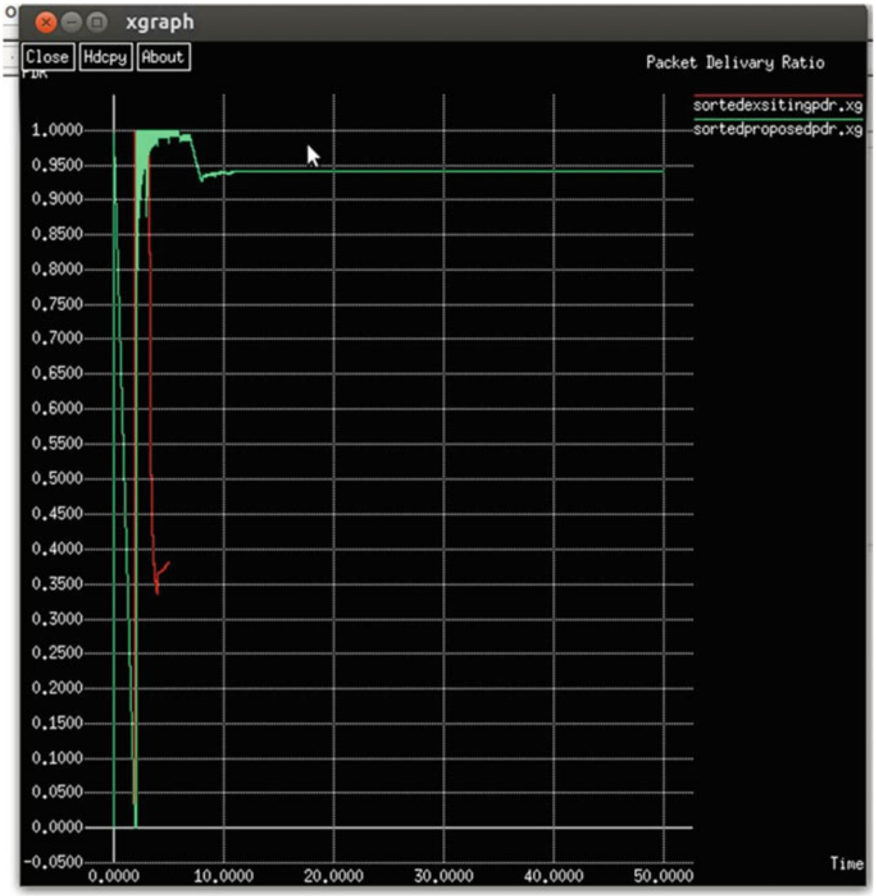

Fig. 5 Packet delivery ratio, time versus successful delivery

Energy Consumption

Energy consumption by every node present in the system is the important parameter to determine the efficiency of the wireless sensor networks because rate of energy consumption decide the lifetime of the WSNs. The total energy consumed by particular node depends upon the amount of energy used in transmission and reception process of the data packets [12]. New schemes and protocols should develop and implemented in a manner that the consumption of energy is minimum. In the given architecture, there is a minimal use of energy because of two reasons:

- Overload is minimum in the proposed scheme because of high throughput and packet delivery ratio. Packet drop count is less due to which the congestion of data is minimum, and hence the load is less.

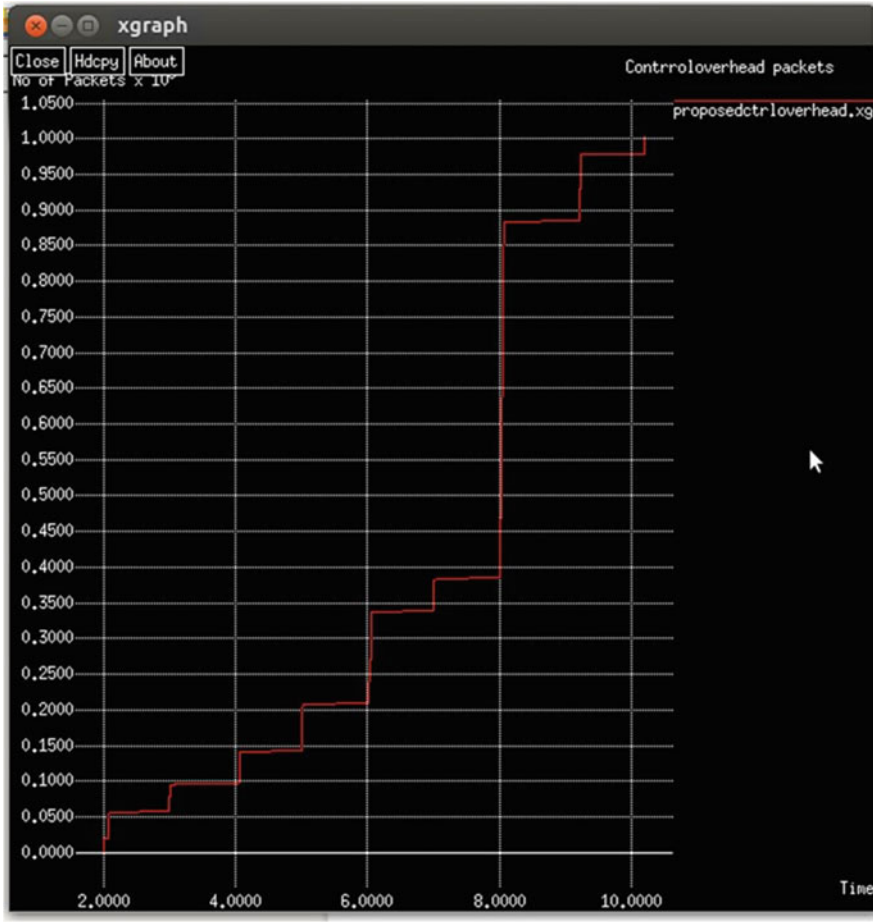

Fig. 6 Control overhead

- Cryptography scheme used in the proposed solution is less complex and provides high authenticity and security as compared to other schemes (Fig. 6).

3 Conclusion

The proposed work helps to compute the performance of the sensor networks after the implementation of the security algorithm based on RSA to prevent the malicious data infusion in the WSNs used in the RPM architecture. In RPM, the security of the patient's data and the efficiency of the whole system are the two important things which has to be addressed. The proposed system smartly handles both the issues simultaneously in effective manner. As compared to previous researches like MAC-based BECAN scheme it provides high security with the help of public key cryptography, privacy, high efficiency, high throughput value, etc. And the most important thing is that it is easy to implement and less complex due to which it takes less energy consumption and hence increase the efficiency of the whole system. Remote patient monitoring is the biggest game changer in the health sector. It simplifies the lives of both the doctors and the patients as well as reduces the burden on the traditional health sector. With the implementation of this new proposed RSA-based security scheme with AODV protocol the concerns related to the security of the patients data and the efficiency of whole system has also been addressed.

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An Effective Intrusion Detection System in Cloud Computing Environment

Sarvottam Dixit and Gousiya Hussain

Abstract Cloud computing is gaining popularity in the domain of computer science and is commonly called as a new data hosting technology; thanks to the cost reimbursement inflicted upon companies, the technology is becoming very popular. Cloud computing plays an integral role in computer science and assists in the development of computer science in a very fast manner. Cloud computing can be defined as a method of sharing resources with clients in a more efficient way. It works with the idea of virtualization and there are several types of service providers, like SaaS, IaaS, and PaaS. Cloud computing has some problems in security and the data stored in the cloud server. The main concern in cloud computing is the security. Due to its distributed and open architecture, an intrusion detection system plays an important role to protect a computer system. Main goals of the IDS include monitoring access and identifying unusual access or attacks on the system. In machine learning, detecting anomalies in data is a fundamental task. These techniques used to identify known and unknown attacks in the cloud.

Keywords IDS · HIDS · NIDS · Cloud storage · Cloud computing · Machine learning

1 Introduction

Cloud computing is a satisfactory solution to the problem of ease of access and durability of data. It allows clients to take privilege of a wide range of online offerings without having to bother about the technical requirements of their use, as it can handle and server digital data through a fully outsourced infrastructure. Described in the NIST report, cloud computing involves the provision of various services via the Internet, including data storage, servers, databases, networking, software, and more that are instantly accessible and released without much managerial effort or interaction with the service provider [1]. It is characterized by ubiquitous, convenient,

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on-demand network access to customized computing resources. Organizations are relocating their data and application software to cloud storage systems due to the ease [2]. The major downside of cloud computing is that client lose physical control over their records when they offload them to an unreliable cloud service provider. In spite of how effective and extensive a server's computational power are in contrast to a client's computational power and performance, the cloud encounters innumerable security concerns from both external and inside the cloud that could leverage security vulnerabilities to pose a threat. These failings can jeopardize confidentiality of data, authenticity, and accessibility [3]. The cloud provider ensures security of data for cloud client's stored data by using techniques such as firewalls and virtualization. Because of network vulnerabilities, aforementioned approaches could not deliver the complete data security. Therefore, designing an IDS powerful in terms of preventing both inside and outside security breaches in the cloud framework is vital [4, 5]. An intrusion detection system (IDS) is a hardware/software framework that supervises and examines events in a device or network in order to identify privacy violations. Intrusion detection systems (IDSs) focus on ensuring the privacy, integrity, and availability of a network or system. Following are some of the data storage security breaches and challenges [6, 7]. Data privacy and integrity issue: If an intrusion on a data entity is successful, it will result in a privacy breach, granting the intruder illegal rights to acquire access to the client's data. Data stored in the cloud loses its multi-tenant characteristics as a result of this violation. SaaS vendors, in specific, may lose their technical details. Aside from these potential threats, processing of data poses a significant danger as resources are shared between multiple tenants [8]. As an outcome of virtualization, several physical resources are shared among the clients. As an outcome, malicious insiders of the CSP and/or company can launch intrusions [9]. In these scenarios, a hacker can attack other clients data when processing their own. Another major problem is when the CSP sends data to third-party storage. Data confidentiality issue: In multi-tenant systems, maintaining data confidentiality becomes difficult and conflicting. This is largely because customers entrust their information to untrustworthy cloud service providers (CSPs) and moreover data is stored over multiple physical locations in cloud computing. It is onerous to ensure security in the cloud due to a lack of stable technical and regulatory constraints [10]. One of the most essential security concerns is the confidentiality of user data in the cloud. It is practicable to protect encrypted information from an intruder but not from the cloud provider. Data recoverability and vulnerability: The cloud provides its clients on-demand resources attributed to its resource pooling and scalability features. The resource allotted to one client may be redistributed to another client afterward [11]. Speaking of memory as well as storage resources, an intruder could employ backup and retrieval approaches to access prior client's data. Cryptography: Cryptographic techniques are used in the cloud to overcome security gaps [12]. However, issues like prime factorization of large integers in RSA and discrete logarithmic problems in ECC, as well as poor implementation could give rise to a brute force attack. Other concerns related to cloud cryptography include improper key management and inadequate computational efficiency. Malicious insiders: Within organizations, the malicious insider has become a serious security issue. People employed, contractors, and third business associates can all constitute an insider threat to an organization. These kind of attacks on the cloud, result in the deprivation of client's data privacy and security eventuating in data breaches both within the organization and in the cloud [13]. Man-in-middle attack: attack arises whenever an intruder is positioned between two entities in a cloud system. This sort of attack seeks to gain access to confidential data that is being communicated. Attack on virtualization/hypervisor: There are two kinds of virtualization intrusions. One of those is, rootkit in hypervisor and the other one is virtual machine escape [14]. An intruder can jeopardize the hypervisor and acquire access to deployed virtual machines, and the affected hypervisor could be utilized to gain control over the users [15]. Phishing attack: Within PaaS cloud model, phishing intrusions have an impact on both providers and clients. This category of intrusion attempts to obtain confidential details from a valid use by exploiting a webpage and redirecting the victim to a spoofed URL, phishing attacks are divided into two types in cloud computing [16]. The first type being abusive behavior, wherein an intruder includes a phishing attack site on cloud environment via one of the service models. The second method entails employing traditional social engineering methods to attain access to the accounts [17]. The most pervasive challenges confronted by conventional approaches are that numerous IDSs still have an elevated false positive, ensuing in innumerable warnings for low-risk instances, putting a strain on security analysts and ultimately allow severe breaches to go undetected [18]. Conventional IDSs also have the downsides of being unable to effectively identify new intrusions. Because network environments are constantly evolving, new intrusion variants emerge on a routine basis [19]. As an outcome, it is imperative to create an IDS that can recognize and prevent such breaches in the cloud while significantly reducing false alarms [20]. Efficacious cloud intrusion detection necessitates the use of intelligent approaches such as machine learning (ML) [21]. Machine learning models are suitable for detecting intrusions because they can handle both real and unfamiliar data [3].

2 Related Work

The author in [17] used deep learning techniques to study and detect DDos attacks. The Tor hammer tool was used to generate DDos attacks against own cloud environment. TShark was used to track both regular traffic and suspicious ones during DDos attacks. The traffic was sent to the server and fed into the IDS Snort. The default rules in Snort were modified to detect DDos attacks. This database is then classified in WEKA using SVM, random forest, Naive Bayes algorithms. The performance results confirmed SVM provides the best results in terms of recall, precision, accuracy, and *F*-measure.

A PSO search for the ideal XGBoost structure was performed by He et al. after they proposed an ML model that makes use of XGBoost [11]. The benchmark NSL-KDD dataset is used to assess the proposed model [11]. In terms of accuracy, mean average precision, recall, and macro-average, PSO-XGBoost outperforms other comparison models, especially when it comes to identifying attack subgroups like R2L and U2R. The study provides experimental justification for the application of swarm intelligence in NIDS.

Yaping et al. created a brand-new machine learning technique to forecast network intrusions based on RF and SVM. A random forest was utilized to choose features depending on the variable relevance score [7]. Using the KDD 99 dataset, the effectiveness of the SVM that utilized the 14 chosen features was evaluated and contrasted to the performance of common classifiers and up to 41 attributes. The findings showed that the chosen features might achieve more accuracy, making it one of the most competitive network intrusion detection classifiers.

In order to compare the effectiveness of the IDS system, Adnan et al. [6] used three ML: DJ, RF, and SVM. The main objective is to provide an ML-based NID model that assesses the effectiveness of the three methods in terms of accuracy and precision for anomalous traffic. These two act as a standard for evaluating IDS. The findings revealed that the average accuracy of the RF is 96.76%, that of the SVM is 98.18 percent, and that of the DJ is 96.50%.

Important network traffic characteristics that can be used to build a powerful ML-based IDS were explored by N Meemong et al. The CICIDS2017 dataset was used to train and test a selection of ML algorithms in order to evaluate their performance [15]. The bagging ensemble classifier, which only selected the top 30 features, produced the best results, with an accuracy rate of 99.9% and a low false-positive rate of 0.03%.

In addition to a hybrid IDS that blends support vector machine (SVM) and genetic algorithm (GA) techniques, Ammar et al. also proposed a novel fitness function to measure system accuracy [22]. The CICIDS2017 dataset, which includes common assaults from the past and present, was used to study this system. In this case, an SVM was used to modify the kernel function's hyperparameters, gamma and degree. NSL-KDD and KDD CUP 99 were both used to compare the results. The outcomes demonstrated that the proposed model exceeded these benchmarks by as much as 5.74%.

The effectiveness of five machine learning techniques for recognizing grayhole, blackhole, flooding, and scheduling in network DoS attacks was tested by Lama et al. using WEKA. The WSN-DS dataset was utilized for the ML evaluation. The RF classifier outperforms the other classifiers with an accuracy of 99.72% [18].

A voting ensemble model based on three base classifiers was developed in [23] for making a better learner. We used K-nearest neighbors, logistic regression, and decision trees. We used the NSL-KDD dataset to analyze the results. Detection rates were twice as high as those for existing approaches when dealing with user-to-root attacks.

The proposed hybrid technique of network anomaly detection is used by Garg et al. [24]. The technique is based on GWO and CNN, which are used to detect network anomalies. For network anomaly detection, the first stage uses GWO, and the second stage uses CNN to classify network anomalies. The obtained results showed that the suggested hybrid network anomaly detection method outperformed the existing method.

The Kasongo et al. [9] approach was used to identify and analyze malicious activities using the UNSW-NB15 dataset. Dimensionality reduction was applied to reduce the dataset's complexity using the XGBoost algorithm, which produced 19 ideal attributes. The following algorithms were then applied to identify intrusions: support vector machine, k-nearest neighbor, logistic regression, artificial neural network, and decision tree. In an effort to evaluate the efficacy of algorithms, the following methods were used: comparing the results obtained using all 49 features of the UNSW-NB15 dataset with those obtained by selecting only 19 ideal features, and moreover comparing the performance of algorithms to the pre-existing models. Application of XGBoost for reduction of dimensionality to the decision tree resulted in an improvement in accuracy from 88.13 to 90.85%.

3 Overview of Machine Learning Classifiers

3.1 Random Forest Algorithm

Intrusion detection data can be classified and evaluated using RFs, which are ensemble classifiers. Unlike bagging, random forests only select a subset of attributes randomly from the entire collection of features and use the best split attribute to split each node in the tree, whereas with bagging, all attributes are considered when splitting each node [25]. Training trees use a randomly selected subset of records from the original training data, resulting in the most popular class labels. When using RF, classification accuracy is exceptional, as well as its ability to handle outliers and noise. The likelihood of over fitting is minimal when RF is used [6].

3.2 Decision Tree Algorithm

Decision trees are a specific form of supervised machine learning that categorizes or predicts a set of questions based on how they were answered previously. It is a form of supervised learning, which means that the model is tested on the set of data containing the desired categorization. In decision trees, the answers or decisions may not always be clear-cut, but alternatives are presented to allow data scientists to make their own informed decisions. For data scientists, decision trees mimic human reasoning, so they are relatively easy to interpret [26].

3.3 Support Vector Machine Algorithm

In the area of machine learning, SVMs are one of the most popular algorithms. They are used for both classification and regression problems, but their primary application is in classification. By using SVM, our aim to find the optimal boundary of n-dimensional space that will classify data points into the correct category so that they can easily be placed into the right category in the future. This optimal boundary of n-dimensional space is known as a hyperplane. The support vector machine creates a hyperplane by selecting, the decision boundaries that classify two different categories from the extreme points/vectors that help make that hyperplane [27].

4 Cloud Storage

Cloud data storage makes use of large numbers of decentralized storage equipment that are grouped by system and use shared file systems and other storage e server software. It is normally structure to integrate capacity asset pools, disseminated record frameworks, benefit level agreements, and management interfaces to provide distributed storage administration to clients. In addition, they can be isolated by physical and sensible limits and connections to improve compatibility and communication. Compact disks are merging with CDSS, enabling them to have greater reliability [28]. Cloud storage is among the most prevalent applications of cloud computing. Instead of incorporating an entirely devoted server like conventional networked data storage, cloud storage stores data on numerous third-party virtual machines [29, 30]. The customer data is saved on any of the machines used to construct the cloud. A cloud storage framework necessitates one server to have Internet access at its most basic stage. A customer sends files to a cloud service over the Internet, which holds data. Data is requested through a web-based interface. Once the data is requested, the server responds either by sending the records back to the service user or by allowing the service user to access and update the server's statistics.

5 Intrusions to Cloud System

Various intrusions that jeopardize the availability, confidentiality, and integrity of cloud services and resources are: user-to-root attacks, denial of service attack, service injection attack, attack on virtualization/hypervisor, port scanning, etc. Regardless of the fact that the cloud servers are efficient and robust than clients' in context to computational capabilities and reliability, there are innumerable threats to the cloud environment both from the exterior and from within, who can exploit cloud security flaws to cause damage. As a result of these vulnerabilities data confidentiality, integrity, availability, and authentication may be compromised. Conventional data transfer security protocols have some imperfections when it comes to fully securing networks and systems from highly sophisticated intrusions. For the detection of a wide range of cyberattacks, particularly those that the firewall cannot detect, deep packet analysis is necessary. As a result, it is important to design an IDS that can detect both internal and external threats in the cloud environment. The purpose of an intrusion detection system (IDS) is to supervise and examine events in a network or device to detect privacy violations. It is the goal of intrusion detection systems (IDS) to ensure the security, integrity, and availability of networks and systems. An IDS is often used in conjunction with a firewall as a first line of defense when the firewall cannot prevent an attack. With the increase in the intensity and frequency of breaches, intrusion detection systems (IDSs) have become an essential part of most companies' security architecture [31]. Anomaly based intrusion detection framework based on machine learning models uses classifiers to differentiate between regular and abnormal data. On an initial basis, the cost of the ML models is high, but as they are trained on the data they learn to classify, their performance improves greatly. Cloud security framework based on machine learning for intrusion detection IDS can also be used with other approaches like feature selection techniques to increase the efficiency of the detection technique.

6 Results

For training and testing, NSL-KDD dataset has been used in the proposed solutions. To justify its performance, the proposed solution must meet specific parameters. IDS' capability and performance can be evaluated using these parameters, which include precision, recall, $F1$-score, and accuracy. Figure 1 shows the overall accuracy of the classifiers specified above and the table represents the performance of the above-specified approach in detail.

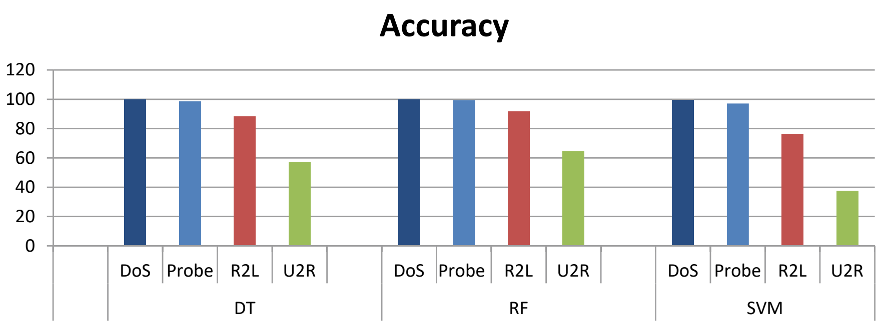

Fig. 1 Graphical representation of accuracy of different attack types using NSL-KDD dataset

Table 1 Performance matrices of NSL-KDD dataset using various classifiers

S. No	Classifier	Accuracy	Attack type	Accuracy	Precision	Recall	$F1$-score
1	RF	99.50%	DoS	99.93	100	100	100
			Probe	99.45	99	99	99
			R2L	91.71	97	94	92
			U2R	64.66	93	76	65
2	DT	98.67%	DoS	99.84	100	100	100
			Probe	98.57	97	98	99
			R2L	88.23	86	87	88
			U2R	57.14	86	69	57
3	SVM	98.26%	DoS	99.65	99	99	100
			Probe	97.14	97	97	97
			R2L	76.68	88	82	77
			U2R	37.59	76	50	38

Table 1 compares the accuracy, precision, recall, and $F1$-score of various approaches specified above on the basis of certain parameters.

7 Conclusion

As a replacement for legacy storage, cloud storage has the enormous potential. However, preparation is a must with security and execution to avoid any misfortune later on. In addition, cloud vendors must ensure the service cost is reasonable for cloud customers, while also addressing security and execution concerns so that customers are satisfied with the service. Cloud storage approaches and service requirements are still emerging. To resolve issues caused by cloud storage, standardization of service providers' service levels must be improved by better load balancing methodologies. An intrusion detection system can be used to achieve cloud security in an effective and efficient way. In this way, it ensures that all traffic entering and leaving the cloud system is monitored before passing through, so that malicious data cannot penetrate it and violate its security policies. Machine learning approaches are used in anomaly based IDS as a means of securing cloud systems in an optimal manner.

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Correction to: Smart Industrial Scanner for Implementation of Relevant Data Parsing from Prescriptions Using SSWF Algorithm

Jephin V. Jose, Sherin Eliyas, Sathish Kumar, and Angeline Benitta

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The original version of the book was inadvertently published with incorrect author name in chapter "Smart Industrial Scanner for Implementation of Relevant Data Parsing from Prescriptions Using SSWF Algorithm". The second author's name has been changed from "M. Sherin Eliyas" to "Sherin Eliyas".

The correction chapter and the book have been updated with the changes.

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Tejinder Kaur, Vidhu Kiran, Abhinav Ahlawat, and Nandini Verma

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The original version of the book was inadvertently published with incorrect authors' affiliation in chapter "Greedy Theory Using Improved Performance Prim's Algorithm, Big Bang Speedup of the Bellman-Ford Algorithm" The authors' affiliation has been changed from "Institute of Engineering and Technology, Chitkara University, Punjab India" to "Chitkara University Institute of Engineering & Technology, Chitkara University, Punjab, India" The correction chapter and the book have been updated with the change.

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