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Jennifer S. Raj *Editor*

# International Conference on Mobile Computing and Sustainable Informatics

## ICMCSI 2020

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Editor

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*We are privileged to dedicate the proceedings of ICMCSI 2020 to all the participants and editors of ICMCSI 2020.*

# Foreword

It is with deep pleasure that I write this Foreword to the Proceedings of the International Conference on Mobile Computing and Sustainable Informatics (ICMCSI) 2020 held at Tribhuvan University, Nepal, 23–24 January 2020.

This international conference serves a forum for researchers to address mobile networks, computing models, algorithms, sustainable models, and advanced informatics that support the symbiosis of mobile computing and sustainable informatics.

The conference covers almost all the areas of mobile networks, computing, and informatics. This conference has significantly contributed to addressing the unprecedented research advances in the areas of mobile computing and sustainable informatics. ICMCSI 2020 is dedicated to exploring the cutting-edge applications of mobile computing and sustainable informatics to enhance the future of mobile applications. The papers contributed the most recent scientific knowledge known in the field of Mobile Computing, Cloud Computing, and Sustainable Expert Systems. Their contributions helped to make the conference as outstanding as it has been. The local organizing committee members and their helpers put much effort into ensuring the success of day-to-day operation of the meeting.

We hope that this program will further stimulate research in Mobile Communication, Sustainable Informatics, Internet of Things, Big Data, Wireless Communication, and Pervasive Computing while also providing practitioners with better techniques, algorithms, and tools for deployment. We feel honored and privileged to serve the best recent developments to you through this exciting program.

We thank all authors and participants for their contributions.

Conference Chair – ICMCSI 2020 Subarna Shakya
Kirtipur, Nepal

# Preface

This Conference Proceedings volume contains the written versions of most of the contributions presented during the International Conference on Mobile Computing and Sustainable Informatics (ICMCSI) 2020. The conference provided a setting for discussing recent developments in various topics, including Mobile Computing, Cloud Computing, and Sustainable expert systems. The conference has been a good opportunity for participants coming from various destinations to present and discuss topics in their respective research areas.

ICMCSI 2020 Conference tends to collect the latest research results and applications on Mobile Computing, Cloud Computing, and Sustainable expert systems. It includes a selection of 80 papers from 287 papers submitted to the conference from universities and industries all over the world. All of the accepted papers were subjected to strict peer reviewing by 2–4 expert referees. The papers have been selected for this volume because of quality and relevance to the conference.

ICMCSI 2020 would like to express our sincere appreciation to all authors for their contributions to this book. We would like to extend our thanks to all the referees for their constructive comments on all papers, and especially, we would like to thank the organizing committee for their hard work. Finally, we would like to thank Springer publications for producing this volume.

Namakkal, India — Jennifer S. Raj

Kirtipur, Nepal — Subarna Shakya

Prague, Czech Republic — Robert Bestak

# Acknowledgments

International Conference on Mobile Computing and Sustainable Informatics (ICMCSI) 2020 would like to acknowledge the excellent work of our organizing committee and keynote speakers for their presentation on 23–24 January 2020. The conference organizers also wish to acknowledge publicly the valuable services provided by the reviewers.

On behalf of the editors, organizers, authors, and readers of this conference, we would like to thank the keynote speakers and the reviewers for their time, hard work, and dedication to this conference. The conference organizers would like to acknowledge all the technical program committee members for the discussions, suggestions, and cooperation in selecting the keynote speakers of this conference. The conference organizers also wish to acknowledge the speakers and participants who attend this conference.

Many thanks to all those who help and support this conference. ICMCSI 2020 wishes to acknowledge the contribution made to the organization by its many volunteers. Members contribute their time, energy, and knowledge at a local, regional, and international level.

We also thank all the Chair Persons and conference committee members for their support.

# Introduction

Sustainability and mobile computing embraces a wide range of Information and Communication Technologies [ICT]. This book focuses on the recent research and development in almost all the facets of sustainable, ubiquitous computing and the communication paradigm. The recent research efforts on this evolving paradigm help advance the technologies for the next generation, where socio-economic growth and sustainability pose significant challenges to computing and communication infrastructures. The main purpose of this book is to promote the technical advances and impacts of sustainability and mobile computing to informatics research.

The key strands of this book include green computing, predictive models, mobility, data analytics, mobile computing, optimization, Quality of Service [QoS], new communicating and computing frameworks, human–computer interaction, Artificial Intelligence [AI], communication networks, risk management, ubiquitous computing, robotics, smart city, and applications. The book has also addressed a myriad of sustainability challenges in various computing and information processing infrastructures.

# Contents

# Chapter 1
# Analysis of Design Quality and User Requirements of Online Taxation Portal of Nepal


**Sumina Maharjan, Pi De Chang, and Deepanjal Shrestha**

## 1.1 Introduction

Electronic government (e-government) in general means the use of information and communications technology (ICT) to provide easy and online access to the procedure and services of the public sector organizations. The attempts at e-governance implementation in Nepal haven't been successful to a great extent. Since Nepal is a developing country, it has major problems with the digital divide, poorly provided e-governance services, and unenthusiastic approach to the technology by the people. Apart from this trust issues with software quality of e-governance is another big problem that makes people hesitate to move from a manual paper-based system to a web-based system. However, these issues in the developing countries are unavoidable, if proper measures are taken while designing e-government projects, greater participation of stakeholders in e-government ventures can be guaranteed. The current research project is based on identifying the issues related to poor performance and the failure of ICT applications installed in government offices. The study employs qualitative statistical methods, testing methods, and user perspective to uncover the quality of service and design issues of the taxation portal. This approach brings coherence to government processes in terms of time, effort, and cost needed to implement e-government services.

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## 1.2 Literature Review

E-governance applications can serve better distribution of government services to citizens, boost interactions with industry and business, citizen authorizes through access to information, or more systematic government management [1]. Badu stated that Nepal is in stage II of the e-governance maturity model and moving toward stage III where stage II indicates interaction stage which involves online form submission, queries, and correspondence, send emails, download forms, ask queries, etc. Stage III indicates the transaction stage this stage involves in making transactions from the government portal. This stage should be very secured as citizens' transaction and important information is being shared online. He has also explained e-Sewa and Khalti which is Nepal's most used online payment gateway [2]. E-Sewa and Khalti are brought up by private companies, while Nepal has also introduced the government's first payment gateway recently in 2018, i.e., ConnectIPS by NHCL [3]. S. Chakraverty and G. Rani explained comparative evaluation based on qualitative attributes like security, authentication, interoperability, flexibility, extensibility, adaptability, privacy, transparency, robustness, and verifiability of quality in e-governance system [4]. Software quality of e-governance has become a topic of high interest as it is developing into an extremely important part for a government to be competitive in its business and development; the requirement for the software is to have a great level of user convenience, utility, and quality for being successful [5]. One of the challenges in the e-governance system is to find better principles and techniques for developing quality and bug-free software. ISO introduced a quality model of the software which can be evaluated with a set of attributes defined for each characteristic (functionality, reliability, usability, efficiency, maintainability, portability) [6, 7]. Hooda and Chhillar researched on software testing life cycle phases and various testing types. They set up four main phases in the testing life cycle that are categorized as analysis, planning and preparation, execution, and closure [8]. Also, they stated that the most recent failures of software take place due to a lack of security and performance testing. Their paper presented the right mix of testing that included performance and security testing for the better quality of software [8] (Fig. 1.1).

## 1.3 Research Framework

### *1.3.1 User Survey*

#### 1.3.1.1 Survey Design

Surveys are an essential section of an evaluator's toolkit. It can be a very effective means of accumulating subjects' feedback in an easy and potentially low-cost way [9]. The survey designed was on quality analysis of the e-government system that

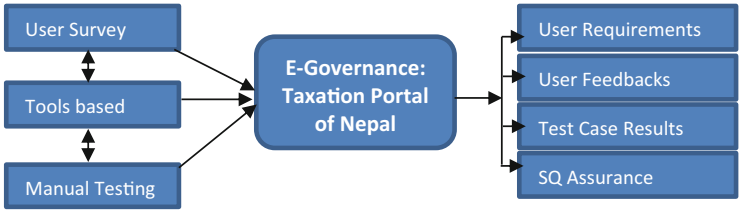



**Fig. 1.1** Research framework: A taxation portal of Nepal

collects information about the current quality status of the e-governance system. The survey was designed based on literature review and feedback from users of the taxation portal, employees of Inland Revenue Department, and software users (legal firms). After the design of the survey, respondent sampling was carried out. After the completion of the overall framework of the survey, to organize content validity, a meeting was held at the Inland Revenue Department of Nepal, to which all of the five head members of the IRD technical department were requested to join the discussion of the survey. Then, a final draft of the survey was distributed to the head members for the feedback.

#### 1.3.1.2 Survey Sampling

Samples were divided into three groups which included the head of the department, end users, and citizens. The questionnaire was developed to satisfy software quality attributes explained by ISO/IEC 9126. As the aforementioned survey is divided into three groups, three sets of questionnaires were developed. The total number of a survey taken was 101 where 5 were head members, 14 were end users, and 82 were citizens who use the taxation portal for taxation services. The results for the software quality of the taxation portal from the survey are explained below.

## 1.4 Data Analysis and Findings of the Survey

The reliability result from the user's perspective is competent since the results show a high number of positive feedback in terms of reliability compliance, recoverability, and maturity. On the other hand, portability seems inadequate, because a high number of users agreed on the browser-dependent issues (Figs. 1.2 and 1.3).

Speaking about maintainability's feedback, it seems neutral in terms of modifiability and updating application. Though efficiency shows the conflicting result in terms of efficiency compliance and time & resource behavior. However, the usability attribute is proved as strongly satisfied with an enormous number of user's positive feedback (Figs. 1.4 and 1.5).

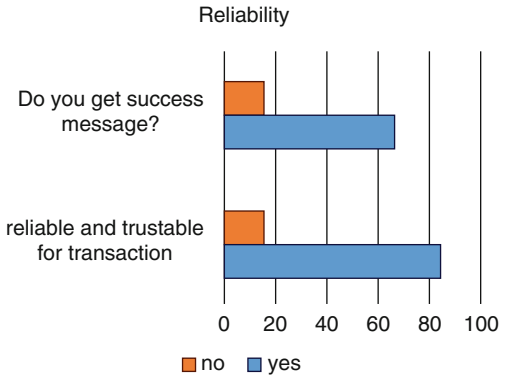



**Fig. 1.2** Reliability survey result

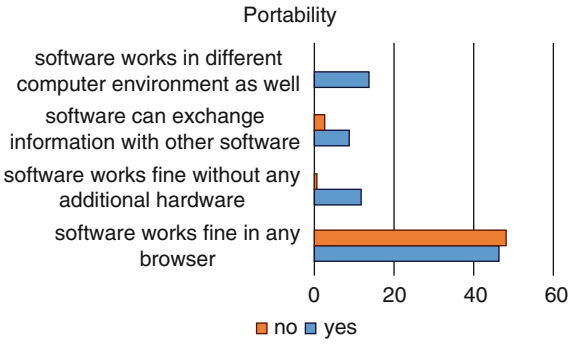



**Fig. 1.3** Portability survey result

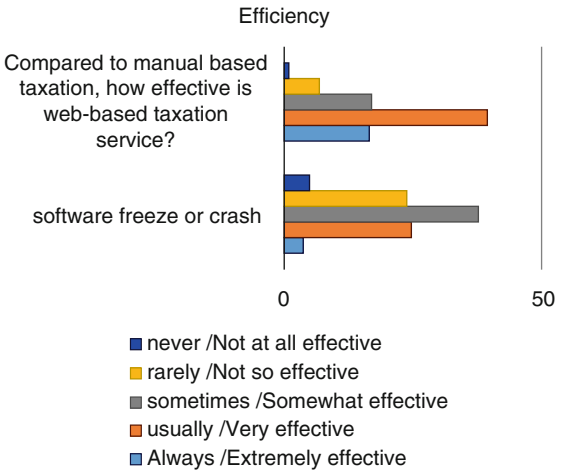



**Fig. 1.4** Maintainability survey result

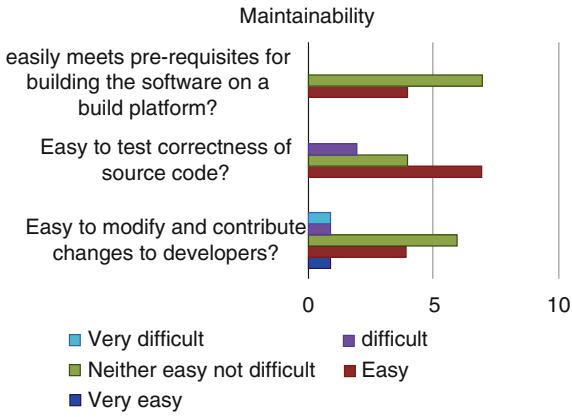



**Fig. 1.5** Efficiency survey result

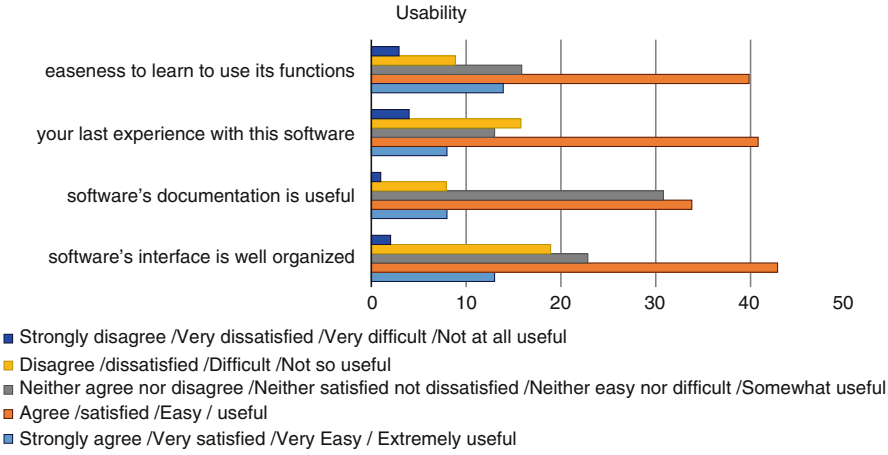



**Fig. 1.6** Usability survey result

Furthermore, functionality has strongly positive feedback in terms of security and the functions of the application (Figs. 1.6 and 1.7).

## 1.5 Tool-Based Testing

Tool-based testing processes through which thorough and fast testing can be done. Using these tools it helps in avoiding the error humans make. Test done through an automation tool needs less time in exploratory tests and more time in maintaining test scripts. Tool-based tests are convenient for big projects that require testing in a loop. This kind of testing is more suitable for nonfunctional testing types like performance testing and security testing.

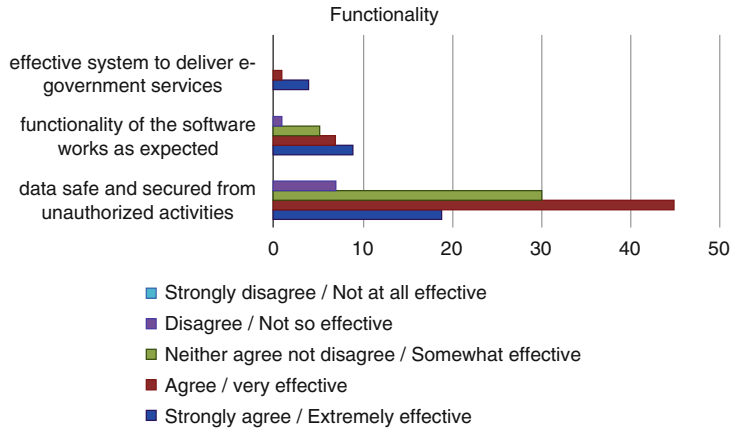



**Fig. 1.7** Functionality survey result

| #Samples | KO | Error % |
|---|---|---|
| 235 | 24 | 10.21% |

**Fig. 1.8** Result for response time execution

| Average | Min | Max | 90th pct | 95th pct | 99th pct |
|---|---|---|---|---|---|
| 8850.9 | 356 | 76267 | 21098.8 | 42679 | 59389.36 |

**Fig. 1.9** Response time

### *1.5.1 Performance Testing*

Performance testing is a process to check whether the software fulfills performance requirements under all critical and noncritical conditions. It includes all parameters correlated with time like access time, load time, execution time, run time, etc. Since this kind of nonfunctional test is carried out with an automated testing tool, so we choose JMeter to run the performance testing of a taxation portal where test scripts were generated by BlazeMeter which an automated test script generating a tool for JMeter [10]. The test results are explained below.

The result shows that the average response time is 8850.9 ms which means 8.8 s. The expected response time is less than or equal to 1 s, if its less than 1.0 s, then it is said to be instantaneous and no interruptions, whereas above 10 s means interruption, or user switches to another task. Likewise, 20th percentiles are also greater than average response time which is expected to be less than average response time. In addition (Fig. 1.8), the response time execution results in a 10.21% error for 235 samples which roots different kinds of problems like bottlenecking, request timed out, etc. Hence, the application isn't efficient enough in terms of software quality (Fig. 1.9).

### *1.5.2 Security Testing*

Security testing is a process to govern the system to preserve data and maintain functionality as intended. It is a nonfunctional testing type, so automated testing was carried out to check SSL/TLS vulnerabilities and security holes using the Amberloom testing tool which generated results shown in tables below. Secure Sockets Layer (SSL) is a protocol created to secure communication over the Internet by providing privacy and reliability. Transport Layer Security (TLS) is just a successor of Secure Sockets Layer (SSL) introduced with stronger encryption algorithms to overcome the weakness of SSL [11]. SSL and TLS are protocols which works for the encryption of network data [11]. TLS 1.2, TLS 1.1, TLS 1.0, SSL 3, and SSL 2 are the protocol versions supported in taxation portal [12] (Table 1.1).

The result demonstrates that the application is secured of different vulnerabilities like Heartbleed, POODLE, BREACH, OpenSSL CCS Injection, CRIME, FREAK, LOGJAM, etc. but also points out BEAST and downgrade attack prevention as a

**Table 1.1** Vulnerabilities protected in taxation portal

| Protocol details | |
|---|---|
| Secure renegotiation | Yes |
| Secure client-initiated renegotiation | No |
| Insecure client-initiated renegotiation | No |
| OCSP stapling | Yes |
| Strict transport security (HSTS) | Unknown |
| Session resumption (session IDs) | Yes |
| Session resumption (session tickets) | No |
| Deflate compression | No |
| Downgrade attack prevention (TLS_FALLBACK_SCSV) | No |
| Supports insecure ciphers | No |
| Supports weak ciphers | No |
| Common DH prime | No |
| Forward secrecy | Yes |
| BREACH vulnerability | No |
| CRIME vulnerability | No |
| OpenSSL CCS injection | No |
| Heartbleed vulnerability | No |
| POODLE vulnerability | No |
| BEAST vulnerability | Yes |
| FREAK vulnerability | No |
| LOGJAM vulnerability | No |

**Table 1.2** TLS 1.2 cipher suite algorithm

| Cipher suite | Grade | Size | Fs | Export | Anon | Prefer |
|---|---|---|---|---|---|---|
| TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384 (0xc028) | Secure | 256 | Yes | No | No | Yes |
| TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA (0xc014) | Secure | 256 | Yes | No | No | No |
| TLS_RSA_WITH_AES_256_GCM_SHA384 (0x9d) | Secure | 256 | No | No | No | No |
| TLS_RSA_WITH_AES_256_CBC_SHA (0x35) | Secure | 256 | No | No | No | No |
| TLS_RSA_WITH_AES_256_CBC_SHA256 (0x3d) | Secure | 256 | No | No | No | No |
| TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA (0xc013) | Secure | 128 | Yes | No | No | No |
| TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256 (0xc027) | Secure | 128 | Yes | No | No | No |
| TLS_RSA_WITH_AES_128_GCM_SHA256 (0x9c) | Secure | 128 | No | No | No | No |
| TLS_RSA_WITH_AES_128_CBC_SHA (0x2f) (TLS_FALLBACK_SCSV) | Secure | 128 | No | No | No | No |
| TLS_RSA_WITH_AES_128_CBC_SHA256 (0x3c) | Secure | 128 | No | No | No | No |
| TLS_RSA_WITH_3DES_EDE_CBC_SHA (0x0a) | Secure | 112 | No | No | No | No |

**Table 1.3** TLS 1.1 cipher suite algorithm

| Cipher suite | Grade | Size | Fs | Export | Anon | Prefer |
|---|---|---|---|---|---|---|
| TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA (0xc014) | Secure | 256 | Yes | No | No | Yes |
| TLS_RSA_WITH_AES_256_CBC_SHA (0x35) | Secure | 256 | No | No | No | No |
| TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA (0xc013) | Secure | 128 | Yes | No | No | No |
| TLS_RSA_WITH_AES_128_CBC_SHA (0x2f) | Secure | 128 | No | No | No | No |
| TLS_RSA_WITH_3DES_EDE_CBC_SHA (0x0a) | Secure | 112 | No | No | No | No |

noncritical problem that requires serious attention; further investigation and fixing should be considered.

TLS 1.2 generates cipher suite to build a secured network; cipher suite is generally an algorithm that includes a code that explains four parameters, and they are key-exchange method, encryption cipher, hashing algorithm, and authentication algorithm. Thus, the result (Tables 1.2 and 1.3) shows secured of all the four parameters of the cipher suite algorithm.

## 1.6 Manual Testing

Manual testing is a type of software testing where test cases are manually executed by testers without using any automatic tools. It is the most primitive testing types to discover bugs in the software system. Mainly functional testing types are manually executed. Functional testing tests the functions of the software based on the user input and expected output. Generally, a testing table is created for each test cases, and both expected output and real output are compared based on the combination of inputs. It is one of the most important types of testing that verifies the correctness of a particular function in software [13, 14] (Tables 1.4 and 1.5).

### *1.6.1 Usability Testing*

The process of checking application flow and the ease of use of the product.

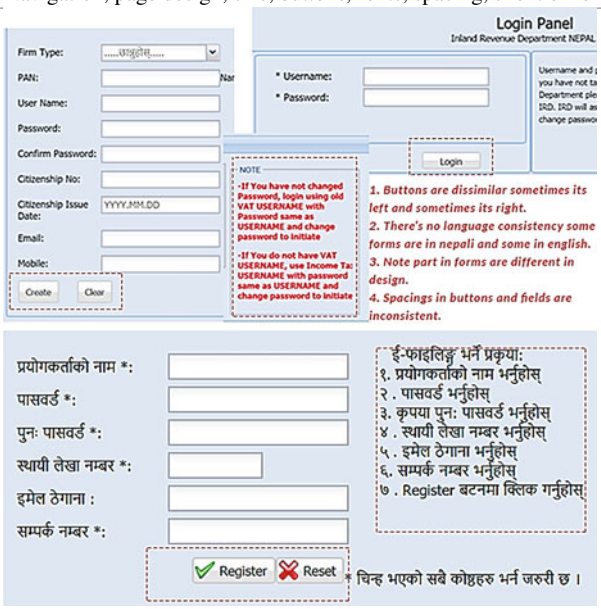
### *1.6.2 Functionality Testing*

The process of testing the functionality of a software or an application under test is known as functionality testing. It tests the behavior of the software under test based on the requirement of the client [14].

**Table 1.4** Test case developed for manual testing

| Steps | Test case description |
|---|---|
| Steps 1 | Verify the homepage whether the web application is well guided, easily accessible, or not |
| Steps 2 | Check if the font family, size, and color of the font used in a web application is readable |
| Steps 3 | Check that the images have good clarity and are properly aligned |
| Steps 4 | Verify that search module retrieves correct results |
| Steps 5 | Verify form validation |
| Steps 6 | Verify that proper error message is displayed when wrong info is entered |
| Steps 7 | Verify that the application works well in different browsers |
| Steps 8 | Verify that the navigation from links available in header-footer should open in a different tab |
| Steps 9 | Check the positioning of GUI elements for different screen resolution |
| Steps 10 | Verify that there's a similarity in page design, e.g., buttons, font, title, etc. |
| Steps 11 | Verify layouts like size, position, width, length, alignments |
| Steps 12 | Check if there are any forceful constraints |

**Table 1.5** Usability manual test result

| Usability | |
|---|---|
| Properties | Simplicity, attractive, layout, consistency, controllability |
| Elements | Navigation, page design, size, buttons, fonts, spacing, silent or forceful actions |
| Result |  <br>Usability error results recorded in manual testing |
| Remark | Broken labels (single-line labels showed off in two lines)<br>Misalignment of info icons, labels, text boxes<br>Easy to find the available services, the services are displayed well on the homepage<br>Taxation portal doesn't have a language option<br>Some forms are in Nepali, while some are in English, whereas some are mixed with both languages<br>Buttons are sometimes left aligned and sometimes right<br>Buttons layout differs in a different form<br>Misaligned buttons and input boxes<br>Design for note section in different<br>Asymmetric spacing between texts and two different sections<br>There was no forceful limitation or silent actions<br>A web application is well guided as navigations for services are easily accessible, but the design doesn't look attractive enough, and some links don't work<br>Some page doesn't have home navigation or back menu; user might get lost or have to enter URL again to go back to the homepage |

### *1.6.3 Reliability Testing*

It checks whether the software can perform under a stated condition for a specified period of time in a specified environment.

### 1.6.4 Compatibility Testing

The process of checking the ability of software to run in a different environment.

### 1.6.5 Link Testing

It is the process of checking all the outgoing links from all the pages to the specific application under test. There are various types of links, for example, internal links, external links, broken links, and mail links. The total links in the application are 225 among which 9 were broken links shown in Table 1.6 below.

### 1.6.6 Broken Link Status Code

- 302 (Moved Temporarily): The page has been temporarily moved. The client will usually perform a redirection to another URL.

**Table 1.6** Functionality manual test result

| Functionality | |
|---|---|
| Properties | Functionality |
| Elements | Search bar function, form validation, the error message |
| Result |  |
| | Results recorded while testing functionality manually |
| Remark | The search bar works well, but it doesn't find the related keywords and only gives results for the exact keyword<br>Forms work well, it is well guided, but there's no language option<br>Gives error message with appropriate icon while wrong credentials are entered |

- 404 (Not Found): The resource could not be found on the server. These are caused by spelling mistakes in URL or if deleted resources have been requested.
- 500 (Internal Server Error): This shows when an unspecified error occurs while generating the response.

## 1.7 Summary of Software Quality

Software quality is the capacity of software, system, or process to meet user's needs, expectations, or specified requirements. Software quality models generally refer to the metrics which evaluate the attributes of characteristics and sub-characteristics [13, 14]. The qualitative analysis is executed with the reference of a software quality model (ISO/IEC 9126). Accordingly, the taxation portal is analyzed on the basis of six characteristics explained by ISO/IEC 9126, to analyze these characteristics, software testing strategies were applied. Since we don't have access to the code and design of the e-governance system, the qualitative analysis is performed from the user perspective for this reason system testing was executed with the black box testing technique. Black box testing doesn't require an understanding of internal codes, structures, or design of the software under test. Therefore, few functional and nonfunctional testing was carried out to check the quality of the taxation portal (Tables 1.7, 1.8, 1.9, and 1.10).

**Table 1.7** Reliability manual test result

| Reliability | |
|---|---|
| Properties | Reliability |
| Elements | The error message, recoverability |
| Result |  <br>Positive and negative testing to check the reliability |
| Remark | Gives error message with appropriate icon while wrong credentials are entered; it also suggests for appropriate steps<br>It has an option to save the form so that the data remains even if the application is terminated |

**Table 1.8** Compatibility manual test result

| Compatibility | |
|---|---|
| Properties | Context, responsiveness |
| Elements | Browser dependency, tablet, and phone screen view |
| Result |  |
| | Results recorded while testing compatibility |
| Remark | Clearly advertises to use Mozilla Firefox<br>The phone and desktop view is the same, so modules look much smaller and unreadable in phone view |

**Table 1.9** Broken links

| S.no | Broken link reference URL | Status code |
|---|---|---|
| 1 | RevenueTribunalRegulation | 302 » 500 |
| 2 | HealthServiceTax | 302 » 500 |
| 3 | EducationServiceFee | 302 » 500 |
| 4 | TaxIncentives | 302 » 500 |
| 5 | Taxpayer | 302 » timeout |
| 6 | Officerportal | 302 » ConnectFailure |
| 7 | PoliciesStrategies | 302 » 500 |
| 8 | ContentAttachment/1019/ | 404 |
| 9 | ContentAttachment/5240 | 404 |

## 1.8 Conclusion

Software testing is a prime concern nowadays for almost every government sector and software development companies. E-governance system should grow rapidly in terms of software quality in order to gain trust from citizens and encourage them to move to a web-based system from the manual system. The aim of this paper is to research on software quality of the e-governance system of Nepal. We have learned about various types of software quality models in software engineering one, and all of these quality models are included in a number of characteristics. Determining quality models and preparing test to analyze those quality attributes are a big challenge. The overall quality assessment depicted that the taxation portal

**Table 1.10** Software quality model ISO/IEC 9126

| Characteristics | Definitions | Sub-characteristics |
|---|---|---|
| Functionality | Attributes which provide functions that satisfy the needs of the user | Security, accuracy, suitability, functionality, compliance, interoperability |
| Efficiency | An attributes that bear on the ability to measure the level of performance of the software and the number of recourses that are used under the stated conditions | Time behavior, resource behavior, efficiency compliance |
| Maintainability | An attributes that describe the ease with which the software product can be updated or changed | Analyzability, changeability, testability, operability, attractiveness, maintainability compliance |
| Reliability | An attributes that bear on the ability to maintain its specific level of performance under the specific conditions for a specific period of time | Maturity, fault tolerance, recoverability, reliability compliance |
| Portability | An attributes that bear on the ability of software to be transferred from one environment to another | Replicability, adaptability, installability, co-existence, portability compliance |
| Usability | An attributes that bear on the ability to measure the ease to learn to use the product | Usability compliance, understandability, learnability, operability, attractiveness |

is not designed as a robust system and lacks many principles of software engineering needed for developing a quality software. The survey of the users stated that the UI design is not so user-friendly and is not so structured. A user finds difficulty in locating particular information to fill in the details, and it has a very poor integrated search system. The understandability quotient of the software is poor and has very poor maintainability in terms of recovery and enhancement. The tools based and manual testing procedure uncovered many errors in the security, performance, and web-based links. It can be stated that this software though in use for a very important e-governance function is not as per defined standard of the software industry. It can only supplement the current needs but needs a strong design revision in the near future to avoid software malfunctions and robust performance. The government should improvise the design to pull up the level of the e-governance system in Nepal.

### *1.8.1 Future Work*

There are huge come out of ICT trends contributing to digitize countries in the public sector. One such recent trend is the advancement of the e-governance system and its role in improving human development. In order to maintain and improve the e-government system, the government should focus on the citizen-

centric approach putting in agile techniques instead of the traditional approaches. The major concern is the lack of a framework and strategies in developing ICT applications. Consequently, it is recommended to develop quality software referring to quality models, using the best strategies and techniques in the design phase of e-governance.

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# Chapter 2
# Breast Cancer Recurrence Prediction Model Using Voting Technique


**M. S. Dawngliani, N. Chandrasekaran, R. Lalmawipuii, and H. Thangkhanhau**

## 2.1 Introduction

Breast cancer is the tumor arising from the cells of the breast tissue [1]. This cancer usually commences in the inner lining of milk ducts or the milk-producing glands (lobules). There are two types of breast cancer: invasive breast cancer (malignant) and noninvasive breast cancer (benign). Breast cancer is the most common type of cancer prevalent among female cancer patients, while it is also the second most dreaded disease, causing cancer deaths among women. World Cancer Research Foundation identifies breast cancer as the second most common cancer in women worldwide due to the fact that a few million new cases are diagnosed every year [2]. Breast cancer has become a huge existential issue for women as it arises one out of every four cancer in women. It can be inferred from GLOBOCAN 2012 data [3] that India's mortality rate for breast cancer is the highest, see Fig. 2.1, and is double or even more when compared to China and the USA.

Computer scientists are involved in building intelligent models with predictive capabilities and are being aided by the extensive research work being carried out in the field of data mining. Machine learning is considered to be one of the most important components as it sits at the heart of the knowledge discovery database (KDD) process [4]. It is customary to define data mining as a process of discovering interesting and useful patterns and relationships that exist in large amounts of data. It is an important step in the knowledge discovery process as it deals with the application of intelligent algorithms to get useful patterns from the data. At the

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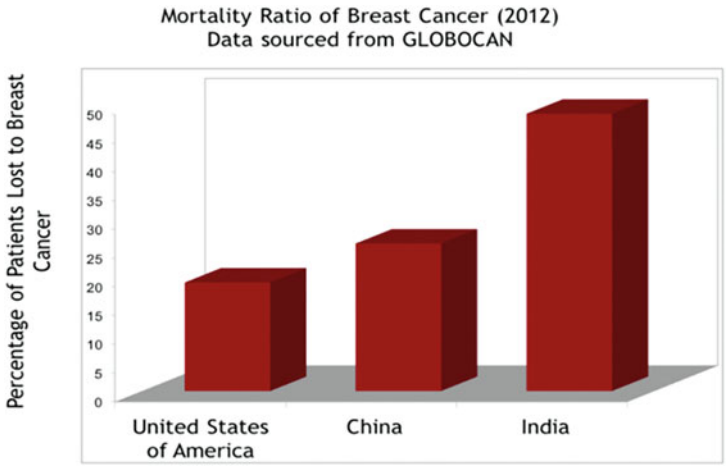


**Fig. 2.1** Death percentage of breast cancer patients (2012) [3]

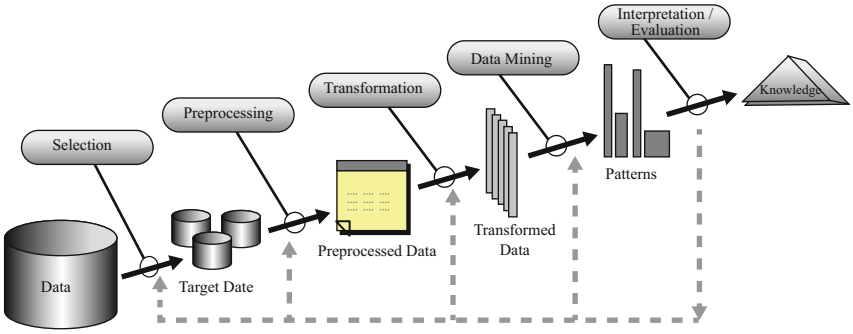


**Fig. 2.2** The five steps involved in the KDD process

end of the KDD process, we are able to generate information that is in a formal form that is useful to the healthcare professionals and others; see Fig. 2.2. Both the terminologies, viz., KDD and data mining, are used interchangeably because data mining is at the heart of this process.

As the power and capabilities of the algorithms are improving by the day, the knowledge systems built using the data mining algorithms are being extensively developed for implementation in the hospitals to facilitate decision-making activities. These intelligent platforms are far more reliable as they rely on logical analysis to dispense with the subjectivity or errors that may arise due to human fatigue. The recent trend indicates a shift from placing reliance on base classifiers to more on ensemble methods. The objective of the current work is to focus on the voting technique, which is an ensemble method that uses various combinations of base data mining classifiers to arrive at a final prediction based on the best possible accuracy.

## 2.2 Related Study of Data Mining Using an Ensemble Method

Abouelnadar and Saad [5] proposed a model for prediction of breast cancer recurrence using the UCI dataset. They used four data mining classifiers such as K-nearest neighbor (KNN), decision trees (DT), Naïve Bayes (NB), and support vector machines (SVM). For the purpose of comparison, the authors also employed ensemble techniques like bagging, voting, and random forest (RF). Among the base classifiers, the random forest classifier produced the highest accuracy of 84.3%, while the voting ensemble classifier improved the performance even better with an accuracy of 89.9%.

Yarabarla, Ravi, and Sivasangari [6] made use of three base classifiers, viz., KNN, SVM, and RF, and apart from this, gradient boosting, for the purpose of comparison. The attempt was to predict whether a patient suffers from cancer or not, and they made use of Wisconsin (diagnostic) data set. Gradient Boosting has the ability to improve the performance of weak techniques to make them stronger performers. It should, however, be stated that their findings have indicated that the random forest (RF) classifiers produced the highest accuracy, as it uses both classification and regression methods.

Salama, Abdelhalim, and Zeid [7] attempted to create a hybrid model using five data mining classifiers using the WBC dataset. The work had demonstrated clearly that the fusion between MLP and J48 classifiers with features selection (PCA) was superior when compared to the other classifiers. On the other hand, the use of the WDBC dataset had proved that using single classifiers (SMO) or a fusion of SMO and MLP or SMO and IBK also improved the performance. In addition, the combination of MLP, J48, SMO, and IBK had also been seen to produce superior performance for WPBC dataset.

Sivakami [8] proposed a hybrid classification algorithm-based approach that combined DT and SVM to analyze breast cancer datasets to prove that this approach resulted in better accuracy when compared to other classifier algorithms. The variables that were part of the dataset included age, chemotherapy, radiotherapy, tumor size, the number of examined lymph nodes, the number of attacked lymph nodes, and pathological staging. The prognosis was carried out to predict the survivability of breast cancer patients after treatment.

Safiyari and Javidan [9] have analyzed the lung cancer dataset from SEER to predict the probability of survival within a period of the first 5 years from the onset of breast cancer. The dataset was fairly large as it contained 149 attributes and 643,924 samples. After preprocessing, it was reduced to 24 attributes and 48,864 samples. Five ensemble methods were used for the purpose of evaluation. The performance of AdaBoost was found to be the best both in terms of accuracy and AUC metrics. The performance of almost all of the base learners increased by the application of ensemble techniques. The two major exceptions included the J48 algorithm in terms of accuracy and the Naïve Bayes algorithm in AUC.

Kumar, Nikhil, and Sumangali [10] used the voting ensemble machine learning technique on a breast cancer dataset. Three combinations they chose involved voting with SMO, voting with both SMO and Naïve Bayes, and voting with SMO, Naïve Bayes, and J48. They concluded that the combination of Naïve Bayes, SMO, and J48 produced the highest accuracy.

Mohebian, Marateb, Mansourian, Angel, and Mokarian [11] also made an attempt to build a diagnosis system for prediction of breast cancer recurrence using optimized ensemble learning. It was seen that 19.3% of the 579 patients had a recurrence of cancer within the first 5-year period after diagnosis. The hybrid approach that the authors followed combined three algorithms, viz., decision tree, SVM, and MLP, and this resulted in producing the best results.

Lavanya and Usha Rani [12] performed their analysis using two-hybrid approaches, viz., bagging and boosting. Bagging ensemble method involved the CART decision tree classifier with feature selection. The study was performed using three Wisconsin breast cancer datasets. The authors were able to achieve accuracies with bagging and boosting for breast cancer dataset of 74.47% and 65.03% and Wisconsin breast cancer (original) dataset of 97.85% and 95.56%. Wisconsin breast cancer (diagnostic) dataset produced an accuracy of 95.96% and 95.43%. Through this study, they concluded that the bagging ensemble method was preferable for the diagnosis of breast cancer data than boosting.

Avula and Asha [13] proposed a hybrid method based on two supervised algorithms, viz., Naïve Bayes and JRIP. The methodology adopted in their paper for proposing a new hybrid machine learning algorithm was implemented using the R programming language and WEKA software tool. Further, a comparative study was made between the individual algorithms and the proposed hybrid algorithm to establish both an improvement in prediction accuracy and enhanced performance.

## 2.3 Ensemble Method

Ensembling involves a combination of base classifiers as learning algorithms to construct a set of classifiers. New data points are created by taking a weighted vote of their predictions [14]. The combination of several models facilitates the improvement of predictive performance as opposed to deploying a single model. Ensemble learning does not attempt to create just one strong classifier. Instead, the method creates a number of weak classifiers and then combines their outputs into one final decision [15]. The main scope of base models had all along been to produce one strong classifier with an aim to reduce the classification error to the barest minimum. Several ensemble algorithms like boosting, bagging, random forest, stacking, and voting have since been created. For the current study, we are making use of voting ensemble machine learning algorithms.

Voting is the simplest ensemble algorithm and is often very effective for solving classification or regression problems. Voting works by creating two or more sub-models, with each one of the sub-models making predictions [16]. The sub-models

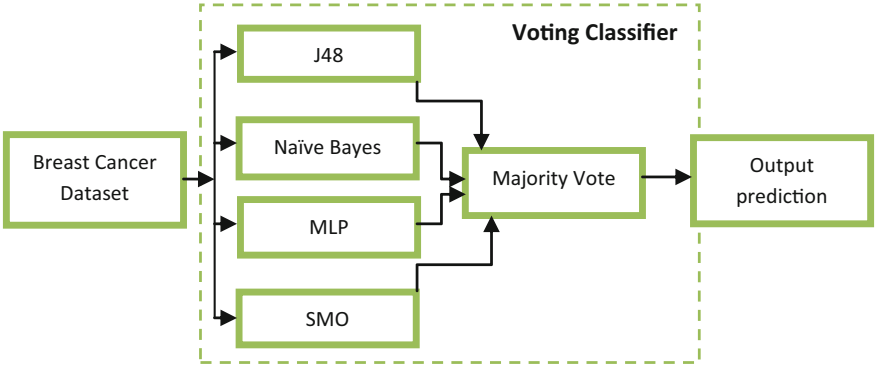


**Fig. 2.3** Components of the voting classifier

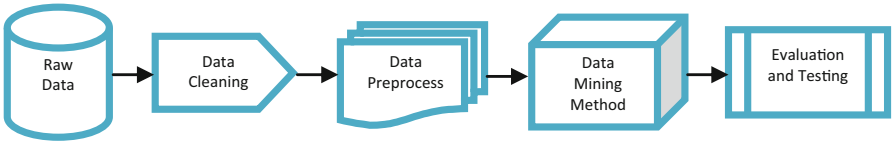


**Fig. 2.4** Various steps involved in the data mining process

are combined in some way, and for the purpose of making the final prediction, the mean or the mode of the individual results is used. Each sub-model can vote to determine the eventual outcome. In the current study, we have done voting with four classifiers such as J48, Naïve Bayes, MLP, and SMO. In majority voting, the predicted class label for a particular sample is the class label that represents the majority (mode) of the class labels predicted by each classifier [17]; see Fig. 2.3.

For example, if the prediction for a given sample for classifier 1 is class 1, classifier 2 is class 1, and classifier 3 is class 2, the voting classifier would then classify the sample as "class 1" based on the majority class label [18].

## 2.4 Methodology

The proposed methodology involves data preparation in which the raw data is cleaned by filtering the incomplete and redundant data. Then it is transformed into a format (comma delimited) which is ready for analysis. The formatted data is then analyzed by using data mining classifiers. Finally, the result is evaluated for its accuracy; see Fig. 2.4.

### 2.4.1 Data Collection

Breast cancer data was collected from Mizoram Cancer Institute from 2009 till 2016. The collected data contains 23 attributes and 575 records from the medical record which has been obtained in HBCR (hospital-based cancer registry) format. The format ensures that the datasets have records of registration no, hospital registration no, date of diagnosis, age (in years), date of birth, sex, height, weight, contact, method of diagnosis, laterality, morphology, sequence, socioeconomic status, comorbid condition, tumor size, axillary lymph node, supraclavicular node, skin involvement, TNM stage, stage grouping, type of prior treatment given, habitual data, vital status, and disease status.

### 2.4.2 Data Preprocessing

The data quality depends mainly on the completeness, correctness, and consistency of the data. Data preprocessing is an important step in the data mining process, and this involves transforming raw data into an understandable format [19]. The raw data cannot be directly used for analysis, and hence it becomes necessary to code the raw data into a specific value and categorize the same into ranges. Since machine learning models are based on mathematical equations, it becomes necessary to encode the data into nominal and numeric data types [20].

### 2.4.3 Analyze Using Data Mining Classifier

We use WEKA software for the analysis of the breast cancer dataset. WEKA provides the environment for dataset transformation, attribute selection. It also has the capability to carry out preprocessing using data mining and machine learning methods. Other operations such as classification, regression, clustering, association rules, and visualization can also be performed [21].

Using WEKA, the breast cancer dataset was analyzed by data mining classifiers. In this study, we have used four base classifiers such as J48, Naïve Bayes, MLP, and SMO as well as voting. The performance of these four classifiers is evaluated first. Then using voting these classifiers are combined to determine whether there is any enhancement required in performance. Results are interpreted after they are displayed in the form of tables and charts.

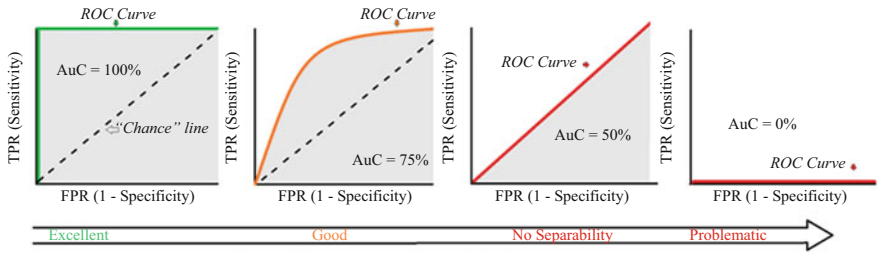


**Fig. 2.5** Graphical representation of the ROC curve [25]

### *2.4.4 Evaluation and Testing*

A tenfold cross-validation technique and ROC curve-based approach have been used to evaluate and validate the results. Cross-validation is a technique, which can be employed, to evaluate the predictive models by partitioning the dataset into a training set and a test set [22]. In tenfold cross-validation, the original sample is randomly partitioned into ten equal-sized subsamples. Of the ten subsamples, a single subsample is retained as the testing data, and the remaining nine subsamples are used as training data. It is repeated ten times, with each of the ten subsamples used exactly once as the testing or validation data. The results from each fold can then be averaged to produce a single estimation.

The receiver operating characteristic curve is used both to check and to visualize the performance of classifiers at various threshold settings. It has the ability to show how much a classifier is capable of distinguishing between classes. Higher AUC would imply that the model is better at predicting true as true and false as false [23]. The ROC curve graphically displays the variation of sensitivity (TPR) along the y-axis with respect to the changes in FPR (1 – specificity) plotted along the x-axis for varying cutoff points of test values [24]; see Fig. 2.5.

## 2.5 Experimental Result

Firstly, we analyze our dataset using four base data mining classifiers, namely, J48, Naïve Bayes, multilayer perceptron, and support vector machine. The performance accuracy is highest in J48 which has a value of 84.2105%, followed by Naïve Bayes possessing an accuracy of 82.4561%. But in terms of ROC value, it is highest in Naïve Bayes (0.781), followed by J48. Table 2.1 shows the performance of the four base classifiers tested. Figure 2.6 shows the performance accuracy chart for the four base classifiers.

Table 2.2 shows the error statistics of the classifiers. The statistics shown in the table are Kappa statistic (KS), mean absolute error (MAE), root-mean-square error (RMSE), relative absolute error (RAE), and root relative squared error (RRSE). The

**Table 2.1** Performance of the base classifiers

| Classifiers | Accuracy | TP rate | FP rate | Precision | Recall | F-measure | MCC | ROC area |
|---|---|---|---|---|---|---|---|---|
| J48 | 84.2105 | 0.842 | 0.336 | 0.841 | 0.842 | 0.842 | 0.510 | 0.769 |
| NB | 82.4561 | 0.825 | 0.456 | 0.811 | 0.825 | 0.815 | 0.411 | 0.781 |
| MLP | 75.7895 | 0.758 | 0.55 | 0.747 | 0.758 | 0.752 | 0.219 | 0.670 |
| SMO | 80.7018 | 0.807 | 0.614 | 0.776 | 0.807 | 0.775 | 0.275 | 0.596 |

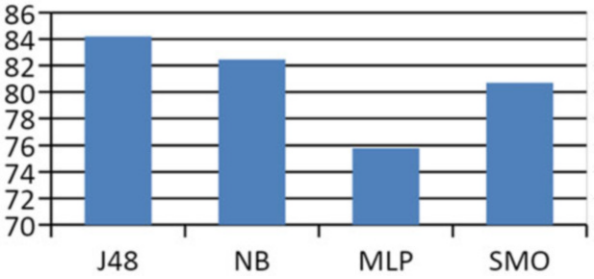


**Fig. 2.6** Accuracy of performance of the base classifiers

**Table 2.2** Error statistics of base classifiers

| Other statistics | J48 | NB | MLP | SMO |
|---|---|---|---|---|
| Kappa statistic | 0.5098 | 0.4054 | 0.2181 | 0.2448 |
| Mean absolute error | 0.2169 | 0.2344 | 0.2459 | 0.193 |
| Root-mean-square error | 0.3484 | 0.3681 | 0.4496 | 0.4393 |
| Relative absolute error | 66.62% | 71.98% | 75.52% | 59.27% |
| Root relative squared error | 86.52% | 91.41% | 111.65% | 109.10% |

Kappa statistic determines the attribute measure of the agreement. Higher values of Kappa statistic implies higher agreement, and for a perfect agreement, it goes up to a value of 1 [26]. In our study, the Kappa statistic for J48 has been determined to be the highest. Again for the error statistics, J48 has the lowest RMSE as well as RRSE. SMO analysis results have indicated that it has the lowest MAE and RAE. It is pertinent to note that the lower the error statistics, the more efficient is the classifiers. Figure 2.7 shows the characteristics chart of the error statistics.

The next step involved the analysis performed by the voting ensemble method. Since J48 has the highest performance accuracy, it was thought wise to combine the same with the three other classifiers separately. The performance of J48 combined with Naïve Bayes (NB) produced the highest accuracy of 83.86%. We then further combined both J48 and NB with MLP and SMO as two separate cases. The analysis indicated that the performance of the combination of J48, NB, and SMO is better than the one with MLP. An attempt was also made to combine all the four classifiers, and this resulted in an accuracy of 82.1053%. Table 2.3 shows the performance of voting classifiers, while Fig. 2.8 depicts the performance accuracy chart of the voting classifiers.

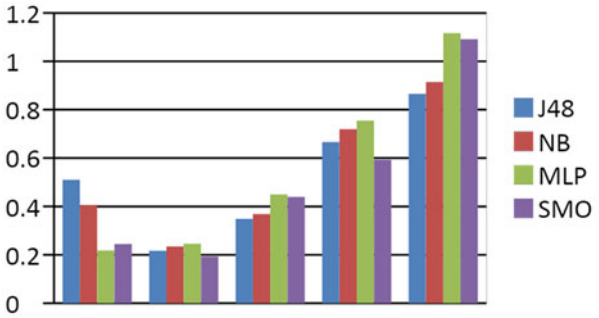


**Fig. 2.7** Chart showing the error statistics for the base classifiers

**Table 2.3** Performance of voting classifiers

| Voting classifiers | Accuracy | TP rate | FP rate | Precision | Recall | F-measure | MCC | ROC area |
|---|---|---|---|---|---|---|---|---|
| J48 &NB | 83.8596 | 0.839 | 0.388 | 0.831 | 0.839 | 0.834 | 0.477 | 0.815 |
| J48 & MLP | 81.4035 | 0.814 | 0.484 | 0.798 | 0.814 | 0.803 | 0.371 | 0.77 |
| J48 & SMO | 81.0526 | 0.811 | 0.575 | 0.784 | 0.811 | 0.786 | 0.309 | 0.779 |
| J48 & NB & MLP | 81.4035 | 0.814 | 0.497 | 0.796 | 0.814 | 0.801 | 0.364 | 0.796 |
| J48 & NB &SMO | 82.1053 | 0.821 | 0.585 | 0.798 | 0.821 | 0.792 | 0.336 | 0.813 |
| J48 & NB & SMO & MLP | 81.7594 | 0.818 | 0.534 | 0.796 | 0.818 | 0.798 | 0.352 | 0.796 |

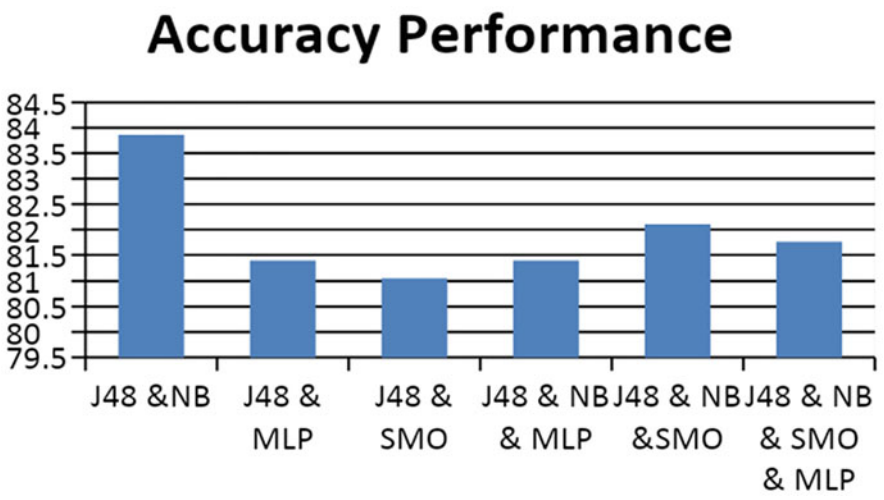


**Fig. 2.8** Chart showing the performance of the voting ensemble with different combinations

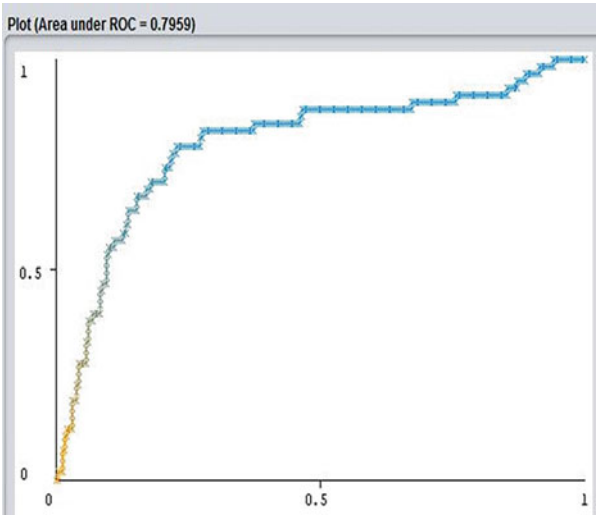


**Fig. 2.9** ROC of voting classifiers with the combination of J48 & NB and SMO & MLP

Comparing Tables 2.1 and 2.3, it can be estimated that the accuracy of voting classifiers is relatively higher than the individual classifiers. Though the accuracy is highest in J48, the results indicate that the voting classifier enhances the performance of the weakest of the classifiers.

Figure 2.9 shows the ROC for the voting classifier which is a combination of J48, Naïve Bayes, MLP, and SMO. The area under this curve is highest with a value of 0.7959, and this clearly demonstrates that this combination has good prediction capability. In Fig. 2.10, ROC of all the base classifiers are shown, and the corresponding values of the respective areas under ROC are indicated within brackets (J48 = 0.769, NB = 0.781, MLP = 0.670 and SMO = 0.596).

## 2.6 Conclusion

Data mining plays an important role in extracting information contained in any complex database including the medical database. It is clear from the analysis that the stage of cancer plays a vital role in cancer survival. So, early screening is very important in order to increase the chances of survival. Our computations indicate that the performance accuracy of the base classifiers such as J48, NB, MLP, and SMO are 84.2105%, 82.4561%, 75.7895%, and 80.7018%, respectively. The performance accuracy combinations of J48 & NB, J48 & MLP, J48 & SMO, J48 & NB & MLP, J48 & NB & SMO, and J48 & NB & SMO & MLP are 83.8596%, 81.4035%, 81.0526, 81.4035%, 82.1053%, and 81.7594%, respectively. This work has demonstrated that the voting classifiers improve the overall performance of

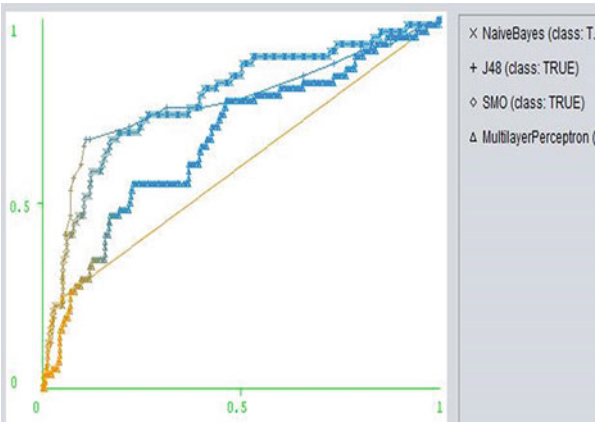


**Fig. 2.10** ROC of four different base classifiers

individual classifiers, more so the weaker ones. Based on our current study, we can conclude that apart from the overall improvement (with one exception), the voting classifier has the ability to enhance the performance of weak classifiers like MLP and SMO. The performance has been evaluated using the performance accuracy, computing the area under the ROC and error statistics.

As part of our current study, we have used only four data mining base classifiers, but this approach can be extended, in principle, to cover several numbers of classifiers. Further extensive computations have to be performed using a number of such combinations before we start to implement a fully optimized version of the computer-aided prediction system that will have the ability to predict the recurrence of breast cancer with greater accuracy.

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# Chapter 3
# A Learning Ecosystem for Dyslexic


**Pritalee Kadam, Maitri Thaker, Gargi Vyas, and Anusha Vegesna**

## 3.1 Introduction

Dyslexia is not merely a behavioral problem [1] (Lyon, Shaywitz, & Shaywitz, 2003, p. 2). Approximately 20% [2] of the students in the United States are dyslexic which is a major problem for teachers who are not trained to handle dyslexia. The lack of interest in reading and writing is because they do not understand the letters and sentences in front of the eyes, which doesn't mean they are not intelligent. They have extremely good visualization power. So their brain works even faster while visualizing things. The advances in MRI [3] and other forms of brain imagery **have** been of great benefit for neuroscientists conducting research on dyslexia. Some of the factors on which the research has been conducted are processing speed, temporal processing, and phonological deficit viewpoints. One of the major issues with dyslexic people is they will have potential, but when it comes to writing them down, they struggle a lot. Dyslexic people face problems like mixing up similar letters, short-term memory, coordination, reading and writing, and a problem in decoding symbols and sounds. Thus we aim to design a process that develops an interactive educational module with multimedia functions.

Datasets [5] of the proposed system containing all the conditions that the user asks for are not readily available. We have expanded the datasets available online to cater to all the needs of different users. Learning ecosystem for dyslexic is an application we plan to design to help students having reading disabilities to read online articles and text files without any difficulty. Traditional text presentation requires physical interaction like zooming and scrolling while reading. Another

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glitch with traditional text presentation is that there is a need for squeezing a lot of information into a small area. The text is presented as smaller pages that fit the screen or as a long page which implies that the user has to scroll, thereby increasing the physical interaction with the device. All existing systems do not contain the features that suffice the basic needs of different users. So the challenge in the proposed system architecture will be the combination of all the features. This application can be used as a support to espousing smart devices for educational purposes not only for the dyslexic but for the normal people since they can use text to 3D scene visualization to learn concepts in a better way.

## 3.2 Existing Work

1. WEB READER FOR DYSLEXIA PEOPLE [6] – This system identifies the requirements for the user interface of dyslexic children. It provides functions like changing font size, font color, font style, background color, and spacing. Some stories with pictures are present which the dyslexic person is supposed to read. Researchers found some user interface requirements which suggests font size should be 12 to 14 points or bigger. This system also provides name, shape, and sound of all alphabets for the dyslexic user to learn.
2. DYSLEXIC BACA [7] – This is a mobile app which is developed to help dyslexic children to recognize and distinguish letters. It assists them in alphabet recognition and also motivates them to learn and recall the information in a fun and exciting way. The dyslexic-friendly user interface is provided with a changing reading environment. It also provides some games which help in recognizing alphabets.
3. iLearnRW [4] – This system contributes toward a move away from traditional which uses a computer simply as an alternative to pen and paper. It provides a changing reading environment with a sensible preset. The narration of a story for the uploaded document is provided. Games provide language-related activities and memorizing activities. For memorizing, games are provided in which the user is asked questions related to the read document, e.g., select the words seen in the document. iLearnRW also provides dictionary support.

The following are the existing systems for converting text to 3D image:

1. WordsEye [8] is a system for translating English text into 3D graphical scenes that represent that text. WordsEye works operates by carrying out syntactic and semantic analyses on the input text, generating a description of the agreement of objects in a scene. As the semantic intent was ambiguous, user expectations were roughly matched in the resultant 3D scene.
2. Real-time automatic 3D scene generation [9]: Real-time automatic 3D scene generation system proposed an automatic system that benefits non-graphics domain users and applications which give an advanced scene production. The

methodology for depicting spatial relationships amid and among different objects is used for building real-time scene descriptions.

3. Rich lexical groundings [10]: The preparation of the textual descriptions to physical objects can be determined by the 3D scene dataset expounded with natural language description which is introduced in this system. The variety of lexical terms to specific referents is prepared in this method. It is also seen that this method displays enhanced 3D scene generation compared to the methods that use only rule-based methods.
4. Snap & Read [11]: Snap & Read is the next-generation reading tool for Google Chrome that can cover the most diverse reading needs. It has many features like reading aloud, dynamic text leveling, translation, reading lines guide, picture-supported dictionary, and screenshot reader. It reads accessible text as well as text embedded in image or video with the help of a read-aloud feature. Dynamic text leveling is used to change a few words of the sentence without changing its meaning. The translation feature is used to translate words from one language to another. Reading lines guide brings focus to text paragraph by paragraph and even line by line – by masking the reading area. The picture dictionary shows meaning as well as multiple icons to represent its meaning. Screenshot reader instantly gets access to text embedded in images, inaccessible PDFs, and flash through optical character recognition (OCR). It also delivers usage data to teachers who then can more easily assess students' reading needs individually.
5. Read & Write [12]: This software assists people with dyslexia to do their work with confidence and independence. It transforms text into speech on the click of a button with a huge variety of audio voices from which the user can choose. The picture dictionary helps dyslexic users to visualize what they read to get a better understanding of the word. Talk&Type function allows them to write without typing but by speaking. It transforms the audio input into the text which is displayed on the screen. "Focus on what you need" function enables users to highlight the part of the screen which is active with the color of the user's choice.
6. Nessy Reading and Spelling [13]: When the user uses this for the first time, games are used to find out their baseline reading and spelling ability. Memory strategies are embedded within the animation to help students learn important concepts. It provides the performance data and analysis which helps parents to identify areas of difficulty for their children. Students can progress by unlocking the new levels and by collecting rewards.

### *3.2.1 Literature Related to Methodology/Approaches*

1. Real-time automatic 3D scene generation – It presents a newly developed system that generates 3D scenes from text natural language input, in which an automatic system produces an advanced scene. Formation of real-time scene description was done by using a method for illustrating spatial relationships amid and among

different objects. According to the given description, the system forms scenes also allowing for positioning and repositioning of the objects.
2. Rich lexical groundings – In this method, specific referents are assigned the lexical terms. This method also shows enhanced 3D scene generation as compared to those which only used rule-based methods. An automatic metric is offered to ease the assessment which strongly associates with human judgments.

### *3.2.2 Literature Related to Algorithms for Text to 3D Scene Conversion*

1. Placement and rule-based algorithm. Steps involved in this process are:
   - The first step is to separate the input from the user into multiple sentences which are then parsed using the Stanford CoreNLP pipeline [10]. To encompass physical objects, head words of noun phrases are determined as candidate object categories that are filtered using WordNet [14].
   - By using the Stanford reference system, references to the same object are disintegrated. Properties are adhered to each object by obtaining other adjectives and nouns in the noun phrase. These attributes are then used to query the 3D model database. A polygon to voxel alteration process converts the input polygon objects to their respective vowelized representations for further processing. During preprocessing iteration, this stage is performed once for each 3D model in the input collection.
   - In the next stage, the object's surface is retrieved and segregated into spatially consistent regions using voxel depiction.
   - The last stage selects and approves a location from the regions that satisfy the spatial relation for the object.
   - In the concluding stage, objects are added to the scene. The newly placed objects must not collide with the reference objects. Results are affected in two ways, one is when there is no accurate placement within a region or if numerous placements are there to choose from but none of them are correct. If there is no accurate region, the algorithm matches N voxels representing the entire surface. This matching can be decreased by setting a threshold for the number of regions to validate. This proposed system emphasizes mainly on the portraying natural language descriptions in actual time as an introductory framework.
   - Currently, the authors have supposed that the descriptions include spatial relations and the proposed system creates scenes in accordance with a definite description. Thus, the objects are positioned and repositioned effectively.
2. Learning lexical groundings algorithm [9]: A classifier is trained on related grounding tasks, to get the lexical mappings from examples that are used to retrieve weights of lexical features to generate a scene. In the scene dataset,

the scene in each scene-description pair is hidden among four other distractor scenes sampled evenly. The classifier learns from a "discrimination" version of this dataset. Maximizing the L2-regularized log probability of this scene discrimination dataset under a one-vs-all logistic regression model is the primary objective of training. This model adopts each true scene and each distractor scene as a single example (with accurate/distractor as the resultant label). The learned model takes binary-valued attributes that indicate the coexistence of a unigram or bigram and an object class or model ID.

3. Visually guided spatial relation extraction from tex [15]: Two models are trained first, word-segment alignment, trained on ImageCLEF referring to an expression dataset, and second preposition classifier which is trained on visual genome dataset. This serves to connect two modalities and helps in resolving link disambiguation. A graph is generated which is based on both image and text data and a proposed global machine learning model is used to exploit the information from the companion images [15]. A model is described by trajectory, landmark, and spatial prepositions. For example, a car (trajectory) is in front of (spatial preposition) the bus (landmark). Per concept (spatial relations), a model is trained, and predictions are done based on global inference. A global inference on these classifiers ensures consistency over modalities and identifies the spatial relations in the text in accordance with their counterparts in the image [15]. The models are trained on various datasets to resolve ambiguity in spatial relations in text.

## 3.3 Observation

We observe that all the existing systems try to adapt the reading environment according to the dyslexic by changing either the fonts or the background color. Some provide auditory support by reading the texts aloud, while some try to enhance memory using interactive games. The power to set the reading environment according to their requirements should totally be vested in their hands; however, only a few systems do so. Interactive games are fun, but their scope is limited; they fail to provide a deeper understanding of texts. It has been studied that the dyslexic has wonderful creative thinking and visualizing capabilities. They can think really fast, and on observation, none of the existing systems have explored this. They also struggle with depth perception which has not been addressed by any existing system. While writing, they tend to make mistakes with certain letters; identifying these mistakes and reporting their frequency can help them track their progress, which all the existing system fails to address. Thus we see there does not exist one software that serves all their needs.

## 3.4 Proposed System

Many people in India suffer from dyslexia; preliminary help to improve their reading and writing skills can greatly benefit them. Today many software are available in the market, but they fail to cater to the basic needs of dyslexic kids. Dyslexia affects different people in different ways, but there is no specific computer application that will be useful in every case. Psychology approves that visualization helps in a better understanding of information; this would be very beneficial for dyslexic learners. Therefore, we aim to provide a one-stop solution for dyslexic kids wherein they have all the tools which help them in reading and visualizing things.

Assumptions: The user is equipped with a personal computer and an Internet connection to access the Internet.

Constraints:

- The age group targeted is 10–20 years. Datasets might not contain all the data requested by the user.
- Output to a few user inputs might not be available due to a lack of sufficient data in the dataset. So, all user conditions will not be covered.
- The sentence entered by the user should have a scene description.

The authors aim to include the below-mentioned features in the proposed system:

Font size and color: Not only do colors send signals to the brain to calm us, but they also have the power to distract a child or enhance a child's learning potential. Hence, we propose a system where users can adjust the size and color of the letters according to their requirements. All colors and sizes will be available since every user has different requirements. An option is provided for the users to change the font color as per his comfort.

Background color: The text to be read is highlighted using a background, which the user gets to select. The color combination increases the user's comfort while reading since he is aware of where to focus on the entire page.

Font style: If the user is not comfortable with the current font style, he can change it.

Read aloud: For dyslexia-affected people, to read is easier than writing. For people with difficulties to put their ideas on paper, word-retrieval problems, this is an important feature that will help them with this process. A text to speech voice reader that reads the content displayed on the screen is provided by the system.

Reading speed: Dyslexic people experience a condition called "visual stress" when reading. In this condition, a dyslexic may see the letters within words to be blurred and distorted. A text might seem to be moving in random places on the paper. Every user is accustomed to different pace so the user can adjust the speed of displaying the text according to his/her requirement.

Repeat after me: Sometimes it may happen that a dyslexic person might not know the pronunciation of various words. Users will get help for pronouncing every word by splitting it into its component phonetics.

Visualization aids: The brains of dyslexic kids are wired for better memory of pictures than words. They remember things faster if pictures related to the word are shown. For this, we provide an option where the user can view a related image of the selected word.

Dictionary support: At times, it happens that while reading, one doesn't know the meaning of a particular word. In the proposed system, the user can find meaning to any word on hover. Frequency of errors: A dyslexic person makes many mistakes while writing. To provide help to find mistakes, the user can upload a picture of the text that needs to be checked, and the system will highlight the errors.

3D visualization: To provide a better understanding of the document being read, the system helps to convert the text to the 3D scene.

The system consists of all the features that satisfy the basic needs of the dyslexic. Considering the fact that dyslexia has a very good visualizing power, the system provides a text to 3D scene conversion system which helps them in visualizing the text, in turn, helping them in memorizing and understanding the text. The teachers teaching dyslexic students can also use the application to recognize the errors by uploading the image of the handwritten documents as well as help them to visualize using text to 3D scene generation.

## 3.5 Text to 3D Scene Generation

The most crucial task of mapping words/sentences to 3D objects is extracting their positional relationship. The authors first tag parts of speech in a sentence and then establish a relationship between the nouns (objects) and their respective adjectives (properties). The main object, its attribute, reference object, and the spatial relationship between them as understood by the prepositions are extracted. Then the objects along with their attributes are stored in a text file. The spatial relationship of the objects is stored in another text file. The file is fed to Unity software which reads them, and raw objects are created. After the creation of these objects, they are positioned in space according to the spatial relationship stored in the text file. Thus, objects along with their location are rendered in the 3D space (Figs. 3.1 and 3.2).

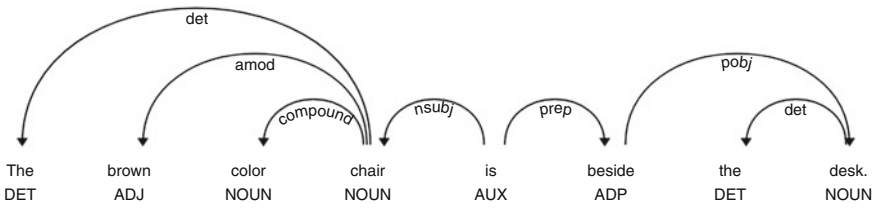


**Fig. 3.1** Parts of speech tagging

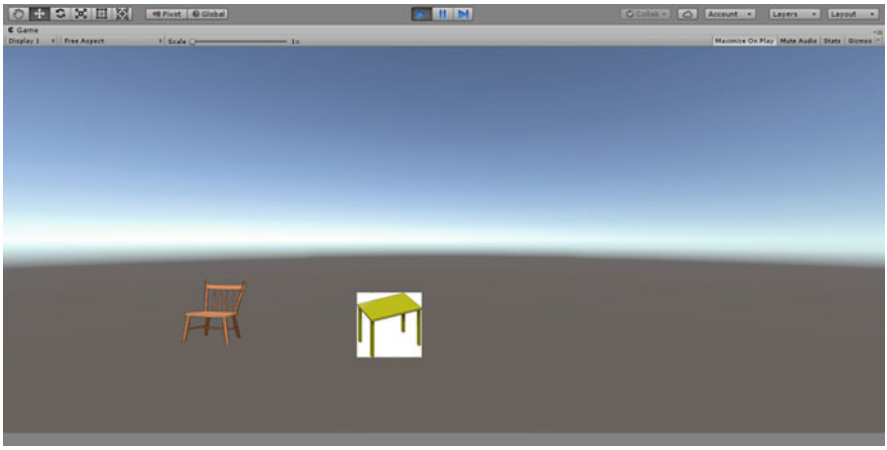

**Fig. 3.2** 3D scene in unity

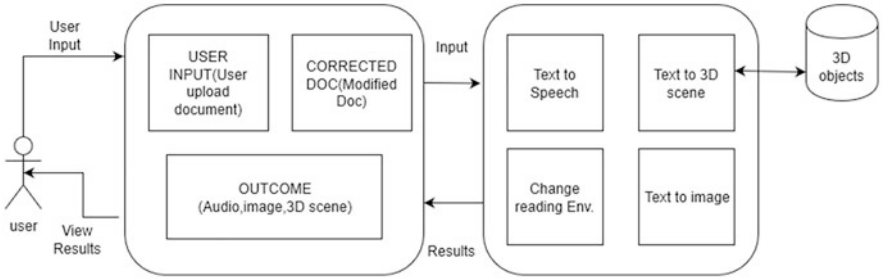


**Fig. 3.3** The architecture of the proposed system

## 3.6 System Architecture

The architecture of the system is shown in Fig. 3.3. The system consists of the user interface and processing unit. The user interacts with the interface, which is a web application console. This interface displays output to the queries processed by the processing unit.

The Processing Unit does four tasks; converting the textual input to speech, changing the reading environment (such as font size, color, and background) according to user requirements, producing an image for a given text and generating a 3D scene for an input text.

The text to 3D scene generation module uses a database of 3D objects to translate text into 3D visualizations. The last module in the processing unit (text to image) converts the text selected by the user to its equivalent image. This module makes use of image database for retrieving appropriate images.

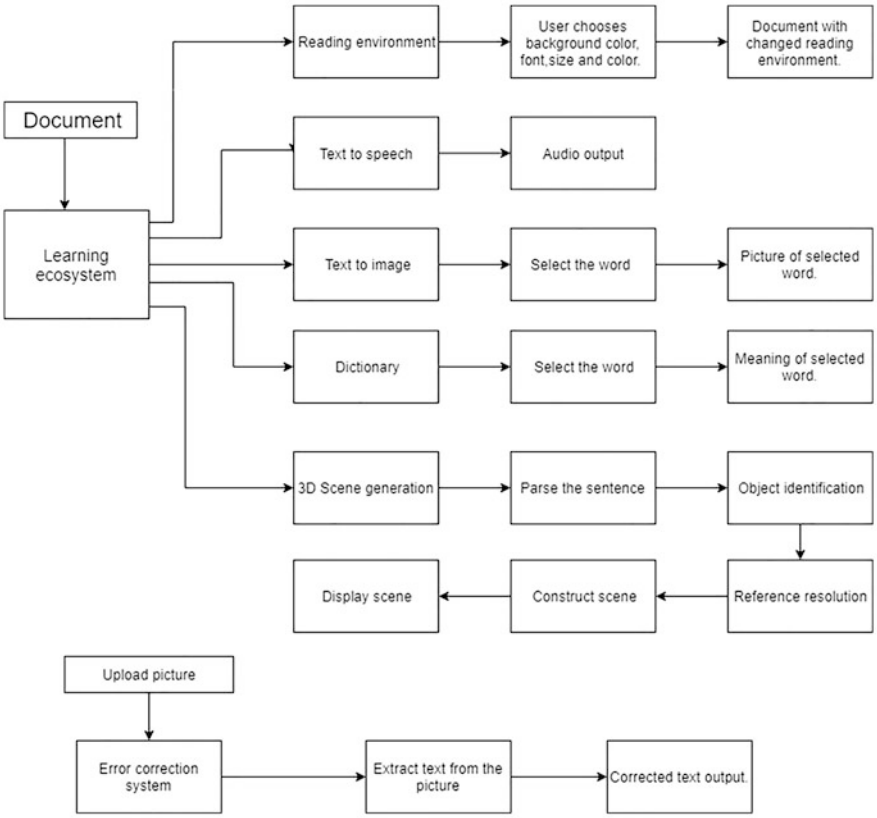


**Fig. 3.4** Flow diagram of the system

The user interface unit takes user input and displays corresponding user output. One module takes user input in the form of an uploaded document; the next unit shows the corrections in spelling and saves this data for every user to track his progress. This unit also outputs the audio, image, and 3D scenes depending on user request.

Figure 3.4 shows the flow of the system. First, the user uploads the document to be read. On uploading, the user can choose various parameters for a reading environment suitable to him. For a better understanding of the text, user can hover over a word to check its meaning or view an image of the object (this feature is limited to some objects). Text to 3D feature helps in visualizing a particular sentence in the form of a scene. This can be used to generate settings in a storybook or fable.

## 3.7 Conclusion

On observing the existing systems, it was concluded that there is no system that integrates 3D visualization techniques for dyslexic readers. Moreover, on discussing with Dyslexia Correction Centers, the authors have inferred that providing an adaptive reading environment (adaptable audio and visual support) can boost reading and comprehension experience for dyslexic readers. Therefore, heeding their requirements the authors have accommodated for 3D scene help of text. This approach aims to map words and their relations to corresponding 3D objects while generating a scene which is done using core natural language processing concepts and using tools such as spaCy.

## 3.8 Future Scope

This web application can further have a new feature of showing the frequency of errors. The percentage frequency of errors will make them understand how frequently they make the same mistake which will further help them in being more cautious while writing. Background music while reading an article has been found to enhance the comprehension of text. Therefore, further research on suitable frequencies can greatly increase the usefulness of this endeavor.

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# Chapter 4
# Green Computing: An Approach Toward Eco-friendly Environment


**Kiranjit Kaur and Munish Saini**

## 4.1 Introduction

Today's computing is based on the scenario where the consumer pays the provider only for when and how much they use the services mainly refers to as the "Pay-as-per-Use" model and such kind of model referred to as cloud computing [1]. Basically, cloud computing services are supported by servers (data center) where virtual machines are incorporated to provide isolation. The main problem with this data center is that their power consumption [3]. Cloud computing provides infrastructure, platform, and software as a service on demand [4]. The term green computing is used to lessen the problem of power consumption. It mainly focuses on the efficient usage of computing resources so that they cause a minimal impact on the environment. Mostly, IT departments consume an immense amount of power which leaves the carbon footprints in the atmosphere. Figure 4.1 measurement of energy consumption is being termed as "green computing." Green computing is practice for designing, manufacturing, using, and disposing of the computer server system in an effective way so that they do not cause a negative impact on the environment [2, 3].

So, we have to take some small initiatives just to have a big change. For instance, we should use Blackle instead of Google which will save a huge amount of energy. With this, we started some simple but effective initiatives like using sleep mode and standby mode in our PC or in mobile phones which will also save an immense amount of energy.

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**Fig. 4.1** Green computing [16]. (Source: green-computing-69791681, [16])

## 4.2 Need for Green Computing

Green computing is a technology that mainly focuses on designing a better computer system means their processing must be better and they must consume less energy. Nowadays, use of computer system and IT services has become a necessity for everyone, and it makes life easier and works rapidly which in turn saves time. The emission of a greenhouse gas like CO2 rises with an increase in power consumption. Since, the computer system and its peripherals also consume power even when these are idle. With this, data center also requires a large package of energy and cooling mechanism, but it leads to the wastage of energy at the time when the demand for power and cooling capacities are not fulfilled which in turn causes environmental pollution. Green computing mainly focuses on declining the energy utility level and reusability with the reduction of resource usage by means of sharing them. There are a number of steps that should be attained just to decrease the environmental threat which is caused by the overutilization of resources which increases the carbon dioxide concentration in the climate where we are just surviving, and these are just described as follow:

### *4.2.1 Cloud Computing*

It has many benefits like it enables anybody to obtain environmental benefits of virtualization. It also remove the need for the user to run high power PCs since it provide infrastructure as a service.

### *4.2.2 Virtualization*

It is one of the most important steps which can be attained just to overcome the problem of power consumption. It is the usage of more than one operating system on a single machine. The attainment of such a system can result in less usage of resources which can even increase the power efficiency and decrease the level of carbon dioxide in the environment.

### *4.2.3 Recyclability*

Recycling of the waste or equipment is a one good deal toward reduction of environmental pollution [4].

- *Climatic Change*: Researches done in the passing years depicts that CO2 and emission of other substances have a drastic impact on the global climate and even though responsible for damaging our environment.
- *Cost Savings*: Green computing can lead to saving income at an amazing rate.
- *Power*: As the demands for energy get incremented, with the other hand, the supply for the same gets declines. So, not to face any problem regarding this, most of the industries are just generating their own electricity which will automatically force them to consume less power. And even the computing power consumption has reached a critical point [5].

## 4.3 Current Trends

Current trends are toward productive use of computing resources, and the most important resource is energy, and on the downside incrementation in the carbon content is considered as a major environmental threat. Therefore, the aim is just to reduce the vitality consumption and carbon content in the atmosphere and to escalate the overall computing performance. The following are various areas where the researchers are focusing to get the desired results. The areas are as follows:

### *4.3.1 Recycling of e-Waste*

The greater part of the nation mainly those countries which are under development are in the need of some electronic companies which will manage the whole process of recycling for their items. Green computing must take the product life cycle into consideration just to reuse the items that have been produced. The survey provides a complete picture that shows that more than 130,000 PCs are disposed of on a

daily basis and even small percent of hardware is recycled at a time. Recycling of the e-waste is an easy job that can be made under consideration. The reusability of lead and mercury helps to maintain dignity as it reduces the bad impact on the environment just by saving the energy [6].

### *4.3.2 Data Center*

The data center of green computing is getting a great concern nowadays as they are known for their inefficient vitality utilization. As viewed from the survey of the US Department of Energy in 2006, it was experienced that the data center consumed one-fourth of electricity and even the demand for electricity rises respectively. As, the demand increases, the cost of the electricity also gets increased with nearly about $7 billion per year. The flow report undertaken by the department of energy in 2011 indicated that the data center consumed about 4% of all the US electricity and this utilization of energy gets doubled after 4 years which was reported in 2015 [7]. Just focusing on the more demand for energy utilization in the data center, much concern is on the following [8]:

- Information System – For building a green data center, the perfect design of data frameworks for business requirements is a key function. According to the green computing, the efficient servers, the storage devices, networking equipment, and selection of power supply, all these are assumed as a key job in the planning of information systems.
- Cooling System – It is suggested by the researchers that at the underlying phase of constructing the data center cooling system, the current and upcoming requirements are to be considered and design the cooling system framework in such a way that it is expandable according to the requirements.
- While designing and selection of data center electronic system equipment, all the initial and the future burdens are to be considered.

### *4.3.3 Energy Utilization*

Various researchers think that a source and amount of energy utilization gives rise to the emissions of greenhouse gas. Due to which various organizations are using the upcoming condition:

Reduction in energy utilization = reduction in emission of greenhouse gas = reduction in operative costs of a data center.

It demonstrates that undertaking lesser and number of energy-efficient frameworks while just refactoring the application environments to utilize physical resources is the best structural model. As per Environmental Protection Agency,

around 35% to 45% of PCs are kept "ON" after office hours and during the end of the week and even around 80% of those PCs are idle.

### *4.3.4 Virtualization of Resources*

The meaning of virtualization is described by its name "virtualization" that is the abstraction of computer resources. It is the main aspect of green computing. In virtualization, the two or more logical computer systems are just running on a single physical hardware. Virtualization is a pattern of green computing as it offers both virtualization and management software for the virtualized environment [9]. One of the ideal approach towards green and spare enough space, enough resources, and the environment is by streamlining efficiency with virtualization. This type of green computing gives rise to server consolidation and just increases the security of computer [10]. Virtualization permits usage of computer resources and advantages as follows:

- Lesser the number of the hardware
- Power off the servers which are not in use at a time just to spare the energy
- Reduction in all-out space leads to cost savings

## 4.4 Related Work

### *4.4.1 Power Aware Hybrid Deployment*

To cope with the difficulties such as trade out of energy consumption and QOS, various efforts in the conscious QOS and implementation capabilities of applications based on the work investigator called Zhiwu, Fanfu, and the other researcher Zhengwei have proposed an intensive hybrid implementation of I/O and CPU in order to optimize resource utilization in the virtualization environment. In this study, they investigated the resource allocation between virtual machines where I/O and CPU-oriented applications take place, in order to run the hybrid implementation of applications that require energy. To bring out the I/O difficulties and the CPU resource in the virtualization environment, the researchers used Xen as the virtual machine monitoring for the experimentation. They also conclude that the CPU-Intensive applications in the hybrid deployment applications need to satisfy Quality of service [11].

- *Power and Its Utilization*: Power consumption is demonstrated as a percentage value of peak power across the various data centers.

The estimation for the power usage was proposed in the model of Wang [12] for a fixed operational frequency, and it was concluded that power utilization of server

is just approximately the static functions of the server utilization that is the number of servers used. As a result, they conclude from the analysis that CPU-Intensive and I/O-Intensive applications hybrid deployment can improve power efficiency.

### *4.4.2 Green Algorithm for Power Management*

In the research work of R. Yamini in 2012, it was proposed that due to the increase in the global warming trend, the large amount of the carbon content is just taking place in the environment which in return becomes the major challenge for the environment. Just to overcome the problem of the energy crisis, green computing just join hands to make the environment green and saver. But, green computing needs a number of algorithms and redesigning of the mechanism to increase energy efficiency. There are a number of approaches to green computing which include virtualization, data center, recycling of e-waste, utilization of resources, power management, and so on. The basic principles of cloud computing is to make the computing be assigned in great number of distributed computer or remote server. Currently, a large number of cloud computing systems waste a tremendous amount of energy and emit a considerable amount of carbon dioxide. The carbon footprints harm the environment as a large amount of carbon dioxide content causes pollution. So, it becomes a necessity to reduce pollution and also increment the energy efficiency level. R. Yamini uses the green algorithm to increase the energy efficiency. Both public and private clouds are used for analysis purposes. Cloud computing with green algorithm can enable more energy-efficient use of computing power, as energy efficiency is inversely proportional to resource utilization. In this study, the task was to make a streamline for resource usage which in return improves energy efficiency. Based on the above fact that resource utilization is related to energy efficiency, Malviya has successfully developed two energy-conscious task consolidation heuristic. Hence, the outcome in this study should not only focus on the electricity bill reduction of the infrastructure provider of cloud but also depict the possible operational cost savings just by overcoming the impact on the environment [13].

### *4.4.3 Power and Energy Management for Server System*

The researcher Ricardo and Ram Rajamony works on power and data center efficiency. The study was proposed in 2009 using the power and energy consumption as a technique for the data center. These data center controls thousands of servers, and the cooling mechanism was supported. The main effort was to conserve energy in the servers. Inspired by this initial progress, researches just go deeper into this topic [14].

## 4.5 Comparison Table

| Name of author | Year | Technique used | Power efficiency | Data center efficiency | Resource utilization | Cost saving |
|---|---|---|---|---|---|---|
| Zhiwu Liuma | 2010 | Power-aware hybrid deployment | Yes | No | Yes | No |
| Fanfu Zhou | 2011 | Power-aware hybrid deployment | Yes | No | Yes | No |
| Zheng | 2010 | Power aware hybrid deployment | Yes | No | Yes | No |
| R. Yamini | 2012 | Green algorithm | Yes | No | No | Yes |
| Richardo Binachni | 2009 | Power and energy management for server system | Yes | Yes | No | No |

## 4.6 Conclusion

Green computing is not only helping companies to reduce cost but even also saves the environment and makes it sustainable. As with the span of time, they need for computers as a dependable machine increasing progressively. To overcome the workload on a single system, more systems are to be preferred. But as well said by David Wang "Every single step consumes energy and buying a new, more efficient computer may not always be the right answer" [15]. So, a focus should be made on resource utilization and implementing more green techniques in our future.

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# Chapter 5
# A Survey on On-Board Diagnostic in Vehicles


**Deepa Saibannavar, Mallikarjun M. Math, and Umakant Kulkarni**

## 5.1 Introduction

In the global world, automotive electronics plays an important role and is extremely growing. Due to this, it has become essential for us to reduce the emission generated by vehicles. Henceforth it has become mandatory requirements for the vehicles to visit the diagnostic center regularly to diagnose the faults in the vehicle [1]. This is a bit troublesome for the mechanics to diagnose the faults with standard tools and technology. To overcome this problem, the On-Board Diagnostic (OBD) was developed and made mandatory in the cars manufactured after 1996. The OBD in vehicles is capable of collecting the sensory data from the vehicles, process, and store the raw vehicle data to blockchain [2].

Vehicles are equipped with various Electronic Control Units (ECUs). ECUs are electronic systems that optimize the performance and control the engine based on the data collected from various types of sensors [3]. The ECU design is as shown in Fig. 5.1.

They are various categories of ECUs:

1. *Engine Control Module (ECM):* These ECU controls a series of actuators on an internal combustion engine to ensure optimal engine performance.

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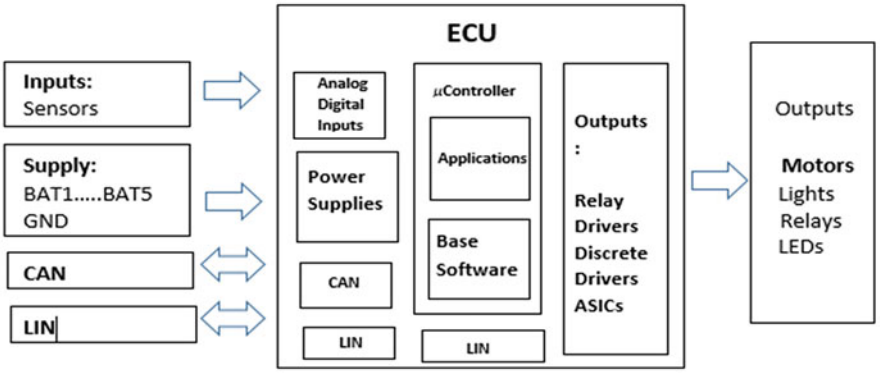


**Fig. 5.1** Design of Electronic Control Units

2. *Powertrain Control Module (PCM):* PCM is also called the "brain of the car" that coordinates different functions of the car. This has two subsystems: Engine Control Unit (ECU) and Transmission Control Units (TCU). It mainly concentrates on optimizing the performance of the engine and maximizing fuel efficiency.
3. *Brake Control Module (BCM or EBCM):* EBCM reads the information from sensors and if required it activates the ABS or traction control system. When the EBCM fails, it can disable the ABS and sometimes cause issues with braking the vehicle [4].
4. *Body Control Module (BCM):* This module coordinates the functions like Exterior and Interior Lamps, Courtesy Lamps, Cargo Lamps, Fog Lamps, Intermittent Wiper Controls, Park Lamps, Central Locking, Horn Chirp, Chime Warning, Dome Defeat, Head Lamp Time Delay, Door Ajar Switch Status, Remote Radio, Low and High Beam Head Lamps, Speedometer, Radio, Power Door Locks, Instrumentation Lighting and Gauges, and Dome Lamps [5].

The challenge for the automotive industry is to communicate between various electronic units in the vehicle by reducing the complexity and bulkiness of the system. Therefore, CAN bus was introduced to establish communication between various electronic units efficiently and reducing complexity. Each electronic unit in the vehicle should have compatible hardware and software to communicate with each other. CAN protocol addressed this issue by offering various rules that help electronic devices exchange information over a common serial bus.

This paper presents the review of OBD-II and discusses OBD-II protocols, Diagnostic Trouble Codes, and OBD frame formats in the coming sections (Fig. 5.2).

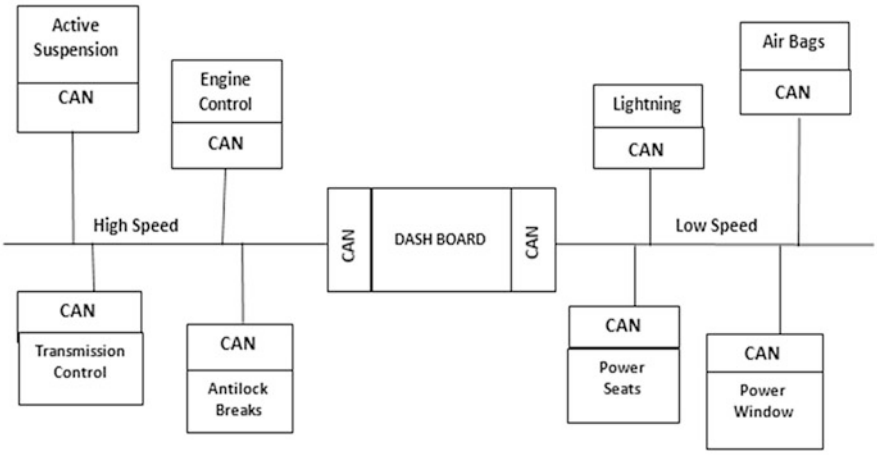


**Fig. 5.2** Connectivity between various ECU using CAN Bus

## 5.2 Literature Survey

The modern vehicles equip a lot of electronic devices; it is a time-consuming and tedious job to diagnose. The 23% overall price of the vehicle is the cost of electronic components; this may reach up to 50% by 2020 [1]. Therefore, it is complex to detect the fault in vehicles by using the traditional method. Table 5.1 gives the literature survey.

## 5.3 Comparison of OBD-I and OBD-II

As per the previous researcher, 70% of the time is consumed for diagnosis and 30% is for repair and maintenance [13]. To overcome this problem, the fault diagnosis system called On-Board Diagnostic (OBD) was developed and adopted by most of the vehicle companies. In the 1980s, the Society of Automotive Engineers (SAE) developed OBD standards.

As per the author, OBD had some imperfections [14].

1. The data link connectors in OBD that were used for interfacing with ECU were non-identical which made it difficult for the scan tools to connect with different vehicles. Fault codes to detect errors would vary for every vehicle. This made it more complex for manufacturers to design standard diagnosis hardware.
2. The format of information stored on each ECU was different for different vehicles.
3. OBD was California Standard and OBD-II is a Federal standard (University Standard).

**Table 5.1** Literature survey

| Author and Year | Proposed work | Advantage | Limitation |
|---|---|---|---|
| Dennis K. Nilsson; Phu H. Phung, Ulf E. Larson, 2008 | In this work, cyber-attack threats are identified. The ECUs are classified in the in-vehicle network to support in defining which ECUs to protect and restrict access to [6] | It emphasizes on security and limit the remote diagnostics and performs firmware updates over the air procedures to few ECUs | ECUs are classified to provide protection to access them. There is no solution provided on gathering the data generated by ECU |
| Chin.E.Lin, Ying Shing Shiao, Chih-Chi Li, Sung-Huan Yang, Shun-Hua Lin, Chun-Yi Lin, 2011 | To identify engine operation conditions for air pollution monitoring, On-Board Diagnostic (OBD) is developed [7] | The performance of the engine is monitored | The author has used general – Packet Radio Service for communication in which results in higher transit delay |
| Jheng-Syu Jhou, Shi-Huang Chen, Wu-Der Tsay, Mei-Chiao Lai, 2013 | Cloud computing technologies are integrated with OBD-II and 3.5G wireless network [1] | The proposed system could classify the fault conditions depending on vehicle type and its model year | The data is being transmitted to the remote vehicle diagnostics center without processing that makes it difficult for humans to understand |
| Xiaohuan Li, Bin-Jie Hu, Hongbin Chen, Guillaume Andrieux, Yide Wang, Zong-Heng Wei, 2015 | In the proposed scheme, On-Board Unit (OBU) allows to reserve service channels (SCHs) in the control channel (CCH), and on different SCHs, it allows simultaneous transmissions [8] | The proposed scheme concentrates on improving the performance of the channel to improve driver safety | The proposed system only concentrates on improving channel performance |
| Malintha Amarasinghe, Sasikala Kottegoda, Asiri Liyana Arachchi, Shashika Muramudalige, H.M.N.Dilum Bandara, and Afkham Azeez, 2015 | The ELM-327 commercial adapter to connect via Bluetooth and establish communication with the vehicle using OBD-II Parameter IDs (PIDs) [9] | Provides driver monitoring and vehicle diagnostic systems. Real-time alters are provided for rising engine coolant temperature and fuel drops in vehicle implemented on a mobile app | Complete dependence on a smartphone for data. The driver phone may not be capable of running an android app |

| | | | |
|---|---|---|---|
| Marco Steger, Michael Karner, Joachim Hillebrand, Werner Rom, Carlo Boano, Kay Römer, 2016 | Author proposes a generic framework enabling secure and efficient wireless automotive software updates and hence supporting a vehicle's whole lifetime [10] | Using IEEE 802.11s network as a wireless medium, the vehicles and diagnostics devices are interconnected in a reliable, trustworthy, and fast way to provide a dedicated cross-layer security concept applying strong authentication as well as encryption mechanisms is described | The author has concentrated on updating the software of the ECU and vehicle remotely through roadside infrastructure but also needs to concentrate on the software faults |
| Lucian Andrei perisoara, Alexandru Vasile, Dragos Ioan Sacaleanu, 2017 | The LABView developed the virtual instrument using toolbox that communicates with ECUs in the vehicle through OBD interface using the Controller Area Network (CAN) protocol that can be used for real-time monitoring and diagnosis of vehicles [11] | Experiments were carried out on three models of vehicle: Renault Logan 2, Ford Focus 2, and Hyundai i10. The application can be used for most of the vehicles with no modifications | The experiment is tested only on a few modes of the car and is not sure that it works on all the models of the car |
| Pooja Rajendra Sawant, Yashwant B Mane, 2018 | Used ISO-15765 CAN as a signaling protocol of OBD-II. The controller used in this system is of KEAZ128 product family of ARMR Cortex – M0+ MCUs [12] | This tool has some added features like making provision to add new information and provide GUI to the user that gives DTC with description | Synchronizing both Bluetooth and CAN communication simultaneously is challenging |

**Table 5.2** Comparison of OBD and OBD-II

| Features | OBD-I | OBD-II |
|---|---|---|
| Support | All the cars manufactured before 1995 support OBD-I | Car manufactured in or after 1996 |
| Interface | Manufacturer specific | Universal |
| Installation | Connects to console | Wireless via Wi-Fi/Bluetooth |
| Accuracy | Poor | High |
| Popularity | Low | High |
| Functions | Work better with sensors and actuators | Air fuel ratio, RPM, fuel, speed, coolant temperature, live map, engine, battery |
| Benefits | Calculates the total energy and fuel consumed | To solve the problem, it includes different calculations and codes |

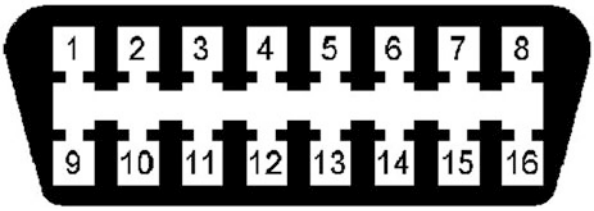


**Fig. 5.3** OBD-II connector

To overcome the limitations of OBD, in 1996 the OBD-II was developed to improve standardization. The DLC was standardized by J1962 that leads to the manufacturing of standard hardware that can work on any current automobiles. Fault codes were modified and redefined to be compatible with standards. All the modern automobiles should have implemented OBD-II by law in the vehicles. The comparison of OBD and OBD-II is explained in Table 5.2 [15].

## 5.4 On-Board Diagnostic-II (OBD-II)

OBD-II is a system that has built-in self-diagnosis capability for the vehicles. When there is malfunctioning in the vehicle, the OBD will set upon the Malfunction Indicator Lamp (MIL) on the dashboard that indicates the driver of the problem in the car and to take the vehicle to the servicing center. OBD-II data is the most convenient way to access data from ECUs of the vehicle. OBD-II has a standardized hardware interface called OBD connector. OBD connector is a 16-pin connector as shown in Fig. 5.3. The pin configuration of the OBD-II is as explained in Table 5.3. Every car has the OBD port on the dashboard near the steering wheel and varies based on the make and model of the vehicle. OBD port is mainly used by a mechanic to read the fault codes and monitor the health of the vehicle.

**Table 5.3** Pin configuration of OBD-II connector

| Pin No. | Description | Protocols |
|---|---|---|
| 1,3,8,9,11,12,13 | – | These pin are manufacturer specific pins and are not standardized |
| 2 | Bus+ | This is used by SAE J1850 VPM protocol |
| 10 | Bus− | |
| 4, 5 | Ground | Ground signal |
| 6 | CAN high | These pins are used for 2-wire ISO15765-4 CAN protocol for CAN high pin and CAN low, respectively |
| 14 | CAN low | |
| 7 | K line | This pin is used by ISO 9141 asynchronous serial communication protocol for K line and L line, respectively |
| 8 | L line | |

### *5.4.1 OBD-II Protocols*

OBD-II uses the following five communication protocols:

1. *SAE J1850 PWM:* Ford vehicles use this protocol which is "Pulse Width Modulation" and has a signal rate of 41.6 kbps.
2. *SAE J1850 VPW:* This protocol is "Variable Pulse Width," at the signal rate of 10.4 kbps. It is developed by General Motors. This encoding scheme offers low radiated emissions [16]. Pin Description of SAE J1850 PWM and SAEJ1850 VWM OBD-II protocols is discussed in Table 5.4.
3. *ISO 9141-2:* The rate is 10.4 kbps and is "Asynchronous Serial Communication." Asian vehicles/European use this protocol. Length of the message is 260 bytes.
4. *ISO 14230 KWP2000:* The "Keyword Protocol 2000," it is "Asynchronous Serial Communication" method at the signal rate of 10.4 kbps. Chrysler, European, or Asian vehicles use this protocol. The message length is 255 bytes. ISO 14230-4 KWP comes in two variants, i.e., 5 baud init and fast init with 10.4 Kbaud.
5. *ISO 15765 CAN"(250 Kbits or 500 Kbits):* It is a two-way communication method at the signal rate of 1 Mbps. ISO 15765-4 CAN have variants based on identifier length and bus speed.

(a) 11 bit ID, 500 Kbaud
(b) 29 bit ID, 500 Kbaud
(c) 11 bit ID, 250 Kbaud
(d) 29 bit ID, 250 Kbaud

The OBD-II OSI model architecture is as shown in Fig. 5.4.

**Table 5.4** Pin Description of SAE J1850 PWM and SAEJ1850 VWM

| Feature | SAE J1850 PWM | SAE J1850 VWM |
|---|---|---|
| BUS+ | "Pin 2" | Pin 2 |
| BUS− | "Pin 10" | Pin 10 |
| 12 V | "Pin 16" | Pin 16 |
| GND (ground) | "Pins 4, 5" | Pins 4, 5 |
| "Bus state" | Active: BUS + is HIGH<br>Inactive: BUS − is LOW | Bus idles low |
| Max. "Signal voltage" | "5 V" | +7 V |
| Min "signal voltage" | "0 V" | 0 V |
| "Bytes" | 12 B | 12 B |
| Decision signal voltage | – | +3.5 V |
| "Bit timing" | "1" bit – 8uS, "0" bit – 16uS, SOF – 48uS | "1" bit – HIGH 64uS, "0" bit –HIGH 128uS, SOF – HIGH 200uS |

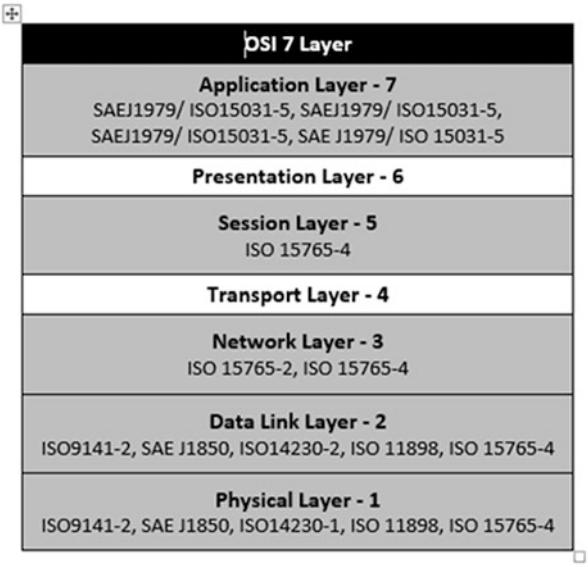


**Fig. 5.4** OBD-II protocols in OSI model

## 5.5 Diagnostic Trouble Codes (DTCs)

Diagnostic Trouble Codes (DTCs) are automotive computer codes stored by the on-board computer diagnostic system (OBD) in your vehicle [17]. DTC was originally introduced by SAE and can be used by all vehicle manufacturers. The example for the DTC is shown in Fig. 5.5.

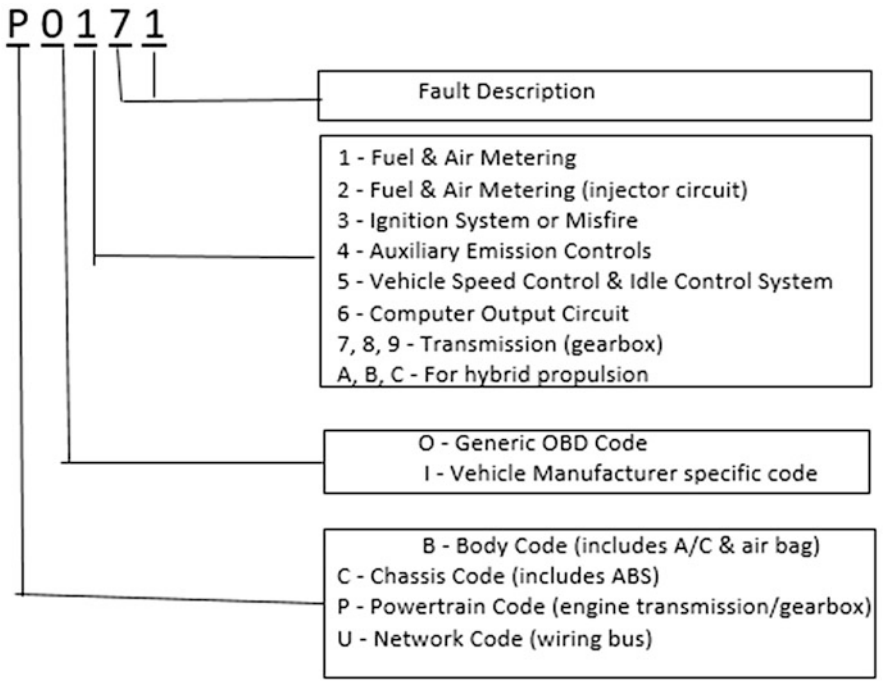


**Fig. 5.5** Example of Diagnostic Trouble Codes

Trouble codes are classified into four classes:

1. "Powertrain" codes ("P")
2. "Body" codes ("B")
3. "Chassis" codes ("C")
4. "Network Communications"codes ("U")

Each of the trouble codes is again classified into two categories:

1. *Generic/Global (0):* It is represented by zero in second position of fault codes, and these categories of fault codes represent that these codes are generic or common to all the makes and models of vehicles.
2. *Enhanced/Manufacturer Specific (1):* It is represented by one in the second position of fault codes, and these categories of fault codes represent that these codes are unique for each vehicle make and model and defined by the manufacturer to offer more diagnostic details which are not listed in generic codes.

The most common trouble codes are discussed in Table 5.5.

The codes that are used to request data from the vehicle using a diagnostic tool are called Parameter ID (PID). PID is standardized by SAE J1979. All the latest

**Table 5.5** Common trouble code

| S.No. | Trouble codes | Type | Description |
|---|---|---|---|
| 1 | PO171-P0175 | Oxygen sensor | Based on the amount of oxygen in the exhaust, the fuel mixture is adjusted in the engine to reduce the emissions and maximize the fuel economy |
| 2 | P0300-P0305 | Engine misfire | By observing the speed of the crankshaft when the engine is running, the engine misfire is tracked. Whenever it detects a small loss in speed in the crankshaft, the OBD-II system logs a misfire [17] |
| 3 | P0411, P0440, P0442, P0446, P0455 | Evaporative system | When fuel is burned, vapors are produced. This system is responsible for eliminating vapors |
| 4 | P0401 | Exhaust gas recirculation (EGR) | To recirculate the exhaust gas in the engine, the computer system in the car opens and closes the valves [17] |
| 5 | P0420, P0430 | Catalytic converter | To reduce the hydrocarbons (HC) and carbon monoxide (CO) emissions, cleaning the pollutants from combustion is necessary to pass the emission test [18] |

vehicles support with mandated PIDs. Manufacturers also support a manufacturer-specific range of PIDs under non-mandated.

OBD-II has defined wide ranges of Parameter IDs for the different vehicle electronic groups. There are ten diagnostic services referred to as "Modes." These modes are represented in HEX values. For each mode, list of PIDs exists. The DTC Range structure is well-defined in DTC first, second, and third character range in OBD Standard of Mode 3. Mode "0x0A" regarding the "SAE J1979" standard is for Permanent Diagnostic Trouble Codes (DTC clearing) [19].

The ten modes of PID are:

1. *01:* "Current Data"
2. *02:* "Freeze frame data"
3. *03:* Show stored "Diagnostic Trouble Codes"
4. *04:* Clear "Diagnostic Trouble Codes" and stored values
5. *05*: Test results, oxygen sensor monitoring (non-CAN only)
6. *06:* Test results, other component/system monitoring (test results, oxygen sensor monitoring for CAN only)
7. *07:* Show pending "Diagnostic Trouble Codes" (detected during current or last driving cycle)
8. *08:* Control operation of onboard component/system
9. *09:* Request vehicle information
10. *0A:* Permanent Diagnostic Trouble Codes (DTCs) (cleared DTCs)

The OBD-II message format to request data from the vehicles is shown in Fig. 5.6.

| Identifier 11 Bit | Length | Mode | PID | Ah (Data) | Bh (Data) | Ch (Data) | Dh (Data) |
|---|---|---|---|---|---|---|---|

**Fig. 5.6** Message frame format

1. IDENTIFIER: Standard 11-bit identifier. For request message, the identifier is "7DF" and for response messages ID is "7E8 to 7EF."
2. LENGTH: This is the length of bytes (03 to 06).
3. MODE: MODE will be between "01-0A" for requests and responses the 0 is replaced by "4" (i.e., 41, 42, 4A).
4. PID: This is the PID for which we are requesting the data in that particular mode.
5. "Ah, Bh, Ch, Dh": HEX Data Bytes.

Example frame for requesting speed is as follows:
Request frame: 7DF 0x02 0x01 0x0D 0x55 0x61 0x55 0x55
Response frame: 7E8 0x03 0x41 0x0D 0x4B 0x61 0xAA 0xAA

In the above example, the frame is sent for requesting the vehicle current speed. The vehicle speed falls in mode 01 and the PID for the same is 0d, i.e., 13 in decimal. The response frame of the vehicle returns the current speed of the vehicle in hex "4b," i.e. 75.

## 5.6 Conclusion

Automotive industry is intensive on improving efficiency and utilization at a low cost. The focus is on zero air pollution, reduced emissions, and significantly lower energy costs. It is been observed in the study that in-vehicle diagnostic, the on-board diagnostic is an important component in the vehicle. The study covers the review of previous works done by the researchers in the area of vehicle diagnostics. The paper describes the standard protocols of OBD-II and the shortcomings of OBD-I that lead to the development of OBD-II. OBD-II is a must to collect sensory data from the vehicles. In this paper, we explain commonly used DTC by vehicles, modes of PIDs, and the communication with ECUs using CAN bus. The data received from the OBD has increased in all the modern vehicles and can be used by insurance companies for claiming insurance, manufacturers to measure the performance of the vehicle, avoid service frauds, the study of driver behavior, fleet management, GPS fleet tracking, identifying driving patterns, and driver profiling.

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# Chapter 6
# Active Bandpass Filter Design to Attenuate Harmonic Distortions in MPI Scanner


**Vandana Dhillon, Amruta Pabarekar, and Sreedevi Nair**

## 6.1 Introduction

Magnetic particle imaging (MPI) is an image-based technology that makes use of superparamagnetic iron oxide nanoparticles (SPIONs). It detects their concentration using the magnetic response of these ions which is mostly nonlinear. It is also called tracer-based imaging technology. MPI technique gives a better improvement over the MR detection technique due to its output result containing no-background image or signal for distortion [3]. This leads to the requirement of a Bandpass filter to block unwanted contrast signals or agents in a particular frequency range. Another advantage is to utilize the strong SPION magnetic moment [2]. Since there is a limitation for humans for detecting and working with frequency range, we consider suitable bandpass range as 20–26 kHz. This shall serve the purpose for both the application and the studying of output within the required and suitable range of behavior of SPIONs.

Magnetic particle imaging (MPI) is one of the latest findings in the technological world [2]. This process involves knowing how the magnetic nanoparticles are spread in an area of interest by using techniques of imaging and oscillation of those particles [3]. The technique also involves sensing of a change in tracer through the magnetization process. The time-varying excitation field overlays the nanoparticles induced signals and also further leads to a coupling of that filed into receive coils [4]. An excitation coil is required for nanoparticles so as to make the tracing easier. When the magnetic nanoparticles are required to be excited, we need to apply an oscillating magnetic field on them. This field can be used as a tracer too. But it is required that there are no or minimum harmonic distortions during this excitation

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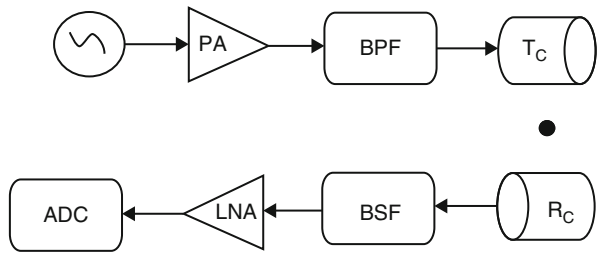


**Fig. 6.1** Signal chain of MPI scanner [1]

process and frequencies are received on the coils without distortion. Therefore, we require a good quality bandpass filter so that unwanted harmonics shall be eliminated before the signal can be applied to coils and then the excitation of drives takes place.

In the figure of MPI scanner, PA represents power amplifier, BPF represents bandpass filter, Tc stands for transmitting coil, Rc stands for receiving coil, BSF is a bandstop filter, LNA is low-noise amplifier, and ADC is analog to digital converter (Fig. 6.1).

## 6.2 Objective

The power amplifier amplifies the AC sinusoidal signal. Along with the required frequency of excitation, the amplification also leads to the addition of some other frequencies as harmonics. So we need a BPF to suppress the unwanted harmonics, and then the signal can be applied to the drive coils. Hence we require a filter in this set up which we can be either Butterworth or Chebyshev of order 2, 3, 4, or 5. On comparison, it is observed that the fourth-order Butterworth filter gives the desired response for this particular application.

A filter is a circuit that passes desired frequencies from input and blocks all unwanted frequencies in the output. The basic types of filters can be classified as to be a low pass for passing low frequencies, high pass for passing high frequencies, bandpass for passing frequencies only in a particular band, and bandstop filter for attenuating frequencies in a particular band. The analog or passive filters use resistors, capacitors, and inductors. The transistors, operational amplifier, and RC circuit have features to give voltage gain and hence can be used in active filters for various purposes to provide wanted voltage gains or impedance [5]. We need to have good linearity and wide range dynamically for ease of designing and analysis. So the best solution will be to use active filters than passive ones.

For this research, Butterworth and Chebyshev active bandpass filters of order 2, 3, 4, and 5 are designed with various types of topologies and implemented on software, and outputs are compared by simulation on National Instruments (NI) Multisim.

## 6.3 Methodology

### *6.3.1 Design of Bandpass Filter (BPF)*

A bandpass filter (BPF) is designed by placing both a high-pass filter and a low-pass filter in a cascaded manner. This arrangement will ensure the passing of wanted signals from a particular band only and blocking all other frequencies before and after that particular band. This band will have a lower critical frequency and also a higher critical frequency. Therefore, the BPF is divided into two sections. These sections are separately studied and worked upon to calculate the component values of resistors and capacitors. The response consists of passband and stopband cut-off frequencies and also the transition band. The representation of the magnitude response of a bandpass filter can be depicted as in Fig. 6.2.

The Fig. 6.3 depicts a simple 2-pole active filter. It has admittances of $Y_1$ $Y_2$ $Y_3$ $Y_4$. So it can be used to design either a high-pass or low-pass filter. This will require the study of admittances of these filters before fixing the values of filter components.

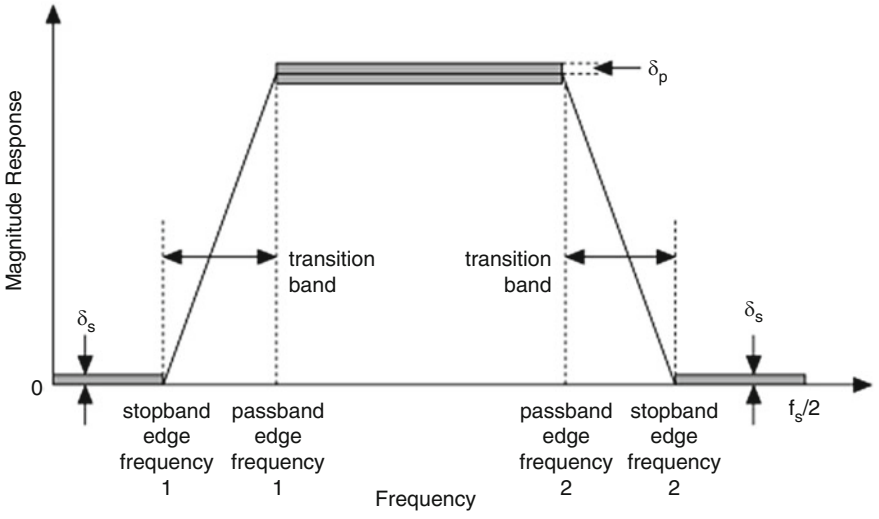


**Fig. 6.2** Bandpass filter magnitude response as shown by National Instruments

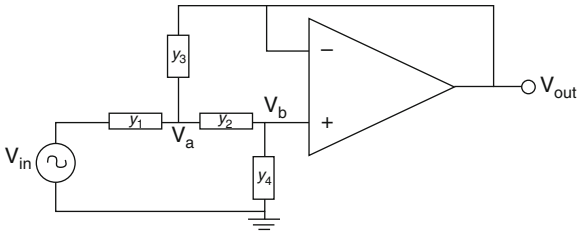


**Fig. 6.3** Block diagram of Unity Gain 2-pole Active Filter [1]

The general transfer function equation for a 2-pole active filter is given by

$$T(S) = \frac{V_{out}(S)}{V_{in}(S)} = \left[\frac{Y_1 Y_2}{Y_1 Y_2 + Y_4 (Y_1 + Y_2 + Y_3)}\right]$$

We can further solve this equation to find the transfer functions of variable pole filters whether high-pass or low-pass filter by using values of admittances. Therefore, this equation is utilized in the low-pass and high-pass filters design to determine the values of the RC components required to realize a BPF [1].

### 6.3.2 BPF Design Implementation

Multisim is a comprehensive development platform for electronic circuit schematics, design simulation, and prototyping. The results obtained from the two simulations of Butterworth and Chebyshev filters are presented and compared.

### 6.3.3 Implementation of Filter in NI Multisim Software

Figure 6.4 shows the part of the circuit diagram to be implemented for the bandpass filter on NI Multisim software. This implementation uses values of RC components calculated using a previous formula for both sections low-pass filter and high-pass filter circuits. Figure 6.5 gives the details of the implementation of a filter circuit for fourth-order active Butterworth filter, and Fig. 6.6 gives the details of fourth-order active Chebyshev filter implementation.

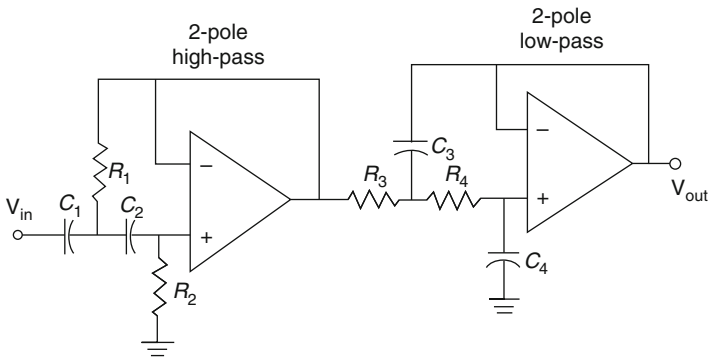


**Fig. 6.4** General circuit diagram of fourth-order active bandpass filter [1]

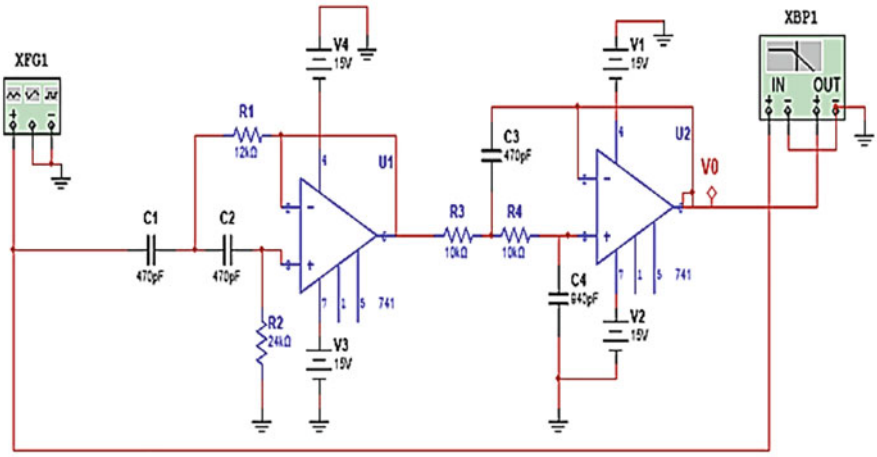


**Fig. 6.5** Screenshot of circuit implementation of fourth-order Butterworth active bandpass filter

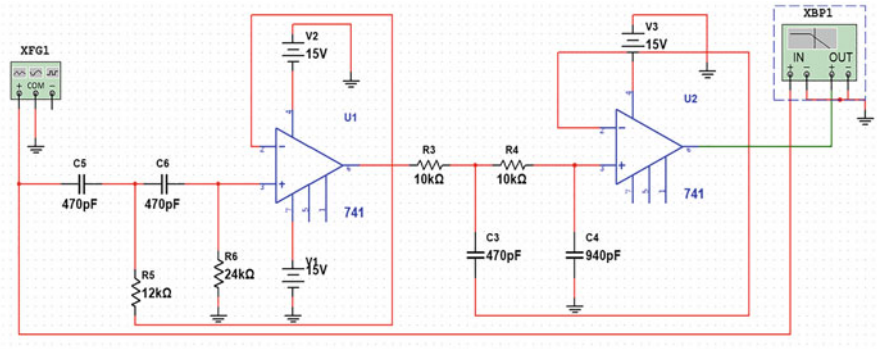


**Fig. 6.6** Screenshot of a circuit implementation of fourth-order Chebyshev active bandpass filter

## 6.4 Result

Simulations were implemented on NI Multisim software, and the results obtained are presented in the following Figs. 6.7 and 6.8, respectively, for Butterworth and Chebyshev filter responses.

The result of the NI Multisim simulation and experiment for the fourth-order Butterworth active BPF is shown in Fig. 6.7 for the circuit diagram in Fig. 6.5. The flat magnitude response in the passband is observed in the Butterworth filter output. It also has roll-off which is very steep when the passband ends. The response shown by the output of Chebyshev active BPF in Fig. 6.8 for the circuit diagram in Fig. 6.6 has ripples in the passband in the simulation result.

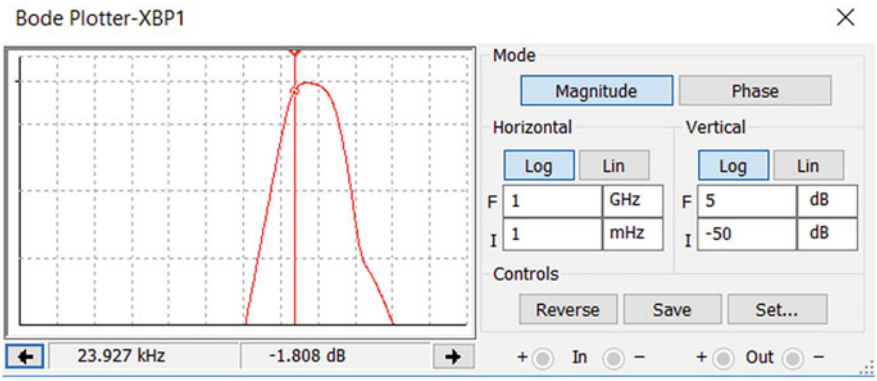


**Fig. 6.7** Screenshot of Bode Plot Output for Butterworth fourth-order active bandpass filter

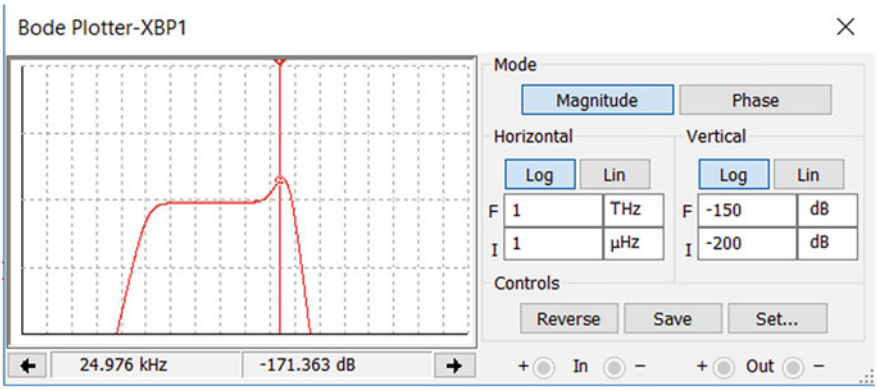


**Fig. 6.8** Screenshot of Bode Plot Output for Chebyshev fourth-order active bandpass filter

In comparison, the bandpass filter realizations can be analyzed in detail by changing the output scale also in NI Multisim software. It is noted that both graphs give a detailed comparison of flatness, ripples, and center frequencies of operation and also the steepness of response can be differentiated by this software. Since there is an abrupt change to zero after the end of stopband in Butterworth filter, this feature seems more useful in scanner application even though it reflects non-linearity in phase response. Due to this, the ripples are not preferred, and hence Chebyshev filter is not a good choice for this medical application in scanners. NI Multisim implementation for Butterworth active bandpass filter is better than other simulations as it gives clear measures about the output of circuits [4]. These two implementations of filters may prove to be a useful part of the MPI scanner development.

## 6.5 Conclusion

The realizations shown in this paper for Butterworth and Chebyshev active bandpass filters of fourth order reveal the output to be ideally similar to the practical output of magnitude response characteristics of those filters when realized physically. We can implement this filter by using variable orders without restrictions, but we can conclude that higher orders give us satisfactory performance as compared to lower-order filters along with cost consideration being one of the important actors in deciding the filter order. So here we finalize that the fourth-order filter is most suitable for this particular application. Also, the filter affects the transition band shape and width related to roll-off factors and its rate of approach to complete attenuation depending on the order of the filter which we select. So we can conclude that the fourth-order Butterworth bandpass filter can be used in this application of MPI scanner.

## 6.6 Future Scope

The future scope of this project is that it can be implemented on MATLAB using FDATool. MATLAB direct method uses the frequency specifications only in designing the filter which is different than NI Multisim. Codes are written for frequency requirements and are analyzed by simulation in MATLAB using various commands. Also, various other frequencies can be worked upon depending on the application in use.

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# Chapter 7
# Class Pulse: An SMAC Application to Enhance Student Feedback and Interaction


**S. R. Rapole, V. Gunta, and N. Bolloju**

## 7.1 Introduction

Many researchers in the field of education agree that interaction in the classroom enhances students' learning abilities and supports in actively constructing their knowledge [1]. In a typical classroom environment, when the instructor asks a question – to confirm the understanding of the material that was just covered – only a few students respond occasionally as most of them are hesitant or do not like to respond. The instructor quickly moves to the next topic of the lecture session assuming that the students have understood the material covered.

Many studies have concluded that students in an interactive classroom environment get better insights about the topics compared to traditional one-way class environments [2]. Students can broaden their thinking abilities as they see different types of questions asked by their peers. This will also help them get a comprehensive understanding of the topic as they get an opportunity to see various ways to view a given point through the classroom discussions. Promoting interaction in the classroom helps the students learn the subject from each other and most importantly help them retaining the subject. In general, lecture sessions that include discussions students tend to focus more and engage better in the class [3]. Instructors can also alter their teaching approach and content based on how well the students are reacting in the discussions. Finally, they also help in motivating students to prepare better for the next class so that they can actively participate in the forthcoming discussions. Some instructors address this issue by conducting activities such as short quizzes either at the end of or during a lecture session which can also

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help the students in assessing their learning process [4]. Although tools such as Google Classroom and Moodle can be used for this purpose, such activities not only limit the classroom interaction and feedback to the instructor but also require prior planning and preparation. Functionality such as the Q&A provided in Google Slides presentation mode can be used without any prior preparation. However, the instructor must initiate such activities during the lecture session, and the students are required to visit a specific web page for posting their responses.

In this paper, we propose a SMAC application named "Class Pulse" to:

(a) Assist students in posting their feedback with reference to the topic(s) being covered during a lecture session
(b) Enable students in the discussion of topics covered after the lecture session as a social group
(c) Offer analytics to instructors on the feedback provided in the classroom and subsequent discussion

A prototype of this proposed application with the feedback functionality was developed and evaluated by demonstrating to a couple of senior faculties and ten students.

The remaining part of the paper is structured as follows. The following section sets the context by reviewing related literature. We present the details of the functionality expected to be included in the proposed application in the third section. The functionality and implementation details of the prototype built are presented in the fourth section. The details of prototype evaluation by representative stakeholders are discussed in the fifth section. The last section concludes by summarizing the work done and further work planned based on the feedback received from the evaluation.

## 7.2 Background

Traditional teaching has always been a one-way path from a teacher to a student. This is called objectivism which is completely teacher-centric, and the student's job is just to understand whatever he is being taught. Objectivism [5] ruled the education system for thousands of years. But people realized that interactive teaching results in much better learning outcomes than the traditional teacher-centric approach. This is termed as constructivism in which students try to interact with each other and with the teacher, ask doubts, and express new ideas to gain a better understanding of the subject matter. Constructivism [5] is based on the concept that knowledge is not attained without the involvement of the learner. Students should put in an equal amount of effort in trying to understand the concepts, think further, and construct the knowledge he is trying to attain by himself. One of the types of constructivism is active learning which requires students to interpret the facts and build knowledge by participating in activities given by instructors and utilizing their skills.

In short, there are many limitations to the scope of student-teacher interactions in the current one-to-many classroom environment [6]. Students may be hesitant to ask for clarification in real time during the lecture, fearing embarrassment in front of their classmates. A student may assume that he/she is the only one with the doubt and hence refrain from asking a question. They might feel it is difficult to express the exact point of confusion without being able to pinpoint it on the slide. Finally, the instructor may assume students have clarity in the topic being explained and quickly cover some points, but those same points could be an area of confusion for multiple students.

In the past few years, it has been observed that usage of technology such as mobile phones or laptops in classrooms helped enhance the learning experience of students [7]. The ubiquitous and portable nature of mobile phones has led educators to utilize such technologies in classrooms for enhancing student learning.

Many technology-based approaches are being used to facilitate interactive learning in classrooms. A popular technology among them is clickers, classroom response systems [8, 9], which allows the teacher to pose any multiple-choice question such as recall-based, conceptual, or application-cased questions on the fly and the students can respond to it by clicking on one of the options from their own smart device. Based on the responses received, the teacher can immediately clarify that particular concept in the same class.

In recent years, classroom presenters have also become popular because people realized that though the replacement of typical blackboard-chalk teaching with slides and presentations has helped in better visuals and understanding, the interaction of students has reduced. Sometimes, they just note down points and try to catch up with the instructor without even bothering about understanding the concept. A typical classroom presenter is an interaction system based on tablet PC developed at University at Washington. Students are given permission to annotate the slides and send them back to the teacher so that the teacher can review and integrate the outcomes into the classroom discussion. Dyknow (Dynamic knowledge) [10] is one such interactive presentation system that facilitates students with authentication and other monitoring capabilities. It adopts a general client-server model where the teacher is the server and the students become the clients. The teacher can send quizzes and get responses from students. Students are also given permission to fill in any information in the teacher's working space.

Another extremely innovative approach, in this regard, is to build a smart classroom environment using IoT technology for behavioral and social analysis [11]. Such a smart classroom will actively observe the students' behavior, voices, etc. to conclude the quality of a given lecture. This feedback will help the instructors to constantly improve their teaching style and come up with new methods. This highly advanced approach is based on the notion that it is possible to analyze human behavior by combining computer and social science. This method requires live capture of audio, motion detection using sensors, and screen capturing and should be able to interpret the parameters in real time. The feedback results will show whether the students are satisfied with the lecture and whether they are able to maintain the same concentration throughout the lecture are other aspects. However, the costs of

this infrastructure can be quite high and therefore cannot be easily implemented in a typical classroom.

While the above approaches of employing technology in the classroom attempt to make the sessions interactive and engaging, they come with some limitations and challenges such as effort required for setting up each session and associated infrastructure investments. However, well-designed SMAC applications have tremendous potential in enhancing the students learning and effectiveness of instructors teaching.

## 7.3 Proposed Application Overview

The proposed SMAC application is designed to be used by the instructors and students essentially to enhance feedback and interaction – in addition to traditional interaction – during and after lecture sessions. For effective use of this browser-based application during a lecture session in the classroom, the following assumptions are made:

(a) PowerPoint or equivalent slides are used by the instructors during the lecture session.
(b) The classroom has a computer that is connected to a projector for displaying the slides.
(c) Access to the Internet is available for the instructor and students.
(d) The instructor can use his/her smartphone for navigating and viewing the feedback provided by students.
(e) Most of the students can use their mobile devices (laptops or smartphones) in the classroom.

The last assumption can be removed when the classrooms are equipped with IoT touch panels placed on the desks of students for providing feedback. Such touch panels can be relatively small-sized (4 or 5 inches) with an optional display on which the slide projected can be shown. However, in the remaining part of the paper, we assume that most of the students have mobile devices for providing feedback during the lecture sessions.

Figure 7.1 illustrates how a typical lecture session is supported by the application that has two different sets of functionalities for the instructor and one for the students. The instructor loads the slides into the application on the computer for projection at the beginning of the session. It is possible that the session slides are loaded into the instructor's account prior to the lecture session. At the beginning of the session, a session code is generated and displayed – on the first few slides – so that the students can join the session using their mobile devices. With the second functionality, the instructor can use her mobile device (usually a smartphone) for viewing and navigating through the slides and viewing the feedback provided by the students. As the session progresses, the students provide feedback by placing one or more markers on the current slide. The type of markers includes a default

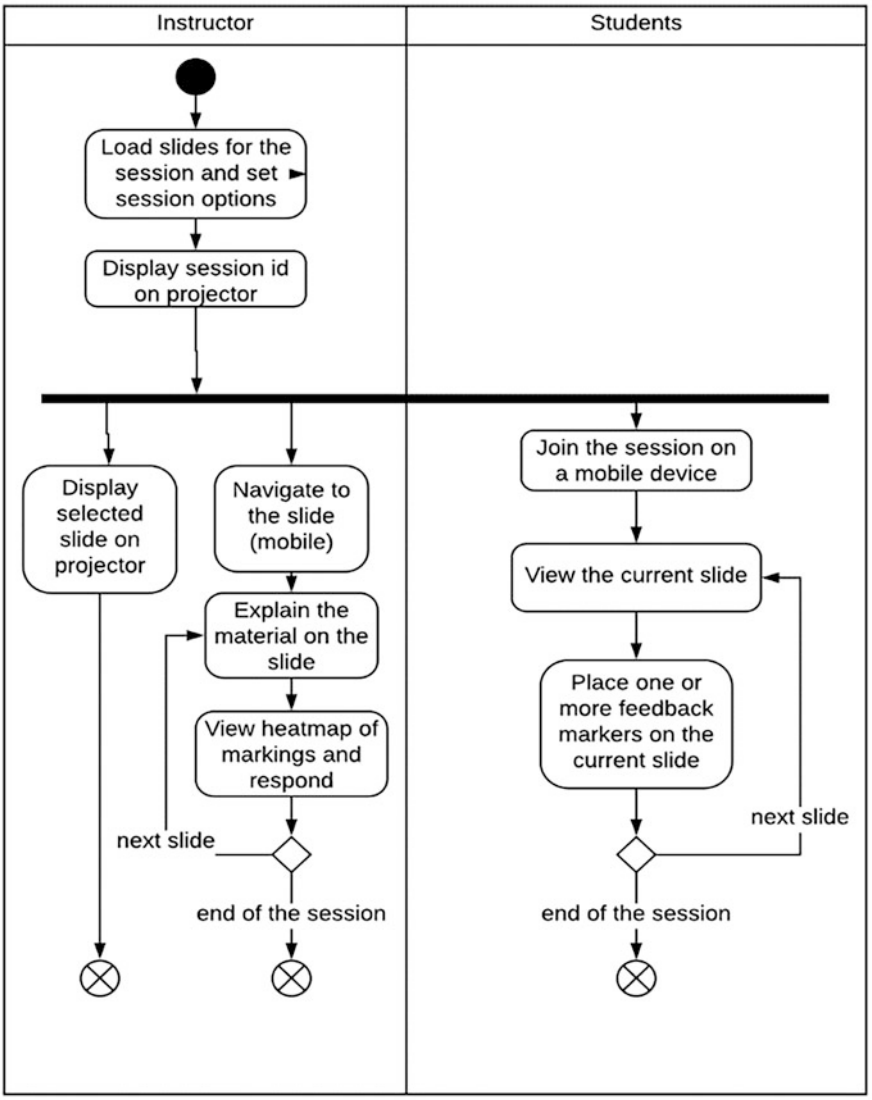


**Fig. 7.1** Activities during a typical lecture session

marker that has green and red symbols to denote positive (e.g., well-understood or well-explained) and negative (e.g., not clear or needs further explanation) feedback, respectively. A student can place markers near the text or diagrams or equations on the slide.

The instructor – using her mobile device – can view a summary of the feedback (e.g., numbers of green and red markers) and select an option to view a transparent

heat map, corresponding to one or more markers, displayed over the current slide prior to moving to the next slide.

In addition to the above functionality, the application includes synchronization of slides displayed, the anonymity option for various types of posting, and usage of images as ad hoc slides. The slides displayed on the students' mobile devices are synchronized with the slides projected so that minimize the need for navigation by the students. The student, however, can also turn off the synchronization and navigate to other slides whenever required. A student can choose to post markers, questions, comments, and responses anonymously. Instructors can use any other images taken on their smartphones as ad hoc slides for receiving feedback. This functionality is especially useful when the instructor would like to receive feedback on the material written/drawn on the blackboard or for collecting feedback on other images such as press cuttings and student's work on paper.

Thus, the combination of the functionality provided by the application to the instructor and students requires hardly any additional effort for providing the feedback and analyzing the feedback. The instructor can also request students, occasionally, to post questions or comments with the markers so that she can go through those for further elaboration of the concerned topic.

The overall functionality to be included in the proposed application can be understood from the class diagram shown in Fig. 7.2. The top left portion of this diagram captures details of course registration. Each lecture session of a course offering is associated with a slide document. Participating students can add markers on specific slides during the session. Any student registered in the course can post questions and comments (posting class) for other students to post-related responses.

The classes MarkerGroup and MarkerDefn facilitate the inclusion of arbitrary sets of markers to enhance the types of feedback to cater to differences in expectations by the instructor. For example, a marker group of three types of marks corresponding to three categories of problems associated with a sample solution depicted on a slide can be used to elicit feedback from the students in terms of problem categories.

After the lecture session, the students can review the slides the initiate discussion by placing markers on any slide with questions and comments attached to those markers. The students can also like (or upvote) questions and comments posted by other students in addition to replying to the questions and comments posted. Thus, this social aspect of the application is expected to extend the interaction linked to specific topics beyond the classroom.

The enormous data – representing the feedback and interactions – collected during various lecture sessions offer great potential for analytics. The proposed application provides analytics on the content covered in a lecture session and across all the lecture sessions conducted so far. These analytics – apart from visualizations of statistical data – can also include dependencies and relationships among the feedback (e.g., different markers, content, and students who provided the feedback) that can help instructors in becoming more effective in addressing the students' learning problems.

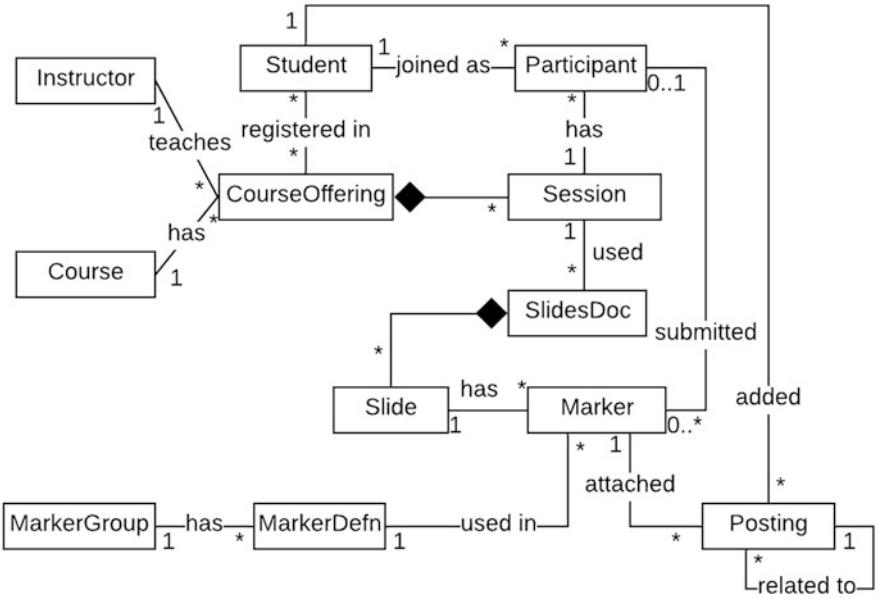


**Fig. 7.2** Key classes and relationships used in the application

## 7.4 Prototype Implementation

Prior to implementing the proposed application, we built a prototype to understand the efficacy of the key functionalities identified. We planned to demonstrate the key functionality to some representative stakeholders and get their suggestions to make informed decisions on further enhancements to the proposed application.

The prototype design is minimalistic and serves to provide the core functionality to the student of marking on a slide and displaying markings along with comments to the faculty. The functionality for instructors includes – apart from the signup and sign in – uploading of slides in the form of a PDF document (instead of PowerPoint or Google Slides), display and navigation of slides, and viewing the feedback with markers placed by students on various parts of a slide. Figure 7.3 depicts the functionality corresponding to the display and navigation of slides during a lecture session of a software engineering course that introduces the Scrum framework.

The functionality for students includes the display of slides and navigating after joining the lecture session in progress on their mobile devices. The feedback provision includes selecting either a green or a red marker and placing it on the slide. In addition to placing a marker, a student can also associate a question or a comment as shown in Fig. 7.4.

The instructor can view the slides – on her smartphone – along with the markers placed by several students (as shown in Fig. 7.5).

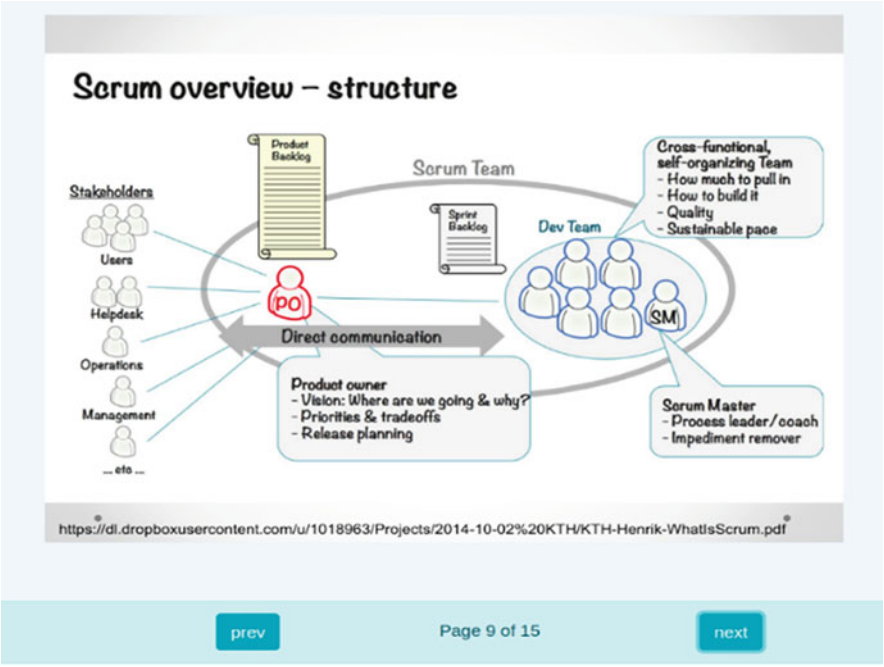


**Fig. 7.3** Sample slide and navigation

We used the MERN (MongoDB, Express, React, Node) stack to build this application with a MongoDB database hosted on the cloud. The reason for using the MERN stack was that the entire stack is JavaScript and it enables us to build highly efficient browser-based applications that can run on any popular web and mobile operating system. As the student-faculty interaction in the classroom is real time, we felt this would be the best for implementation.

## 7.5 Evaluation

The evaluation of the prototype was conducted by demonstrating its functionality to a couple of senior faculty members (Prof. A and Prof. B) and ten students, individually. Six final year students and four pre-final year students enrolled in multiple engineering and science disciplines at BITS-Pilani Hyderabad Campus have participated in this evaluation.

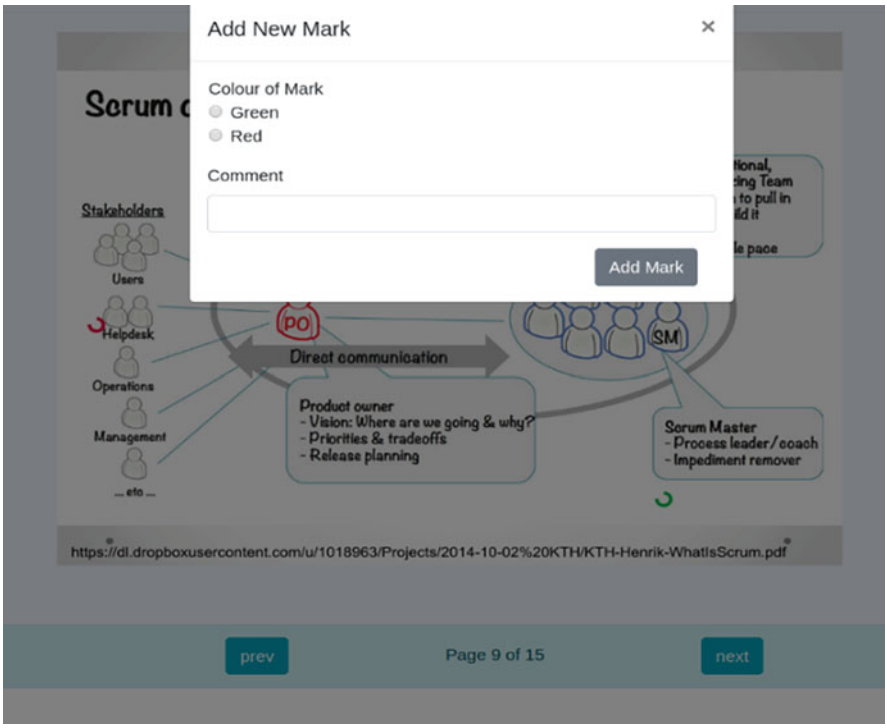


**Fig. 7.4** Student placing a marker with a question

### *7.5.1 Feedback from Faculty Members*

After demonstrating the application functionality and explaining the problems that the application intends to solve, both the faculty immediately showed great interest in the deployment of such an application in their classrooms. They shared anecdotes of students having a poor learning experience in the past and wished to use this application to gain further insight into how that could be corrected. They expressed the desire for tools that could give them some quick and early insight into how students were learning in the classroom. They highlighted and reinforced the need for real-time classroom feedback, which is the aim of our proposed application.

Both the faculty members posed questions as to how instructors should go about reviewing the feedback given by students on the slides. Prof. A expressed concern that if a review of the markings made by the students was required after every slide, then it would significantly reduce his speed of covering concepts in the class. Although he did acknowledge that it would improve the quality of understanding of concepts. He suggested that a faculty could review the markings made on previous slides after a set of slides or after a given time period such as 20 min. Prof. B also raised a query of how the instructor would know that they should go back many

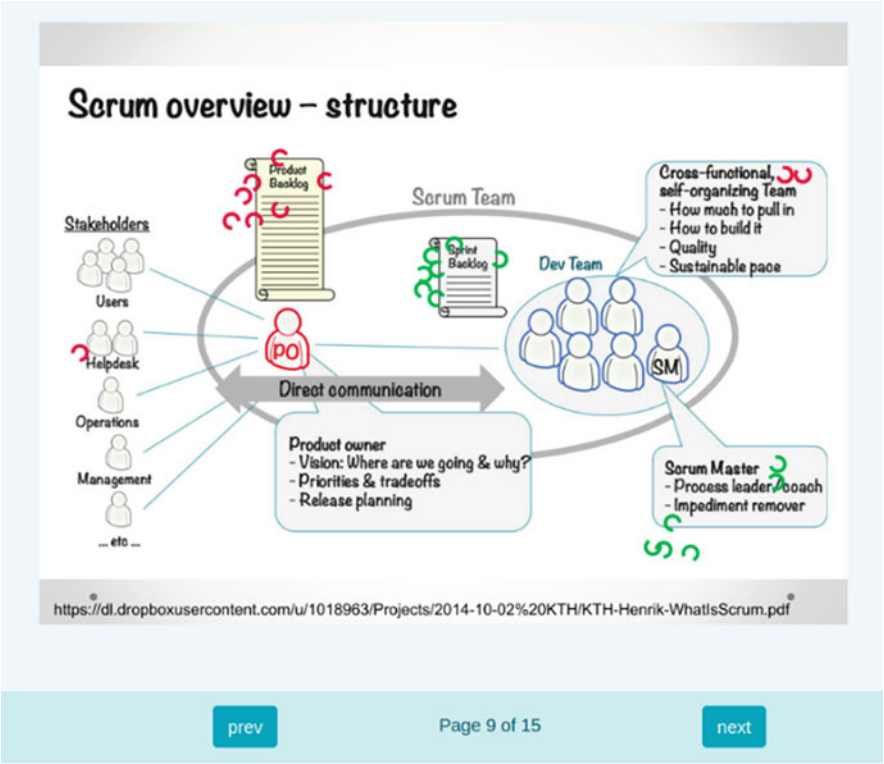


**Fig. 7.5** Instructor screen with markers on a slide

slides if a student adds a mark there after a long time. It is possible to set up a notification system that can raise a flag if the number of red markings on a given slide crosses a threshold. Although the use of the application trivial, the faculty members suggested that a workshop on how to best utilize the application in the classroom and after the class session.

Prof. A suggested that statistics pertaining to the markings be displayed as counting the markings is not possible in the class. So, a percentage of green vs red markings would be a crude but a useful metric to display. He also wanted as an extension to the current application, a way for students to add markings to a diagram/notes written by a faculty in the class on a Smart Board. He also suggested that we could implement a scale of satisfaction for each marking rather than binary markings of just red and green (incidentally the marker types shown in Fig. 7.2 provide this facility as a customized set of markers which can be defined for use on a given slide).

Both the faculty members explained their experience with students in the classroom and listed out the different kinds of students that they have encountered in their experience and how they felt this would be beneficial to each one of them.

Prof. B explained that different students have different attention spans. Students tend to zone out and their thoughts drift in-between explanation. For some students, this might be a few seconds; for some it might be 10 min. So, faculty can tune the speed of their explanation based on the feedback that they receive. Prof. A pointed out how some students, even if they are not embarrassed to ask a question, might hesitate because they do not want to disturb the rest of their classmates and the teacher if they feel everyone else understood. At the other end of this spectrum, there are some students who always questions about every topic that is explained if they don't feel satisfied with their clarity of understanding on that topic or if they are curious and think beyond the scope of the lecture. When such students constantly ask questions, sometimes it can delay the class and waste other students' time, but if they keep quiet, they may forget their questions. So, this gives them a way to mark it on the slide, and they can later discuss it with the faculty outside the classroom.

### *7.5.2 Feedback from Students*

Many students agreed that class pulse was very thoughtful as it is much better than the general feedback taken once in a semester. Students also expressed that the user interface was very simple and direct. They could find all the options they wanted without any confusion and liked the option (using a red marker) provided to express the difficulty in understanding. Most of the students do not come back and study the topic which has been taught in the class on the same day. So, students felt that such comments will help them remember the subject in a better way.

As the number of lectures per semester is very limited, few of them felt that implementing this in real time will engage all the students in the lecture session, but at the same time, this will consume a lot of quality time in class. This will also waste the time of students who have understood the concept but are just waiting for the explanation to end. Adding comments and questions, in fact, is a functionality that can only be used after the lecture session.

Some students suggested that including an option to anonymously chat directly with the instructor for any specific slide for clarifications after the lecture session. This option will also not waste time in class as the teacher can always check the queries after class and answer them. Few also suggested adding an option, though not directly relevant to the intended purpose of the application, to take notes on any slide which is visible only to them. This will be for their own convenience to note down a small explanation for any complex aspect presented on the slide.

## 7.6 Conclusion

In this paper, we presented the details of a SMAC application which aims to give the instructor a sense of the "pulse" of the class in real time during a lecture session and

useful analytics after each lecture session. A prototype of the application has been implemented using the MERN stack. We also conducted a preliminary evaluation of the prototype application by demonstrating it to a couple of senior faculty members and ten students individually.

Based on the evaluation, we are in the process of refining the proposed application functionality before developing the application. We plan to include other functionality to make the application from the user interface and user experience perspective so that the effort required by students and instructors is reduced or eliminated wherever possible. The final version of the application is planned to be tested by conducting controlled experiments in live classroom settings.

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# Chapter 8
# An Efficient Technique for Lossless Address Data Compression Using Novel Adaptive SPIHT Algorithm in WSN


**Sanjay Mainalli and Kalpana Sharma**

## 8.1 Introduction

In numerous sensor structuring applications like condition observing frameworks, sensor nodes must gather information occasionally and transmit them to the destination node through various routes present in the networking structure. It has turned into a significant issue to reduce the content in the information transmitted through sensor systems. The rising innovation of compressive detection opens up new outskirts for information accumulation in sensor systems and targets confinement in sensor systems. The CS technique can considerably decrease the number of information transmissions and equalize the traffic load throughout the system.

The sensor nodes are the tiny devices that can be placed anywhere on the planet to collect physical information from the environment. These devices are installed in many instances with lots of effort and initial cost; hence sensor nodes must work for a longer period of time since replacing these devices is very tedious work. Hence one must design an algorithm for making the sensor nodes to work efficiently for a longer period of time. There are many different algorithms which are proposed for compression systems for data compression in remote sensor structure. The compression systems are for the most arranged into two methods, for example, lossy compression and, furthermore, lossless-compression. In the lossless compression, the repetition is a reversible procedure, and no data misfortune where in lossy compression a certain bit of the data is evacuated. The grouping technique, for the most part, has a preferable traffic burden adjusting over the tree information

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gathering technique. This is on the grounds that the number of hubs in groups can be adjusted when we partition groups. Likewise, the past works overlooked the geographic areas and nodes dissemination of the sensor hubs. While in sensor systems, the data of cluster circulation can help the plan of information gathering strategy that utilizations fewer information transmissions.

## 8.2 Problem Definition

The energy is one of the scarcely available resources in the wireless sensor nodes just because it is very repeated work for replacement purposes as the nodes are distributed across the geographic area; hence one must utilize it in an efficient manner. The sensor nodes are dependent on the battery, and the nature of the sensor nodes is collecting a huge amount of data and transferring on the network without minimizing the contents, thus making the nodes lose lots of energy, hence making the nodes non-functional.

## 8.3 Literature Survey

Anderson [1] C. Luo explained the process of data gathering, and it helps to sense more information by using large-scale sensor system. Sankarasubramaniam and Cayirci [2]. Renu Sharma. A Data Compression Application For Wireless Sensor Network Using LTC Algorithm, LTC calculation is utilized to limit the measure of mistake in each perusing. With regard to the utilization of remote sensor organize innovation for natural checking, the two principles basic exercises of remote sensor arrange are information securing and transmission. Be that as it may, transmitting/getting information is a controlled expending task so as to decrease transmission-related power utilization; we investigate information pressure by preparing data locally. The origin of sensor systems, in-arrange handling, has been touted as empowering innovation for extensive organizations. Radio correspondence is the abrogating customer of vitality in such systems. Along these lines, information that decrease before transmission, by either pressure or highlight extraction, will legitimately and altogether increment organize lifetime. In numerous applications where all information must vehicle out of the system, information might be compacted before transport, so picked pressure strategy can work under stringent asset requirements of low-control hubs and incites middle of the road mistakes.

Mattern [3] E. Candes and M. Wakin. An Introduction to Compressive Sampling: Conventional ways to deal with inspecting signs or pictures pursue Shannon's hypothesis: the testing rate must be in any event double the most extreme recurrence present in the sign. In the field of information change, standard simple to advanced converter (ADC) innovation actualizes the typical quantized Shannon portrayal –

the sign is consistently tested at or over the Nyquist rate. This article studies the hypothesis of compressive testing, otherwise called compacted detecting or CS, a novel detecting/inspecting worldview that conflicts with the normal shrewdness in information obtaining. CS hypothesis affirms that one can recuperate certain signs and pictures from far fewer examples or estimations than using conventional techniques.

Ghosal [4] J. Haupt, W. Bajwa, Compressed Sensing for Networked Data Network observing and derivation is an undeniably significant part of knowledge gathering, from mapping the structure of the Internet for finding stealthy interpersonal organizations and data combinations in remote sensor systems. This article considers an especially remarkable part of the system science that rotates around huge-scale disseminated wellsprings of information and their stockpiling, transmission, and recovery. The assignment of transmitting data that starts with one point then onto the next is a typical and surely known exercise. Yet, the issue of productively sharing data from and among an immense number of conveyed hubs stays as an extraordinary test, principally on the grounds that the creators yet don't have very much created speculations and instruments for appropriated sign handling, correspondences, and data hypothesis in huge-scale organized frameworks. The issue is shown by a basic model. The arranged information vector might be extremely enormous; it might be a thousand, a million, or more. Accordingly, even the way toward get-together x at a solitary point is overwhelming (requiring n interchanges at any rate). However, this worldwide feeling of the arranged information is significant in applications extending from organizing security to remote detecting. Assume, in any case, that it is conceivable to build an exceptionally compacted rendition of x, effectively and in a decentralized design. This would offer numerous undeniable advantages, given that the packed adaptation could be prepared to recoup x to inside a sensible exactness.

Ying [5] L. Xiang, J. Packed Data Aggregation for Energy Efficient Wireless Sensor Networks. It centers around remote sensor systems (WSNs) that perform information gathering with the target of acquiring the entire informational collection at the sink. For this situation, vitality effective information accumulation requires the utilization of information collection. Though numerous information collection plans have been explored, they either bargain the devotion of the recouped information or require confused in-arrange compressions. The creators proposed a novel information accumulation conspire that adventures packed detecting (CS) to accomplish both recuperation devotion and vitality effectiveness in WSNs with self-assertive topology. They utilized dissemination wavelets to locate a merger premise that portrays the spatial (and fleeting) connections well on subjective WSNs, which empowers direct CS-based information total just as high constancy information recuperation at the sink. In light of this plan, they explore the base vitality packed information total issue. It initially demonstrates its NP fulfillment and after that proposes a blended whole number programming detailing alongside a voracious heuristic to explain it. It assesses the plan by broad recreations on both genuine datasets and manufactured informational indexes. It exhibits that the packed information accumulation plan is fit for conveying information to the sink with

high loyalty while accomplishing noteworthy vitality sparing. Vitality proficiency of information accumulation is one of the commanding issues of remote sensor systems (WSNs). It has been handled from different angles since the start of WSNs.

Ying [6]. C.W. Chen. Productive Measurement Generation and Pervasive Sparsity for Compressive Data Gathering. The creators proposed compressive information gathering (CDG) that uses compressive inspecting (CS) guideline to productively diminish correspondence cost and delay arrange lifetime for huge-scale checking sensor systems. The system limit has been demonstrated to build relative to the sparsity of sensor readings. In this paper, the creators further address two key issues in the CDG system. To start with, they explore how to create RIP (limited isometry property) protecting estimations of sensor readings by considering multi-jump correspondence cost.

Amanjot and Jain [7]. A New Energy-Aware Cluster-Based Multi-hop Energy Efficient Routing Protocol for Wireless Sensor Network. The field of study on Wireless Sensor Networks (WSNs) is a created robotization that is utilized as of late to play out different errands in different spaces shrewdly. The uneven vitality scattering of sensor nodes brings about the huge decrease of system lifetime which is the primary issue in WSNs. Bunch-based directing assumes an inalienable job in defeating the vitality dissemination issue and upgrading their system lifetime. In this paper, another Energy-Aware Cluster-Based Multi-bounce (EACBM) directing convention for heterogeneous systems has been proposed which utilizes both the idea of grouping and multi-jump correspondence to lessen the vitality utilization of sensor networks. Additionally Sub-grouping idea is utilized for those SNs which are excluded from any bunch or which are out of the range of CH. This convention is actualized and contrasted and the current directing conventions in MATLAB and found that it beats regarding steadiness, arrange lifetime and gives the better answer for vitality proficiency in various leveled heterogeneous WSNs.

Mohsin and Ammar [8]. A Review of Routing Protocol Selection for Wireless Sensor Networks in Smart Cities. Today, the headways in urban innovation have changed into the idea of savvy urban communities. These brilliant urban communities are imagined to be vigorously subject to remote sensor systems and web of things. In this specific circumstance, a number of steering conventions have been proposed in writing for use in sensor systems. We articulate on why these steering conventions should be isolated based on their operational instrument and utility, with the goal that determination of these conventions brings about the system life span and improved execution. We characterize these conventions in four classes as far as topology incognizant, information-driven, area helped, and versatility-based conventions. We distinguish the overarching open issues to make space for progressively beneficial research and propose how these classes might be valuable regarding their operational utility.

Wang, Gao, and Liu [9]. Energy-Efficient Routing Algorithm with Mobile Sink Support for Wireless Sensor Network. As of late, remote sensor arrangements like WSN has drawn wide consideration. It very well may be seen as a system with heaps of sensors that are self-governing sorted out and participate with one another to gather, process, and transmit information around focuses to some remote

authoritative focus. Thusly, sensors might be conveyed in cruel situations where it is unimaginable for battery substitution. Accordingly, vitality effective steering is significant for applications that present WSNs. In this paper, we present a vitality productive directing outline joined with grouping and sink portability innovation. We first gap the entire sensor field into parts, and every segment chooses a Cluster Head by computing its individuals' weight. Part hubs ascertain vitality utilization of various directing ways to pick the ideal situation. At that point, CHs are associated with a chain utilizing the eager calculation for between-group correspondence.

Liu and Wu [10]. A Method for Energy Balance and Data Transmission Optimal Routing in Wireless Sensor Networks. Remote sensor systems are generally utilized in numerous fields. Hubs in the system are normally controlled by batteries. Since the vitality utilization of remote correspondence is identified with the transmission separation, the vitality utilization of hubs in various areas is extraordinary, bringing about uneven vitality dissemination of hubs. In some extraordinary applications, all hubs are required to work simultaneously, and the uneven vitality appropriation makes the viable working time of the framework subject to the hub with the biggest vitality utilization. The generally utilized bunching convention can assume a job in adjusting vitality utilization, yet it doesn't accomplish ideal vitality utilization. This paper proposes to utilize.

Nawaz Jadoon and Zhou [11]. EEHRT: Energy-Efficient Technique for Handling Redundant Traffic in Zone-Based Routing for Wireless Sensor Networks. Here it exhibits a vitality effective system to deal with excess traffic (EEHRT) in the zone-based steering for remote sensor systems. In this procedure, multi-hop steering is performed dependent on the rest of the vitality of the hubs. Thereafter, it performs position-based directing without the requirement for the hubs to know their particular position. The fundamental goal of this paper is to deal with the repetitive bundles produced in zone-based directing utilizing short signal messages. Hubs of lower zones course the information of the higher zone to the Base Station (BS) with a base number of jumps and use just those hubs on the way which are vitality proficient and found nearer to BS. In addition, the source hub is recognized by the handing-off hub utilizing a remote communication advantage (WBA) without sending any uncommon ACK bundle to the sender for diminishing the control overhead in the directing procedure.

Zeng and Huang [12]. A Heterogeneous Energy Wireless Sensor Network Clustering Protocol. The Low-Efficiency Adaptive Clustering Hierarchical convention, a various leveled directing convention, has the upside of straightforward usage and can successfully adjust arrange loads. In any case, to date, there has been an absence of thought for its utilization in heterogeneous vitality organized conditions. To take care of this issue, the Energy-Coverage Ratio Clustering Protocol (E-CRCP) is proposed, which depends on diminishing the vitality utilization of the framework and using the territorial inclusion proportion. To start with, the vitality model is structured. The ideal number of bunches is resolved depending on the rule of "least vitality utilization,", and the group head choice depends on the rule of "territorial inclusion amplification". So as to adjust the system load however much as could reasonably be expected, in the following emphasis of bunch head choice, the group

head with the most reduced vitality and the most elevated vitality utilization is supplanted to delay the system's life. Our recreated outcomes exhibit that the proposed technique has a few favorable circumstances as far as longer system life, load adjusting, and in general vitality utilization in the earth of a heterogeneous vitality, remote sensor arrangement.

The power supply line helps to associate the hubs in order to completely adjust the vitality. The association conspires with the most limited electrical cable length will be additionally proposed. Based on the vitality balance, the technique for transmitting information with the best bounce check is proposed to completely diminish the power utilization in the information transmission process.

Kumar and Dinesh [13]. An energy-efficient and secure data forwarding scheme for wireless body sensor network is considered as one of the most recent research studies on the wireless sensor network utilized in the health care sector where some sensors can be implanted in the body and can be made to observe some physiological changes; if the energy of these sensors are not managed in an efficient way, then longevity of the sensors cannot be preserved, so one has to use the modern technique to monitor the energy and conserve it for delivering a longer period of functionality.

Raj [14]. Nihar Ranjan Roy Analysis of Data Aggregation Techniques in WSN. Wireless sensor systems give an enormous measure of using explicit information. This information should be prepared and transmitted to the base station, which is an expensive undertaking. Since WSN hubs are asset compelled, proficient information handling and monitoring vitality are prime difficulties. It has been seen that a large portion of the information detected by the sensors is repetitive in nature.

Wang [15]. Om Jee Pandey, Rajesh M H. Low Latency and Energy Balanced Data Transmission Over Cognitive Small World WSN. Vitality adjusting and quicker information move over a remote sensor organize (WSN) is a significant issue in applications like digital physical frameworks, the Internet of things, and setting mindful inescapable frameworks. Tending to this issue prompts expanded system lifetime and improved system practicality for constant applications. In WSNs, sensor hubs move the information utilizing the multi-hop information transmission model. The enormous number of jumps required for information transmission prompts poor vitality adjusting and huge information inertness over the system. In this paper, we use an ongoing improvement in informal organizations called little world attributes for proposing a novel strategy for low-idleness and vitality-adjusted information transmission over WSN. Little world WSN (SW-WSN) displays low-normal way length and high-normal grouping coefficient. A psychological SW-WSN is created by including new connections between a chose portion of hubs and the sink. Another information directing strategy is likewise proposed by upgrading the vitality cost of the connections. This strategy yields uniform vitality utilization and quicker information move. Examinations are led utilizing reproductions and genuine hub organizations over a WSN test bed.

Wang, Peng, and Huang [16]. An Improved Unequal Cluster-Based Routing Protocol for Energy-Efficient Wireless Sensor Networks. Remote sensor systems (WSNs) have been progressively intrigued by industry and scholarly cycles for their potential use in applications, for example, natural checking and military observation,

etc. The paper considers the vitality imperatives of grouped WSNs and proposes an improved steering convention for such WSNs to accomplish a worldwide enhancement in vitality utilization for all bunch head hubs, which diminish the impacts of problem areas in certain hubs close to the sink hub and counteract the hot head hubs to be over-burden for information correspondence. In such a directing convention, a period arranged challenge calculation is utilized to choose bunch head hubs for a running WSN to decrease the dynamic topology of communicating messages among sensor hubs rather than employing an exchange system, which is planned for lessening system traffic troubles. Moreover, the separations among hubs and the sink hub as a crusade record are considered to decay the inconsistent power dissemination of groups' hubs in WSNs regulated by the conventions, which help to uniformly devour the vitality of all hubs in a WSN. The hubs in a group choose their head hub by considering the separation between their corresponding position and upcoming bunch head hubs for which the proposed convention ensures a discerning size of the group. The epic convention calculation is tried by a Matlab recreation program.

## 8.4 Methodology

Redundancy or copy words cause vulnerability during the time spent pressure. Accordingly, repetition or copy words are not permitted. The proposed procedure applies a set as opposed to a succession during pressure, and decompression to defeat the data is lost. Set partitioning in hierarchal tree (SPIHT) is a ground-breaking wavelet-based picture pressure calculation that accomplished minimized yield bitstream than embedded zero tree of wavelet coefficients (EZW) without including an entropy encoder. This improves its productivity dependent on computational multifaceted nature.

SPIHT is computationally quick and among the best picture pressure calculations known today. As indicated by measurement examination of the yield paired stream of SPIHT encoding, propose a straightforward and successful technique joined with Huffman encoding for further pressure. Countless trial results are indicated that this technique spares a ton of bits in transmission, further upgraded the pressure execution. SPIHT proposes an exceptionally adaptable information pressure conspire dependent on the set dividing in various leveled trees calculation. The calculation, called exceptionally versatile, bolsters spatial and SNR adaptability and gives a bitstream that can be effectively adjusted (reordered) to given data transmission and goals prerequisites by a straightforward transcoder.

(a) **Lossless V/S Lossy.** Some pressure calculations are intended to help careful remaking of the unique information after decompression (lossless). In different cases, the recreated information is just an estimate of the first (lossy). Utilization of a lossy calculation may prompt loss of data, however, by and large guarantees a higher pressure proportion.

(b) **Mutilation V/S Exactness**. On account of lossy pressure, there is an exchange off between the information rate (R) accomplished and the mutilation (D) in the remade signal. Mean square error is a common contortion metric. Be that as it may, MSE can be deceiving, since various sorts of contortion may have altogether different consequences for the measurable derivations, which can be drawn after decompression. What's more, the vitality utilization of correspondence ought to be taken into account.

(c) **Information Aggregation.** In certain applications, just a rundown of the sensor information is required. For model, factual questions, for example, MIN, AVG, MAX, take into account conservative reactions from the sensors. In any case, the first example esteems can't be recreated from the outlined portrayal. Total requires in-organize handling of sensor information yet can extraordinarily diminish correspondence overhead.

In the SPIHT, spatial orientation tree (SOT) course of action is utilized to interface the coefficients after the (DWT) is applied to break down a picture into various subgroups. Besides, a dynamic mode in SPIHT grants the way toward coding/unraveling to be halted at any phase of the pressure. Arranging pass and the refinement passes are utilized in the coding process of SPIHT. It comprises three records in particular rundown of inconsequential sets (LIS), a rundown of irrelevant pixels (LIP), and a rundown of critical pixels (LSP) which are utilized to store coding data (Fig. 8.1).

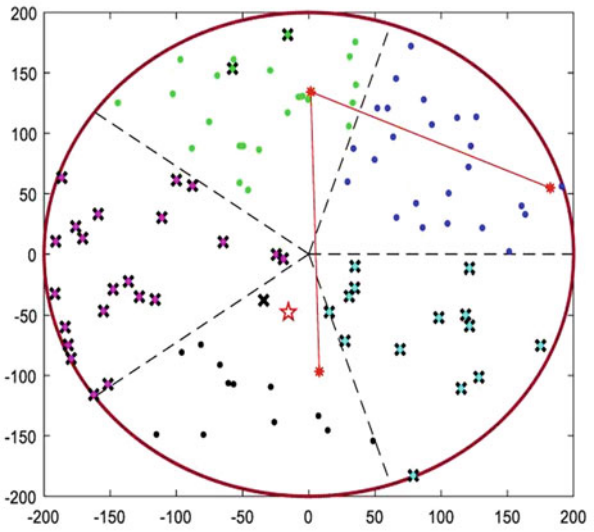
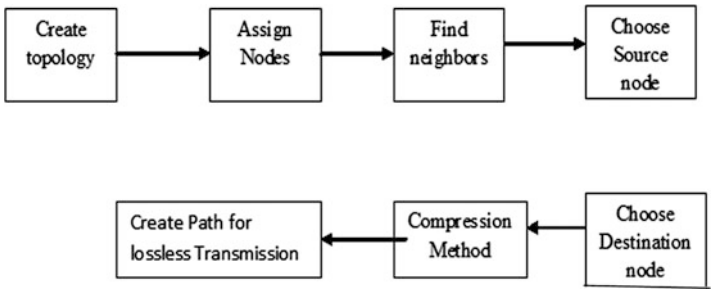



**Fig. 8.1** Energy Distribution and clustering formation of a wireless sensor network

1. **Block Diagram:**




As one can see from the above block diagram that initially a topology is created and then nodes are assigned to the topology, neighbor node selection is done by using the distance from each node. Source node and the destination node are selected for the data transmission purpose, once that is done compression algorithm is applied to minimise the data by using lossless technique data is transmitted over the network.

## 8.5 Performance Evaluation

The major issue of lossless pressure is to disintegrate an informational collection (for instance, a book document or a picture) into a succession of occasions, at that point to encode the occasions utilizing as a couple of bits as could be expected under the circumstances. The thought is to dole out short code words to increasingly plausible occasions and longer code words to less likely occasions. At whatever point a few occasions are almost certain than other information is compacted. In statistical coding systems, we use evaluations of the probabilities of the occasions to dole out the code words. For example, in any case given a lot of commonly unmistakable occasions s1, s2, s3, ..., s and precise evaluation of the likelihood circulation $Q$ of the occasions, Shannon [17] demonstrated that the littlest conceivable likely number of bits expected to encode an occasion is the entropy of $Q$, meant by n

$$H(P) = \sum_{k=1}^{n} -p\{e_k\} \log_2 p\{e_k\}$$

where $Q\{ek\}$ is the likelihood that occasion has happened. A code yields - log, $p$ bits to encode an occasion whose likelihood of an event is $Q$. Unadulterated number-crunching codes with right probabilities will deliver a great pressure.

Because of the productive lossless location information pressure of proposed versatile SPIHT, the transmission of information devours a less vitality. Along these lines, the lifetime of the sensor system is to be improved. In addition, the proposed work expands the speed of the transmission because of the diminished size of the bundle.

## 8.6 Results and Analysis

From the current system, the SPIHT-based picture pressure furnishes better pressure proportion with the blend of bunching. Notwithstanding, the computational intricacy isn't undermined. By and large, the qualities of the Double Density Discrete Wavelet Transform (DDDWT) and DTCWT are connected in numerous viewpoints.

(a) Power consumption: As one can easily understand that WSN networks are very much dependent on energy since we are using the compression technique with lossless data transmission, power utilization of the given technique is relatively less than the many existing methods, and average 9.8% more power is saved with the proposed method of data transmission.
(b) Delay: Delay is done when lots of data and redundant data are transmitted over the network, which causes the network bandwidth to be utilized wasting lots of resources since the given system uses the compression method to compress some amount of data before transmitting and 11% faster data transmission is done.
(c) Throughput is the average amount of data transmitted over the network from the source to the destination node. As delay increases the throughput parameter decreases. The delay is less in the given method of compression technique; the throughput of the system is increased hence giving lots of data in less time; 9.2% of throughput is increased using the given technique.
(d) Average Latency: It is the proportion of typical time taken by data groups to reach the sink or tolerating center point. Convey ability of sensor center points moreover impacts the typical lethargy in light of defilement of association quality in case of wrong decision of MAC convention. The average latency of the proposed system using the compression technique is better.

## 8.7 Conclusion

The current SPIHT-based picture pressure systems so far produced for WSN gives better pressure results at the expense of high calculation time. Consequently, in this paper, the altered SPIHT picture pressure calculation alongside DDDTCWT is created to diminish the calculation time while keeping up the picture quality measures. Advancement of successful pressure calculations is critical to the improved use of the restricted resources of WSNs (vitality, data transfer capacity, computational power). A huge number of research recommendations have tended to the issue. The recommendations are different and include different pressure draws near. In this work, we have made an exertion to place these works into viewpoints and to show an all-encompassing perspective on the field. In doing this, we have given a wide outline of existing methodologies, the current cutting edge, and introduced a legitimate order. Works are ordered as including either conglomeration, content-based pressure, distributed source coding, change-based

pressure, compressive sensing, or prescient coding. The proposed research tackles information pressure issues in quadtree procedure utilizing a proficient strategy for lossless address information pressure utilizing versatile set partitioning in various leveled trees (SPIHT).

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# Chapter 9
# An Exploratory Study on the Role of ICT Tools and Technologies in Tourism Industry of Nepal


**Deepanjal Shrestha, Tan Wenan, Bijay Gaudel, Sumina Maharjan, and Seung Ryul Jeong**

## 9.1 Introduction

Information and communication technologies (ICT) are indispensable technologies for the management, operation, and execution of a business [1]. The studies carried out by different scholars have found that there is a huge transition in the tourism industry due to the role and application of ICT [2]. These tools and applications have helped the business to expand beyond the global reach and blurred the dimensions of geographical boundaries. ICT has invented new business models and new supply chains and empowered a common man to become master of his own choices [3]. The tourism industry is the best example that finds a complete and multifaceted use of ICT helping businesses to sell and market its products and services and serving as the backbone for the industry. It connects the beneficiaries, the service providers, and consumers forming a value chain of cohesive nature [4].

ICT plays a very important role in underdeveloped countries like Nepal to get it connected globally and expose itself in various fields including business, education, culture, research, etc. [5]. Nepal is continuously witnessing development in information and communication technologies accounting to the high growing number of mobile and Internet users, web-based information management systems, e-commerce, and m-commerce applications which increase in the number of social site users and similar applications [6]. Studies have shown that tourism and ICT are

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deeply connected and make a great impact on each other; hence it is important to study the role of ICT tools and technologies in the tourism industry [7].

## 9.2 Literature Review

Macintosh and Goldner defined tourism as the sum of phenomena and relationships arising from the interactions among tourists, business suppliers, host government, and host communities in the process of attracting and hosting these tourists and other visitors [8]. It is an industry that benefits a country at all levels by supporting GDP, providing jobs, and integrating small to big businesses of a country. The data has shown that tourism development has played a vital role in the economic growth of developed nations and also as a vital tool for underdeveloped nations to foster the same. In the worldwide economy, the tourism industry has contributed 7.6 trillion US dollars, which means 10.2% of the global GDP and generated 292 million employment opportunities [9]. Tourism has created a greater benefit to developed countries than underdeveloped countries as per the studies of Seng (2015) and Ma et al. (2003), and they stated that the critical reason for the advanced tourism industry in the European nations is due to the emergence of technology and awareness of ICT capabilities [10].

Tourism is the key industry of Nepal that contributed 4.0% of total GDP and shared 3.2% of total employment in 2017 alone [11]. The government of Nepal has realized the importance of tourism in its economy and has initiated various projects, plans, and policies to promote it. Besides many other components, ICT is taken as one of the primary components by the government to plan and utilize it to its full capacity [6]. The current data regarding ICT development shows that this sector is booming in Nepal. The 10 years' data of communication industry in Nepal shows that all communication industries have grown with some showing drastic jump in the last 3 years which include mobile communications (5.04 million in 2008 to 39.2 million in 2019), Internet, and data services (0.54 million in 2008 to 19.8 million in 2019) as shown in Fig. 9.1 [12]. Similarly, the data regarding social site use has also increased in the recent years (Facebook 93.87%, YouTube 1.96%, Twitter 1.48%, Pinterest 1.45%, Instagram 0.95%) [13]. ICT and tourism are taken as important topics in research and academia. The results of the interconnectedness between the two have made them a compulsory part of one another. Many scholars clearly state that ICT has a profound impact on tourism and has led to a new form of business models, value chains, and new demands in this industry [14]. They also highlight the importance of ICT and digital technologies in the development of the tourism industry as a powerful industry of the twenty-first century.

Tourism has always pulled scholars of Nepal to study its various aspects including economic support, as a potential industry, trekking destination, and cultural hub, from religious aspect, but very few have tried to explore the relationship between ICT and Tourism [15]. Some notable academicians and researchers who have

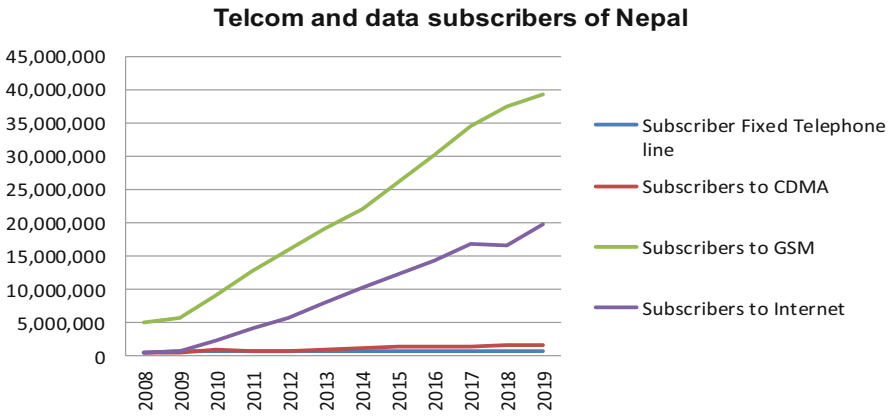


**Fig. 9.1** Data representing 10 years growth and subscription of communication technology in Nepal. Compiled from NTA, MIS reports [15]

worked in different aspect of ICT and tourism industry of Nepal include Mahabir Pun et al. who talk about tourism development in his work on Nepal wireless project; Goodman who talked about Internet from top of the world in his case study in Nepal [16], Thapa, Devinder, Sein, and Maung K who discussed about ICT, Social Capital, and Development: the Case of a Mountain Region in Nepal [17], and Shrestha and Jeong's work which proposed an ICT framework for tourism industry of Nepal. This area still has many aspects that need to be studied and discussed to find a real understanding of ICT and tourism in the context of Nepal.

## 9.3 Research Framework

The research framework represents the overall study about the role of ICT in the tourism industry of Nepal as shown in Fig. 9.2 below. The study employs inbound tourism as the main source of data and uses secondary literature to supplement the facts and figures.

### *9.3.1 Research Framework and Methodology*

The below framework depicts the overall scenario of the research undertaken to explore the role of ICT tools and technologies in the tourism industry of Nepal. Inbound tourism and secondary literature are the main inputs of the study that are analyzed and interpreted to find out the current status, role, and usage of these tools and technologies in the tourism industry of Nepal. Descriptive and inferential

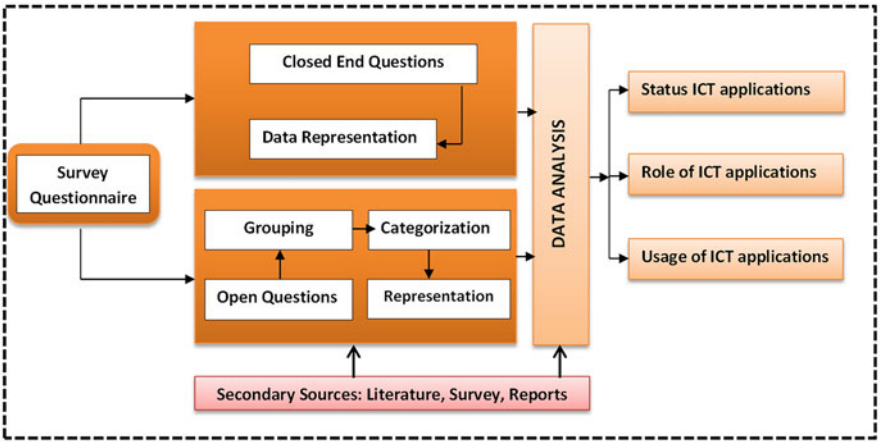


**Fig. 9.2** Research framework regarding the study

statistics are used to analyze data and interpret results obtained from the respondents and secondary literature. The study is qualitative in nature and represents results in the form of tables, graphs, and charts of the subject under investigation as shown in Fig. 9.2.

### *9.3.2 Sampling*

Convenience sampling is used for the study for a set of inbound tourists to find out what ICT tools and technologies they use in their course of planning and visiting and on the return of their journey from Nepal. A total set of 150 questionnaires were distributed online to tourists of 10 countries, and only 109 responses were received. The survey questions consisted of 34 questions which included the demography data like age, country, and name of the respondents, while income level, educational background, and marital status were ignored as they were not considered so important for the current study. The three open questionnaires were used to get the free views of the respondents which were grouped, categorized under suitable headings, and then represented in the form of the table to depict the scenario. The country of inbound tourists was considered based on data retrieved from Nepal tourism report 2018 published by the Ministry of Culture Tourism and Civil Aviation.

## 9.4 Data Analysis and Findings

The data analysis was done using statistical tool, and data was represented in the form of bar graphs, pie charts, tables, and figures. The demographic data depicted that all the ten countries chosen for data collection responded with more than 80% of respondents from India, Japan, USA, China and Canada, while others were in the range of 40% to 60% with France and Ukraine about 25% as shown in Fig. 9.3.

The second demographic data regarding age group show that most of the respondents belong to the two age groups between 26–35 making 44.8% and 36–45 making 45.7% of the respondents 8.4% between 18 and 25 and 1.1% between 46 and 55. It was interesting to find that most of the young people were frequent to visit Nepal as shown in Fig. 9.4. The data regarding the frequency of visit depicted that 64 respondents out of 107 visited Nepal only once, 11 visited 2 times, 8 visited 3 times, and 11 visited 5 times with 2 visiting more than 10 times (Fig. 9.5). The data represented that the frequency of repetition was low among the tourist as shown in Fig. 9.5.

The inbound tourist was asked about their purpose of visiting Nepal that had multiple choices. The data depicted that 59 answered for relaxation and recreation, 56 answered for trekking, 27 for a religious purpose, 26 for cultural exchange, 25 for visiting friends and relatives, 22 for adventure sports, and very less about 2 of them for health and meditation as shown in Fig. 9.6.

The basic questions regarding the tourism industry of Nepal were further investigated for the use of ICT tools and technologies. The respondents were inquired about how they booked for the accommodation in Nepal? (Fig. 9.7).

The 25.2% of the respondents answered that they booked it through phone with a travel agency in their own country, 21.1% booked through travel websites like

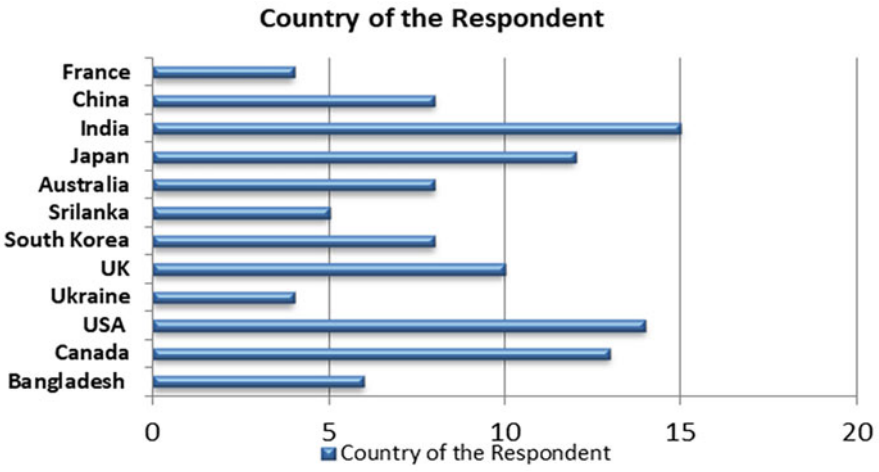


**Fig. 9.3** Representation of respondents' country

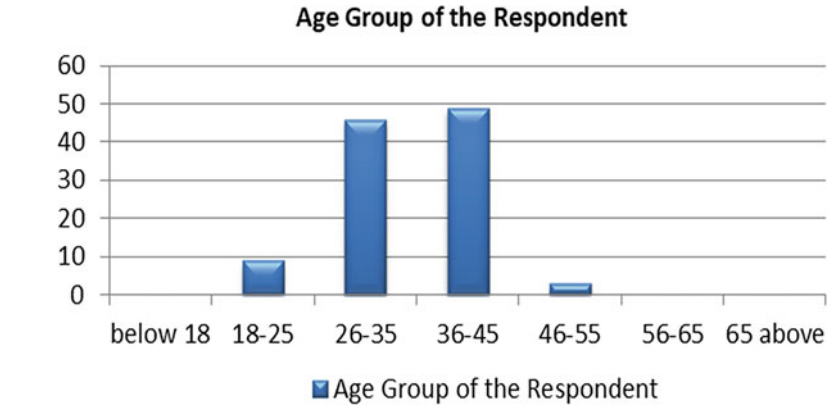


**Fig. 9.4** Representation of respondents' age group

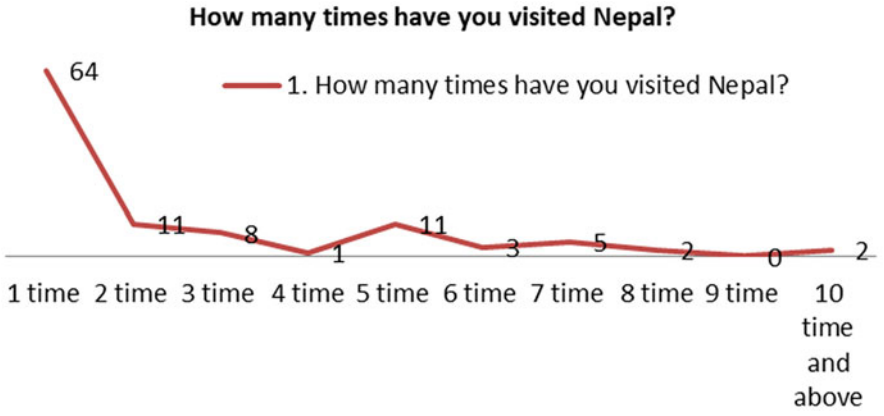


**Fig. 9.5** Representation of respondents Nepal visit

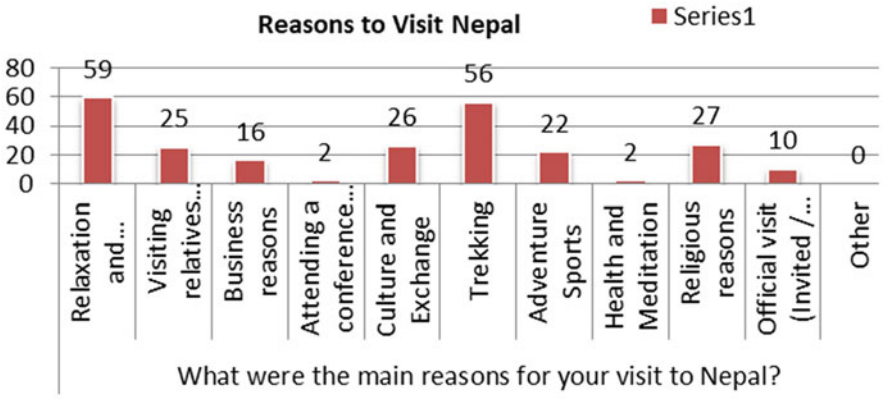


**Fig. 9.6** Representation of tourist purpose of visit to Nepal


**Fig. 9.7** Representation of tourist accommodation booking information

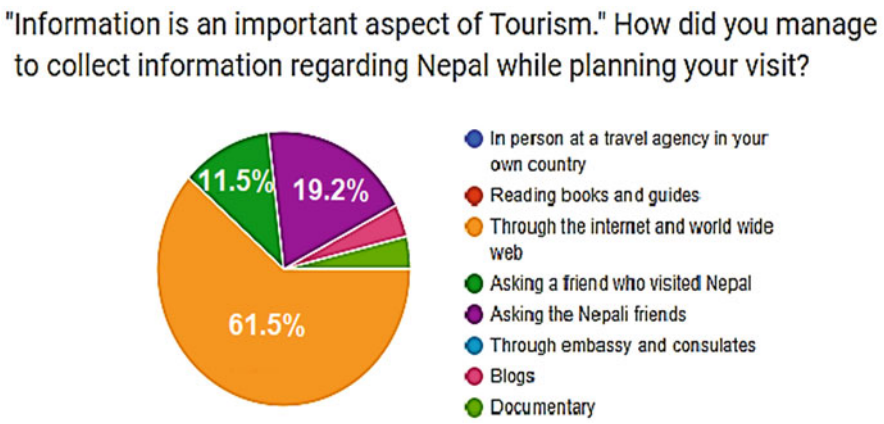


**Fig. 9.8** Representation of information collection for Nepal through different medium

Agoda, Trip, Booking, etc., 13.1% booked with Internet with accommodation in Nepal, 7.4% through friends, and 7.4% in person with a travel agency in their own home country. There were other sources of accommodation booking that included through invitee, staying with friends and family, conference, and so on that made up a small number.

Information is an important aspect of tourism when the respondents were asked about how did they manage to collect information about Nepal; 61.5% said they used the Internet and world wide web to collect information about Nepal, and 19.2% collected by asking their Nepali friend, while 11.5% asked the friends who had already visited the country. The data of this aspect concluded that on average, 61.5% were using Internet technology to gather information as shown in Fig. 9.8.

Further analysis of the use of ICT in tourism was explored by asking the question to the respondents if they found any digital assistance systems in their course of the journey to Nepal. The digital system was explained to them as any system like

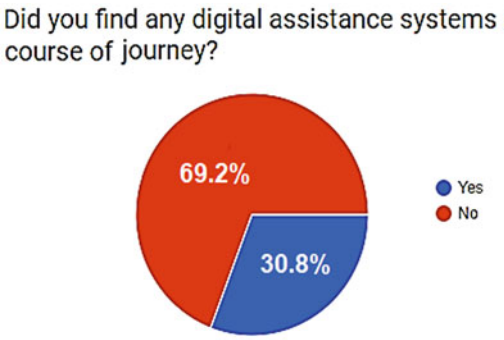


**Fig. 9.9** Representation of digital assistance available in Nepal

location finders of destinations, language translators, or e-commerce-based systems, etc. to assist them in their course of the journey to Nepal. 69.2% answered as NO, and 30.8% answered as YES as shown in Fig. 9.9. The respondents who answered "yes" included Google maps, the use of digital payment cards, and other such software in existence. None of them found any specific digital application made in Nepal for their assistance. This indicates that Nepal is still way behind in terms of local and customized applications for specific use like in the tourism industry and others.

Communication is a vital component for human beings to exchange ideas, keep in touch, express their feelings, and get connected to each other. To find out how tourists kept in touch with their friends and family during their visit to Nepal, it was discovered that 33.3% used emails and instant messaging services, 22.2% social networks sites, 40.7% used mobile phones, and only 3.8% used fixed telephone lines. It was interesting to note that social network sites were having a good share in the communication activity of the tourist besides the traditional digital applications like emails as depicted in Fig. 9.10. Further when inquired about the use of social applications, the data showed that 88.9% of the respondents used social network sites like Facebook, Instagram, Twitter, etc. And only 11.1% of the respondents did not use the social sites as shown in Fig. 9.11.

Facebook was the most popular social site among the respondents with 50% using it, followed by Instagram 23.1%, 7.7% used twitter, 7.7% used WeChat, 3.8% almost all kinds, 3.8% LinkedIn and 3.8% line, and others as per Fig. 9.12. The data regarding the use of social sites for gathering information and communicating in Nepal was prominent as 70.4% of the respondents felt so, with 22.2% not sure and only 7.6% were negative as shown in Fig. 9.13.

When respondents were inquired about the future role of social network sites in tourism of Nepal, 33.3% felt that it will strengthen the global reach, 33.3% felt it will reach the global audience for both positive and negative information, 14.8% felt it will make Nepal tourism industry rich with abundant data, 7.4% felt that misleading and fake information will prevail and create negative impact, and 3.7% felt that it

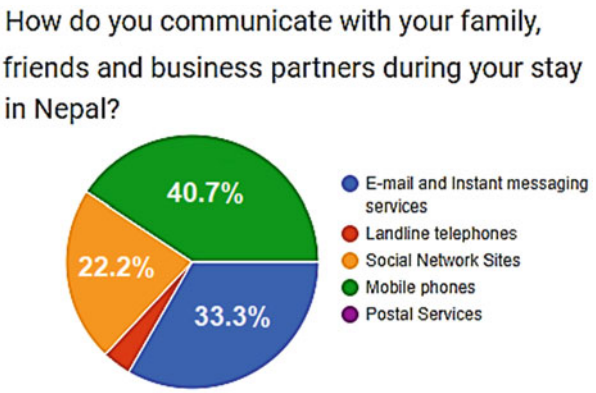


**Fig. 9.10** Representation of communication tool used by tourist in Nepal

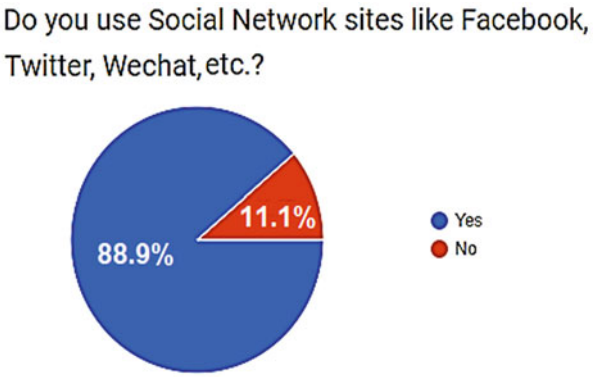


**Fig. 9.11** Pie chart depicting the population of social site users from the survey

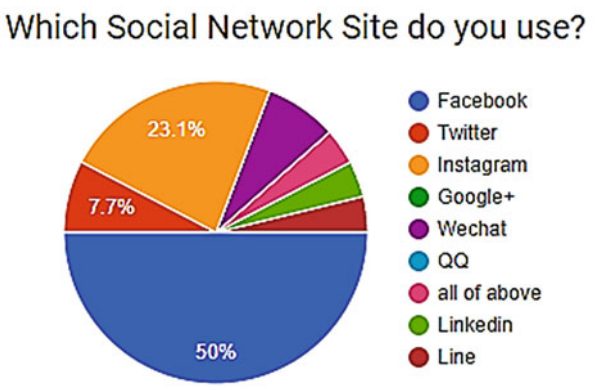


**Fig. 9.12** Representation of popular social network sites used by respondents

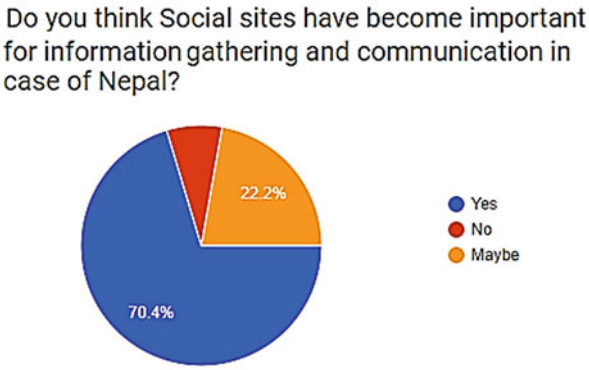


**Fig. 9.13** Role of social network sites in information collection and communication

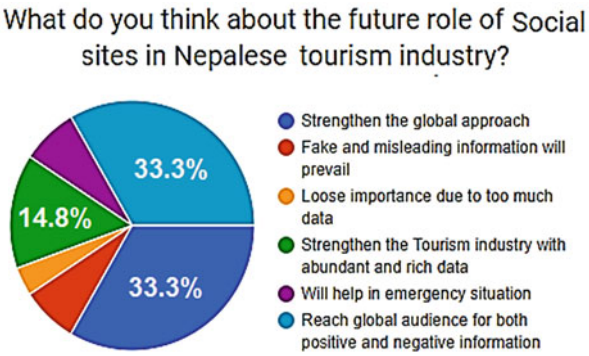


**Fig. 9.14** Representation of respondents views regarding future of social network sites in tourism of Nepal

will diminish in importance due to too much data as depicted in Fig. 9.14. About 88.9% of the respondents suggested that the government should integrate social sites and other information data sources to promote tourism in its planning and policies, Fig. 9.15. Above figures make us conclude that social site is growing in popularity in Nepal, and the government should see these digital applications as an important part of their planning and policy making.

Social sites have become important for people around the world to share their feelings, experiences, knowledge, news, and other related information. The investigation into this component of the study revealed that 63% of the respondents shared their good and bad experiences of their journey, while 37% did not do so as shown in Fig. 9.16. Further, 100% of the respondents of the study agreed that reviews and information on the website do create an impact on the tourism industry (Fig. 9.17). This states that digital technologies have become an important part of the business, and users' feedbacks, information content, news and other such source of information should be considered and analyzed regularly.

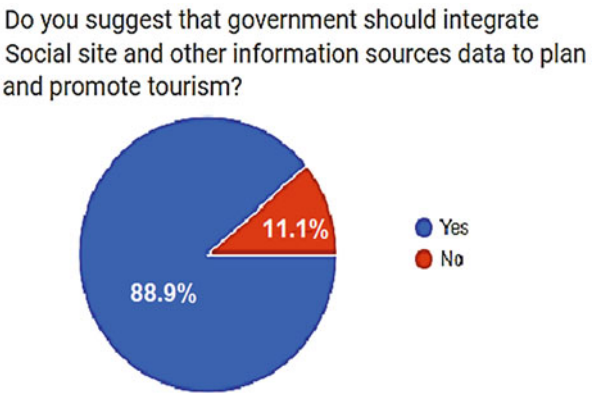


**Fig. 9.15** Representation of respondents views regarding integration of social network sites in tourism of Nepal

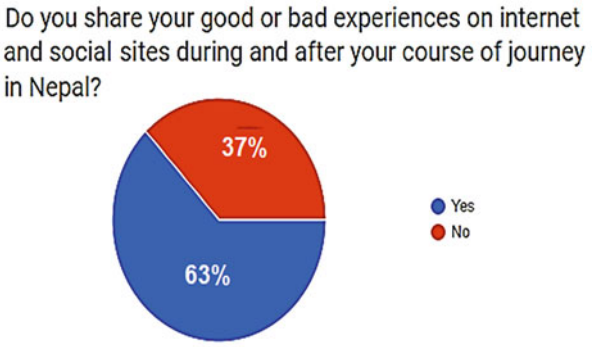


**Fig. 9.16** Representation of social sites usage in sharing experience

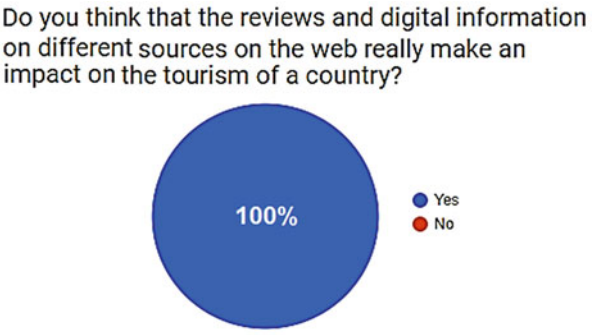


**Fig. 9.17** Representation of respondents views regarding information on website

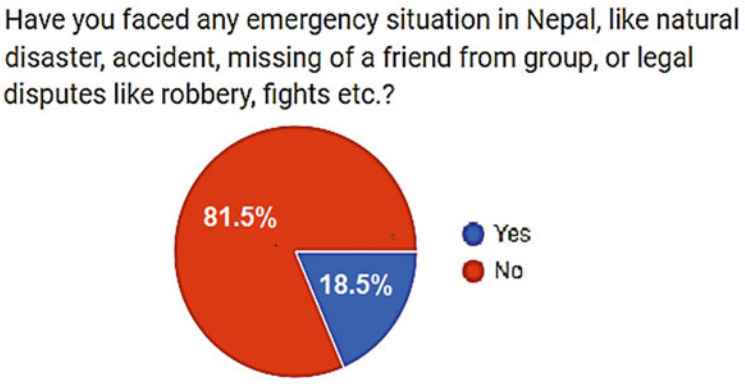


**Fig. 9.18** Representation of respondents facing emergency situation in Nepal

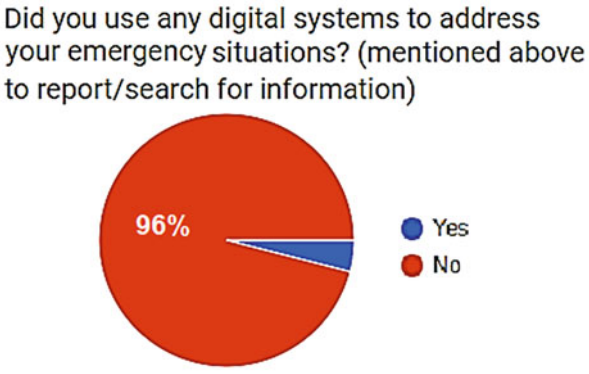


**Fig. 9.19** Representation of respondents using digital systems during emergency

The study further analyzed the role of digital technologies in emergency situations in Nepal like natural disasters, legal disputes, accidents, etc. The data regarding this component in Fig. 9.18 show that only 18.5% of the respondents faced such situations in Nepal and only 4% (Fig. 9.19) out of them used digital systems for help. The main case that was reported was of friends missing during a trek and during an earthquake. Facebook was used to trace and rescue them back.

When the respondents were inquired about why they did not use any digital systems for assistance during such extreme situations? 27.3% said they had no idea if such systems existed, 27.3% felt they are not available, 36.5% did not face any such situation, 9.1% got local people assistance, 4.5% felt that mobile and telephones were better, and 4.5% felt it was more time consuming as shown in Fig. 9.20. Some questions were open, so there were different ways of answering that led to ultimately number of options depicted later in the table.

Nepal is known best for its mountains and the highest peaks in the world. It serves as a favorite destination for trekking, which can be fun as well as challenging

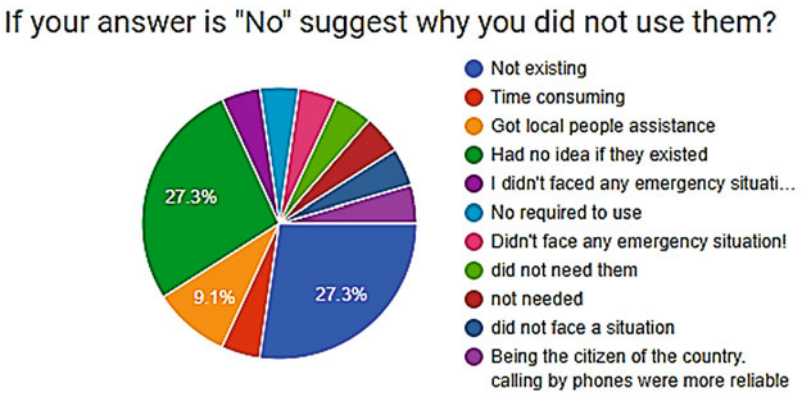


**Fig. 9.20** Representation of respondents views on the use of digital system during emergency

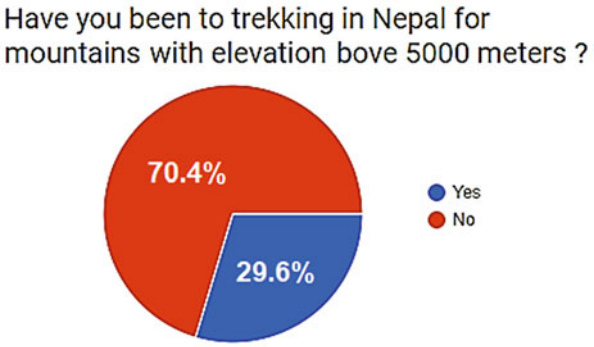


**Fig. 9.21** Representation of respondents on trekking to mountains above 5000 m

due to its difficult structure. ICT technologies can serve as a boon for these kinds of destinations in many ways by providing the facility of navigation, information on climate change, and other related aspects. To find out this aspect of digital systems, respondents were asked if they have been on trekking and how ICT systems and technologies helped them? It was seen that around 29.6% (Fig. 9.21) of the respondents had been on trekking and 85.7% out of them did not find any assistance on their way. Only 14.3% out of the number agreed that they had found some sort of assistance as shown in Fig. 9.22 below.

The role of ICT and digital systems in providing security to the tourist was answered positively by the respondents. 81.5% agreed that these systems are important and can provide safety and assistance during travel to the tourist, while 18.5% were not sure as shown in Fig. 9.23. The tourist respondents were positive to see the development in the field of ICT and digital systems with 44.4% believed that it is improving and 14.8% believed that the technology is available, but the quality of service poor. 25.9% felt that it is way behind in comparison to the current

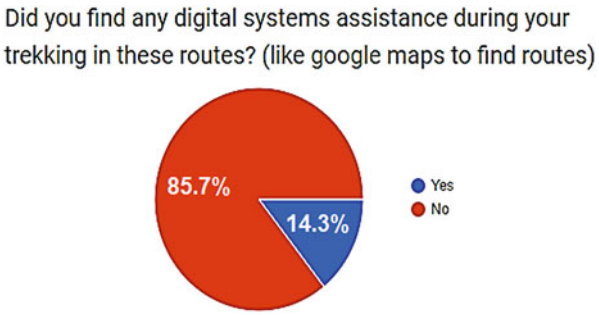


**Fig. 9.22** Representation of respondents views on the use of digital system during trekking

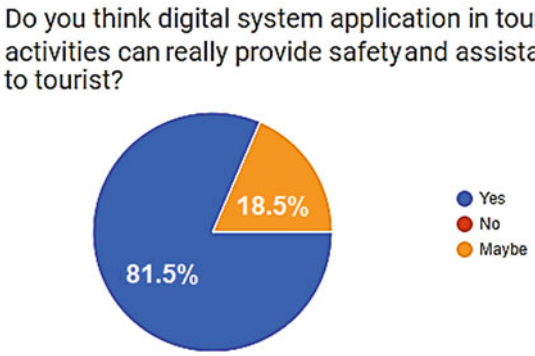


**Fig. 9.23** Representation of views on the role of digital systems for safety assistance

developments in ICT around the globe, while 14.8% felt that the technology is not uniformly implemented and is available in fragments making the quality of service appears poor as shown in Fig. 9.24.

There are many different kinds of ICT and digital systems seen in existence around the globe today that help and manage tourism activities. The tourist respondents were inquired about what kind of digital system would they prioritize in Nepal based on their priority on a scale of 1 (low) to 5 (high) for some mentioned systems. It was discovered that Language Translator Systems was the first choice with 48.5%, Destination Information Systems as second with 46.7%, and followed by Domestic Travel Management Systems as third choice with 45.7% rating as the highest priority as shown in Fig. 9.25.

The respondents were asked to write free opinions to the two open questions that included "What are the obstacles and lapses that you see in the Tourism Industry of Nepal in context to ICT and digital systems?" and "What suggestion would you give to Government of Nepal, regarding digital implementation in Tourism?" The analyzed text with similar context and meaning was grouped under one theme and then converted into meaningful statements to make an understanding of the obstacles, lapses, and suggestions put forward by respondents in context to ICT and

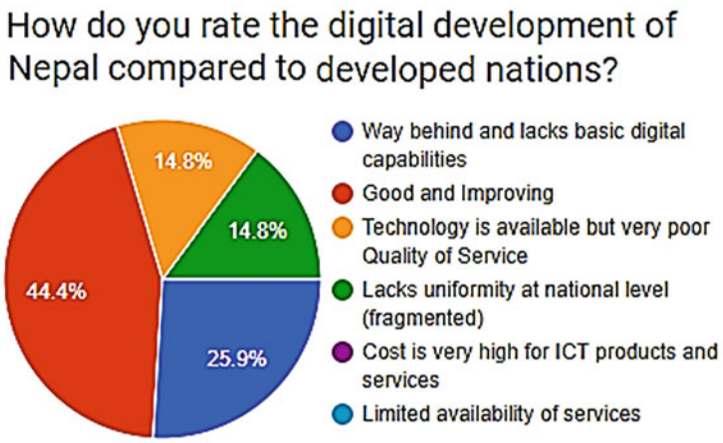


**Fig. 9.24** Representation of respondents views on the development of digital systems in Nepal

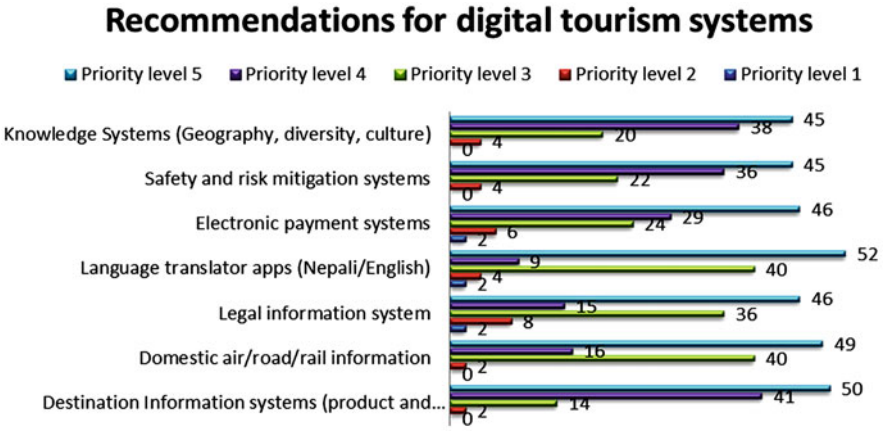


**Fig. 9.25** Representation of respondents' recommendations for digital tourism systems in priority

digital implementations in the tourism industry of Nepal as shown in Tables 9.1 and 9.2. Altogether 21 obstacles and lapses were identified and 12 suggestions from the open questions answered by the respondents.

## 9.5 Conclusion

The study represented interesting facts and figures about the role of ICT tools and technologies in Nepal. The data of the respondents supported the growth and depicted the exponential increase of use of ICT technologies in Nepal as per Fig. 9.1

**Table 9.1** Data representing themes for obstacles and lapses in ICT and Tourism

| S.n | Keywords and themes (obstacles and lapses) | Frequency |
|---|---|---|
| 1 | Lack of digital payment systems | 102 |
| 2 | ICT education and awareness | 96 |
| 3 | Poor Internet connectivity in remote areas | 93 |
| 4 | Issues in information reliability, availability, and authenticity on food, health, and hygiene | 92 |
| 5 | Poor quality of ICT service | 86 |
| 6 | Less and not updated information on natural disasters, accidents, and risk | 84 |
| 7 | Digital divide and lack of education in rural and remote areas | 81 |
| 8 | Government agencies lack digital implementations | 77 |
| 9 | Lack of updated technology with global developments for digital implementation | 76 |
| 10 | Information update and information availability is poor for tourism destinations | 71 |
| 11 | No proper tourism applications for Nepal tourism are available | 67 |
| 12 | Lack of basic infrastructure | 67 |
| 13 | Lack of policies at the national level for development and implementation of ICT systems | 66 |
| 14 | The scattered and fragmented system in existence | 61 |
| 15 | Poor website, website should be interactive allowing real opinions | 59 |
| 16 | Fast Internet connectivity, better quality, uninterrupted digital services | 54 |
| 17 | Lack of support in technology (untrained men to troubleshoot problems in remote areas) | 54 |
| 18 | Technology and difficult terrain do not meet tourism needs | 53 |
| 19 | Lack of integrated approach for digital systems in tourism | 46 |
| 20 | Poor quality of apps available | 43 |
| 21 | Lack of availability and promotion of digital systems | 34 |

**Table 9.2** Data representing suggestions for ICT and Tourism Industry of Nepal

| S.n | Keywords and themes (suggestions) | Frequency |
|---|---|---|
| 1 | Introduce e-commerce | 97 |
| 2 | Improve the infrastructure of ICT systems and services | 91 |
| 3 | Make Internet services accessible to remote areas and high altitudes | 87 |
| 4 | Integrate ICT as a component of tourism | 83 |
| 5 | Introduce simple but useful apps like language translators, shopping for food, travel, etc. | 79 |
| 6 | Update website with authentic and real information | 77 |
| 7 | Make websites dynamic with user personalize pages | 74 |
| 8 | Educate people in remote and rural areas about ICT use and applications | 67 |
| 9 | Provide enough information on health hygiene and food | 76 |
| 10 | Develop mobile-based apps for tourism navigation and information | 71 |
| 11 | Develop policies at the national level for compulsory use of ICT in tourism | 67 |
| 12 | Make better plans and approaches for digital marketing and reach | 67 |
| 13 | Government offices of tourism must use digital technology as their priority | 66 |
| 14 | Introduce risk mitigation and management systems | 61 |
| 15 | Make people aware of digital technologies and their use in tourism | 59 |
| 16 | Identify the national and global needs in digital tourism and develop plans | 54 |

and online data statistics from the stat counter. This clearly shows that the demand is growing for digital systems, and people are slowly adopting ICT in their lives. The survey of inbound tourist also represented positive indication of ICT tool and digital technologies in use with 25.2% and 7.4% using Internet directly to look destinations; 61.5% used Internet and websites to gather information on Nepal; 33.5% and 22.2% used emails and social sites to communicate with their relatives and friends. The use of social sites in Nepal was also prominent. It was seen that almost all 88.9% of the respondents used some kind of social application in Nepal with Facebook being the most popular 50% followed by Instagram 23% and similarly other applications. This data projected an important aspect that future businesses including tourism must concentrate on social apps to promote, plan, and manage the business.

The implementations of digital technologies in remote areas, high altitude, and in emergency situations were not witnessed by the respondents. There were issues of Internet connectivity at remote locations combined with the quality of service. The support and awareness level in ICT was also seen at marginal state in the remote and rural areas. The respondents were interested in seeing digital implementation in travel arrangements (combining scale 4 and 5) 66%, language assistance 58%, destinations management 74.6%, safety and risk mitigations systems 70.3%, and knowledge management systems 73.7% as the most prioritized systems. The response regarding the role of ICT and digital systems was low, but, still, the respondents were hopeful as 59.2% said that it is improving and available.

The most frequent problems and suggestions were provided in the area of the digital payment system, ICT education and awareness, quality of service, and high accessibility. Respondents were of the view that the Government of Nepal should integrate ICT as a major and vital component in tourism to increase tourism services with better delivery models. Overall the study clearly highlighted that ICT and digital system have started to appear in different areas of tourism industry of Nepal and the future needs an integrated system design that should take care of existing technology, meet the global demands, and enforce plans and policies at a national level to fully harness the benefits of ICT.

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# Chapter 10
# Analysis and Prediction of Soil Nutrients pH,N,P,K for Crop Using Machine Learning Classifier: A Review


**Disha S. Wankhede**

## 10.1 Introduction

Agriculture domain is very much important and sensitive domain of research, as far as consult with farmer side all the citizen is helping the farmer in terms of finding new solution in existing system, research, and innovation in actual farming, also Government provide some funding for the same to do new research and innovation in agriculture, it will directly help to our farmer. The computer engineering field is also working on the same, in this field, lots of work was done with the assistance of new technique proposed like some software, hardware which directly helped to our farmer for easy way to take decision making for better yield and crop also some research is going on in soil quality and disease detection in plant. Much of the work is going on in the computer field under the smart agriculture system. This paper will focus on various machine learning techniques which are available and proposed by a different author in the last 10 years by considering various parameters of soil nutrients like organic carbon, electric conductivity, potassium, pH value, nitrogen, phosphorous, etc. In computer fields, the machine learning is one of the area of research where we can help our farmers for better crop prediction and analysis purpose. Computer, electronics, and other field researcher are doing somewhat contribution after finding a new solution, research, and project for the easy way of farming with less cost and efforts which directly help our farmer. Also, the government provides some schemes for research in terms of the grant.

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## 10.2 Literature Survey

### *10.2.1 J48 J48\C4.5Machine Learning Algorithm*

Soil is an essential factor for better yield and crop, and for soil analysis purpose, various classification algorithms are proposed.

Nikam et al. [1], J48/C4.5, knn, ID3, artificial neural network, support vector machine, and Naive Bayes had used for classifications. These classifications fall into three categories statistical, machine learning, and neural network [1].

Gholap et al. [2] experimented by using three algorithms 1. Naïve Bayes,2.J48(C4.5), 3.JRip algorithm and concluded using 1988 soil instances in that J48: It is an extremely basic classifier to generate a decision tree with the highest accuracy is 91.90%. Soil instances from Pune region bhor, velhe, and khed testing laboratory and 9 attributes like(a). pH: value of soil nutrients pH, (b). EC: Value of soil nutrients Electrical conductivity decisions per meter, (c). OC: Value of soil nutrients Organic Carbon, (d). % P: Value of soil nutrients Phosphorous ppm, (e). K: Value of soil nutrients Potassium, ppm, (f). Fe: Value of soil nutrients Iron, ppm, (g). Zn: Value of soil nutrients Zinc ppm, (8) Mn: Value of soil nutrients Manganese, ppm (9). Cu: Value of soil nutrients Copper, ppm. The author have suggested future scope in this paper is to create one recommendation system in collaboration with the Soil Testing Laboratories Amravati Maharashtra, The proposed system suggest applicable or appropriate fertilizer for the given soil test sample and cropping pattern.

Rajeswari et al. [9] compare and experimented by using six algorithms J48, Random Tree, JRip, OneR, Naïve Bayes, in that J48 gives accuracy 93.46% out of other algorithms but comparatively Naive Bayes gives 93.81% high accuracy as related to other algorithms. Both algorithms have minor differences between them. For experiment purpose 203 soil lime instances from rural area soil testing lab, District Virudhunagar, Tamilnadu, India and 6 attributes as the same [2, 25]. The author have suggested some future scope as to envision and endorse applicable fertilizer and crop benefit for the lime status level in the soil.

Mrs. N. Hemageetha et al. [14] implemented and analyzed the soil condition constructed on pH value. The J48 gives high accuracy results for verifying the soil is whether suitable or non-suitable for crop cultivation. Pawar M. et al. [17] have built the system that conveys farmers about harmfulness levels in their soil; if toxic is present in their farm, then the farmer or user can take proper movement for empowering their field farming and get more crop yields. J48 machine learning computer engineering algorithm works more accurately as compared to the decision tree.

Rajeswari et al. [20] proposed Jrip algorithms have provided good results as related to other machine learning algorithms in 110 instances of soil (black and red) 8 attributes.

Basker et al. [29] made a system for soil fertility prediction and analysis purpose in consideration of Trichirappalli district, the regression technique least median squares which were produced improved results than the classical linear regression for most accurate prediction attribute was N-Nitrogen value from the soil sample.

Kumar et al. [25] build system and experimented by using five algorithms 1. Naive Bayes, 2.J48(C4.5) 3. Jrip 4. Linear Regression 5. Least median Regression, considering 1500 soil instances in that JRip and J48(C4.5) give better results as 92.53%, 87.03% respectively. Author had collected soil instance from Warangal district, Andhra Pradesh, India and 10 attributes like [2] Zinc, Potassium, Phosphorus, PH, Nitrogen, Magnesium, Humus, Iron, Calcium and Sulphur.

Bhuyar et al. [28] demonstrate that after the comparative result of J48, Naïve Bayesian, Random forest. J48 classifier performs exceptionally very good for the conclusion of the fertility index; also investigation shows that the fertility rate for district Aurangabad Maharashtra is average.

### *10.2.2 Naïve Bayes Machine Learning Algorithm*

Chiranjeevi M N et al. [5] developed a system for analysis of soil conditions and nutrients by considering two algorithms like Naïve Bayes and J48. Instances had considered for experiment purposes from Belagavi Department of agriculture, Belagavi, and 12 attributes had considered as potassium, pH, nitrogen, EC, phosphorus, OC, sulfur, iron, zinc, magnesium, boron, and copper. J48 had given the accuracy of 2.68% whereas Naive Bayes 1.98%; Naive Bayes has produced a better result than the J48 algorithm, which correctly classified the determined number of instances of the soil sample.

Bhargavi et al. [8] presented that Naive Bayes classifier had applied to Tirupati, Andhra Pradesh soil. The soil data instances had 100% classified with the categories of different sands like loamy sand, clay, loam, sand, sandy loam, sandy clay loam, and clay loam.

Arunesh et al. [9] have investigated and experimented in 203 soil instances with 6 attributes of soil from Virudhunagar District, Tamilnadu, India, the author had concluded Naïve Bayes machine learning classification algorithm gives better results as compared to J48, random tree, JRip, OneR, Naive Bayes.

Ramesh et al. [21] had calculated accuracy of soil instances after building a system using classification algorithms like Naive Bayes, Bayes Net, Naive Bayes Updatable, J48, and Random Forest. For experiment purpose, they had considered Kanchipuram and Tamil Nadu, Soil Science and Department of Agricultural, and Kanchipuram and National Informatics Center Tamil Nadu with 1500 instances. J48 had calculated 92.3% accuracy, whereas the Naïve Bayes algorithm has calculated 100% accuracy in the classification of soil nutrients.

### *10.2.3 Artificial Neural Network*

Puno, J. C. et al. [18] proposed and developed a system that is a fully functional system using IP (IP enhancement, IP segmentation, and feature extraction) using an artificial neural network in MATLAB software. Classification is with L, M, H, S, and D (low, medium, high, sufficient, deficient), respectively, the value of all 7 attributes (1) pH, (2) N, (3) P, (4) K, (5) Zn, (6) calcium, and (7) Mn. ANN gives 100% accuracy.

### *10.2.4 Support Vector Machine*

Ahmad et al. [4] experimented last five years data and only one attribute for classification considered i.e. VIC moisture after experimentation author concluded that using his experiment of model 1 and model 2 for soil moisture estimation SVM model performs better than ANN and MLR models.

Morellos et al. [6] build and experimented on 140 soil instances and 3 attributes from Premslin, Germany. LS-SVM algorithm gives improved results for the previsision of OC and MC. The cubist method had given a good estimated for TN.

Panchamurthi et al. [15] proposed SVM gives improved results in machine learning.

## 10.3 Soil Analysis Using Machine Learning Algorithm

Machine learning is the new domain in the area of the interdisciplinary field of computer engineering, where finding some pattern in the big data set. This domain is combined with other new technology like AI, ML, IOT, and statistics also big databases. Machine learning is the emerging domain of computer engineering area; it is based on scientific, logical facts, and algorithms also have statistical calculus models that computer use to accomplish a precise task without using clear-cut information, depending on examples and assumptions. It is seen as a subsection of AI domain (Ref: Wikipedia). Soil testing is an important way to find and analyze the nutrients content. Oil testing is performed to quantify fertility and demonstrate inadequacies or absences that need to mitigate ("soil test," Wikipedia). In this literature, soil nutrients data set has soil testing results that have been applied to different classification techniques in machine learning algorithms. Soil fertility is critical parameter which is consider for land, so soil fertility purpose which nutrients are good for crop production, this paper includes literature survey of 30 paper of

last 10 years what's other are worked in this domain where they are successful and which algorithm's give better result in data set.

The machine learning algorithm like J48, Naive Bayes, KNN, Random Forest, SVM, JRip have previously used and experimented in large and small data set with different parameter list of soil testing.

## 10.4 Soıl Testıng Attrıbute

The agriculture sector in India is completely associated with soil, basically, in all north, south,west,east side,soil has found the following four types: Loamy, Silt, Clay, Sandy soil and every soil has required nutrients for good crop production purpose so for that purpose following are the nutrients were considered previously in research, like OC, Nitrogen, pH, EC, Magnesium, Potassium, Sulphur, Phosphorus, Iron, Copper, Boron and Zinc [5] and Label Soil fertility class as (moderate, moderately high, high, very high very low, low,) [29]. For experiment purpose various author proposed their system with different level of instances and attribute.

## 10.5 Applıcable Classıfıcatıon Technıques

The following various available methods for classification of soil analysis for crop prediction based on nutrient level in soil are K-NN [11, 19], SVM [4, 6, 15], Naïve Bayes [5, 8, 9], J48/C4.5 [1, 2, 9, 14, 20, 21, 25, 28, 29], ANN [18], decision tree [2, 17, 25], logistic regression, fuzzy technique, etc. which give the best outcomes for classification used for the soil data set listed in Table 10.1 [3, 7, 10, 12, 13, 16, 22–24, 26, 27].

## 10.6 Dıscussıon

I have discussed here the various machine learning classifiers that include J48, Naive Bayes, k-NN, Random Forest, SVM, JRip for soil nutrients prediction purpose is soil is good for a particular crop in the respective region. In Table 10.1 classification and prediction of soil and their feature were classified previously. In the literature survey, Table 10.2 had shown various topmost machine learning algorithms used for classification prediction purposes in soil analysis considering attribute OC, P, K, Zn, Cu, Fe, Mn, boron, sulfur, N, pH, and EC.

**Table 10.1** Review of soil nutrients and analysis using different machine learning classification techniques

| Classi fier used | Instance of soil | No. attribute (feature) | Attribute name (feature) | Accuracy |
|---|---|---|---|---|
| 1. Naïve Bayes [2] | 1988 | 9 | OC, pH, P, EC, K, Fe, Zn, Mn, Cu | 38.40% |
| 2. JRip [2] | 1988 | 9 | | 90.24% |
| 3. J48 (C4.5) [2] | 1988 | 9 | | 91.90% |
| 1. Naïve Bayes [25] | 1500 | 10 | Sulfur, iron, pH, humus nitrogen, phosphorus, calcium, magnesium, zinc, and potassium | 38.74% |
| 2. JRip [25] | 1500 | 10 | | 92.53% |
| 3. J48 (C4.5) [25] | 1500 | 10 | | 87.06% |
| 4. Linear regression (relative absolute error (%)) [25] | 1500 | 10 | | 12.18 |
| 5. Least median regression [25] | 1500 | 10 | | 12.73 |
| J48% [9] | 203 | 6 | Soil type, color, pH, lime status, soil texture, village name | 93.46% |
| Random tree [9] | 203 | 6 | | 50.66% |
| JRip [9] | 203 | 6 | | 93.46% |
| OneR [9] | 203 | 6 | | 39.92% |
| ZeroR [9] | 203 | 6 | | 39.92% |
| Naïve Bayes [9] | 203 | 6 | | 93.81 |
| LS-SVM method provided best prediction for MC and OC 1. Root mean a square error of prediction (RMSEP) 2. Residual prediction deviation 3. Cubist method provided the best prediction for TN [6] | 140 | 3 | OC, MC, TN | **LS-SVM MC prediction** 1.RMSEP-¼ 0.457% 2.RPD- ¼ 2.24% **LS-SVM OC prediction**- 1.RMSEP-¼ 0.062% 2.RPD ¼ 2.20 **Cubist method for TN prediction** 1.RMSEP -¼ 0.071 2.RPD-¼ 1.96 |

| | | | | |
|---|---|---|---|---|
| **Model I** 1. RMSE 2. MAE 3. R **model-II** 1. RMSE 2. MAE 3. R [4] | 5 years of data, i.e. **model-1–**1998–2002 and tested on 3 years of data, i.e. 2003–2005 **model-2-**1998–2004 and tested on 2005–2007 | 1 | VIC moisture | **Model-I** 1.→ 1.31–2.44% 2.→ 0.84–1.31% 3.→ 0.44–0.68% **model-II** 1.→ 1.98% 2. → 1.86% 3. →0.57% |
| ANN [18] | Nitrogen-130,phosphorus–9000pixel potassium-130, zinc-50, calcium-50, magnesium-50,pH CPR-9023 pixel | 7 | Magnesium, zinc, potassium, pH, calcium nitrogen, and phosphorus | 100% |
| Naive Bayes [5] | 1003 | 12 | Iron, zinc, copper, phosphorus, pH, EC, OC, nitrogen, phosphorus, potassium, magnesium, sulfur, and boron | 1.98% |
| J48 [5] | 692 | 12 | | 2.68% |
| Naive Bayes [21] | 1500 | | Soil classification | 1.10% |
| Bayes Net [21] | 1500 | | | 2.92.3% |
| Naive Bayes Updatable [21] | 1500 | | | 3. 100% |
| J48 [21] | 1500 | | | 4.92.3% |
| Random Forest [21] | 1500 | | | 5.10% |
| Naive Bayes [8] | | | | 100% |
| JRip [20] | 110 | 8 | Village name, PH, EC (electrical conductivity), lime status, phosphorous, soil type, color, soil texture, | 98.18.% |
| J48 [20] | 110 | 8 | | 97.27.% |
| Naive Bayes [20] | 110 | 8 | | 86.36% |

(continued)

**Table 10.1** (continued)

| Classi fier used | Instance of soil | No. attribute (feature) | Attribute name (feature) | Accuracy |
|---|---|---|---|---|
| Naive Bayes [29] | 2200 | 10 | 1.OC,2.P,3.K,4.Fe,5.Mn,6.Zn,7.Cu, 8.pH,9.EC, 10.N | 1.38.86% |
| JRip [29] | 2200 | 10 | | 2.90.81% |
| J48 [29] | 2200 | 10 | | 3.93.86% |
| J48 [28] | 1639 | 9 | 1. P2O5, 2. K2O, 3. FI. 4. PH, 5.EC, 6.Fe, 7.Cu, 8.Zn, 9. OC | 1.98.17% |
| Naïve Bayesian [28] | 1639 | 9 | | 2.77.18% |
| Random Forest [28] | 1639 | 9 | | 3.97.92% |
| The decision tree [17] | | 11 | **Data set of the crop:** soil nutrients (Na, Mg, N, P, Cl, Ca) and also crop name, temperature, humidity, pH. **Data set of fertilizer:** Fertilizer name, crop name, date | J48 algorithm is more accurate |
| J48 [17] | | 11 | | |
| Support vector machines (SVM) [19] | 438 | 12 | Magnesium, copper, iron, manganese, pH, salinity, potassium, sulfur, zinc, boron, calcium, organic matter% | 1.94.95%, |
| k-nearest neighbor (k-NN) [19] | 438 | 12 | | 2.92.93% |
| Bagged trees [19] | 438 | 12 | | 3.90.91% |
| Naive Bayes [14] | 792 | 9 | Sample no., block no, soil type (red soil, black soil, alluvial, and loamy soil), pH value, electric conductivity, organic carbon, phosphorous, potassium, nitrogen | 95.14% |
| Bayes Net [14] | 792 | 9 | | 99.84% |
| J48 [14] | 792 | 9 | | 100% |
| JRip [14] | 792 | 9 | | 99.71% |

*OC* organic carbon percentage, Notation- *OC* organic carbon percentage, Boron, Sulfur, *Fe* iron, *Mn* magnesium, *EC* electrical conductivity (dS/m), *N* nitrogen, *Zn* zinc, *Cu* copper, pH-pH, *P* phosphorous, *K* potassium

**Table 10.2** Some top most classification techniques used in the prediction purpose. k-NN, k-nearest neighbor; SVM, support vector machine; J49/C4.5; ANN, artificial neural network, decision tree

| Applicable classification techniques | k-NN | SVM | Naïve Bayes | J48 | ANN |
|---|---|---|---|---|---|
| Key point | Classified data required which is needed to be labeled, it works on distance portion and also the number of the adjacent element | SVM splits the data into two parts both non-linear and linear data, hyperplane, kernel trick applied on non-linear data | Separate various object-based on a feature | Statistical classifier | It neural network, simpler, very flexible and powerful |
| Advantages | Basic simple, powerful too loud preparing information, less structure unpredictability, no preparation time | It reduced number of classification; it gives precise results, totally liberated of feature dimensionality | Implementation is quick and simple | Decision tree | Deal with the non-linearity, good predictive accuracy |
| Disadvantages | Size of memory is large and also response time is more, low precision in multidimensional information with unimportant highlights, no thumb rule for the guarantee of k | The constraint in size and speed during testing and training also results rely upon determination of kernel, rely upon the size of information | Requirement of predictors to be independent | Close to zero values, overfitting happens | Complicated, harder to understand |

## 10.7 Conclusion

There is no single machine learning classification algorithm which gives consistent results for all types of soil analysis considering all soil nutrients as an attribute. The performance of a machine learning algorithm is sustained by the type and size of the fact-finding data set. So, one can use hybrid or integrated classification methods such as the merging of distinct classifiers for higher-quality performance. The real-time sensing data using IOT, soil testing attribute section, and predicting suitable crop according to soil condition have a broad scope of research in the agriculture domain. Acquiring 100% classification for soil data is absolutely a threat.

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# Chapter 11
# Privacy Protection and User Traceability in Strong Key-Exposure Resilient Auditing for Cloud Storage


**R. Ahila and S. Sivakumari**

## 11.1 Introduction

The emerging development in the Internet and technology starts a trend in the direction of outsourcing data and its management. The development of the Internet makes cloud computing one of the emerging technologies. Organizations may focus on the core business problems by transferring information to the cloud. Cloud service provider (CSP) [1] is concerned for the provision of sufficient hardware, software, and network resources for the storage of personal data of the owner and for providing processes for generating, upgrading, and accessing its outsourced data. Clients have become concerned with the integrity of outsourced data. It can be avoided by verifying the completeness of data and adding significant validation burdens on consumers. Public auditing is implemented to address this problem.

A third-party auditor (TPA) is used in public auditing [2, 3] to regularly monitor whether the cloud servers have stored the client's information correctly. This relieves customers from the data audit process. In the data auditing process, data owners first express doubts about the state of their data to the auditor. The request is then driven to the cloud server; the auditor and the CSP share the encryption keys and information that are to be audited during this interaction. Though TPA requires critical resources such as communication channels and memory, it is considered to be a centralized auditing solution. Moreover, the TPA can use complex algorithms to validate the outsourced data.

When the information is audited, there may be a number many chances to reveal hidden keys for the vendor which will be forged later when the customer requests them. To solve this issue, cloud storage auditing with verifiable outsourcing

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of key update (CSA-VOKU) [4] was proposed. Through accepting TPA as an authorized party, CSA-VOKU had solved the key exposure problem and maintains the encrypted customer hidden key version. When a server must hook a file in the cloud, the encrypted client's hidden key has to be decrypted for uploading the document. But, CSA-VOKU not fully solved the key exposure problem. So CSA-ISKER [5] was proposed to handle the key exposure problem in the cloud effectively. The malicious cloud is not able to get the signature of hidden keys in unexposed times with CSA-ISKER. The CSA-ISKER technique can, therefore, upgrade the key for indefinite periods.

In this article, the efficiency of CSA-ISKER is further improved by the proposed cloud storage integrity checking and auditing-ISKER (CSIA-ISKER). It ensures the integrity of data in the cloud by generating users key based on their identity information. Moreover, CSIA-identity-based privacy and traceability-ISKER (CSIA-IPT-ISKER) is proposed to ensure user's identity data protection and tracing power where the public auditing concept for distributed cloud data has been formalized. This encourages the open auditing of remote information while maintaining identity protection and identity monitoring in the field of sharing. This enhances the security of cloud data and effectively verifies the cloud data integrity.

## 11.2 Literature Survey

An effective and safe adaptive audit protocol [6] was proposed in the cloud environment. Following the development of a cloud storage audit system, an effective audit privacy protocol was introduced, using bilinear mapping and authentication methods to guarantee data privacy. However, this protocol still has security problems. A combined technique [7] was designed to perform public integrity auditing of data and for secure deduplication of encrypted data. The combined technique processed challenge-response protocols using the Boneh–Lynn–Shacham signature-based homomorphic linear authenticator to perform data auditing and deduplication of encrypted data. However, light schemes for storage services must still be planned because of the rise in data volume.

Multi-replica public auditing (MuR-DPA) [8] was introduced based on a multi-replica Merkle hash tree (MR-MHT) for public auditing in the cloud. The MuR-DPA focused on the problem in MR-MHT that was secure against dishonest servers. However, the proof size of MuR-DPA is still dependent on the dataset. To verify an untrusted and outsourced data, a dynamic audit service [9] was proposed. In dynamic audit service, audit services were built according to the supporting provable updates to outsourced data. However, the dynamic audit service still has some constant amount of overhead.

An efficient audit service outsourcing [10] mechanism was proposed for data integrity in clouds. It focused on effective audit services for existing cloud data

and the design of high-performance audit schedules. However, the computation cost was increased sharply when the data is large. To support the security of privacy, the public audit was recommended for a protected cloud storage system [11]. It did not learn the data, but it checks the outsourced data of the user in the cloud with an external auditor. The computational complexity of this system is high.

An integrated public audit and information model [12] were proposed for the security of cloud data storage. This considered the issue of cloud storage data integrity verification. However, it involves a high computational complexity problem. A Dynamic Outsourced Auditing (DOA) [13] was proposed for cloud storage auditing. It defended against fraudulent collisions and entities, and it enabled dynamic verifiable uploads to outsourced data. However, it has a high computational complexity problem. A TPA auditing scheme [14] was proposed to preserve the privacy of cloud storage. When the server receives the information that the user initially saved and performed complex procedures on the outsourced data, the server must give the user a time-stamping receipt from both parties. However, it is not more efficient.

## 11.3 Proposed Methodology

Here, the proposed cloud storage integrity checking and auditing-ISKER (CSIA-ISKER) and CSIA-identity privacy and traceability-ISKER (CSIA-IPT-ISKER) are described in detail.

### *11.3.1 Cloud Storage Integrity Checking and Auditing-Improved Strong Key-Exposure Resilient*

Both the provable data security [15] and the successful upgrade are supports by CSA-ISKER when the client and TPA will produce the secret signing keys jointly. In order to improve CSA-ISKER, CSIA-ISKER is proposed in this paper. The main concern of cloud clients is data leakage and integrity. It is considered in the proposed CSIA-ISKER scheme where a public key generator (PKG) is engaged to generate keys for users by using their identity information. It is more secure because when a user stores their data on the cloud, they lose the clear tracking of their data. Furthermore, the server of the cloud is not completely trusted. So, it is required for the users to effectively check whether the outsourced data are unharmed or not. The CSIA-ISKER consists of the following processes.

- **Setup:** It is processed by the PKG and client. This algorithm gets input $k$ and outputs the master hidden key *msk*, system parameters *param*, and master public key *mpk*. At the client side, a security parameter $k$ is obtained as input, and it

creates the system public key $PK$, the TPA's hidden key $W_{TPA}$, the current time $t$, and client hidden key $W_c$.

- **Extract:** It is implemented by the PKG. It gets input as the system parameter $param$, $msk$ and identity of user $ID \in \{0,1\}^*$ and generates $W_{ID}$ that related to the identity $ID$.
- **Gen_Tag:** It is processed by the proprietor of data with identity $ID$. It gets $param$, the hidden key of the user $W_{ID}$, and a file $F = \{0,1\}^*$ as input and generates the tags $\sigma = (\sigma_1, \sigma_2, \ldots \sigma_n)$ of each file block $x_i$, which is saved with $F$ on the cloud.
- **Gen_UpdateMessage:** TPA implemented this algorithm at the starting time. It gets the $PK$, $t$, and $W_{TPA}$ as input and returns an update message $\sigma_t$.
- **CKeyUpdate:** It is processed by the client at the starting time. The $PK$, $t$, $\sigma_t$, and the $W_c$ are taken as input and create the signing hidden key $W_t$ for $t$.
- **Gen_Authenticator:** It is implemented by the client. The $PK$, $t$, $W_t$, and $F$ are given as input to this algorithm, and it creates a group of authenticators $\Psi$ for $F$ in time $t$.
- **Gen_Proof:** The cloud runs this algorithm which gets the $PK$, $t$, a challenge $Chal$, $F$, and $\Psi$ as input and creates a proof $P$. It is utilized to verify whether the cloud holds $F$ correctly. In the proofGen algorithm, a set of the current time and challenge is given by the TPA and then fed as input to the cloud.
- **Check_Proof:** It is run by the TPA. The $PK$, $t$, $chal$, and $P$ are taken as input. It generates output as true when the verification is passed; otherwise it generates output as false.

**CSIA-ISKER Algorithm**

**Setup Algorithm:**

At the PKG side:

The PKG randomly selects two primes $p_0$ and $q_0$ and generates the Rivest, Shamir, and Adleman (RSA) modulus $N_0 = p_0 q_0$. PKG randomly selects a prime $e$ and calculates $d$ as $\equiv e^{-1} \; mod \; \phi(N_0)$. Let $l_1 \in \mathbb{N}$ and describe two hash functions: $H_1 : \{0,1\}^* \rightarrow \{0,1\}^{l_1}$, $H_2 : \{0,1\}^* \rightarrow Z_0^*$, and $H_3 : \{0,1\}^* \rightarrow Z_N^*$. Describe a pseudo-random function $f : Z_N \times Z_N$ and a pseudo-random permutation $\pi : Z_N^* \times \{1,2,\ldots n\} \rightarrow \{1,2,\ldots n\}$. The PKG publishes the system parameter $mpk = (N_0, e, H_1, H_2, f, \pi)$ and keeps the $msk$ secret.

At the client side:

- The client randomly chooses $W_{TPA}$, and it is given as the TPA's hidden key to the TPA. $PK_{TPA} = s^{W_{TPA}}$ denotes the public key of TPA.
- Assign the system public key $PK = (s, u, PK_{TPA}, PK_c, spk)$.

**Extract Algorithm:**

A $ID \in \{0,1\}^*$ and $msk$ are given as input, and PKG calculates the user's hidden key $W_c = H_2(ID)^d$ and forwards $s_{ID}$ to the user through a safe channel.

**Gen_Tag Algorithm:**

It is implemented by a cloud user to save $F$ into the cloud. It is explained as:

- Select two keys $p$ and $q$ and calculate RSA modulus $N = pq$.
- Choose a random key $\mu$ and calculate $\gamma = \mu^{-1} \; mod \; \phi(N)$.

- Create a pair of signing keys $\{pk, sk\}$ of a signing algorithm $SSig()$.
- Choose a random $r \in Z_N^*$ and calculate $R = r^e mod N_0$.
- Calculate $t = H_1(R||\mu||pk)$and $s = r.s_{ID}^t$. $\mu_{pk} = (t, s)$ represents an identity-based signature on the public key $(\mu, pk)$.
- Given $F$, separate into $n$ blocks $F = \{x_1 \| \ldots \| x_n\}$.
- Let $\tau_0 = Fname||n||u$, where $Fname$ represents the file name and its chosen from a huge domain $Z_N$; $u$ is a random value of $Z_N^*$. Set $\tau = \tau_0 \| SSig_{sk}(\tau_0)$ as the tag of file $F$.
- Calculate the tag $\sigma_i = \left(H_3\left(Fname \middle\| i\right) u^{x_i}\right)^{\mu} \bmod N$ for the block $x_i$. Denote $\sigma = \{\sigma_i\}_{1 \le i \le n}$.
- Store $\{F, \sigma, \tau, \sigma_{pk}, pk, \mu\}$ to the cloud and avoid the limited memory.

**Gen_UpdateMessage Algorithm:**

- Get $PK$ at each $t$ from the client.
- At first, TPA computes the update message $\sigma_x = F_1(x)^{W_{TPA}}$ to the client based on their $W_{TPA}$ key.
- The client can search for legitimate or unauthorized update message by using the following equation

$$\hat{m}(s, \sigma_t) = \hat{m}(PK_{TPA}, F_1(t)) \tag{11.1}$$

**CKeyUpdate Algorithm:**

- The client computes $W_t = H_1(t)^{W_c}$ when they obtain the $\sigma_t$ from the TPA at $t$.
- $\sigma_t$as the signing hidden key in $t$.

**Gen_Authenticator Algorithm:**
If a user needs to transfer $F$ to the cloud in $t$, the following steps have to follow:

- The user selects $r \in R^{Z_q^*}$ and then calculates $R = g^r$.
- After that, the client calculates the authenticators $\theta_i = H_2(t\,||i||\,name,\, R)^r u^{r x_i} W_t$, where name is the file name.
- The user transfers the file tag $tag = name||t||SSig_{ssk}(name\|t)$ and the set of authenticators $\Psi = \{t, R, \theta_1, \ldots \theta_n\}$ along with $F$ to the cloud.

**Gen_Proof Algorithm:**

- Through analyzing $SSig_{ssk}(name\|t)$ using $spk$, the TPA checks the authority of the file tag. Then, they choose a $c-$ element subset $I = \{s_1, s_2, \ldots s_c\}$ of set [1,n] as the index of the blocks to be checked when the $SSig_{ssk}(name\|t)$ is valid.
- For every $i \in I$, the TPA chooses random values $v_i(||v_i|| < ||q||)$, and sends the challenge $\{i, v_i\}_{i \in I}$; they calculate an aggregate authenticator $\theta = \prod_{i \epsilon I} \theta_i^{v_i}$. The TPA also calculates $=\sum_{i \in I} x_i v_i$ .
- The cloud sends $S = (t, R, \theta, \rho)$ to the TPA as his reply.

**Check_Proof Algorithm:**

- If $P$ is obtained by TPA, then they check whether the following equation holds:

$$\hat{e}(s, \theta) = \hat{e}\left(R, \prod_{i \in I} H_2(t \,||i||\, name, R)^{v_i}.u^{\rho}\right).\hat{e}\left(PK_c.PK_{TPA}, H_1(t)^{\sum_{i \in I} v_i}\right)$$

If it holds, then it generates output as true. Otherwise it generates output as false.

### *11.3.2 Cloud Storage Integrity Checking and Auditing-Identity-Based Privacy and Traceability-Improved Strong Key-Exposure Resilient*

To ensure the user's identity traceability and privacy, CSIA-IPT-ISKERA is proposed where a group manager helps the users to protect their privacy. The IBL list is used to track the members making the latest changes to identity tracing on each block. The group manager can help the users in the group to generate or change the shared data. Also, if the information dispute arises, a group manager is going to access the user identity. The group manager is responsible for managing clients in the group. This theory and proof guarantee the traceability and security of users.

**Theorem 11.1**
The chance of a public checker effectively accessing the genuine user identity on the data block is 1/m when m is the number of users in the group during the daily integrity testing tasks of specific cloud data.

*Proof* The public keys of the client who created the authenticators of the selected portion of data are required to check the cloud data integrity in the task of auditing. A public checker can collect the identity information on each data block because of relying on the unique relationship between the user identity and the public key. Only the final authenticators are determined from a collection of partial authenticators with each team member's hidden key. A final authenticator with the hidden key of the group is created using the group manager. An authenticator doesn't require the hidden key of the user those asks to authenticate a portion of data. While the public checker checks the integrity of data, the public key of the group is enough for the verification process. Because all data authenticators are created with the group's hidden key, the public checker cannot then identify the user using the public key on a block. The chance that the public checker estimates the right user on a portion of data is $\frac{1}{m}$ when there is $m$ user in the group. Therefore, the confidentiality of identification is protected.

**Theorem 11.2**
When the argument takes place, the group manager can find which deceptive user can change the data and reveals the identity information of that user.

*Proof* To help users to produce partial authenticators, a group manager is appointed in CSIA-IPT-ISKERA scheme. Whenever a user requesting that a partial authenticator is created by the group manager, it is documented in the identity block list (IBL). It has some data, such as user identity and modified identity of the portion of data. If a user in the group changes a portion of data intentionally, the other users of the group can detect this nasty data block. When a user submits such a discrepancy, the group manager can check the IBL and see the user making the newest change on this portion of data. All data changes, including malicious information, are registered in the IBL database. If the group manager sees the list, the dishonest member will reveal their identity. The traceability of identity is therefore accomplished.

## 11.4 Result and Discussion

Here, the effectiveness of CSA-ISKER and CSIA-ISKER and CSIA-IPT-ISKER is tested in terms of user time to revise the hidden key, communication complexity, and auditing process time. The cloud auditing services are tested using the pairing-based cryptography (PBC) library.

### *11.4.1 User Time to Revise the Hidden Key*

It is a measure to calculate the time consumption to revise key on the user side in CSA-ISKER, CSIA-ISKER, and CSIA-IPT-ISKER schemes.

Figure 11.1 shows the user time to revise the hidden key in CSA-ISKER, CSIA-ISKER, and CSIA-IPT-ISKER auditing scheme. The user time to revise hidden key in CSIA-IPT-ISKER scheme at 8 time period is 13.95% less than CSA-ISKER and 7.5% less than CSIA-ISKER schemes. This is because where each file is split into a number of blocks so the client can easily update the hidden key for a particular block with less time consumption. From this analysis, it is known that the CSIA-IPT-ISKER has less user time to revise hidden key than the other cloud auditing schemes.

### *11.4.2 Communication Complexity*

This is how much time the TPA and user spent to communicate.

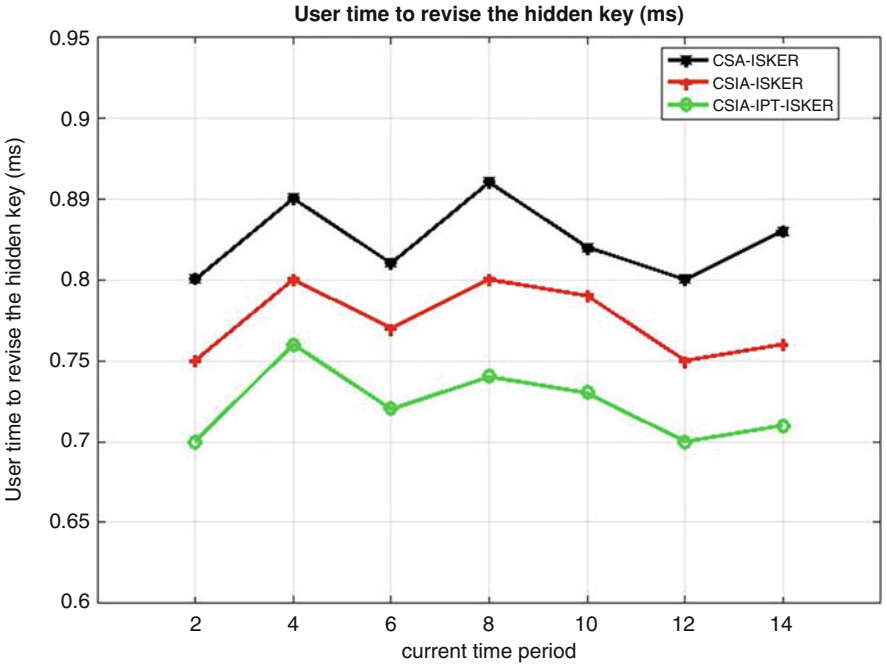


**Fig. 11.1** Evaluation of user time to revise hidden key

Figure 11.2 shows the communication complexity in CSA-ISKER, CSIA-ISKER, and CSIA-IPT-ISKER. If the challenged block is ten, then the communication complexity of CSIA-IPT-ISKER is 6% less than CSA-ISKER and 2.08% less than CSIA-ISKER scheme. It is because of the IBL that trace the identity information. From this analysis, it is known that the CSIA-IPT-ISKER has better communication complexity than the other cloud auditing schemes.

### *11.4.3 Auditing Process Time*

It defines the time needed for cloud storage audits.

Auditing process time for CSA-ISKER, CSIA-ISKER, and CSIA-IPT-ISKER schemes is shown in Fig. 11.3. By ensuring the identity privacy and traceability, the time in auditing process for CSIA-IPT-ISKER scheme is low. From Fig. 11.3, it is proved that the CSIA-IPT-ISKER has better auditing process time than other cloud storage auditing schemes.

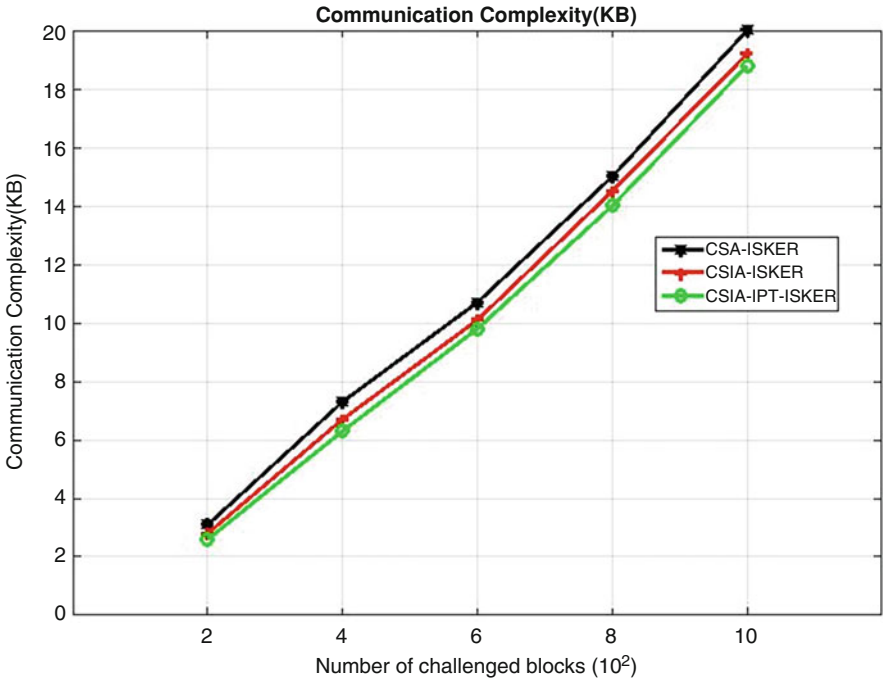


**Fig. 11.2** Evaluation of communication complexity

## 11.5 Conclusion

In this article, the cloud storage auditing based on CSA-ISKER is improved by the proposed CSA-ISKER. The data integrity problem in cloud storage is considered in CSA-ISKER which creates hidden keys for users based on their identity information. Hence, it enhances the security of data. Also, CSA-ISKER verifies the outsourced data through the proof verification process. The CSIA-IPT-ISKER is used to ensure the user's identity and traceability. The users in the cloud protect their privacy with the aid of a group manager, and then they maintain an IBL to achieve identity traceability. The experiments are conducted in terms of user time to revise hidden keys, communication complexity, and auditing process time to prove the effectiveness of proposed CSA-ISKER and CSIA-IPT-ISKER.

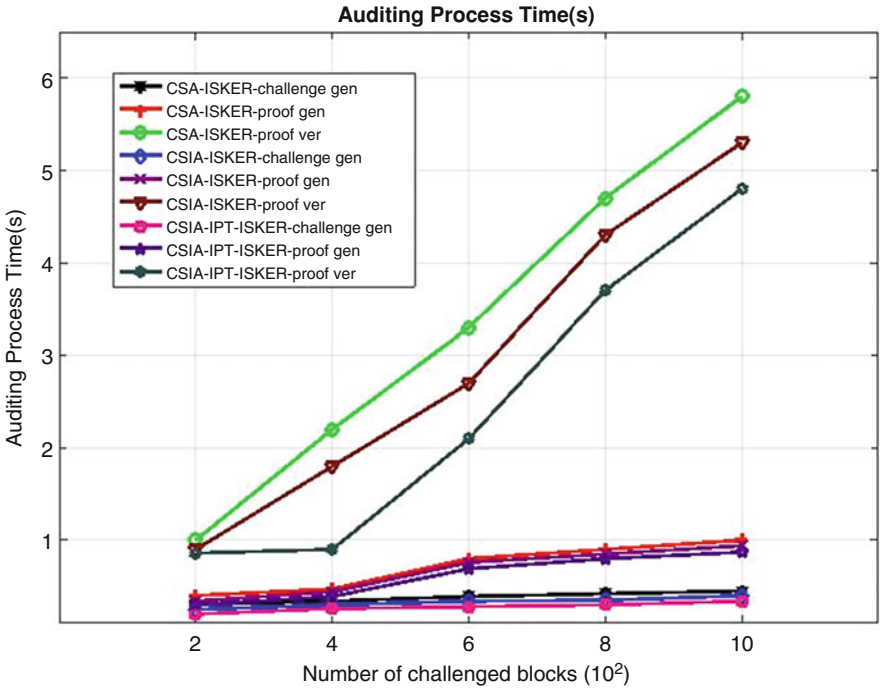


**Fig. 11.3** Evaluation of auditing process time

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# Chapter 12
# Cloud Computing Challenges and Concerts in VM Migration


**J. Keziya Rani and M. Sri Lakshmi**

## 12.1 Introduction

The huge changes in information technology in recent years have made it very difficult to manage IT resources in the cloud. In this regard, virtual machine technologies adopted by organizations to efficiently allocate and manage resources. In this regard, reduce the cost in the operation in turn enhancing the performance of the application along with the reliability. In traditional communication, the process of virtualizing is dividing the physically available resources into logical resources to have a flexible resource allocation. The separation of the logical resources form the physical resources [5], makes it easier to distribute the workload, thus enabling the loads to be executed on the different VM but on same machine and transition of the VM from one system to another. VM migration departments have many parallels to their origin, called process migration, where the migrant wants the process to run from one system to another. The procedure causes the migration of the particular state from one system to another.

Any way the purpose is to choose walking strategies rather than VMs [7]. At some point in the 1980s, political migration was well studied; however, it has never been used in practice because of the problem of maintaining dependency between different modules of the work system. However, virtual machine migration is no longer subject to these restrictions.

With VM migration running and the entire system running, the migration issue is simplified and effectively resolved. Virtual machine migration over the past decade has proven to be an effective approach to many goals, including workload strengthening, workload balancing, reducing power consumption, and

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cellular packet assistance. As a result, in recent years, it has received huge acclaim in the industry. However, virtual machine migration also presents problems specific to service disruption, bandwidth usage, management top-end features, and rapid security breaches. Because VM migration, application development effectively closes the question of re-searching, which has generated tremendous interest in the search network.

This overrides all the roles involved. Virtual machine migration must be carefully applied to cloud management. In this article, we look in detail at virtual machine migration [8] and discuss its benefits and challenges.

## 12.2 Background

### *12.2.1 Cloud Management*

Many features in managing the cloud are done supporting the migration of VM, which summarizes all the benefits of VM migration and their use in cloud and intracloud management [1]. The main causes of server interruptions are prolonged server interruptions or poor hardware performance. Also material restoration. Load balancing in cloud management is a major issue that can shorten server's life and reduce quality of service. For the time being, the servers are running at a higher capacity with the download effect.

Using direct VM migration credentials, it works consistently across all data center servers based on improved service quality. In addition, by speeding up VM migration on the web, load balancing between different data centers using geospatial space. Server association VMs are tightly built and demolished in the data center. In addition, some may be delayed or inactive. Virtual machines can be ugly if the data center servers are not connected. In a server pool, virtual machines can be routed to a power resolution or declaration decision which is shown in Fig. 12.1.

Hybrid cloud is performed with some benefits, i.e.:

1. Elastic in nature and cost-effective
2. Most suitable with business needs

Service Level Agreements are prime concern sometimes migration from one cloud to other cloud providers has to migrate VMs to cloud datacenters.

### *12.2.2 VM Migration and Challenges*

The challenges and the issues associated with the VM migration are summarized below along with the immigration exit scheme.

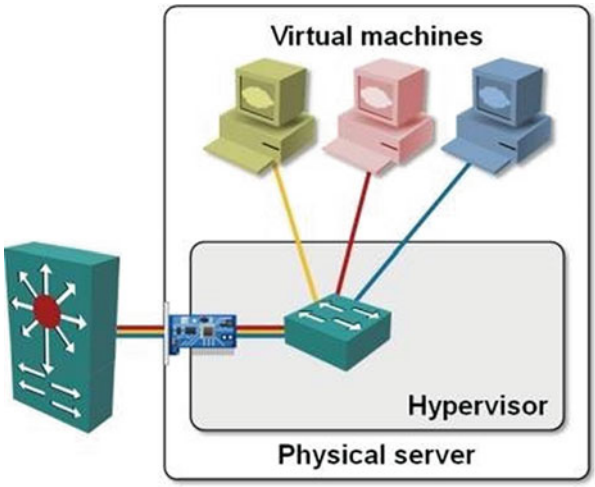



**Fig. 12.1** Virtual Machines

VM migration data moves from one location to another. Direct migration is subject to the condition that the migrating VMs should not be suspended for services that are running, but there are no restrictions on dead migration [3].

In overall VM migration aspects, these are the prime challenges:

- Storage data migration
- Memory data migration
- NCC(network connection continuity)

#### 12.2.2.1 Storage Data Migration

VM migration is done on a server storage system; the site is transferred to virtual disks; disk data is available remotely due to high disk I/O latency but violently ALS.

**Memory data migration:** migrating data to memory, all current reports must be moved to the destination site if they want to run from the temporary virtual machine location after the migration. Status information includes processor states, memory data, device states, and more. Usually current state memory is found in data migration.

### *12.2.3 NCC*

Moving the virtual machine to a new location needs approaches to reach customers. You can also keep open connections for live streaming during migration. Immigrants

have different problems depending on the circumstances. The migration methods are categorized in three angles: methods of migration, migration space, and migration granularity. Virtual machine migration can be classified into two types as: inactive migration and dynamic migration. Inactive migration can stop the virtual machine depending on the service should continue whether after shutdown or before stopping. If the virtual machine is temporarily disabled, the running states are overlaid and moved to the destination site. No open network connections are maintained during migration, and all connections are reconfigured after the virtual machine is restarted [6].

As shown in Fig. 12.2a, in the case of direct migration, data migration from memory and continuity of network connection are two issues that need to be resolved to avoid downtime. The data migration is done on the cases when the source as well as the destination sites lags the common storage facility. Apparently, the migrant virtual machine has severely disrupted services to non-resident migrants. The scope of the cloud data center is dramatically controlled during its 7/7 operation, so most studies focus on direct migration [4].

Migration of LAN restrictions to description in Fig. 12.2b: the source and destination host is similar to a data center connected to a single network and a single storage system.

Figure 12.2c. Source and destination hosts are not part of a single storage system other than an IP address; the system is connected to a low bandwidth network and has high latency in a homogeneous environment.

## 12.3 Performance Metric and Overhead

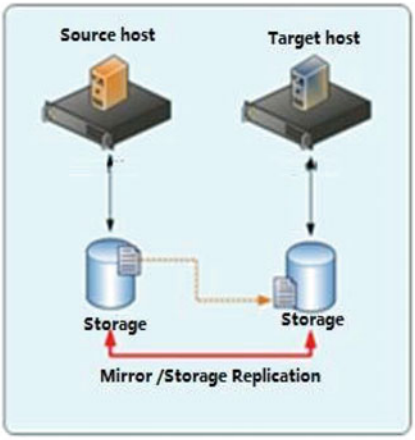
Approaches of qualified migration aim in repositioning the virtual machine reducing the further unwanted secondary effects. In this section we summarize the criteria for assessing the effectiveness of a migration strategy. Some immigration policies focus solely on increasing the factor, while others work best on a number of measures [5].

*Total migration time*: Indicates when the modified virtual machine starts restarting and the rest of the data is stored on the internal site.

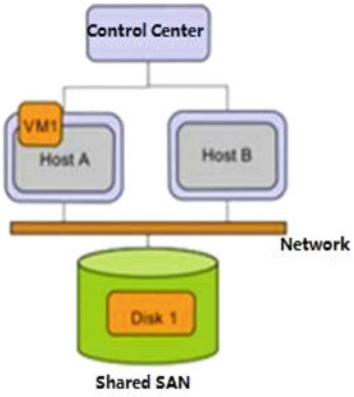
*Downtime*: The migrant VM service is not available. The measurement determines the transparency of the clients of the migrating virtual machine. Dead migration – total duration of migration.

*Total network traffic*: All data is transmitted while migrating, and this competes the network bandwidth with mileage.

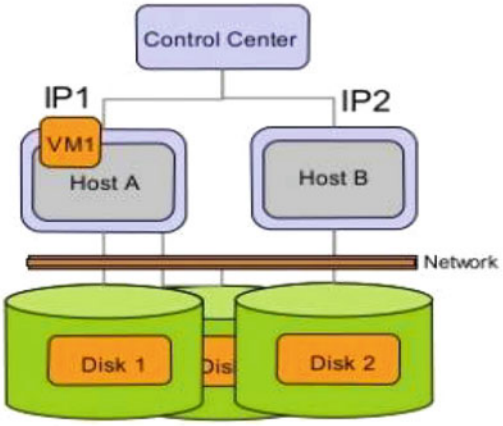
*Service degradation*: Migration affects a service running on the migrated virtual machine. It is measured by growth changes and response times. Network performance is also measured by using network bandwidth. These metrics can be obtained involving the time of the total migration with the traffic in the network. Time required for total migration is short, and overall network traffic is for specific migration and low network usage.




(a)




(b)




(c)

**Fig. 12.2** (**a**) Non-live migration. (**b**) Live migration in LAN. (**c**) Live migration in WAN

### *12.3.1 VM Overheads Are Classified in Three Types*

*Computational* overhead: Migration negotiations are typically conducted with the source and target host VMMs. The migration process replaces certain CPU cycles and memory locations. These two hosts cause interruptions on all virtual machines. When migrating demons run on a migrating virtual machine, certain virtual machine computing resources are consumed. In addition, some migration optimization technologies include data computation, compressing the data.

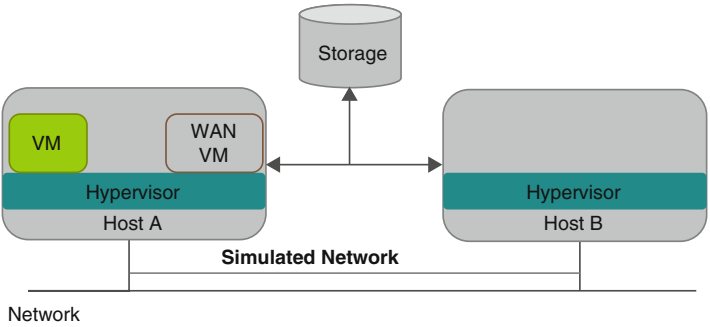



**Fig. 12.3** VM Live migration without workload

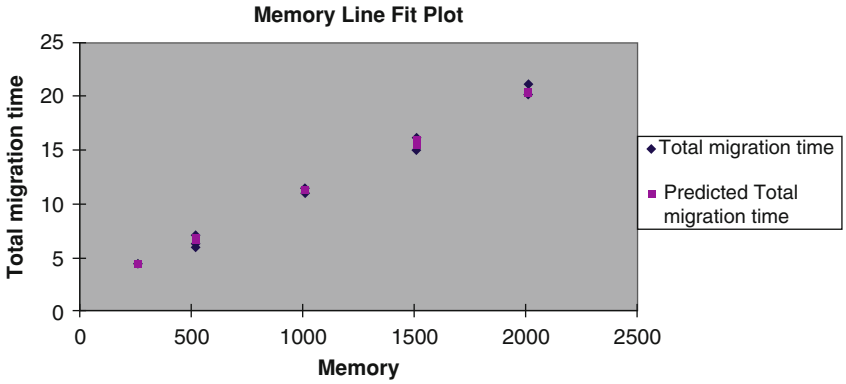



**Fig. 12.4** Memory vs total migration time

**Network overhead:** The migration of VM is highly tedious on the network. It compares resources available in the network with virtual machines working in both the target and the source hosts. Reads data in the onsite storage of the source and places it on the destination where one of the I/O bandwidths is also used.

**Overhead of space:** The VM migration works without workloads when compared to the network bandwidth and the cycles.

In Fig. 12.3, the primary goal is to understand the correlation between memory and total migration time.

In Fig. 12.4, it demonstrates that the total migration time linear gathering of memory and its overhead of time.

Both effected linearly.

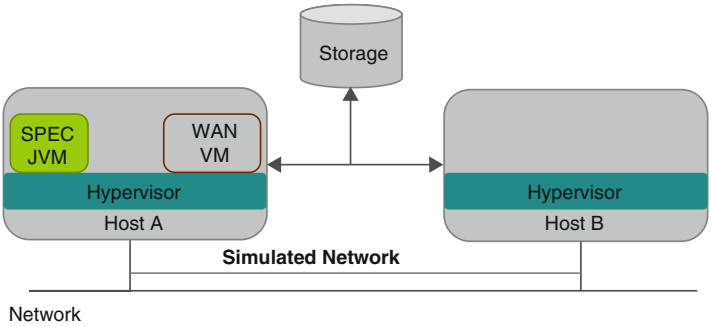



**Fig. 12.5** VM live migration with workload

### *12.3.2 VM Live Migration with Workload [2]*

The above Fig. 12.5 distinguishes the impact of migration and benchmark performance.

## 12.4 Conclusion

Direct migration is a new technology with many benefits that can help cloud service providers and customers. It reflects the foundation of managing the hardware and balancing the load that is termed as the management in cloud. Data center migration can improve VMS compatibility and resolve the vendor lockout issue. When this concept is complete, the virtual machine scrapes to solve many migration presentations. In this article, we mainly provide an outline of the process involved in the migration and the challenges in it. Finally, we conclude with performance evaluation and overheads.

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# Chapter 13
# Arduino-Based Plastic İdentification and Picking Robot


**Shahana Bano, G. Lakshmi Niharika, G. V. R. Y. Vamsi, R. S. K. Pavan Kumar, and G. Srinivasa Koushik**

## 13.1 Introduction

Different research works [8] employ different types of sensors [7], but for the identification of plastic, we can use the capacitive proximity sensor. As these proximity sensors are for the industrial purpose, these can also be used for our day-to-day activities. The capacitive proximity sensor is similar to the inductive proximity sensor. This capacitive proximity sensor works on the principle of an electrostatic field, but the inductive proximity sensor works on the principle of an electromagnetic field. This sensor switches or senses objects such as metals and non-metal objects. These non-metallic objects include paper, plastic, cloth, glass, and liquids. When the target object is near to the sensing plate or face of a sensor then it starts exhibiting the electrostatic field and it senses the object whether it is a metal or non-metal. As well as the robotic arm is a mechanical usage product called as forced labor which is mostly programmable by microcontrollers and also can be made think and act like a human arm and mostly used for repeating works such as "pick and place" [6] and assembling things. The total work-some can be divided into parts and can be fed to robotic arms. The robot car contains the robotic arm, IR sensor, and Capacitive proximity sensor. When the vehicle or rover is moving with all these, finds objects in front of the vehicle and the vehicle stops and checks whether the object is plastic or not then with the help of the robotic arm it picks and holds the object. If it is plastic, when checked by the capacitive proximity sensor then it puts the object into the bin [1]. Else, it drops the object on to the ground.

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## 13.2 Requirements

### *13.2.1 Hardware Components*

- **Plywood:** The plywood is used for the construction of the robotic arm and also handling the objects on it.
- **Arduino Uno:** Arduino is an ATMega328 microcontroller board. It is DIP (dual in-line package). In this Arduino, we have 20 input/output pins, out of which 6 can be used as PWM pin, i.e., which can also be used for analog inputs. It contains crystal oscillator whose frequency can vary according to manufacturer, but generally it is 16 MHz quartz oscillator. Supplies power by external using USB cable and external 9v battery (Fig. 13.1).

- **Motor driver:** The motor driver used in this is L293D. It is usable from 5 to 12 V, at up to 1 A total output current. The direct wiring and usage are somewhat difficult, but it can be more convenient to use. The maximum switching frequency is 5 KHz (Fig. 13.2).

- **Servo motor:** This servo motor was used for greater precision of rotation of the object to an angle and distances.

Specifications:

- Torque: 1.8 kg-cm (4.8 V)
- Speed: 0.10 s/60 degree
- Weight: 9 gm
- Gear type: plastic
- Rotational range: 180 degrees (Fig. 13.3)


**Fig. 13.1** Arduino Uno R3

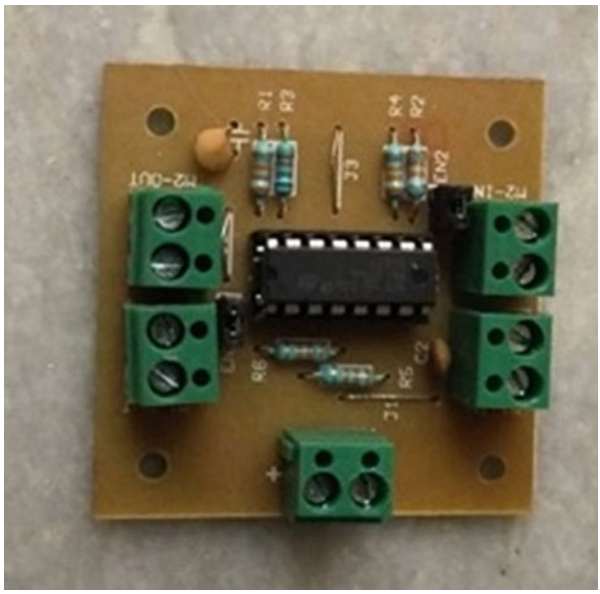
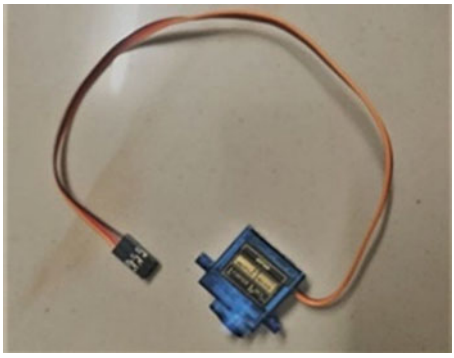



**Fig. 13.2** L293D motor driver

**Fig. 13.3** Servo motor



- **Gear motor:** This gear motor is used for our domestic purposes as it is very simple to use. This motor mainly transforms the shaft speed into particular ratios of torque.

  Specifications:
- Working voltage: Dc 3–12 V
- Torque: 800 gm-cm
- Speed: 130 rpm
- Rotational range: 360 degrees (Fig. 13.4)

**Fig. 13.4** Gear motor

**Fig. 13.5** Teethed wheels

- **Capacitive proximity sensor NPN no:** This sensor was used for the identification of plastic for this research. But it can also be used for identifying objects like metallic as well as non-metallic objects.
  Voltage: (10–15) Vdc
  Sensing range: 15 mm
- **IR sensor:** This IR sensor [2] was used for some specific purposes to detect the object in front, and also it transmits the light spectrum.
- **Teethed wheels:** These wheels were used for the movement of the robotic arm. It is eco-friendly to use this teethed wheel.
  Specifications:
- Outer teethed: 24
- Inner teeth: 12
- Compatible shaft size: 6 mm
- Thickness: 6.5 mm (Fig. 13.5)

## 13.3 Procedure

### *13.3.1 Robotic Vehicle with IR Sensor*

For this research, the robotic vehicle is the moving vehicle on the ground which holds the robotic arm, IR sensor, and capacitive proximity sensor. This IR sensor has the voltage of 5 V, and the potentiometer can be varied in order to set the object to be detected [16, 17]. This IR sensor uses the wavelength of the object by the infrared spectrum. It mainly works on the intensity of light; by changing its potential value, we can detect the object. This vehicle moves on the ground when it finds or detects the object in front of it then it stops moving the vehicle. With the help of capacitive proximity sensor, it checks whether the object is plastic or not, and with the robotic arm, it picks the object and throws it into the bin (Fig. 13.6).

### *13.3.2 Robotic Arm Procedure*

The function of the robotic arm can perform only 2 types of operation and coded in a controller when a plastic detected every motor goes to up position and then again goes to the rest position and keeps on monitoring till it gets an active input. This is shown in the flow chart below. So here, the controller keeps on monitoring for an input signal; this input signal can be given based upon the type of usage as the controller receives the signal; it has to initiate the operation of an arm that is to activate motors. To power motor a small input signal from the controller is not sufficient there comes the action of motor driver. We used L298 driver module, using L298N chip can directly drive 3–30 V DC motor and can provide 5v single-chip circuitry to supply, support 3,3vMCU control, L298N Dual H Bridge Dc Motor Driver IC Driven part of the terminal supply area Vs: +5 V Driven part of peak current lo:2A.

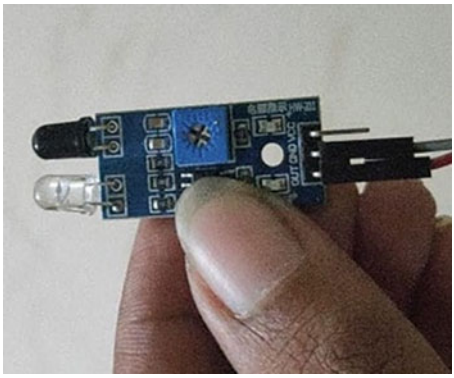


**Fig. 13.6** IR sensor

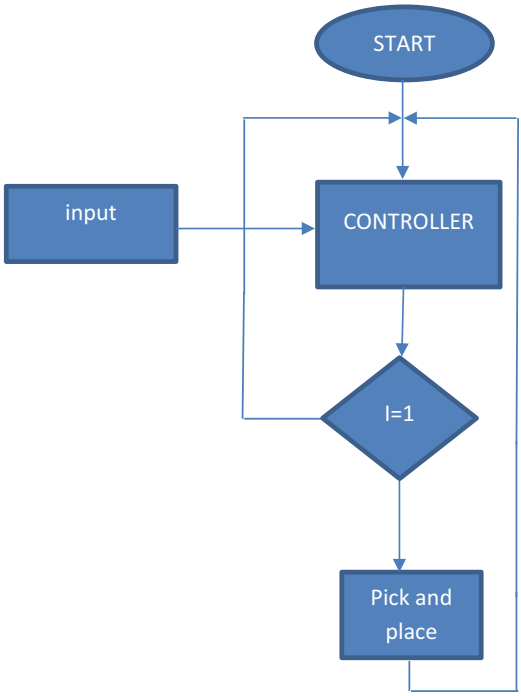



**Fig. 13.7** Flow chart for the controller of robotic arm

İn this below Fig. 13.7 flow chart we can identify that when an object is identified in front of the bot then it picks, and checks using the sensor and decides to place the object inside or on the ground.

#### 13.3.2.1 Gripper

This is the front part of the arm which performs the same operations of human fingers to pick and drop the plastic wastes. For this one toothed wheel is used and connected to a gear motor, and maximum stretch length is 180 degrees for dropping. The gripper has movement along x-axis and maximum stretch length in the opposite direction (Fig. 13.8).

#### 13.3.2.2 Wrist

The wrist is a link between the gripper for adjusting the position of the gripper and can pick, place objects in a specific co-ordinate. This wrist has only one degree of freedom; it can roll along the x-axis. A servo motor is used because servo has an

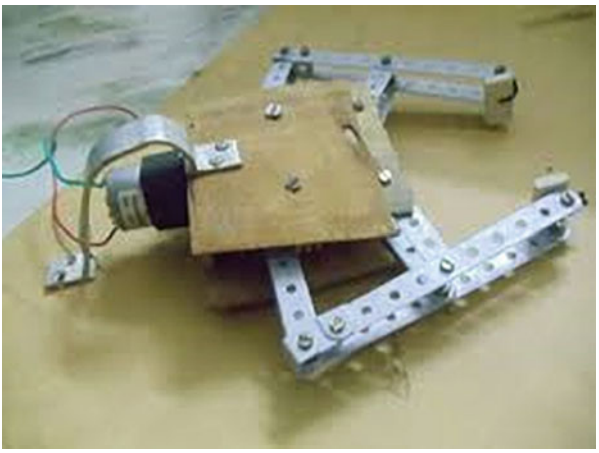


**Fig. 13.8** Gripper

inbuilt controller which can tell the position of the wrist, so it is more flexible for finding a specific coordinate. Even if the gripper moves by some external factor, we cannot do it manually as the controller knows the position and can adjust the wrist.

#### 13.3.2.3 Elbow

See the fig of the elbow part has the pitch along the y-axis. It has only one degree of freedom that is used for lifting the objects. The elbow part is linked to the wrist so after picking it lifts it in air. Here the lifting is done by a gear motor. The gear motor provides a specific delay so that it can move up to an angle (theta). Angle theta will be the same as angle swept by a motor, the radius of both wheels is the same as the rpm of gear motor = 130 (Fig. 13.9).

$$\text{so} \quad \theta = (130 * (360/60)) * \text{delay}$$

$$= 780 * \text{delay}$$

$$\text{Torque} = 800 \text{ gm} - \text{mg}$$

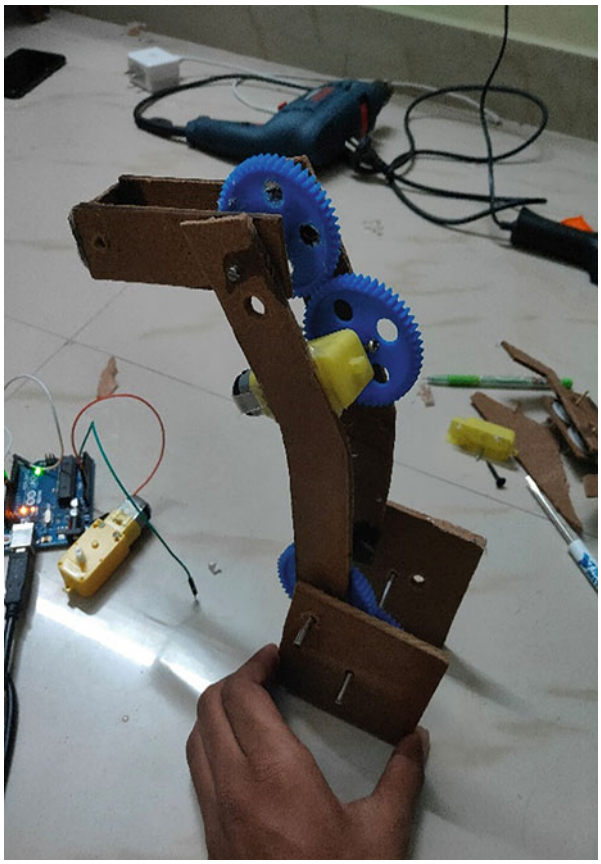


**Fig. 13.9** Elbow

#### 13.3.2.4 Shoulder

This shoulder part links the elbow and helps in shifting the object. It has freedom along yaw. Here the 12 teeth wheel rotates the 24 teeth wheel one that is the speed of 12 teeth must equal to 24 teeth. Therefore, every one degree of smaller wheel angle swept will be 2 degrees.

$$\theta = (2 * 130\,(360/60)) * \text{delay}$$

$$= 1560 * \text{delay}$$

$$\text{Torque} = (l1 + l2) * \text{mg}$$

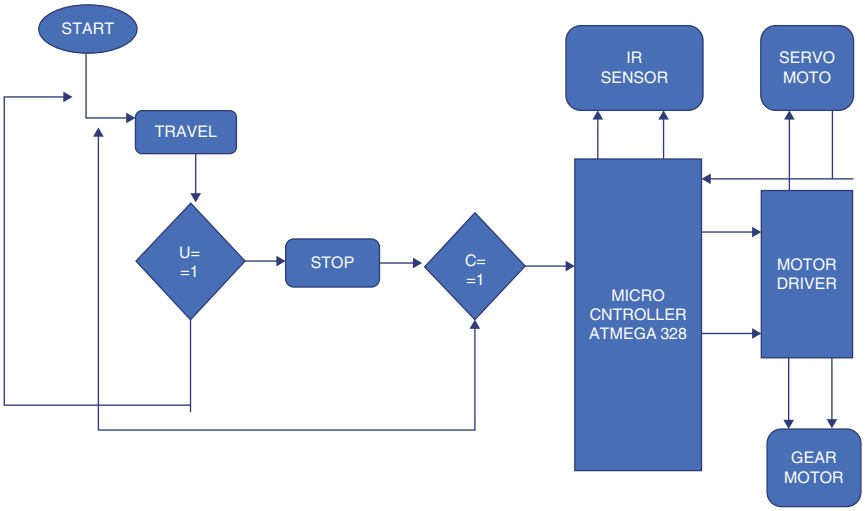



**Fig. 13.10** Flow chart for complete structure of prototype

$$\text{L1} = \text{length of elbow}$$

$$\text{L2} = \text{length of shoulder}$$

The above Fig. 13.10 flow chart shows the procedure of our prototype. This is a dynamic robotic arm where the arm is placed on a rover. This rover travels all around the floor. As shown in the (Fig. 13.10) flow chart while rover traveling in the room if any obstacle is detected by an IR sensor which will be on rover it stops for a particular amount of time and then checks by capacitive proximity sensor which type of material is the obstructed. If it is plastic, then the sensor produces a positive signal which is fetched to the controller [4] as soon as it receives the signal the controller penetrates a pick operation. So the servo and gear motor get the power and angle that should be rotated. But the main problem here is the height of obstacle and what depth should the arm be rotated. This problem is solved by an IR sensor that measures the distance between gripper and obstacle and sends it to the controller. As it receives the information, it subtracts the angle from the maximum angle that should be rotated by the elbow and rotates to rest of the angle, and the operation of placing the object into a bin is done as usual. So here all the assembling and working are done by the controller receiving and sending information, and all the calculations are done and programmed in the controller.

### *13.3.3 Capacitive Sensor Procedure*

For this research, we have taken the capacitive proximity sensor. The sensing capacity is of 15 mm and voltage of 10–35 VDC. The external voltage was supplied from the battery of 9 V to the Arduino [3] using breadboard connections. The direct connection of signal out wire to the Arduino board may lead to the damage of the board. So, a 1000 Ω resistor is placed in between signal out and digital pin of the Arduino board. This capacitive sensor can detect the objects either by touching the objects and also up to the sensing range of sensor. To detect the objects by capacitive proximity sensors knowing object dielectric constants. The dielectric constant varies from object to object and material to material. The dielectric constants are available for every object. The capacitive proximity switch sensor of NPN NO is in which the calibration is done. To get the accuracy and adjust the readings to identify only plastic. The sensor glows when the target object is plastic, and it sends the status signal to the robotic arm. If the status is *high*, then it throws the object into the basket. Else it drops the object down to the ground (Figs. 13.11 and 13.12).

Step 1: Start.
Step 2: Rover moves with the IR sensor, capacitive proximity sensor, and robotic arm.
Step 3: IR sensor functionality.
Step 4: If the object is nearer to the rover, then it stops at that point.

Else it moves until it finds the object.

Step 5: Capacitive proximity sensor functionality.
Step 6: Identifies whether the object is plastic or not.

If it senses as plastic, then it gives a signal to the robotic arm.

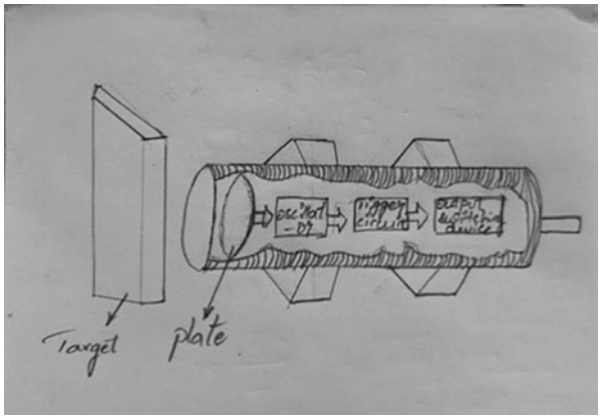



**Fig. 13.11** Internal mechanism of a proximity sensor

**Fig. 13.12** Capacitive proximity sensor

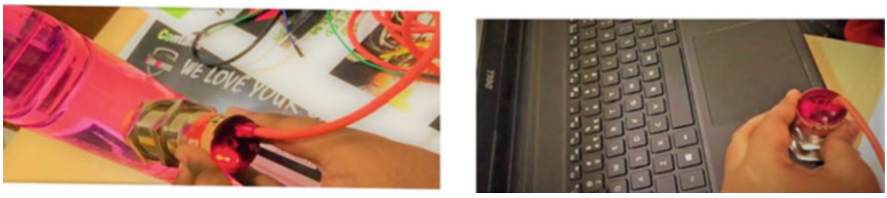


**Fig. 13.13** Detecting the plastic by a capacitive proximity sensor

Step 7: Robotic arm [5] takes the signal given by the capacitive proximity sensor, and if it is high, then it picks the object and throws it in the bin.

Else the arm doesn't pick anything.

Step 8: Rover moves to the next object if that job is completed.
Step 9: Repeat the steps 1, 2, 3, 4, 5, 6, 7, and 8.
Step 10: End.

## 13.4 Results

The identification of plastic is in the above results, i.e., in Fig. 13.13. So, in this way, the sensor sends a positive signal to the robotic arm [5] and goes for a further step process of picking of the object if it is plastic.

Figure 13.14 is the side view of our robotic arm in which the arm picks the object and keeps it in the bin. When the signal passed from the capacitive proximity sensor checks for positive or negative signal. As soon as the controller receives the positive signal, it gives power to the servo and gear motors and the angle that should

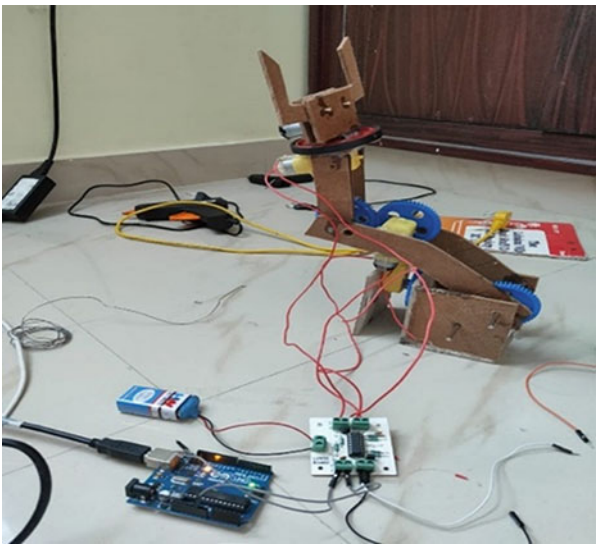


**Fig. 13.14** Robotic arm connections

be rotated. This complete movement was handled by calculating the height of the obstacle is detected by the IR sensors which measures distance between gripper and obstacle and sends to the controller. So the picking operation of plastic is seen in Fig. 13.15. These snaps of Figs. 13.16, 13.17, 13.18, 13.19, and 13.20 were the movements of the robotic arm at various stages. At first, it finds the plastic from the available objects; later it picks and lifts and keeps aside the available plastic. So the identification and robotic arm mechanism work coordinately to identify plastic.

Figure 13.21 identifies that there is no plastic in front of it so the controller doesn't respond to pick it. Figure 13.22 is the case if it is no plastic i.e. other than plastic.

## 13.5 Conclusions

By doing this project, we have learned how the arm actually functions and can be shifted to different directions. The use of different kinds of motors is to be used for different purposes and calculation of angles that arm can sweep according to delay.

Because of these arms, most of the works have become simpler and time-effective. These are a bit costly but more useful in many industries. Till now, we have many methods for identifying the plastic but using this industrial purpose sensor for our regular needs is a bit identifying our route in it. So, this capacitive sensor can also be used for water leveling and waste segregation. All the connections should not be directly given to the Arduino because the Arduino board may be

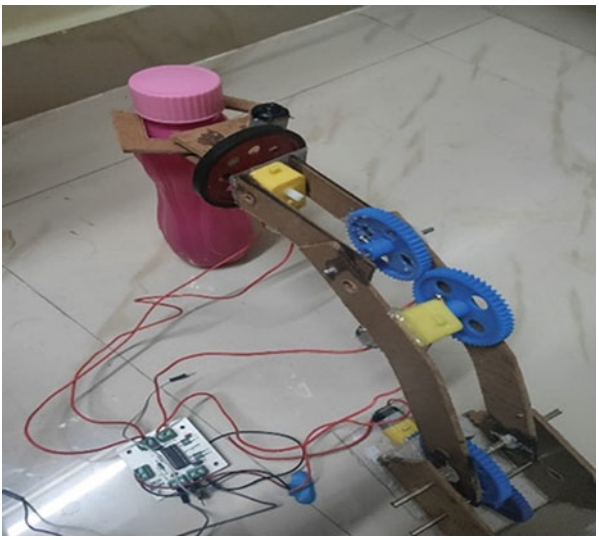


**Fig. 13.15** Picking the object if it is plastic

**Fig. 13.16** Picking the plastic object from different objects

damaged. Once starting the programming, one must verify all the connections. Identify the sensitivity point with a bit of patience. The sensors functionality is variant to understand. By doing this prototype we have learned the functionalities of different sensors.

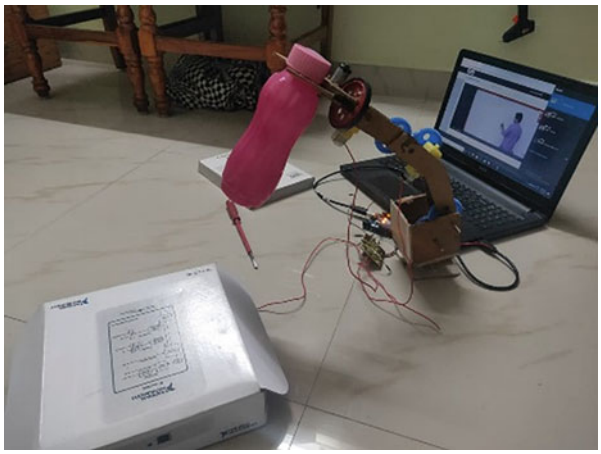


**Fig. 13.17** Holding the plastic object

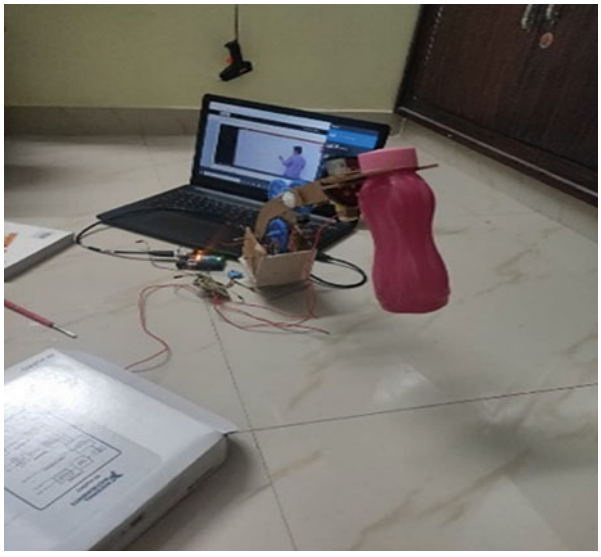


**Fig. 13.18** Lifting the plastic object

## 13.6 Future Scope

We can use digital image processing [9] and machine learning techniques to detect objects with more accuracy. For further improvement of this research work, we are planning to develop an Alexa skill to the robotic arm by using the node MCU to help in smart applications like finding the phone.

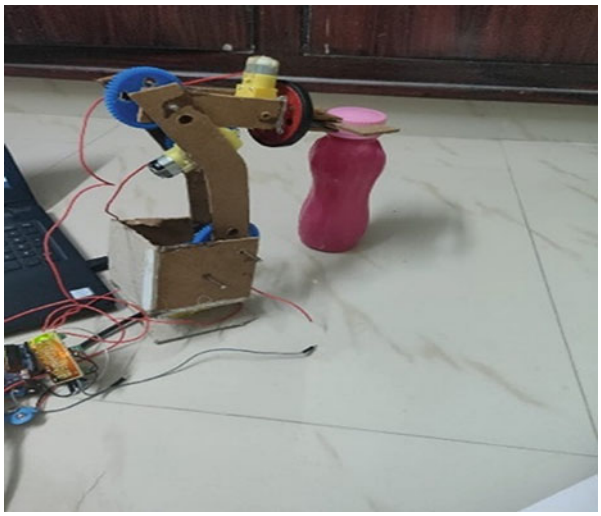


**Fig. 13.19** Keeping the plastic object aside

**Fig. 13.20** Placing the plastic down

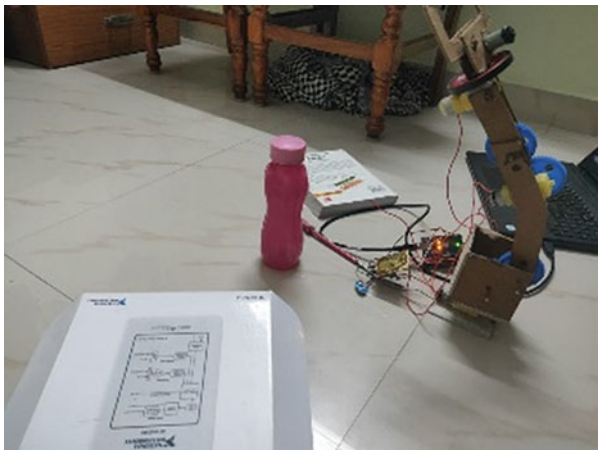


**Fig. 13.21** No plastic case

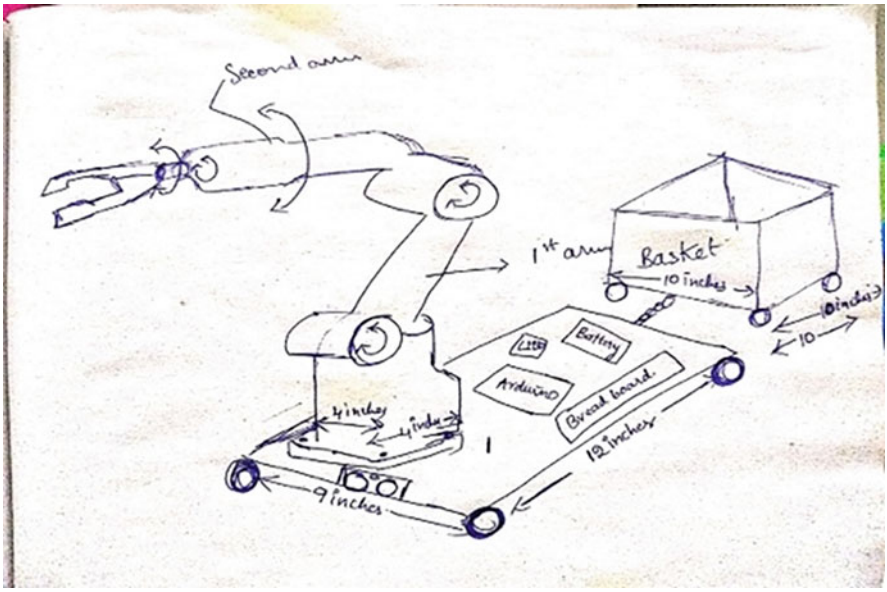



**Fig. 13.22** Rough sketch of our prototype

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# Chapter 14
# Ingenious Lighting System (ILS) for Smart Cities Using IoT


**R. Praveen Kumar, S. Smys, and Jennifer S. Raj**

## 14.1 Introduction

The smart city development has to concentrate every area including the power utilization of the city [1, 2]. The street lamps that are used in the cities to avoid accidents and the uncertainties during night time though it ensures safety consume a large sum of energy [3, 4]. As a solution to these problems, the ingenious lighting system is proposed in this paper. Ingenious lighting system has the advantage of automation control with the help of networking [5, 6]. Automation plays an associate degree progressively vital role within the world economy and in the standard of living. Automatic systems are being preferred over manual systems [13]. The analysis presented provides the automation in managing the street lights and shows power conservation to a certain level.

In existence, the street lamps are mainly based on manual management and light perception control, and both the methods pose certain demerits such as:

1. Extended period for maintenance
2. Hard fine-grain control
3. High energy consumption

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https://doi.org/10.1007/978-3-030-49795-8_14

To overcome the above three problems, we proposed the ingenious lighting system. To reduce the maintenance period, we are moving to the automation, and in case of a broken lamp, a certain mechanism would be available to identify the broken lamps; the brighter the street lights, the higher the consumption of the power.

To reduce the energy consumption, a dynamic luminance adjustment adjusting the intensity is used based on the demands in the current. To satisfy fine-grain control, every street lamp needs a unique identification, such as the independent control, all day through control, and adjustable brightness based on the prevailing demands. The current street light system uses incandescent lamps, mercury vapor lamps, etc. Different styles of light-weight technology are employed in lighting style with their glowing potency, lamp service life, and their consideration. Due to its advantages like low power consumption and long life, LEDs are considered to be a promising source for modern street lighting systems [11, 12]. Because of these advantages, LEDs are likely to replace traditional street lamps in the future. Materials of top quality with high precision and also advanced production lines are needed for diode technology. Therefore, the analysis work highlights the energy economical system of the road lights system victimization diode lamps with an IR device interface for dominant and managing.

## 14.2 Literature Survey

1. Survey on LPWA technology: "LoRa and NB-IOT: Rashmi Sharan Sinha, Yiqiao Wei, Seung-Hoon Hwang. Year of Publishing: 2018. In this paper, they provide a survey on NB-IoT and LoRa as efficient solutions connecting the devices." Interference on open frequency makes data rate low.
2. An overview of Bluetooth Wireless Technology™ and some competing LAN Standards: "Ruisi He, Bo Ai, Gongpu Wang, Ke Guan, Zhangdui Zhong, Andreas F.Molisch, Cesar Briso-Rodriguez, and Claude" OestgesYearofPublishing: 2017. In this paper "ensures the safety of the travelers, and updates real-time multimedia information. It uses UDP, so no acknowledgment is done or requested."
3. "SSL: Smart Street Lamp based on Fog Computing for Smarter Cities: Gangyong Jia, Member, IEEE, Guangjie Han, Member, IEEE, Aohan Li, Member, IEEE, JiaxinDu. In this paper they provide the importance of (1) fine management; (2) dynamic brightness adjustment; (3) autonomous alarm on abnormal states, Auto Rectification of malfunctioning lamps are not available."

## 14.3 Methodology

The ingenious lighting system adopts a dynamic control methodology [7, 8, 25]. In the framework for street lights put forth the street light glows on sensing the human passing by and switches off by the time the humans reach the arena of the next street

light that glows on recognizing the object moving across it. In future, this system can be realized using GSM or other high-level wireless communication networks like 6LoWPAN which can be implemented worldwide [9, 12, 17, 25].

## 14.4 Existing System

Due to its advantages like low power consumption and long life, LEDs are considered to be promising sources for a modern street lighting system. Because of these advantages, LEDs would be the alternatives for conventional street lights. Materials of top quality with high precision and also advanced production lines are needed for diode technology.

In the present field of electronics and electrical technologies, factors such as cost, power consumption, efficiency, and automation are quite important [19, 20]. Economical street lighting systems are developed with complex control and maintenance. For reducing and controlling the energy consumption of the public lighting system, many technologies like automation and cloud are being developed. The existing system is adopted by the hybrid network [8], framing a flexible platform to easily and highly automate the street lights using the IoT with the narrow to establish a connection between the server and the street lights.

## 14.5 Proposed System

In this proposed system, the ingenious lighting system is implemented by raspberry pi, and it is used to trace and adjust the entire node. Light-detecting resistor, infrared, and current sensors are the various sensors used. In this proposed system, if one node gets failed, then raspberry pi gets network from another node and it provides that to the failure node [18, 19]. This project is highly automated and traces street lamp status. Automatically it finds the node failure and immediately resolves by raspberry pi comparing another node in the network.

### *14.5.1 Comparison Between Existing and Proposed*

#### 14.5.1.1 Existing System

- 10 LED bulbs of 150 watts/h glow for 12 h consumes about 18 units (18 kWhr).

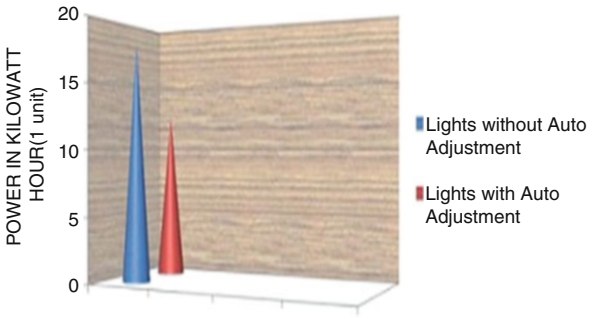


**Fig. 14.1** Comparison – Energy consumption

#### 14.5.1.2 Proposed System

- 10 LED bulbs of 150 watts/h glow for 12 h consumes only about 13 units(13 kWhr).
- Peak hours (6 PM to 11 PM) → 7.5 units for ten bulbs.
- Ideal state → 5.2 units (approx.) for ten bulbs.

The above graph (Fig. 14.1) represents the comparison between the existing and proposed system's energy consumption.

The blue triangle shows the power consumed by the existing system when there is no auto adjustment.

The red triangle shows the power consumed by the proposed system when there is auto adjustment is present.

## 14.6 Block Diagram

## 14.7 Block Diagram Explanation

In the above (Fig. 14.2), the ingenious lighting system is simply implemented by a raspberry pi. The above diagram is containing two nodes, router, and raspberry pi. Three sensors are connected to each node. LDR sensor, IR sensor, and current sensor these all the sensors are input to the node. The two nodes are connected to raspberry pi via a router, and the node status is obtained by every second. That time any node will be failed the raspberry pi get data from another node and it was given to failure node.

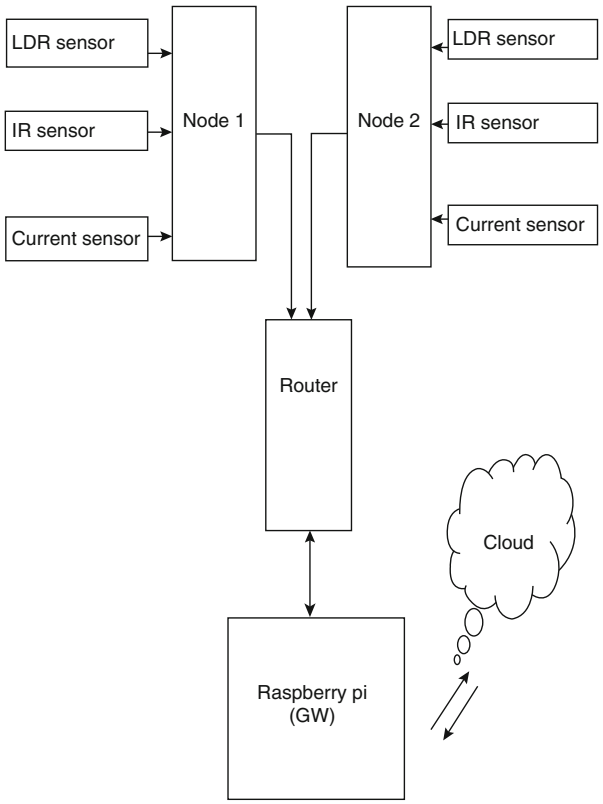


**Fig. 14.2** Block diagram- ILS

### *14.7.1 LDR Sensor*

LDR sensor can be abbreviated as a light-dependent resistor sensor. Each node consists of its own LDR sensor [14]. A light-dependent device works on the principle of photoconductivity, i.e., the resistivity of the material relies on the amount of light incident on them. During the day when the light falls on the LDR, the resistance value decreases, and at dark, the value of resistance increases which is called dark resistance. The resistance begins to drop drastically if the device is allowed to absorb light [21]. When a constant voltage is applied to LDR or when the intensity of light increases falling on LDR, the current tends to get increased.

### *14.7.2 IR Sensor*

IR sensor can be abbreviated as infrared sensor. Each node consists of its own IR sensor. An IR sensor is a sensor that uses its transmitted infrared light to find the obstacle using the intensity of the reflected infrared light. The reflection mechanism is effective only with the range of about 10 m [10]. It can be also used to find the obstacle using the temperature or heat present in the obstacle. The infrared radiations are invisible to human eyes. IR sensor is simply a device that consists of two major parts: they are LED which acts as a source that emits infrared light and the photodetector which is used as a reception for the reflected beam. The photodetector is capable and sensitive only to the wavelength of infrared radiation that is emitted from the source.

### *14.7.3 Current Sensor*

The current sensor is also connected to each node. Each node owns a current sensor. For easily measuring output voltage with respect to the current which is detected. The detected voltage is directly proportional to the current through a particular path. There will be a voltage drop when a current flows through a wire or circuit. The current-carrying conductor is surrounded by a magnetic field that is generated. Designing of current sensors uses the above two phenomena.

### *14.7.4 Working*

All nodes are connected to a router as shown in Fig. 14.2. The required power supply is provided to each node which comprises sensors like IR, current, and LDR sensors. The server is turned on. Using the IP address of the router, connection is established between the server and the router. Each node transmits its data from various sensors to the sensors via the router. During daylight, the LDR value reduces below 200 which keeps the light off. When the LDR value increases above 200, the lights are turned on automatically. Initially, the lights glow in the dim state. When the IR sensor detects any obstacle or any motion of vehicles or auto-motives.

When infrared light radiated from the source gets reflected by the obstacles or motion of vehicles and received by the photodetector, this increases the values of IR, which increases the intensity of light [15, 16]. These values are continuously recorded in the server. The current sensor values are also being continuously recorded by a server. Based on the current sensor values, the state of light bulbs can be measured. When the current is zero and the voltage is not equal to zero, the bulb is broken [23]. When current is not equal to zero and voltage is zero, the bulb

goes to power saving mode. When current and voltage are zero, the bulb is open circuit or short-circuited, i.e., the power line is broken [24].

In this system, if one node gets failed, then raspberry pi gets network from another node, and it provides that to the failure node [22]. For example, during the day when an LDR sensor of one node fails, raspberry pi checks the other node's output of the LDR sensor and rectifies the value of the failure node's LDR sensor. The working is explained by the flowchart Fig. 14.3.

## 14.8 Expected Output

Digital values of the measured analog outputs are from various sensors as follows:

1. Current sensor
2. Infrared sensor
3. Light-dependent resistor sensor

The following are the expected outputs:

- Based on the values of LDR, the light is made off or on.
- Based on the values of the current sensor, the following can be inferred.
- Current $= 0$, Voltage$! = 0 \rightarrow$ Bulb is broken.
- Current$! = 0$,Voltage $= 0 \rightarrow$ Power saving mode.
- Current $= 0$, Voltage $= 0 \rightarrow$ Bulb is stolen or open circuit.
- Based on the values of infrared sensor, the light can be made to glow bright or dim and acts as dynamic light intensity adjuster.

## 14.9 Response Time

For a single measurement, this causes large response time.

**For example**, 35 ms for objects placed 6 m away.

The response time is an important factor for any sensor. It changes according to the increase in the distance between the object far more than 6 m. IR sensor can detect up to 10 m, i.e., up to 30 ft. IR response time also varies with respect to the angle of the object.

## 14.10 Social Relevance and Usefulness

Kaushal [1] The smart city basically tries to develop a more reliable, highly secure, convenient, environment with minimized power consumption.

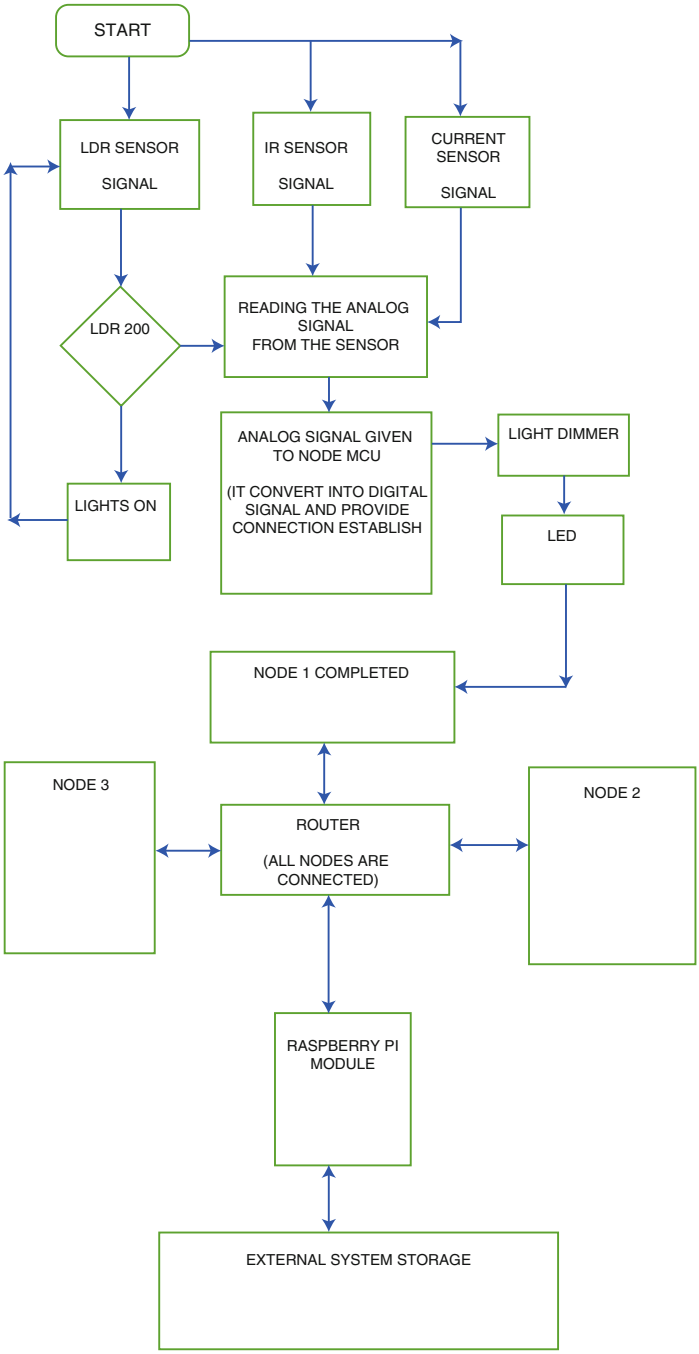


**Fig. 14.3** Flow chart

Meering and Paolo Balella [2] The smart infrastructure is the highest entailment in smart city development.

[3] The street lights are one of the important infrastructures that avoid uncertainties in the night time and ensure safety.

Giffinger et al. [4] It is essential to improve the street light with the adjusting capability and management to reduce energy consumption.

Jin et al. [5] Here we can even solve the problems with no manpower, i.e., using the LDR sensor of one lamp system, other systems can be rectified automatically.

Lombardi et al. [6] Thus, by using this ingenious lighting system, the amount of electricity can be reduced by one fifth.

Zanella et al. [7] This fact again is relevant to the social awareness about energy saving and efficient energy consumption.

## 14.11 Conclusion

An ingenious lighting system reduces the major amount of power consumed by the street lights preventing over usage of the electricity that existed in the conventional methods. The LDR, current, and the IR sensors utilized provide an auto-rectification street lamp system reducing both the energy consumption and the cost. The proposed method is viewed as a more versatile system as it is extendable and adjustable according to the needs. At present, it is utilized in the one-way traffic in the highways, and in the future, it is planned to extend its usage employing the GSM services in the two-way traffic with the improved flexibility even on rainy days and bad weather.

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# Chapter 15
# QoS in the Mobile Cloud Computing Environment


**C. Arun and K. Prabu**

## 15.1 Introduction

In past days the computational process is performed only in the desktop computers only. The mobile cloud computing technology is invented after that all computational process can perform in cloud utilizing the devices that are mobile. The mobile devices usage is increasing highly nowadays [1, 2]. The fresh survey result shows the eagerness of people in using the mobile devices [3]. The benefits of CC and MC are merged into the MCC, the mobile cloud paradigm, and represented in the Fig. 15.1.

Mobile computing user can interact with computer at the time of movement without any technical troubles, and cloud computing user can communicate with cloud and access the cloud resources as on demand [4]. By utilizing MCC, the mobile devices can access the cloud via Internet for the data processing. The mobile devices need not have any high storage capacity and high computational power. All the computational process is performed outside of the user devices inside the remote server which in cloud [5]. MCC is defined and termed to be a more sophisticated technology supporting a very large group of people irrespective of time and place following the principle of pay as you go [6]. Mobile cloud computing competently decreases time and energy consumption of application performance and improves the data storage space of user's mobile devices and extends the life time of the device battery [7–9]. But, few areas in mobile cloud computing need more developments [12], they are the quality of service (QoS), management of

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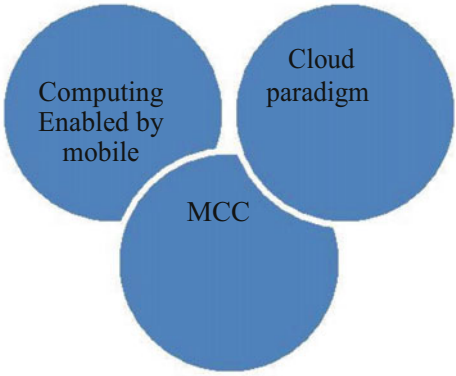


**Fig. 15.1** Basis figure of mobile cloud computing

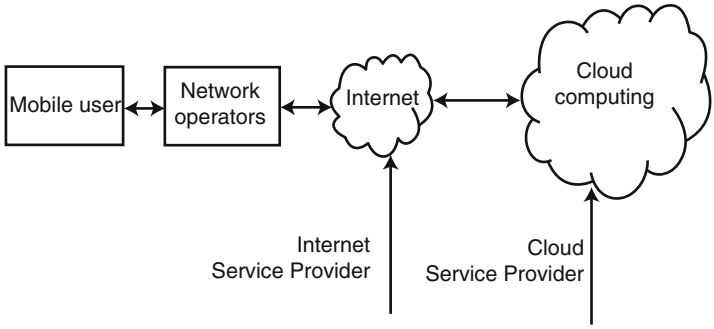


**Fig. 15.2** MCC Architecture

network access, bandwidth, pricing, standard interface, convergence required in services, latency, efficiency in energy, application migration and management of resources, etc [19].

## 15.2 MCC System Architecture

The MCC is comprised of three parts: mobile network, cloud, and Internet service providers. These three parts are integrated and formed the mobile cloud computing. The Fig. 15.2 MCC Architecture.

(a) *Mobile Network*

It is a mixture of network operators and mobile devices. Mobile devices may be smartphones, tablets, laptops, etc. [2]. These devices and network operators are joined to the operator of the network with the help of base stations or any radio networks. BTSs establish the connection and maintain the connection between mobile devices and network operators.

(b) *Cloud Service*

The data centers in the cloud are the layers that provide service to the cloud. Data center layer is a group of interconnected servers with the help of high-speed network connections. PaaS enables the client to install his own applications. IaaS being the top of the data center layer. The main work of this layer is allocated in the server, hardware storage, and other networking components to the user on demand basis. SaaS manages the hosting of the software [4].

(c) *Internet Service*

The Internet enables the requisition transfer from the user to the cloud and delivers the services of the cloud to the user. The user can communicate with the cloud with the help of 3G, 4G, and 5G connections.

## 15.3 QoS in the Mobile Cloud Computing Environment

MCC effectively decreases power and the computation time enhancing the storage space of the and the lifespan of the battery despite the advantages offered by the MCC, it still entails improvements in the major areas quality of service (QoS), management of network access, bandwidth, pricing, standard interface, convergence required in services, latency, efficiency in energy, application migration and management of resources, etc.

(a) *Well-Organized Bandwidth Distribution*

The 5G small cell network is used to improve the bandwidth and the signal strength to in turn improve the execution speed [3].

(b) *MCC Clubbed with the CRN (Cognitive Radio Network)*

Cognitive networks are very useful for accessing the cloud through mobile devices. These two technologies are joined and skip the performance demerits. An effective bandwidth utilization is achieved in MCC by the integration of the CRN [10]. But user mobility and communication failure will make it more critical. So a new method called cloudlet is introduced in MCC that enhances its QOS [5].

(c) *Mobile Cloud Computing with Cloudlet*

The group of computers connected to the internet is called the cloudlet. The nearby mobile devices can access these computers. Using this nearby cloudlet minimizes the cost and time at the time of offloading the task by the mobile devices [6]. Sometimes cloudlet may not be available in near to the user, and then the mobile device can access the cloud or use its own resources.

(d) *Cross-Cloud Communication*

As the demands placed by the users are very hard to be handled by single clouds, the cloud merging is introduced. Mobile sky computing (MCC + Sky computing) can fulfill the user's needs enabling the easy access cross-cloud communication [11].

(e) *Privacy and Security of MCC*

Mobile cloud computing suffers from numerous security threats due to the restriction in the supply and the processing power. So this increases the vulnerabilities in the MCC.

With the entailment for the multilevel authentication.

(f) *Secured MCC*

The MCC performs the processing of the data inside the cloud and outside the mobile devices. The user need not store anything in their devices due to the duplication process available in cloud [13].

(g) *Energy Consumption Minimization in Data Centers of Cloud*

To save the energy, only some server is switched on and other server is switched off at the time of low traffic. To monitor this traffic, a special server is used [14]. In pick time the other server sends the request to the special server and it switched on the all servers in the network. Using this server, the wastage of energy can be controlled.

(h) *Resource Management*

The resource management system must be developed for mobile devices and cloud servers. The resources are allocated before the execution starts, and the unnecessary resources are also allocated to the user [15]. The resource management system must allocate the resources based on the demands.

## 15.4 MCC Applications

MCC technology is used many places. Nowadays mobile cloud computing applications used in many areas such as biometric area, mobile vehicular cloud, mobile learning, remote display, mobile health cloud application, multimedia mobile cloud, social mobile cloud, etc.

(a) *Biometric Authentication Application*

The mobile devices are able to scan the biometric evidence such as face recognition and fingerprint recognition for the authentication purpose [16]. The scanned data is processed in the cloud. The sample data is already in cloud storage. The new data is compared with the exciting data then the authentication

is verified. For this process, it needs a high computational processor. The mobile cloud computing offers a high computational processor to the client. All the process is outside of the cloud.

(b) *Mobile Vehicular Cloud*

Using MCC the user can achieve many benefits in mobile vehicular cloud. Some applications such as route tracking and traffic management are the merits of mobile vehicular cloud [17]. A navigator is fixed in the vehicle. Using this navigator the traffic is monitoring. As per the client's request, cloud will update the best path to the user.

(c) *Mobile Learning*

The mobile learning is mainly used for the education system. The user can read and download the source with the help of MCC anywhere at any time [18]. There are two models in mobile learning as cloud model and client model. In client model, user has to download the mobile learning application from the cloud. Then the user has to pay some amount for accessing the cloud. The user can sent the request to the cloud for accessing the cloud through mobile devices and access any data from the cloud. Cloud model is verifying the user ID for the authentication and response to the user.

(d) *Remote Display*

The data processed in the cloud in a remote location is accessed by the users in their mobile phones in the web browsers.

(e) *Health Mobile Cloud Application*

MCC offers health applications. In this model, it can be split in two models as patient model and admin model. In admin model it is maintained by the hospital side. They provide the unique ID to the patients and verify the ID at the time of user login. The main work of the admin is uploading the periodical report to the cloud. The advantage of this method for the admin is that they can maintain all the patients record safely [20]. In client side the client need not carry the records for all time and they can consult any other doctor anywhere.

(f) *Mobile Multimedia Storage*

The user can store any type of data such as video, audio, document, etc. in cloud using their mobile devices [21]. They can access the data using their username and password anywhere at any time.

(g) *Application in Social Cloud*

Nowadays most people are communicating with their friends via social media such as Facebook, LinkedIn, Twitter, etc.; using this, they need not to store anything in their devices; all the data are stored in cloud [22, 23]. So the large amount of storage is gained by the user.

## 15.5 Conclusion

Mobile cloud computing is the fastest developing technology in these years. In mobile cloud computing, the user can access the cloud during moving position at a normal usage. The paper details the MCC architecture, QoS in MCC environment, and applications of MCC. Some difficulties are placed in mobile cloud computing such as energy consumptions, security issue, etc. Future research work will overcome these problem and mobile cloud computing will be the rich technology to mobile users.

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# Chapter 16
# Digital Communication and the Digital Divide: Cultural Aspects of Human-Computer Interactions

**Marcel Pikhart**

## 16.1 Introduction

### *16.1.1 Literature Review*

ICT (Information and Communication Technology) and business communication are according to generally accepted literature culturally specific, which means that there are some aspects of human communication that are acceptable in one culture but not necessarily acceptable in another one. Nowadays classic research was done by Geert Hofstede, and it was a breakthrough in the area of business and managerial communication even if the vast proportion of his research was also focused on the ICT sector [1]. The cultural dimension in management and planning has already been highlighted by many authoritative textbooks for management studies [2–4]. However, there is not much literature about the similar importance of cultural conditioning in ICT. Business studies have made significant progress in the past few years regarding the improvement of the awareness of cultural conditioning of business communication; however, ICT sector is still lacking behind, and this paper is an attempt to improve the current situation.

Human-computer interaction (HCI) and human-human interaction through the means of computerized information is the basic paradigm of human communication, and now we cannot imagine global communication otherwise. As Hofstede puts it [5], the human communication and human-human computer interaction are based on a platform which works like software of mind, i.e., the cultural platform upon which all communication takes place, and ignoring this aspect will necessarily lead

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to the distorted information or a loss of data, and the message we want to convey will not be transferred properly.

The past research proved that several years ago the management of companies, even if the company was based globally, did not realize the importance of intercultural studies and necessarily led to a lot of frustration caused by business failure. Neglecting these aspects of communication led to a significant loss of information in the business processes and therefore to lower profitability. All these negative consequences stimulated the establishment of a new academic and pragmatic discipline, i.e., intercultural communication [6, 7] which established itself in management studies and business areas very quickly and firmly.

Multilingual and intercultural competence in ICT is, similarly to the global business area, a necessity which if neglected will create a significant loss of information [8, 9]. The mass use of ICT in the global world is unprecedented and the past few years prove that the trend will continue at this quick pace. The modern society is predominantly based on sharing information, i.e., both businesses and the national economy are computational rather than manufacturing-based (Industry 4.0). The realization of this fact is crucial for ICT staff and managers because all manufacturing and service industry is ICT-based and therefore cannot be functional and operational without this informational aspect.

The pragmatics of this scenario is that if we want to succeed in the global world of interconnectedness, we must consider all the significant aspects which are embedded in our communication patterns, and interculturality is one of them. The interculturality has already been reflected in other areas of ICT connected expertise, i.e., not only business communication but also in other professional fields such as in blended learning, eLearning, and mLearning [10–13]. Our dependence on information relates to coordination and communication; therefore, all the communication processes are deeply rooted in the emerging document society as Michael Buckland puts it [14].

## 16.2 Research

### *16.2.1 Research Design*

The research was conducted into the awareness of the foreign (Taiwan, Hong Kong, China) and Czech students (age around 20, both male and female) of business and ICT who attended the class of intercultural business communication in the global world at the Faculty of Informatics and Management of the University of Hradec Kralove, Czech Republic, in the winter semester of the academic year 2019–2020. The aim of the course was to update the students on current trends of intercultural management, intercultural communication in business, and IT; therefore, the instructed needed to have some idea about the initial awareness of the topic.

The number of respondents was 48. The data were collected by a qualitative questionnaire testing the awareness of interculturality and its importance in business, managerial and computer communication. The questionnaire was distributed online at the beginning of the semester (October 2019).

### *16.2.2 Research Question*

The research question was based on a premise by Michael Buckland that "the well-being of individuals and societies is entirely dependent on information and communication technologies" [14] and it was as follows: How much are the university students aware of the importance of interculturality in business communication and in the ICT sector.

### *16.2.3 Research Results*

As expected, based on the previous years, the awareness of the importance of the topic of interculturality in business communication or ICT communication is very limited; however, we can observe some improvements when we compare these results to the results some 10 years ago when the course started.

The students clearly expressed their surprise that there are very important things, apart from technical expertise in programming, design, and software architecture, which can have a significant impact on the way information is transferred through ICT.

The students of business proved to be more aware of the impact of interculturality more than the students of ICT because they are used to realizing the importance of interculturality in everyday business scenarios. Business students also knew that being able to work in an international context and global teams need certain skills that are very much connected to intercultural communication and competencies. ICT students, however, preferred more technical expertise and did not consider interculturality to be very important or even significant in the ICT context.

These results are appalling because they present a potential threat to the proper development of the ICT industry and mostly ICT practical implementation and cooperation in everyday business scenarios. It is crucial that not only business but also ICT employees fully realize the importance of this area in the global business environment.

### *16.2.4 Research Limitations*

The research was conducted with a limited number of respondents; however, we claim that it is still relevant, and the results could be generalized and then motivate further research into this area.

## 16.3 Discussion

We still lack significant and relevant literature on the importance of culture and interculturality in ICT. The articles which focus on the topic are only marginal and lacking depth and breadth which the topic deserves.

However, the book by Michael Buckland *Information and Society* [14] published in 2017 by the MIT Press Essential Knowledge Series presents the most important theoretical foundations of the fact that cultures cooperate through shared information. This background can present a starting point for further discussion and also research into the area of culture in ICT.

Both human-computer interaction and human-human computer-enabled interaction are the two aspects of global communication these days, and these are "the means for monitoring, influencing, and negotiating relationships with others" [14]. Business and any kind of collaboration and communication are based on trust and relationship; therefore, this topic is of the utmost importance for all who are involved or responsible for HCI and ICT [15].

This is only a preliminary research into the awareness of interculturality in business and ICT university students. No further research into the same topic is needed; rather, this should be a starting point for further research into the use of the basic principles of interculturality in ICT and the possible ways of implementation of interculturality in everyday pragmatics of information science and human-computer interactions.

### *16.3.1 Practical Implications*

The results of the research showed that the awareness of the interculturality importance in ICT and business university students is very low, and this could be an impetus for further research into implementation interculturality in ICT and also our university curricula.

There are many aspects of ICT and interculturality that should be pragmatically implemented into the outcomes of ITC departments, such as website creation, presentation templates, preferred communication channels, etc. For example, the use of colors, the layout of the website (eye-tracking optimization based on various

cultural models), various iconic representations of objects could be understood in a different way in a different culture, etc.

## 16.4 Conclusions

The paper attempts to prove that human-computer-based interaction and human-human computer-facilitated interaction are two aspects of communication in the modern world, and they are both influenced by several factors out of which interculturality seems to be significant in the global world of interconnectedness. If ICT follows the trends of business communication in the past two decades, there will be a lot of inspiration for further research and possible implementation of intercultural communication strategies in the websites, intranet platforms, etc., because it will improve our visibility and competitiveness in the global market. There is significant research into intercultural communication in business [16–20]; however, we still lack sufficient research into interculturality in ICT. The topic of interculturality presents a crucial area that needs further investigation.

Digital communication, therefore, should not present a digital divide caused by misunderstanding, and on the other hand, it should be a tool to improve our global communication patterns and competitiveness.

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# Chapter 17
# An Efficient AES with Custom Configurable Encryption Algorithm Using Dynamic Keys for Secure Data Communication in Networks

**P. Pavan Kalyan, Shahana Bano, Y. L. Pranthi, and V. Lokesh**

## 17.1 Introduction

In any communication system wired, wireless, and many different applications, data security is considered as a crucial issue. Different technologies and algorithms are used to secure information and protect it from different attackers and unauthorized users. Nowadays to encrypt the data used technique is cryptography. It is the art of using mathematics to encrypt and decrypt data or information. It is divided into symmetric cryptography, asymmetric cryptography, and hashing. We are using symmetric cryptography, which is a process of encrypting and decrypting the data by using the same key. The symmetric algorithms are RC4, RC5, SHA, DES, AES, etc. Recently used algorithms are DES and AES. DES algorithm using the same key for both encryption and decryption and the block and key size are very poor, i.e., 64 bits, it is easily cracked by the attackers using crypt-analysis attacks. The AES algorithm provides large block size and key size, i.e., 128,192,256 bits, and the algorithm also cracked by the side channel and biclique attacks [1]. To overcome these attacks, we add new features to the algorithm, and it provides more security to the algorithm [3]. The conventional cryptosystem or symmetric key cryptosystem is shown in below Fig. 17.1.

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https://doi.org/10.1007/978-3-030-49795-8_17

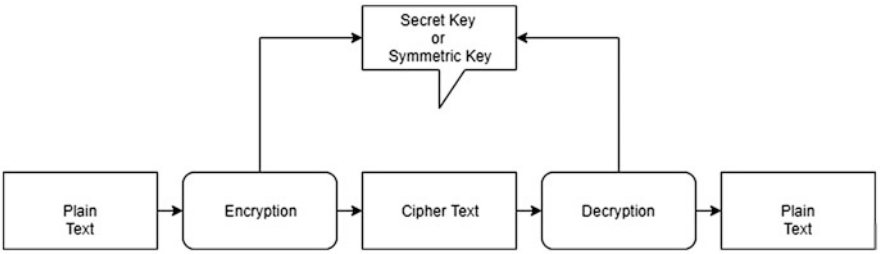



**Fig. 17.1** A conventional cryptosystem process

## 17.2 Symmetrıc Encryptıon Algorithm

The symmetric encryption algorithm is a process of encrypting and decrypting data or information by using the same key [4–6]. Nowadays the most used Advanced Encryption Standard [AES] algorithm is issued by the National Institute of Standard and Technology (NIST) in 2001. It is developed by two Belgian cryptographers, Vincent Rijmen and Joan Daemen. The AES algorithm based on the three different block sizes and key sizes, i.e., 128,192, and 256-bits. It operates data on a 4*4 matrix which is called a state matrix [7–9]. For the conversion of plaintext into ciphertext, it needs several repetitions that is depend on the size of the key used. For 128-bit uses 10 cycles of repetitions, 192-bit uses 12 cycles of repetitions, and 256-bit uses 14 cycles of repetitions are needed. The 128-bit input data will be separated into 16 bytes and arranged into 4*4 matrix of the bytes as shown in Table 17.1. This algorithm consists of four phases [10]. These are add round key, substitute bytes, shift rows, and mix columns. Each round processes the four phases except for the last round which has processed only add round key, substitute bytes, and shift rows.

**Add round key:** The phase performs 128-bit state matrix directly XOR with the 128-bit round key. If it is the last round, the round key value is ciphertext [11–13].

**Substitute bytes:** The 16-byte input values are substituted by looking up a substitution-box (S-box). This S-box implements inverse multiplication in GF ($2^8$).

**Shift rows:** The phase performs 4*4 state matrix, each row is shifted to circular left operation. The first row is unchanged, the second row of each byte is moved to one left position, the third row of each byte is moved to two left positions, and the final row of each byte is moved to the three left positions [14–16].

**Mix columns:** Each column of four bytes now transformed using matrix multiplication function. This function takes four bytes of one column and outputs for four new bytes, which is replaced by an original column. It performs all four columns and replaced by completely new bytes (Fig. 17.2).

The AES decryption process is shown in Fig. 17.3 and performs the round key add operation before the decryption process is initiated. In this process, each round consists of four phases. These are Inv sub bytes, Inv shift rows, add round key, and Inv mix columns. The final round of the decryption process ignores the Inv mix columns.

**Table 17.1** The AES 4*4 data structure

| | | | |
|---|---|---|---|
| $X_{0,0}$ | $X_{0,1}$ | $X_{0,2}$ | $X_{0,3}$ |
| $X_{1,1}$ | $X_{1,1}$ | $X_{1,2}$ | $X_{1,3}$ |
| $X_{2,0}$ | $X_{2,1}$ | $X_{2,2}$ | $X_{2,3}$ |
| $X_{3,0}$ | $X_{3,1}$ | $X_{3,2}$ | $X_{3,3}$ |

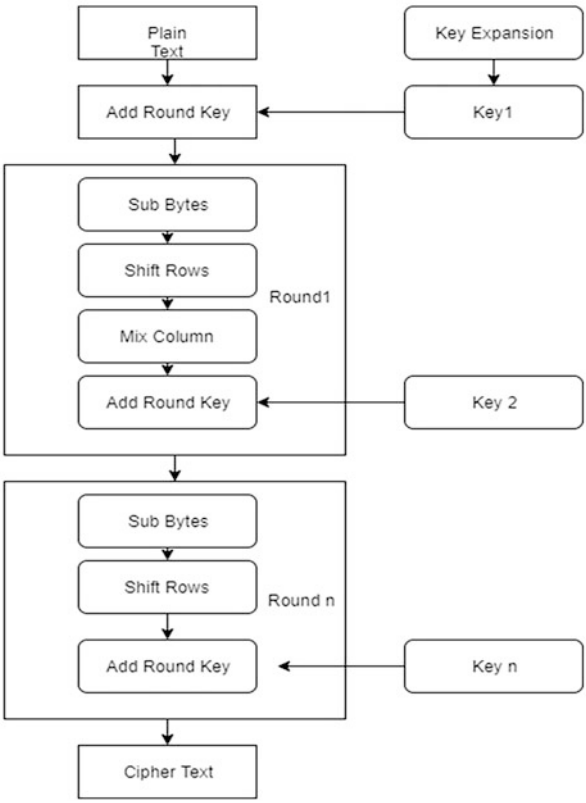



**Fig. 17.2** AES encryption process

## 17.3 Proposed System

The proposed system is working on three phases. The first phase performs custom replacement for input values, i.e., plaintext, the user will choose the character or alphabet in the plaintext replaced with another character or alphabet. In the second phase performs encrypt the data using dynamic keys. Firstly, the data or information are framed, each frame consists of 16-byte data and is transmitted sequentially. Based on the order, the 16-byte of key changed by one unit for each round and

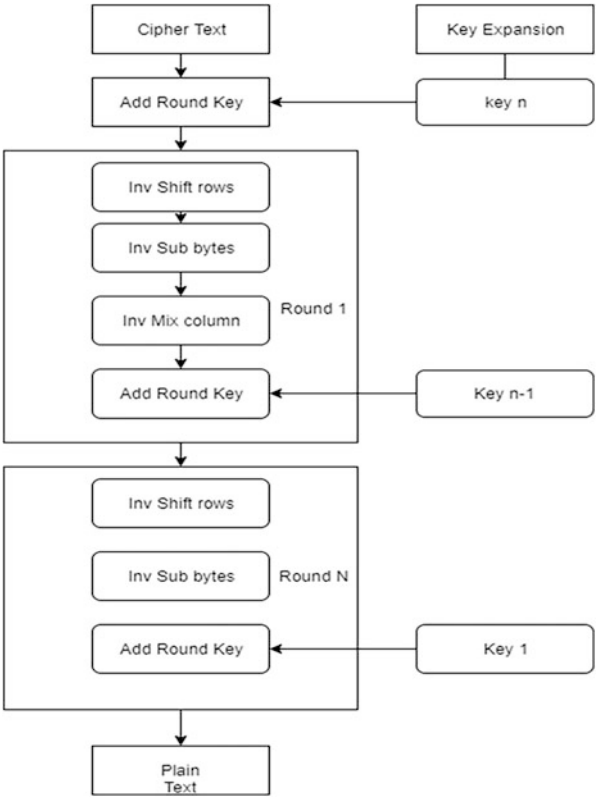



**Fig. 17.3** AES decryption process

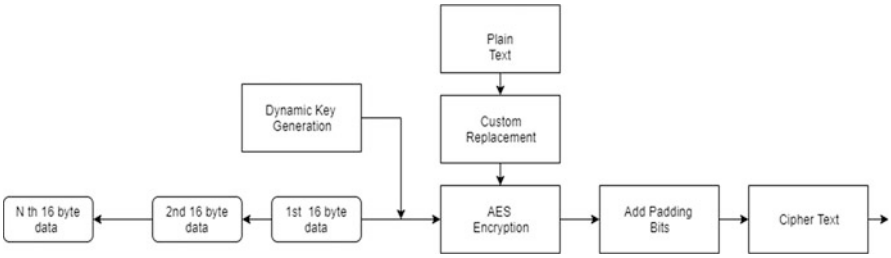



**Fig. 17.4** Proposed custom configurable encryption algorithm process

finally added padding bits to ciphertext either left or right. The proposed custom configurable encryption and decryption algorithm process is shown in figures (Figs. 17.4 and 17.5).

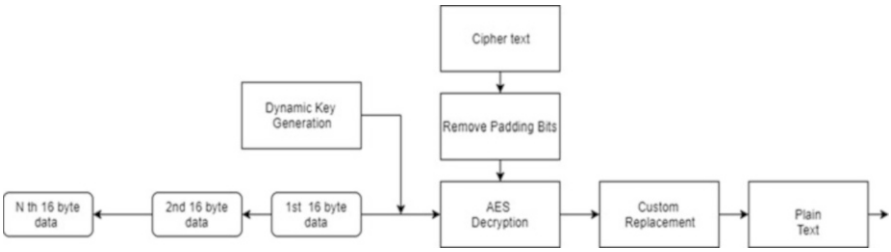
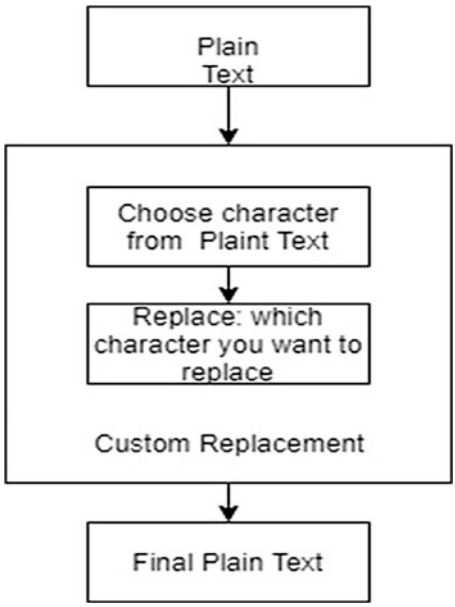



**Fig. 17.5** Proposed custom configurable decryption algorithm process

**Fig. 17.6** Custom replacement for input values




### *17.3.1 Custom Replacement*

The custom replacement is the process of replacing one character or alphabet with another character or alphabet in plaintext. It provides more security to plaintext because it totally changes the plaintext. The attacker breaks the ciphertext and it can't be identified. The custom replacement process is shown in Fig. 17.6.

### *17.3.2 Dynamic Key Generation*

The system starts with 128-bit of block size and 128-bit key size. The sender will make 16-byte data into frames. Each frame is sent in sequential order, primarily

**Table 17.2** Dynamic key generation process

| | | | |
|---|---|---|---|
| $key_0 = key_0 + 1$ | $key_1 = key_1 + 1$ | $key_2 = key_2 + 1$ | $key_3 = key_3 + 1$ |
| $key_4 = key_4 + 1$ | $key_5 = key_5 + 1$ | $key_6 = keye_6 + 1$ | $key_7 = key_7 + 1$ |
| $key_8 = key_8 + 1$ | $key_9 = key_9 + 1$ | $key_{10} = key_{10} + 1$ | $key_{11} = Key_{11} + 1$ |
| $key_{12} = key_{12} + 1$ | $key_{13} = key_{13} + 1$ | $key_{14} = key_{14} + 1$ | $key_{15} = key_{15} + 1$ |

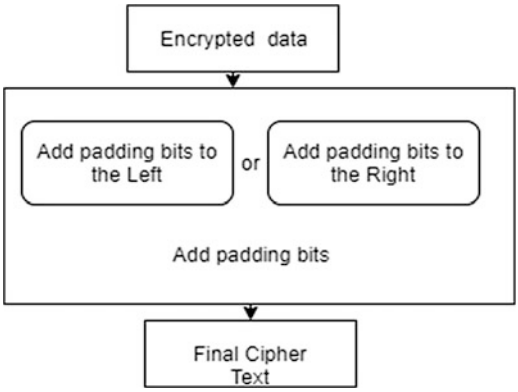



**Fig. 17.7** Add padding bits process

based on the order to generate the key from encrypted data. The receiver will know the key to receive the frames based on the sent by the transmitter. The dynamic key generation process is shown in Table 17.2.

### *17.3.3 Add Padding Bits*

After custom configurable encryption algorithm, some padding bits are added to the either right or left to the ciphertext, it provides more security to the ciphertext. The padding bits will be added to the left or right will be decided by the sender. The add padding bits are shown in below Fig. 17.7.

### *17.3.4 Algorithm Handler*

**Part 1:** The AES round key operation is shown below.

*Step 1:* Add round key: The round key $R_1, R_2, \ldots., R_n$ are obtained from encrypting the key by expanding it.

$$g0 = \begin{matrix} W_0 & X_{0,0} & X_{0,1} & X_{0,2} & X_{0,3} \\ W_1 & X_{1,0} & X_{1,1} & X_{1,2} & X_{1,3} \\ W_2 & X_{2,0} & X_{2,1} & X_{2,2} & X_{2,3} \\ W_3 & X_{3,0} & X_{,1} & X_{3,2} & X_{3,3} \end{matrix}$$

$W_i \leftarrow W_i - N_k$ XOR Sub Byte $(W_i - 1)$

*Step 2:* Substitute bytes: The 16-byte input values are substituted by looking up a substitution-box. S-box maps an 8-bit input, "i," to an 8-bit output, d = S(i). The input is mapped into its multiplicative inverse in Rijndael finite field.

$$\text{GF}\left(2^8\right) = \text{GF}\,(2)\,[x] \,/\, (x8 + x4 + x3 + x + 1)$$

The multiplicative inverse transformation is shown below.

$$\begin{matrix} x_0 \\ x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \end{matrix} = \begin{matrix} 1\,0\,0\,0\,1\,1\,1\,1 \\ 1\,1\,0\,0\,0\,1\,1\,1 \\ 1\,1\,1\,0\,0\,0\,1\,1 \\ 1\,1\,1\,1\,0\,0\,0\,1 \\ 1\,1\,1\,1\,1\,0\,0\,0 \\ 0\,1\,1\,1\,1\,1\,0\,0 \\ 0\,0\,1\,1\,1\,1\,1\,0 \\ 0\,0\,0\,1\,1\,1\,1\,1 \end{matrix} * \begin{matrix} y_0 \\ y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \\ y_6 \\ y_7 \end{matrix} + \begin{matrix} 1 \\ 1 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 0 \end{matrix}$$

where $[x_0, x_1, x_2, x_3, x_4, x_5, x_6, x_7]$ is the S-box output, and $[y_0, y_1, y_2, y3, y_4, y_5, y_6, y_7]$ is the multiplicative inverse.

*Step 3:* Shift rows: All the bytes are shifted to circular left operation that is depends on rows.

$$\begin{matrix} X_{0,0} & X_{0,1} & X_{0,2} & X_{0,3} \\ X_{1,1} & X_{1,2} & X_{1,3} & X_{1,0} \\ X_{2,2} & X_{2,3} & X_{2,0} & X_{2,1} \\ X_{3,3} & X_{3,0} & X_{3,1} & X_{3,2} \end{matrix}$$

After performing the shift row operations result shown in the table.

$$\begin{matrix} X_{0,0} & X_{0,1} & X_{0,2} & X_{0,3} \\ X_{1,0} & X_{1,1} & X_{1,2} & X_{1,3} \\ X_{2,0} & X_{2,1} & X_{2,2} & X_{2,3} \\ X_{3,0} & X_{3,1} & X_{3,2} & X_{3,3} \end{matrix}$$

*Step 4:* Mix columns: Mix column operation performs multiplies with fixed current state matrix.

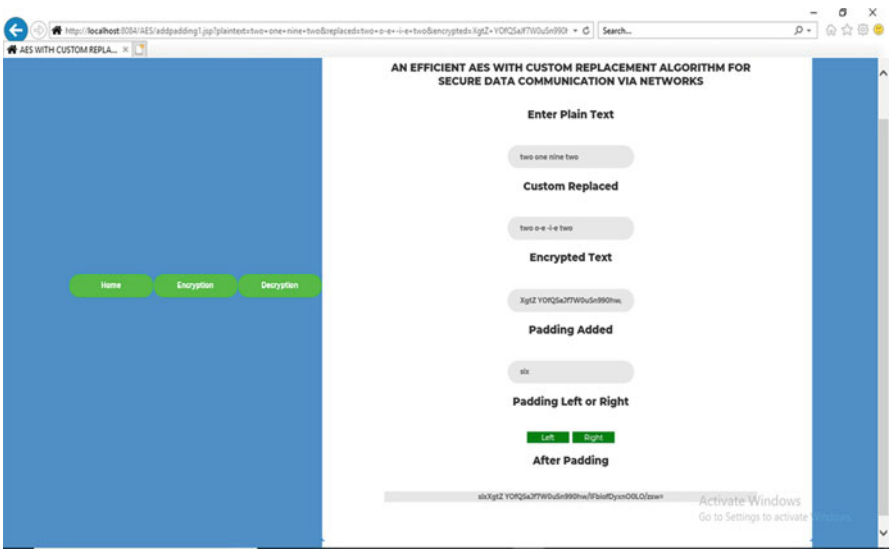



**Fig. 17.8** Result of custom configurable encryption

## 17.4 Result

Figure 17.8 shows the results of a custom configurable encryption algorithm to transmit and receive data in secure communication via networks. In this algorithm, using a custom replacement for plaintext and encrypt data with dynamic key with the size is 16-byte key length. The new key size is increased by 1 byte when the 16-byte data frame is sent. The frames sent in sequence according to equation $\text{Key}_n = \text{Key}_{n1} + 1$, finally add padding bits to the resultant encrypted data. As a result, the encryption of data using custom configurable encryption is using a dynamic key.

Figure 17.9 shows the custom configurable decryption process. İnitially removes padding to the encrypted data and decrypts the data using dynamic keys, where the characters are replaced by the corresponding values.

## 17.5 Conclusion

AES algorithm is proposed using the dynamic key method of a custom configurable encryption algorithm. Initially, plaintext replaced with custom replacement and 16-byte data into the frames and transmitted in sequence and each frame transmits varies the key. With this key change, data security in communication networks will be improved. The above algorithm is an encryption technique for the transmission of data to ensure that the data is not accessed anonymously.

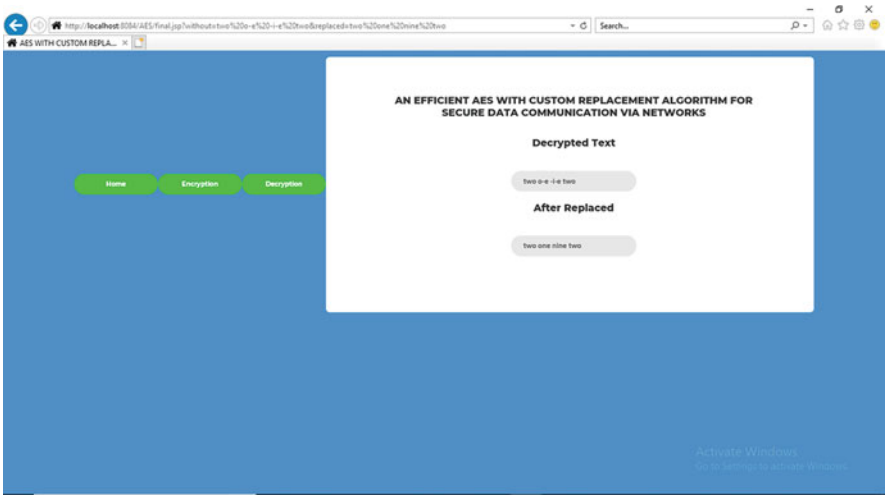



**Fig. 17.9** Result of custom configurable decryption

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# Chapter 18
# Efficient Prevention Mechanism Against Spam Attacks for Social Networking Sites


**A. Praveena and S. Smys**

## 18.1 Introduction

Online social networks are growing day by day similarly its usage also multiplied in terms of great extent. It is used to represent the users to share, display, and represent various feelings by means of text format. These attributes are representing their personal details that may be visible to everyone, and it will be hidden by themselves. Social network is the structure in which the people or a group of associations called hubs is associated by at least one particular sorts of interconnection. It may be a companionship, college team members, family members, trade relationship, etc. Some interpersonal interaction will exchanged with a group of people and shared through networks that are associated through the system. These destinations are exceptionally helpful in maintaining the relationship and associating the general population with intrigue, for example, music or games and so on. In such cases, the data security and images are threatened by various attacks. Hence, there is a need for research activity to identify the attacks present in the real-time issues.

Identifying each attack on a single user or client is one of the major challenges. Cloning attack is a malignant attacks prevailing in the social networks. In describing Facebook or Twitter, everybody will post their own images and somebody will always refresh their status. Nowadays, the social network adapted a security scheme named as profile guard. It makes the profile visible only if they are friends or in a contact.

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In some cases, there is a chance of misusing the user information without knowledge of the person. As per the Wolfe statement, the worst social media attacks are predicted. In that social media attacks are specifically targeted. Web-based social networking has turned vulnerable for the cybercriminal activities. Channels attract the hackers. Hence, there is a need for detecting and controlling various attacks like hacking, denial of service attack, cyber stalking, software piracy, phishing, credit card fraud, and virus dissemination. This research focuses on analyzing the social network attack with its motivation, objective, and its contribution. Section 18.2 provides the detail description of various research activities contributed toward the attack detection and avoidance or prevention. Similarly, Sect. 18.3 provides the problem identification and its solution. Then, research methodology is considered here to analyze the operation of neural network standards and swarm-based algorithms under Sect. 18.4. Finally, the results are observed under Sect. 18.5, and conclusion is carried out in Sect. 18.6 with future work.

## 18.2 Literature Survey

Researchers and scientists from all orders regularly need to manage the established issue of worldwide enhancement where the fundamental target is to decide an arrangement of specific model. It is represented to predict the parameters or state factors that must proceed with estimation of a predefined attack or an arrangement of ideal exchange off qualities on account of at least two clashing destinations. Burnap et al. (2014) discussed about the case of the terrorist event in Woolwich, London, in 2013.

In recent days, according to Zephoria, Facebook is a very popular means of social networking, especially in several English-speaking countries, attracting 2.20 billion monthly active Facebook users for Q1 2018. The username and their details are easily retrieved or accessed by that team or group members. This is the first source for hackers or attackers. Table 18.1 describes the active users in social network

**Table 18.1** Monthly active users in social networks

| Social network | Monthly active users |
|---|---|
| Facebook | 2,200,000,000 |
| YouTube | 1,800,000,000 |
| Instagram | 800,000,000 |
| Twitter | 336,000,000 |
| Pinterest | 200,000,000 |
| Ask.Fm | 160,000,000 |
| Tumblr | 115,000,000 |
| Flickr | 112,000,000 |
| Google+ | 111,000,000 |
| LinkedIn | 106,000,000 |

surveyed by Lee (2010), Pritikallas (2018) and Wolfe, S (2018). Though the spam prevention techniques available in the mailbox, still the mailbox remains flooded with the spam mails and it was suggested by [Burnap, Pet.al (2014), Hong, J (2012)]. The content-based filtering techniques such as the support vector machine, KNN, and Naïve Bayes are used as rule filters and employed in the inbox of the users to reduce the spam in the inbox. The programming for the spam filter enables to reduce the spam in the mail. Boyd, D et al. (2016), Sathesh A (2019) and Karthiban et al. (2019) suggested that anti-spam developers should not only concentrate in filtering of spam but also should consider costs associated with it.

## 18.3 Problem Identification

In social network, the information and the person's identity are linked and all the information are directed with certain intention to the people viewing the message. This reaches a privacy breach if the information disclosed is beyond the scope privacy breach. More than half a billion users are using OSNs and are sharing their details online. With so many privacy concerns, the OSN users would prevent themselves from sharing information. This would essentially bring down the social capital of the online community making it a social and stagnant. Therefore, we aim to develop efficient privacy enhancing algorithms and frameworks that could ensure users' information privacy, protect it from unwanted disclosures and maintain the social capital of the community.

Recent social frameworks empower new open doors for members to draw in, share, and collaborate with each other. This people group esteem and related administrations like inquiry and promoting are undermined by spammers, content polluters, and malware disseminators. With an objective to save the network and guarantee long-term achievement, a swarm-based approaches are revealing social spammers in online social frameworks. Hence, various social networking concepts that are adapting the challenge of sending unwanted requests, messages, postings, etc., which is similar to the mail which is transferred to the spam directory.

## 18.4 Research Methodology

### *18.4.1 AdaBoost LogitBoost Algorithm*

The AdaBoost algorithm, introduced by Freund et al. (1995) [2], is used for many practical difficulties. It is derived from the basic boosting algorithms. Figure 18.1. provides the AdaBoost pseudo code. Initially the training data are fed as input to the algorithm, which is described as (x1; y1) ... (xm; ym) with every xi belonging to the domain space of X and with every label yi denoted in some label Y. In some cases the value of $Y = \{-1, +1\}$ is assumed. Based on the calls of the AdaBoost,

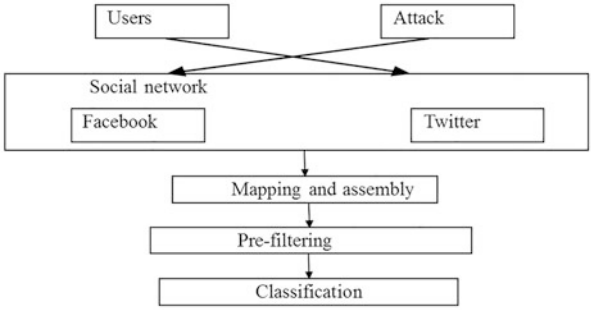


**Fig. 18.1** Overview of the spam detection framework

the algorithm is repeated in series of rounds t = 1, 2 ... T in order to retain the set of weight over the training data. The weights of this unit are distributed in "i" and T units denoted by(i). Though equal weights are set after every round, the weights in the training set get increased. The weak hypothesis is identified by the weak learner's job $h_t : X \rightarrow \{-1, +1\}$ denotes distribution Dt., achieved after the error measurement.

With respect to the Dt, the training is done for the weak. The weak hypotheses are rules are sub-collections that examines are chosen.

Given (x1, y1) ... (xm,ym) where $x_i \epsilon X$, $y_i \in Y = \{-1, +1\}$.

**Step 1:** Initialize

$D_i(i) = \frac{1}{m}$ For t = 1 .T Train weak learner using distribution Dt.

**Step 2:** Get weak hypothesis $h_t : X \rightarrow \{-1, +1\}$ with error $\epsilon_t = P_{r_{i\sim Dt}}[h_t(xi) \neq y_i]$

**Step 3:** Choose $\propto_t = \frac{1}{2} \ln \frac{(1-\epsilon_t)}{\epsilon_t}$

**Step 4:** Update the value $D_{t+1}$(i)

Where Zt is a normalization factor output of the final hypothesis:

$$H(x) = \text{sign}\left(\sum_{t=1}^{T} \alpha_t h_t(x)\right)$$

## *18.4.2 Chaos Genetic Algorithm*

Generally, the usages of chaos in many applications were increased. In this research the analysis and result that show the features are important to efficiency enhancement. By modifying the genetic algorithm, the chaotic function is a very known function and is given below.

$$Z_{n+1} = \lambda\,(1 - Z_n)$$

From the equation, the value takes Zn, which may be from 0 to 1. The variation in Zn provides the new value Zn + 1. Repeat the process if new value of Zn occurs. Where λ is the parameter value represented between 0 and 4 for full length, if the iteration occurs then the value remains constant. The behavior of variable z depends upon the λ, it could be periodic, convergent, and chaotic. If the value of the λ is less than 3 then it leads to solutions of convergent. If the λ is between 3 and 3.56 then the periodic behavior occurs. If the value is in between 3.56 to 4 then the system is fully chaotic, it may be neither convergent nor periodic.

### *18.4.3 Proposed Hybrid Optimization*

Glowworm is the common name for various groups of insect larvae. It includes Elateridae, Lampyridae, and several members of the families Phengodidae. Krishnanand and Ghose (2009) proposed Glowworm Swarm Optimization (GSO) as a novel technique based on the SI with an objective to multiple optimization. This optimization employs with physical agents called glowworms. The glowworm *(m)* at time (*t*) has three significant parameters. It is based on the search space position (*xm*(*t*)), level of luciferin (*lm*(*t*)), and a the range of the neighbor (*rm*(*t*)). They stated that these three parameters may vary with respect to the time. In an ant colony optimization, the finite regions are randomly located in the search space but GSO have an advantage to distribute the glowworms randomly in the workspace. After this process, other parameters are initialized with predefined constants. This approach consists of machine learning algorithm (Wei 2005) to identify the attacker. The objective is to select the innermost data theft points by calculating the position of each attributes by weight age concept. After completing all the process, the glowworm swarm behavior is realized with machine learning to perform metrics. The training phases are represented with the sparse linear models to perform kernel function $\phi$ centered at various training phases.

$$y(x) = \sum_{i=1}^{N} k_i \phi\,(x - x_i)$$

where ki are linear combination weights y(x) is the sparse linear model and $\phi(x - x_i)$ is for multikernel cases.

The modification of Eq. 1 results in Eq. 2, to show multikernel relevance vector machine to perform distributed complex networks to find trilateration.

$$y(x) = \sum_{m=1}^{M} \sum_{i=1}^{N} k_{mi} \phi_m\,(x - x_i)$$

where $\kappa_{mi}$ is the multikernel weights of RVM.

In distributed network, the data propagation will be different, based on the location and its internal characteristics. It enables the automatic detection of proper kernel at each location. The main advantage of this method is that it can locate the node even if different types of nodes are in the same location. Hence, the trilateration is noticed by formulating the unknown nodes as x, y, and z. Next process is identifying the location. For this process, the swarm intelligence optimization-based algorithm is considered. Here, the glowworm-based algorithm is considered, which is derived by Krishnanand and Ghose (2005). The algorithm reflects the behavior of fireflies and lightning bugs.

Algorithm for proposed RVM-GSA-based optimization technique is given as follows:

**Step 1:** Initialize the dataset with each attributes.
**Step 2:** Select random samples and identify the particular affect dataset.
**Step 3:** Calculate the initial conditions and its attributes state with machine learning concepts.
**Step 4**: With respect to the user details, calculate the weight and utilize it for finding the attack with least cost.
**Step 5:** Find the attack node in a particular location based on following GSO process.

(i) Represent luciferin level of glowworm (i) and time (t), it is mentioned by li(t).
(ii) Find the nearest nodes (glowworm) that have higher intensity of luciferin.
(iii) Calculate the value li(t). For example, if $i = c$, then it results in lc(t). In this case, if d has the nearest location, then lc(t) moves toward ld(t). Here, c and d are glowworms.
(iv) Update process: It is given by $l_i(t+1) = (1-\rho)l_i(t) + \gamma J(x_i(t+1))$. Based on the node variation, we need to update the process.

**Step 6:** Assess the exact attack type and find the accuracy. Else go back to Step 4 and proceed until it locates the position.

## 18.5 Experimental Results

It is tested and implemented with the MATLAB simulation to estimate the perception power that prevails in between the spammer as well as users who are genuine. The receiver operating characteristics (ROC) is determined with the X axis denoting the false positive rate and Y axis the true positive rate. The accuracy of the system classifier is determined by this ROC. The corner left of the ROC curve determines the maximum accuracy. The ideal ROC curve includes the coordinate (0,1) that provides the 100% true positive rate (Fig. 18.2).

The collection of data is completely determined by each user, the Facebook (status update messages followers' information, following friend) information, and the user profile were gathered. The spam classification applied on the Twitter data

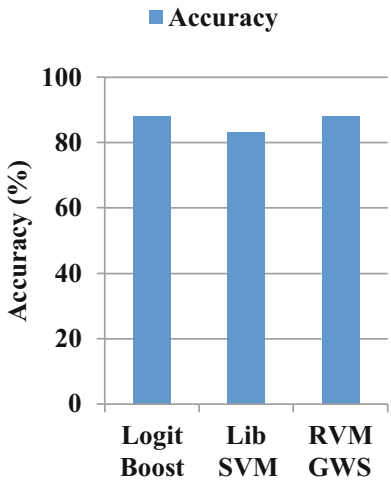


**Fig. 18.2** Experimental results in terms of accuracy

**Table 18.2** Experimental results

| Classifier | Accuracy (%) | False positive (%) |
|---|---|---|
| LogitBoost | 87.86 | 6.2 |
| Lib support vector machine | 83.09 | 10.2 |
| Relevance vector machineBased glowworm swarm | 88.10 | 6.1 |

predicts the nature of the profile as the a promoter, genuine, or spammer (Table 18.2).

Accuracy – It is the measures of classifier to generate an accurate classification of liver disease

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FN} + \text{FP}} = \frac{\text{Total number of correctly classified cases}}{\text{Total number of cases}}$$

## 18.6 Conclusion

The AdaBoost and chaos genetic algorithm were considered as existing, and they were compared with the proposed hybrid methodology. The investigation is based on the implementation of these methods to the cluster the user data vectors. The AdaBoost algorithm is effective to reduce the basic complex recognition problems. In chaos genetic algorithm, the process is based on the iteration such as evaluation, selection, crossover, and mutation. Hence the separable is easily for huge amount of dataset and further provided to clustering. The effective result proves that chaos genetic algorithm is better than AdaBoost algorithm. Similarly, hybrid proposed relevance vector machine-based glowworm swarm optimization technique is considered to test the complex data collected from the real-time

Facebook statistics. It is observed that high dimensional problems are easily solved with exact Receiver Operating Characteristics. The accuracy of the RVM GWS is the maximum value represented as 88.10.

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# Chapter 19
# Interactive English Language Mobile Application


**Blanka Klimova and Ales Berger**

## 19.1 Introduction

Mobile devices are nowadays more common among young generation groups than traditional desktop computers. In fact, only 40% of people in developed countries are using the traditional desktop computer [1, 2]. Currently, more than 90% of young adults between 18 and 29 years possess a smartphone [3] and use it in all their everyday activities since these devices are portable, ubiquitous, and interactive. Thus, young people can access the Internet at anytime and anywhere, especially in developed countries [4].

Therefore, the use of mobile phones, respectively smartphones, is no exception in education where students use them for expanding their knowledge about the discussed topic or communicating with their peers and teachers. This is also true for foreign language learning. Currently, there are several mobile applications for teaching English as a foreign language (TEFL) (cf. [5]). In order to make students motivated to learn English and tailor learning material to their needs, English language teachers with the help of the faculty programmers at the University of Hradec Kralove (UHK) in the Czech Republic decided to develop and implement such a smartphone application (app) in the teaching of English to students of Management of Tourism (MT).

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## 19.2 Literature Review

The findings of the literature review show that the use of smartphone apps has positive effects on English learning among university students aged between 18 and 28 years [5–14]. Although there is an increasing number of smartphone apps used for all aspects of English language learning, they are mostly exploited and effective in vocabulary learning [14]. This was confirmed, for instance, by Lee [7], who in his study discovered that learning English vocabulary via the smartphone apps was enhanced, both when learning independently and with a teacher, in comparison when using traditional printed textbooks. In the study by Luo et al. [8], it was also revealed that the smartphone apps had improved students' vocabulary and sentence structure, but not comprehension. However, it is important to learn this vocabulary in the context, which also contributes to easier retention of new words. Another important fact is the use of media in learning new words, such as audio input, which also contributes to the reduction of cognitive load of learning new words [12].

The results of the identified articles from the literature review indicate that EFL learners when applying mobile apps in their learning are more stimulated to study both formally (i.e., in the face-to-face classes) and informally (i.e., outside the classroom settings) [5, 6, 15]. Furthermore, they exhibit less anxiety [8]. Other research [16] shows that mobile apps are also exploited in developing EFL writing skills, especially in developing their accuracy. The research studies also reveal that Android is the most common operating system in this respect [13, 17].

The main limitations of the reviewed studies were that they included small and homogeneous sample sizes [18].

## 19.3 Smart Solution to Interactive English Education at FIM

Teaching English at the Faculty of Informatics and Management of UHK takes place throughout the whole existence of the faculty, and eLearning and blended learning methodologies have already been implemented [19–21]. In the winter semester of 2017, several students were given the opportunity to try out completely new teaching and learning method. This is the use of smart mobile devices and their potential in a project called Anglictina Today (Fig. 19.1 below). The design and content of the app were tailored to students' study needs. The findings of their needs analysis confirmed the findings of the literature review that students would like to enhance their vocabulary.

The main benefit of the entire learning environment is a chance for the student to be in almost immediate contact with his/her teacher, which leads to a greater motivation of the students and shows the real information about the results and the course of study of all the students. Nowadays, there are many mobile applications for teaching English phrases and vocabulary, but there is no communication between

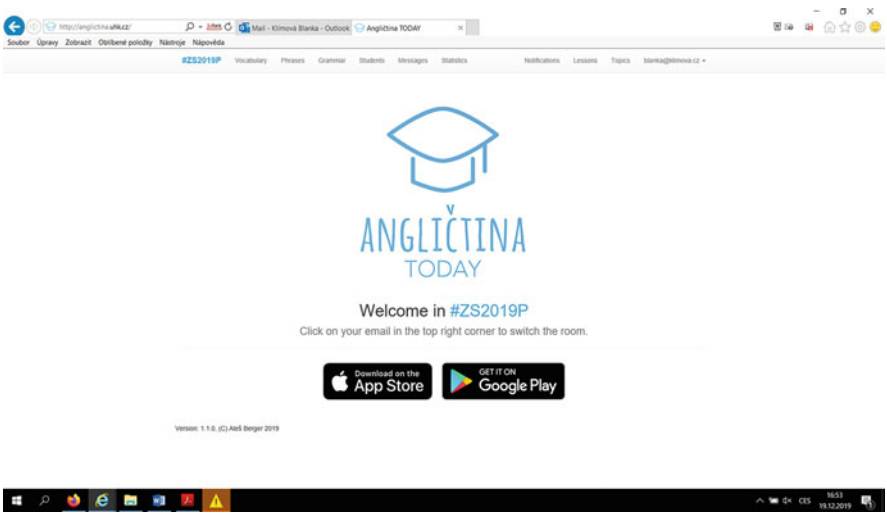


**Fig. 19.1** Anglictina Today – an example of the website part

the teacher and the student. The introduced solution offers this option and opens up a new perspective on the entire teaching.

The entire platform is split into a website part and mobile part and one server part. The server part is responsible for efficient data retention, user authentication, data capture, news distribution, and response to events. The website part (Fig. 19.1 below) has a number of functions, especially for teachers. This is mainly the administration of students, vocabulary and phrases, as well as the distribution of alerts and responses to comments. One of the main aspects is also a possibility to see learners' results.

The mobile app is targeted at students. It offers the opportunity to study new vocabulary and phrases and then to test their knowledge. The application collects all data about the users/students and sends them to the server section for their analysis and assessment. After testing, the Internet domain www.anglictina.today was purchased, where the project English Today was located. There is also a website environment for the tutor on this domain. The mobile application for students is published and freely available on Google Play.

To build a complete solution, it was necessary to overcome many decisions and propose an optimal and advantageous solution, whose outcome then was Firebase technology from Google Inc., which has broad possibilities and many of its services were used in this project. It can be referred to as the server part of the project. The application part for the teacher was built in the way of the Internet application, mainly because of the simple accessibility by the tutor. The programming language is JavaScript, more precisely ECMAScript 6. Furthermore, the authors added Google Cloud Messaging, which enables the tutor to send notifications to his/her

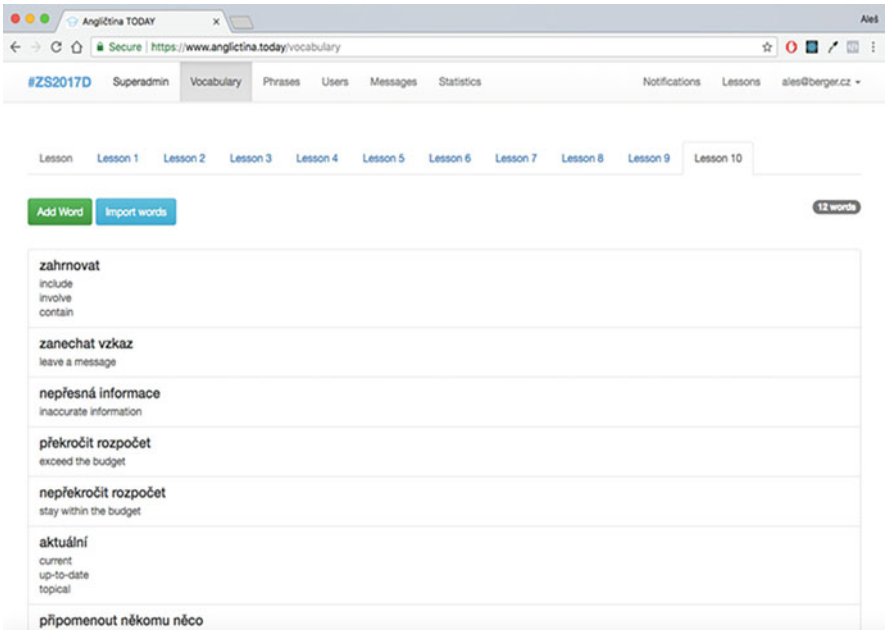


**Fig. 19.2** Web app of vocabulary lesson (authors' own processing)

students. After logging in, the teacher can edit individual lessons, their vocabulary and phrases (Fig. 19.2), or see the students' results (Fig. 19.3).

On the contrary, students can access the application via Google Play and use the following app functions on their smartphone with the Android operating system (Fig. 19.4).

## 19.4 Conclusion

Both the literature review and the analysis of students' needs have revealed that the most suitable smartphone app for learning English should focus on the enhancement of students' vocabulary, respectively phrases, which is in fact one of the core skills students need to know to be able to communicate in a foreign language. In addition, this article has provided a description of the development and implementation of one of these apps for learning English vocabulary and phrases. Although this pilot project is still in its infancy, so far it has seemed to be a smart solution to develop an interactive English education and the students welcome it.

At the end of the semester, students' results will be evaluated and analysis will be made on the shortcomings of the solution. New supplements will be then proposed. Further, the research and implementation of an improved solution will continue. For

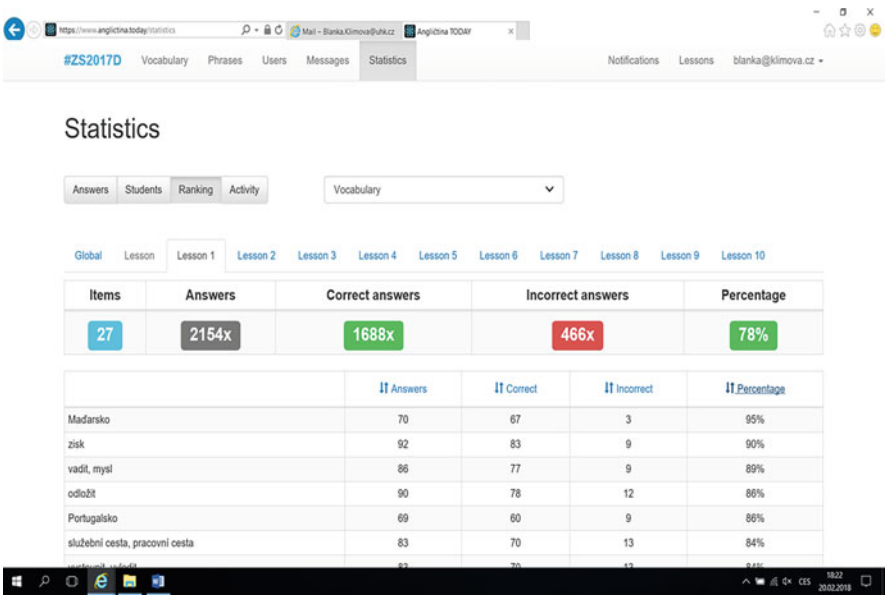


**Fig. 19.3** Web app of students' achievements from Lesson 1 on vocabulary (authors' own processing)

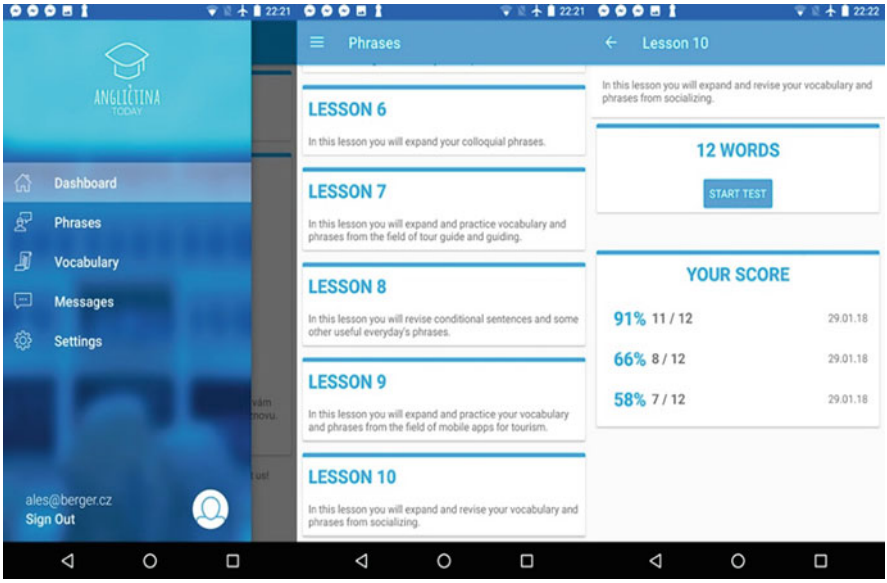


**Fig. 19.4** Mobile app screens (authors' own processing)

testing, the app can be downloaded free of charge on Google Play or on a Google Play store, possibly one might ask the authors for access to the teaching section.

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# Chapter 20
# Numerical Evaluation of Highly Oscillatory Integrals of Arbitrary Function Using Gauss-Legendre Quadrature Rule


**K. T. Shivaram and H. T. Prakasha**

## 20.1 Introduction

The numerical integration of a highly oscillating function is one of the most difficult parts for solving applied problems in signal processing, image analysis, electrodynamics, quantum mechanics, fluid dynamics, Fourier transforms, plasma transport, Bose-Einstein condensates, etc. Analytical or numerical calculation of these integrals are difficult when the parameter Ω is increased, In most of the cases, lower-order quadrature methods are failures such as trapezoidal rule, Simpson's rule, etc. The numerical quadrature method for oscillatory integrals was first implemented by Louis Napoleon George Filon [1]; Filon-type methods show the efficiently computing aspect of the Fourier integral computation of moments where something other than x is itself a difficult task. Levin and Sidi [2] evaluate the first few oscillations of integrand using a standard process, David Levin [3]. the modified method that does not require the calculation of the moment. Iserles [4] developed a similar method by the use of higher-order derivatives of the integrand. Evans and Chung [5] proposed a numerical integration method for computing the oscillatory integrals; recently Ihsan Hascelik [6] evaluate the numerical integrals with integrands of the form on 0, 1. by n-point Gauss rule of three-term recurrence relation method. The integration rule proposed in this paper requires the zeros of $P_{2n}$ (x) and computed associated weights. The integration points are increased in order to improve the accuracy of the numerical solution. The reminder of this paper is presented as follows. In Sect. 20.1, mathematical preliminaries are required for the understanding concept of the derivation and also calculated Gauss-Legendre

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quadrature sampling points and its weights of order N = 20, 50, 100. Section 20.2 provides the mathematical formulas and illustrations with numerical examples (Fig. 20.1).

## 20.2 Gauss-Legendre Quadrature Formula over Oscillating Function

If $\omega = 1$, $r = 2$, numerical integration of an arbitrary function f is described as

$$\begin{aligned} I1 &= \int_0^1 f(x)\cos\left(\frac{1}{x^2}\right)dx = \int_0^1 f\left(\sqrt{t}\right)\cos\left(\frac{1}{t}\right)\frac{dt}{2\sqrt{t}} \\ &= \sum_{i=0}^{m} w_i \frac{1}{2} f\left(\sqrt{t_i}\right)\cos\left(\frac{1}{t_i}\right)\frac{1}{\sqrt{t_i}} \\ &= \sum_{i=0}^{m} w_i \frac{1}{2} f\left(\sqrt{x_i}\right)\cos\left(\frac{1}{x_i}\right)\frac{1}{\sqrt{x_i}} \end{aligned} \tag{20.1}$$

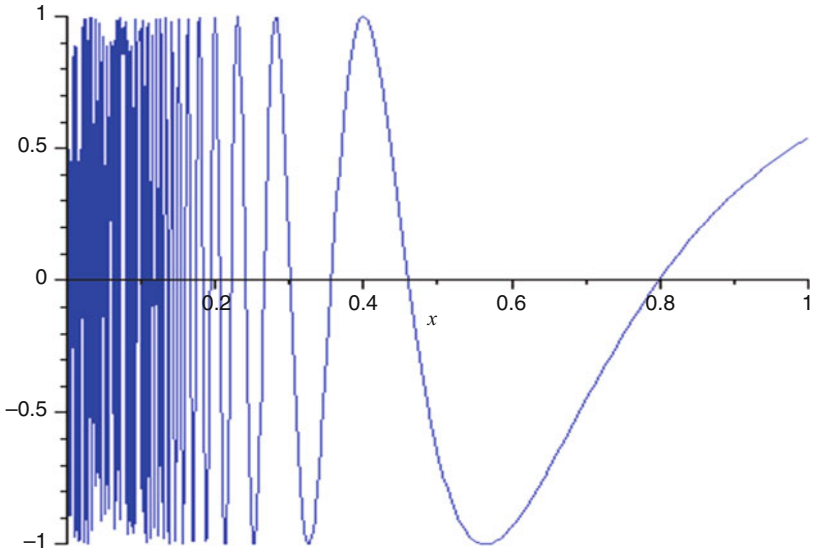
If $\omega = 2$, $r = 200$, numerical integration of an arbitrary function f is described as

$$\begin{aligned} I_2 &= \int_0^1 f(x)\cos\left(\frac{2}{x^{200}}\right)dx = \int_0^1 f\left(t^{\frac{1}{200}}\right)\cos\left(\frac{2}{t}\right)\frac{t^{\frac{-199}{200}}dt}{200} \\ &= \sum_{i=0}^{m} w_k f\left(t_i^{\frac{1}{200}}\right)\cos\left(\frac{2}{t_i}\right)\frac{t^{\frac{-199}{200}}}{200} = \sum_{i=0}^{m} w_i f\left(x_i^{\frac{1}{200}}\right)\cos\left(\frac{2}{x_i}\right)\frac{x_i^{\frac{-199}{200}}}{200} \end{aligned} \tag{20.2}$$

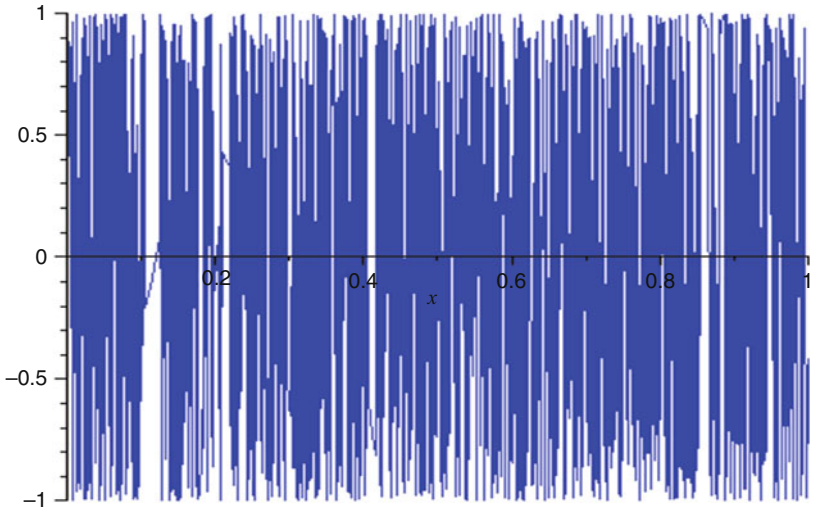
If $\omega = 2$, $r = 1$, numerical integration of an arbitrary function f is described as

$$\begin{aligned} I_3 &= \int_0^1 f(x)\sin\left(\frac{2}{x}\right)dx = \int_0^1 f(t)\sin\left(\frac{2}{t}\right)dt \\ &= \sum_{i=0}^{m} w_k \frac{1}{2} f(t_i)\sin\left(\frac{2}{t_i}\right) = \sum_{i=0}^{m} w_i \frac{1}{2} f(x_i)\sin\left(\frac{2}{x_i}\right) \end{aligned} \tag{20.3}$$

If $\omega = 1, r = 200$, the numerical integration of an arbitrary function f is described as

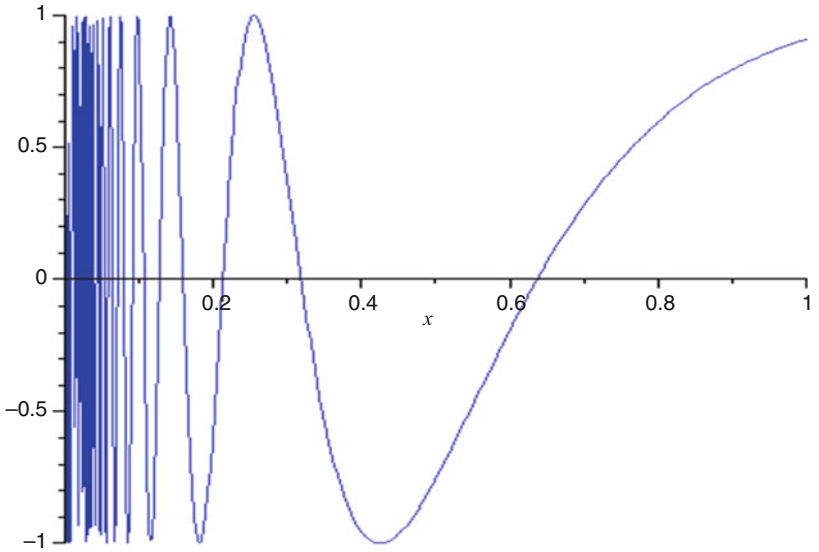



**(a)**

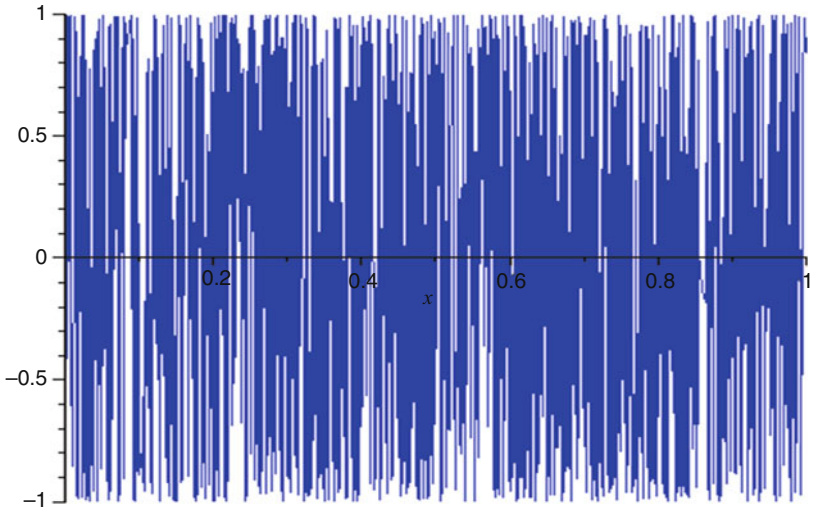



**(b)**

**Fig. 20.1** Oscillation of weighted functions. (**a**) w (x) $= \cos\left(\frac{1}{x^2}\right)$. (**b**) $w(x) = \cos\left(\frac{2}{x^{200}}\right)$. (**c**) $w(x) = \sin\left(\frac{2}{x}\right)$. (**d**) $w(x) = \sin\left(\frac{1}{x^{200}}\right)$




**(c)**




**(d)**

**Fig. 20.1** (continued)

$$I_4 = \int_0^1 f(x)\ \sin\left(\frac{1}{x^{200}}\right) dx = \int_0^1 f\left(t^{\frac{1}{200}}\right) \sin\left(\frac{1}{t}\right) \frac{t^{\frac{-199}{200}} dt}{200}$$
$$= \sum_{i=0}^{m} w_k\, f\left(t_i^{\frac{1}{200}}\right) \sin\left(\frac{1}{t_i}\right) \frac{t^{\frac{-199}{200}}}{200} = \sum_{i=0}^{m} w_i\, f\left(x_i^{\frac{1}{200}}\right) \sin\left(\frac{1}{x_i}\right) \frac{x_i^{\frac{-199}{200}}}{200} \tag{20.4}$$

where $\xi_i$ and $\eta_j$ are sampling points and $w_i$ and $w_j$ are corresponding weights. We can rewrite Eq. (20.1) as where $\xi_i$ and $\eta_j$ are sampling points and $w_i$ and $w_j$ are corresponding weights. We can rewrite Eq. (20.1) as

$$I_1 = \sum_{i=0}^{m} w_k\, f\ (\ x_k\ ) \tag{20.5}$$

where $W_k = \frac{1}{2\sqrt{x_i}} \cos\left(\frac{1}{x_i}\right) * w_i$ and $x_k = \sqrt{x_i}$. We have demonstrated the algorithm to calculate sampling points and weights of Eq. (20.5) as follows:

*Step* 1. $k \to 1$
*Step* 2. $i = 1, m.$
*Step* 3. $W_k = \frac{1}{2\sqrt{x_i}} \cos\left(\frac{1}{x_i}\right) * w_i$

$x_k = \sqrt{x_i}$

*Step* 4. compute step 3.
*Step* 5. compute step 2

Computed sampling points and corresponding weights for different values of N are based on the above algorithm.

## 20.3 Numerical Results

Compare the numerical results obtained with that of the exact value of various order N = 20, 50, 100 by Gauss-Legendre quadrature rule; these are tabulated in Table 20.1, and results are accurate in order to increase the order L.

## 20.4 Conclusion

In this paper, numerical integration of the form $\int_0^1 f(x) \sin\left(\frac{\omega}{x^r}\right) dx$ and $\int_0^1 f(x) \cos\left(\frac{\omega}{x^r}\right)\ dx$ are evaluated numerically with different values of $\omega$ and $r$

**Table 20.1** Compare the numerical results by using Gauss-Legendre quadrature rule

| Exact values | Order | Computed value |
|---|---|---|
| $\int_0^1 \frac{-8x}{x^4+4} \cos\left(\frac{1}{x^2}\right) dx$ $= 0.0946528064$ Hascelik 6 | $L = 20$ $L = 50$ $L = 100$ | 0.0894310923 0.0946122970 0.0946528381 |
| $\int_0^1 -x^2 \cos\left(\frac{2}{x^{200}}\right) dx$ $= 0.002110004128$ | $L = 20$ $L = 50$ $L = 100$ | 0.00160917532 0.00229053172 0.00211090975 |
| $\int_0^1 \frac{x}{(3x+2)} \sin\left(\frac{2}{x}\right) dx$ $= 0.0182548954$ | $L = 20$ $L = 50$ $L = 100$ | 0.01624179037 0.01816533218 0.01825483641 |
| $\int_0^1 x^2 \sin\left(\frac{1}{x^{200}}\right) dx$ $= 0.003117835926$ | $L = 20$ $L = 50$ $L = 100$ | 0.001821673088 0.003127131233 0.003117361087 |
| $\int_0^1 \frac{20}{(x^2+4)} \sin\left(\frac{2}{x}\right) dx$ $= 0.193783272144$ Hascelik 6 | $L = 20$ $L = 50$ $L = 100$ | 0.134418903421 0.192247814349 0.193780915316 |
| $\int_0^1 e^{5x} \sin\left(\frac{1}{x^{200}}\right) dx$ $= 0.461841915645$ Hascelik 6 | $L = 20$ $L = 50$ $L = 100$ | 0.561087771890 0.461889135655 0.461841783027 |

. We have applied Gauss-Legendre quadrature rules of order 2 L to evaluate the typical numerical integration of highly oscillating function.

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# Chapter 21
# An Automated System to Detect Phishing URL by Using Machine Learning Algorithm


**Deepa Parasar and Yogesh H. Jadhav**

## 21.1 Introduction

Over the past few years, the Internet has played an increasingly large part of everyone's personal and professional life. It is not necessary that every website is going to be easily accessible or moneymaking. Day by day more malicious or phishing websites have started to appear. This type of malicious websites is a threat to all facets of the consumer. This may result in economic losses for the consumer, although some may create misperception about the ethical administration of the country. Human comprehensible URLs are used to classify billions of websites running today's Internet [1]. Adversaries trying to gain unauthorized access to confidential data may use malicious URLs to present them to naive users as a legitimate URL. These URLs are called malicious URLs which serve as an unwanted activity gateway [2]. These malicious URLs can result in unethical activities such as theft of confidential and private information. It could lead to ransomware deployment on user phones. Many security agencies are prone to various malicious URLs because they can place the government and private organizations' confidential data at risk.

Some encourage their users to use social networking sites to publish unauthorized URLs. Many of these URLs are synonymous with business promotion and self-advertising, but some of them may pose a vulnerable threat to naive users. Naive users using malicious URLs will face the adversary's extreme security threats [3]. To ensure that users are not allowed to visit malicious websites, validation of URLs is very necessary. Several methods have been suggested to detect malicious URLs.

One of the basic features that a program should have is to allow the harmless URLs of the user to be requested and to prevent the entry of malicious URLs. This

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is done by alerting the user that it was a malicious website, and they should take precautions in the future. Instead of focusing on the syntactic properties of the URL, a program can take semantic and lexical properties from each URL. Traditional methods like blacklisting [4] and heuristic classification [2, 5] can identify and block such URLs until they enter the client. One of the basic methods to detect malicious URLs is blacklisting [4]. The blacklist method is typically maintaining a database containing the list of all previously known malicious URLs. A server search is performed each time a new URL is identified in the process. Here, the new URL must fit and check that previously known malicious URL in the blacklist [6]. The update must be performed in blacklist whenever a new malicious URL is found in the process. With ever-increasing new URLs, the method is repetitive, time-consuming, and computationally intensive.

Another method is the heuristic classification [5] where the signatures are compared and checked to establish the connection between the new URL and the current malicious URL. While both blacklisting and heuristic classification can effectively distinguish malicious and neutral URLs, they cannot cope with the emerging attack techniques. One of these techniques has serious limitations in classifying newly generated URLs that they are inefficient. Most web-based companies use large servers that can store as many as millions of URLs and refine these URL sets on a regular basis. The main problem with these solutions is the human intervention required to maintain and update the URL list. We are proposing a new approach using advanced machine learning techniques that Internet users could use as a tool to overcome these limitations.

Our novel approach will distinguish between malicious and non-malicious URL using machine learning algorithms. Our System will use logistic regression, SVM (Support Vector Machine), and Naïve Bayes method on the URL database by extracting various features URLs such as host-based features and lexical features [4].

Focusing on the URL can often expose fake sites as well. There are a number of ways that hackers can modify the URL to look like the original, and if users are aware of this, they can test the site's security more easily.

In their White Paper, Watson et al. (2005) described "Know Your Enemy: Phishing," a collection of real-world phishing attacks collected in honeynets from Germany and the UK [5]. Honeynets are transparent software networks designed to gather information about various attacks in the real world for further forensic analysis. They found that phishing attacks using insecure web servers as hosts are by far the most effective for predesigned phishing sites compared to using self-compiled servers. For many different phishing sites, a compromised server is often a host. Having been uploaded to the cloud, such pages are often only available for a few hours or days.

Garera et al. (2007) focus on learning the URL structure used in different phishing attacks. They found that it is often possible to tell if a URL fits into a phishing attack without having to know the corresponding page data. This paper describes numerous features that can be used to distinguish between a benign and a phishing URL. Such features are used to design an efficient and highly accurate

logistical regression filter. This filter is used by the paper to conduct detailed measurements on various million URLs and to calculate the incidence of phishing on the Internet today [7].

Ma et al. (2009) suggest a system for classifying malicious URLs using a variable number of URLs lexical and host-based properties. They established a problem-based method based on automatic classification of URLs through statistical approaches to discover the telltale lexical and host-based properties of malicious website URLs. Through mining, these methods can learn extremely predictive models and automatically examine tens of thousands of features that may reveal suspicious URLs [8, 9].

## 21.2 Proposed System

A URL's two major components are the protocol identifier and resource name that specifies the address or domain name of the Internet where the resource is placed. The protocol descriptor and resource name separation syntax is a colon and two forward slashes separating the descriptor of the protocol and the resource name. The blacklist method is the traditional way to detect malicious URLs. It contains the list of URLs which were earlier declared deceitful and verified by sources. The proposed system identifies malicious URLs based on the machine learning approach and updates the URL into the whitelist and blacklist. Performance of three different machine learning approaches: logistic regression, Naive Bayes, and Support Vector Machine, has been done for classifying URL as malicious or not [10]. All these three algorithms are obtaining the appropriate lexical feature that could be used to determine perceptions for finding malicious URLs and then using this representation to train a system for further prediction. The architecture and flow diagram of the proposed system is shown in Figs. 21.1 and 21.2.

The data set of malicious and non-malicious URLs is collected for training purposes. The dataset used for the proposed system is a URL dataset from the website Kaggle, with 480,000 samples in the dataset, 384,000 of which are malicious URLs and others are normal URLs [11]. The proposed system uses feature extraction and data modeling of the URLs. A decision vector is created from the URL present in the dataset. The URL in the data set will get read one by one and every URL will go through the following operations as specified in the flow diagram shown in Fig. 21.1, such as extraction of different features like suspicious characters, no. of dots and slashes, etc. These extracted features are then used for training the classifiers. When the user enters the URL to check its authenticity, then first it is checked in the database. If the URL is present in the database, then it means that it has been already checked and found out to be malicious or not. Accordingly, the result is shown to the user and the session ends. But if the URL is not present in the database then the URL will go through all operations as mentioned in Fig. 21.2 and the result is provided to the user. Simultaneously, the database will also get updated.

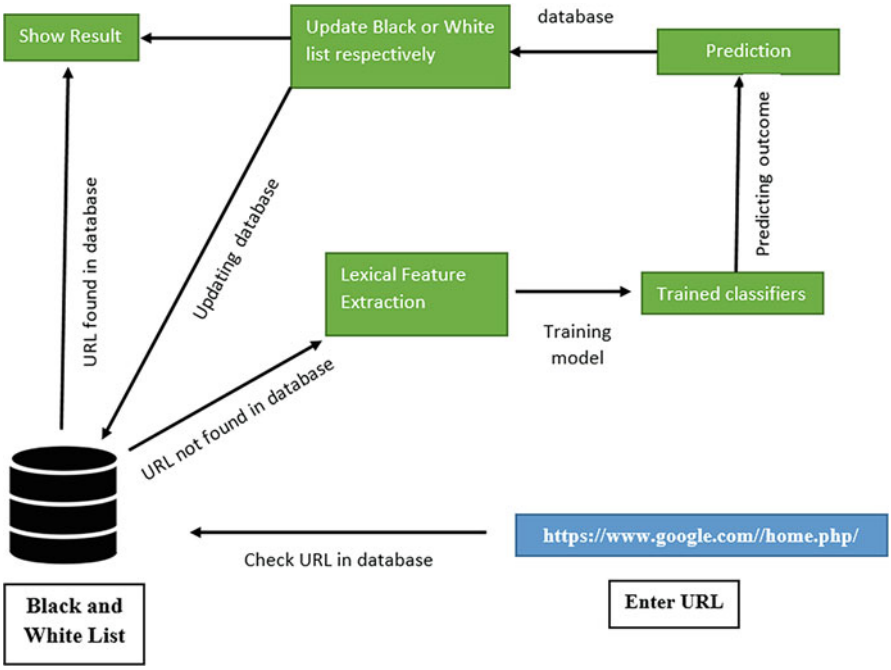


**Fig. 21.1** The proposed system's architecture

The data set of malicious and non-malicious URLs is collected for training purposes. The dataset of URLs used in this experiment is taken from the website Kaggle, with 480,000 samples in the dataset, 384,000 of which are malicious URLs and others are normal URLs [11]. The proposed system uses feature extraction and data modeling of the URLs. A decision vector is created from the URL present in the dataset. The URL in the data set will get read one by one and every URL will go through the following operations as specified in the flow diagram shown in Fig. 21.1, such as extraction of different features like suspicious characters, no. of dots and slashes, etc. These extracted features are then used for training the classifiers. When the user enters the URL to check its authenticity, then first it is checked in the database. If the URL is present in the database, then it means that it has been already checked and found out to be malicious or not. Accordingly, the result is shown to the user and the session ends. But if the URL is not present in the database then the URL will go through all operations as mentioned in Fig. 21.2 and the result is provided to the user. Simultaneously, the database will also get updated.

Black- and whitelist: Traditional black- and whitelist of URLs is the first step toward the categorization of a new URL. First level validation is done through the identification of normal and malicious URLs [4]. The standard URLs are applied to the whitelist, and the blacklist directory includes malicious URLs. For checking of

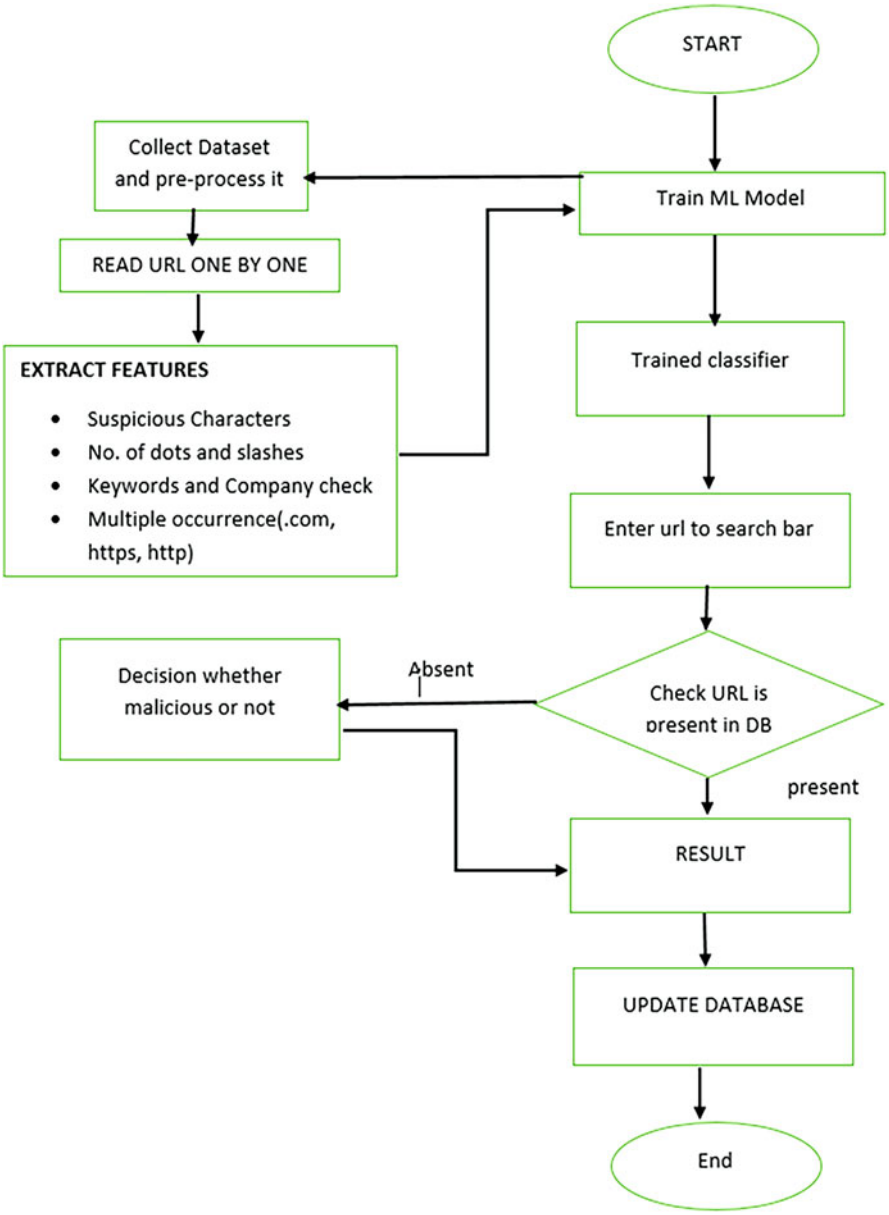


**Fig. 21.2** Flow diagram for malicious URL detection

any new URL, black- and whitelist is traversed to identify the category of URL. It determines whether the URL is in the blacklist or on the whitelist.

Lexical analysis: The second step for the identification of the URL category is the lexical filter. Inside the invalid domain name, it checks for keywords like "com," "www," etc. This checking is based upon the training of the system. Few rules to be checked for the domain name are:

- If there are more than four numbers
- Presence of special characters such as (#, $, @, ~, _, −)
- Top 5 URL address (com, en, net, org, cc)
- Repetition of "." symbol in the domain name
- Total count of characters in the address of the web

Flask framework: Flask is a popular web framework for Python, which means it is a third-party Python library used for web application development.

Feature selection: Syntax for a typical URL is like this http://www.example.com/index.html

Indicating the type of protocol (http), name of the host (www.example.com) is followed by extended file name(index.html).

Garera [12] and Gattani [13] make comprehensive assessments of the selection of URL features. The developer of a fake website knows that his website's domain name is at risk of being blocked, so when we purchase a web address called as a domain name, we often prefer to take cheap or even free domains for saving the cost. The characteristics usually carried by URL [14] and his domain are: (1) following TLD is not the standard domain name; (2) special characters in domain name; and (3) very long domain name.

Based on the content above, few rules can be summarized out to be used by classification methods:

If the domain name contains more than four numbers and presence of special characters addition to that if the URL contains any of some famous domains then it is likely benign URL [3]. The number of dots in the domain name is also very important in the classification of URL. Also, the total length of any URL or domain name can be used for a decision, as a phishing URL have a long domain name. The specific keyword is pushed in the training vectorizer for each of these feathers for training the model.

## 21.3 Classification Methods

### *21.3.1 Logistic Regression*

Logistic regression is the appropriate regression analysis to be carried out when the dependent variable is dichotomous (binary). Since it is a method of binary classification, it is also called binary regression. Logistic regressions are sometimes difficult to understand. The statistics of the intellects allow us to conduct the

analysis too quickly then deduce the performance. It has been observed that logistic regression in this proposed system takes less time for analyzing URLs.

### *21.3.2 Support Vector Machine*

A Support Vector Machine (SVM) is formally defined by a separate hyperplane which is used as a discriminatory classifier. A hyperplane is a line in two-dimensional space that divides a plane into two sections where it lies in each category on either side. SVM is nothing more than a supervised algorithm for machine learning that can be used for classification or regression challenges. It works very well with a clear margin of separation.

### *21.3.3 Naive Bayes*

Naive Bayes for a given element use the training set to measure its subfunctions for training purposes. Using a Gaussian distribution, the classifier is generated from the training set by measuring the mean and variance of each subfeature [15]. Specific category likelihood is determined. The test sample is taken for classification with its measured function. Posterior is determined for each category (malicious, normal). The base for the Naïve Bayes algorithm is Bayes' theorem with naive independent assumptions of Bayesian statistics, according to which in relation to each other all features are self-determined. The classification approach of Naive Bayes decides on the basis of probability by treating the characteristics separately, even if they are dependent on one another or other characteristics. The increasing feature may lead to the probability of marking the data independently. This approach is mostly applicable in text classifications and in complicated predictions with high-dimensional information. Naive Bayes probabilistic classifier generates rules based on initial knowledge and previous assumptions. It uses the concept of a similar attribute to predict the probability of different classes.

## 21.4 Results and Discussion

The dataset used for the proposed system consists of 480,000 samples of URL out of which 384,000 are malicious URLs and remaining normal URLs [11]. The dataset was divided into the ratio of 75:25 as a training sample and testing sample. The three different machine learning algorithms have been implemented to classify the URL into malicious or normal. Lexical analysis has been performed on the URL to extract the lexical feature. We endorsed the lexical feature derived from the bigrams of the URL and the term frequency. The reverse of the term frequency provides a minimal

**Table 21.1** Accuracy measure of different classifiers

| Algorithm | Accuracy |
|---|---|
| Logistic regression | 80% |
| Support Vector Machine | 85.35% |
| Naïve Bayes | 49% |

classification setting. The main task of classifying URLs is done through logistic regression, Naïve Bayes algorithm, and Support Vector Machine. The comparative accuracy of the abovementioned algorithms is shown in Table 21.1.

## 21.5 Conclusion

For the identification of malicious URLs, the traditional list of URLs stored as black- and whitelists and machine learning algorithms have been used in this article. Hackers circumvent anti-spam filtering strategies by placing malicious URLs in the message content. Hence the method of the URL analyzer detects the malicious URL with the aid of a reduced phishing feature set. Malicious URL detection plays a critical role in many cybersecurity applications, and approaches to machine learning are clearly a promising direction. In this paper, using machine learning techniques, we gave a detailed introduction to malicious URL detection. Here, we compared three different machine learning approaches to identify whether the URL is a phishing URL or not. Among logistic regression, Naïve Bayes, and Support Vector Machine, accuracy for identification of malicious URL is high for Support Vector Machine and with respect to time consumption more efficient one is logistic regression.

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# Chapter 22
# An Automated Test Framework for Regression Test Selection for Web Services


**Divya Rohatgi, Gyanendra Dwivedi, and Tulika Pandey**

## 22.1 Introduction

Web services belong to a class of applications built as per the framework of service-oriented architecture. These applications are particularly applicable to provide dynamic functionalities. For tagging of information, they use XML, and for service behavior, WSDL is used. They have given altogether a different approach to develop applications and to increase the productivity of organizations. With the help of these services, organizations can develop business functionality which as per demand can be offered for use and which as per requirements can be integrated with different other available services to impart a better or evolved function. So as per change in business scenarios, such services have to undergo frequent changes. Thus they should be properly maintained. Software maintenance is a software engineering activity that is required whenever the software undergoes a change due to bug or evolution. It is considered to be the most expensive activity in terms of time, cost, and effort. One of the activities of software maintenance is regression testing. This activity requires executing all already written test cases in order to verify that new modifications in the software have not introduced new errors in an already corrected program. Regression testing consumes a considerable amount of maintenance costs. As these services are having heterogeneous plus dynamic nature, the regression

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https://doi.org/10.1007/978-3-030-49795-8_22

testing of such applications becomes a difficult task. Thus if we want to reduce maintenance cost then we have to emphasize on minimization of regression testing efforts. Many authors have proposed various strategies and methods for regression testing, in which regression test selection is a promising one. It requires the selection of a subset of test cases from the existing test suite and executing them in contrast to the execution of all the test cases in a test suite. This research paper elaborates on various methodologies for regression testing especially of web applications and web services and presents a framework aided by a tool that helps in regression test selection of web-based applications particularly web services.

## 22.2 Literature Review

Due to problems in the regression testing of web-based applications, various authors have proposed different approaches. This section covers the literature review covering the regression test selection approaches of web-based applications specifically web services. Nauman bin Ali et al. [1] demonstrated the concept of regression testing and explained that it is used to make sure that new modifications in the program do not add to new bugs. Legunsen et al. [2] emphasized that test selection for regression testing can increase the speed of execution as it runs only those tests which are having an impact due to the change in the program. Athira et al. [3] presented a UML model that is based on the preference factor of the test cases. The author used the activity diagram for coverage data. To decrease the test cases, priority rules were used. Avritzer and Weyuker [4] presented a methodology to get test cases by getting profile data. Daou et al. [5] used data flow information for programs that are data centric. Gagandeep et al. [6] presented a technique that is based on a model applicable for regression testing of web-based applications. The authors presented four steps in the model which include domain analysis, model traversal and test case generation, optimization of test cases using coverage criteria, and lastly production of a regression test suite. Hossain Md [7] used reusable limit value for web application regression testing. Nooshin Anari et al. [8] used semantics for WSDL which is a language for web services description and with the help of which automated tests are developed. Zarrad Anis et al. [9] have done a very organized review of regression testing techniques for web applications which helps in the selection of suitable technique. Anneliese Andrews et al. [10] recognize test cases as reusable, retestable, and obsolete. The authors presented a model-based regression testing black box in nature. In [11] Rothermel and Harrold explained challenges for regression test selection in which first is related to the approach to choose the test cases and second is to find the time and approach to augment the previous test suite. Claudio et al. [12] proposed an analysis of the keyword for regression testing. Ruth [13] has shown empirical studies of Privacy-Preserving Regression Test Selection Techniques for Web Services. In [14] Izzat Alsmadi has reported that it is urgent to decrease test suite in case of web services as compared

to conventional programs. Masood et al. [15] presented a safe and automated testing approach for regression which uses original and modified WSDL.

## 22.3 Proposed Approach

For some software like web-based applications, software testing particularly regression testing is a challenging plus costly effort for the testing team as they are constantly changing and evolving applications. Thus to reduce regression efforts, regression test selection is a good candidate. This section presents the proposed framework supported by an automated tool for choosing test cases for regression, particularly which is known as RTS or regression test selection in literature. The input to the framework is web-based applications containing web services. In the proposed framework, the main objective is to decrease the test suite, i.e., to achieve regression test selection, and to achieve this, the hybrid model is implemented. The hybrid model is a conjunction of a data-based and keyword-based selection model. The test data is kept in external files like Excel, CSV, etc. The keywords are also kept as operations or names or types of the component in external files. The test selection strategy implements a hybrid model. The application either takes data from excel then it is a data-driven approach or it selects input based on keywords like single select, multi-select, etc. then it is implementing the keyword-driven approach. For the demonstration, an online survey reporting system is used. The online survey reporting systems are used to have a survey containing questionnaire which can be offered online to the public. They are normally created as web forms with the back end database to save the answers and statistical software to provide visualization and analytics. The changes can be done on the survey like change in component and component behavior. To retest these web-based applications like surveys whenever any change request is made; regression testing has to be carried out. Figure 22.1 depicts the hybrid framework for the test selection.

A test case for regression is chosen on the basis of test input data. Once the automated tool will execute, then only those test cases will be selected which will have test input information. The automated tool ignores each such test case where test input information is not available. Hence it is implementing the data-driven approach. The data-driven approach integrates with the keyword-driven approach also in which based on the keyword, the test input data is provided to the tool. Figure 22.2 depicts the approach.

To implement the strategy for test selection, first test cases are created on the basis of survey requirement. On a load of the survey, the automation tool will read the expected question text from the test case input file. Figure 22.3 shows the sample test case.

After that, test data is created which is basically test input to the survey. Then the automated tool is run based on the Selenium framework. Figure 22.4 shows the execution.

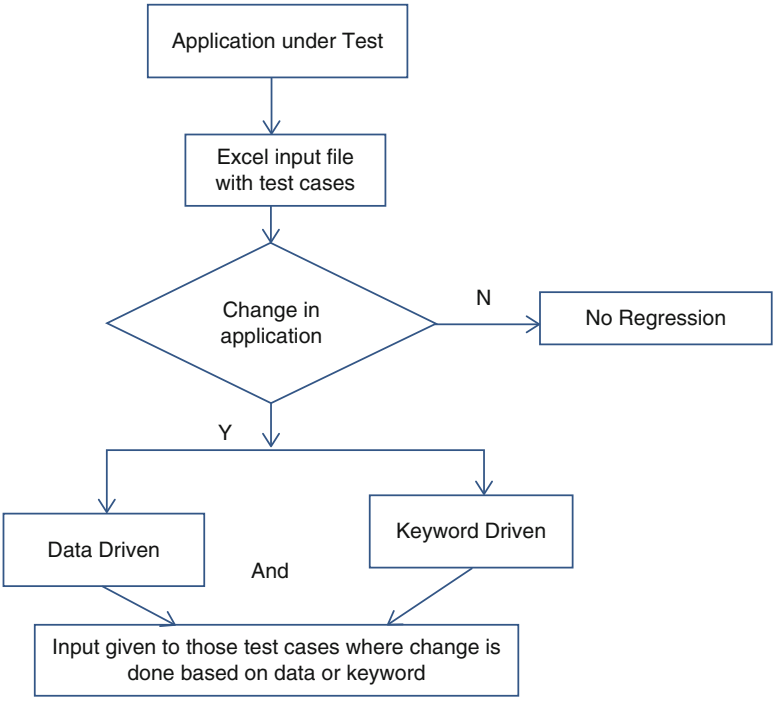


**Fig. 22.1** A hybrid framework for test selection

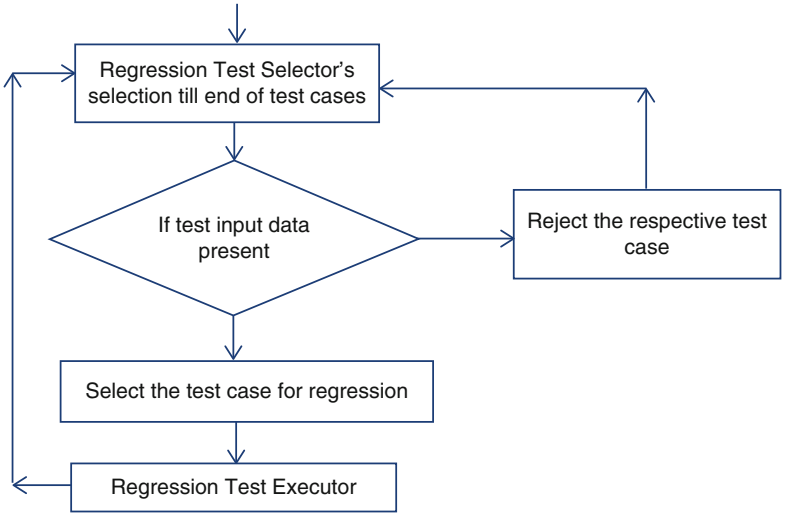


**Fig. 22.2** Test selection strategy

| Path | Q_Type | Input | Expected Question Text | Response Result (Pass/Fail) |
|---|---|---|---|---|
| 1 | list | input~4 | How likely you recommend the product to your friend on a given scale? | |
| 2 | textArea | input~Better quality | what are the reasons behind your score? | |
| 3 | select | input~2 | To which industry do you belong? | |
| 4 | select | input~3 | How satisfied are you with the product? | |
| 5 | select | input~0 | Are you married? | |
| 6 | end | | We thank you for your time spent taking this survey | |

**Fig. 22.3** Sample test case

```
D:\drivers>java -jar silenium-test.jar
Starting ChromeDriver 77.0.3865.40 (f484704e052e0b556f8030b65b953dce96503217-ref
s/branch-heads/3865@{#442}) on port 15031
Only local connections are allowed.
Please protect ports used by ChromeDriver and related test frameworks to prevent
 access by malicious code.
[1573887547.668][WARNING]: This version of ChromeDriver has not been tested with
 Chrome version 78.
[1573887547.882][WARNING]: This version of ChromeDriver has not been tested with
 Chrome version 78.
Nov 16, 2019 12:29:09 PM org.openqa.selenium.remote.ProtocolHandshake createSess
ion
INFO: Detected dialect: W3C
inside GoToNextPage>>1
qType in else>>list
inside GoToNextPage>>1
qType in else>>textArea
inside GoToNextPage>>1
qType in else>>select
inside GoToNextPage>>1
qType in else>>select
inside GoToNextPage>>1
qType in else>>select
inside GoToNextPage>>1
```

**Fig. 22.4** Tool execution run

## 22.4 Results

The results of the execution of the tool are given in Fig. 22.5. The tool will append Pass/Fail in response results.

To validate the performance of the proposed approach, two sample surveys were made containing different types of question types. Survey 1 consisted of 20

| Path | Q_Type | Input | Expected Question Text | Response Result (Pass/Fail) |
|---|---|---|---|---|
| 1 | list | input~4 | How likely you recommend the product to your friend on a given scale? | Pass |
| 2 | textArea | input~Better quality | what are the reasons behind your score? | Pass |
| 3 | select | input~2 | To which industry do you belong? | Pass |
| 4 | select | input~3 | How satisfied are you with the product? | Fail |
| 5 | select | input~0 | Are you married? | Pass |
| 6 | end | | We thank you for your time spent taking this survey | Pass |

**Fig. 22.5** Result of execution

**Table 22.1** Performance improvement on sample survey

| Survey No | No of questions | Type of compo-nents | Changes in the type of component | Impact of change on questions | Performance improvement in % |
|---|---|---|---|---|---|
| Survey 1 | 20 | 4 | 3 | 15 | 25 |
| Survey 2 | 25 | 5 | 4 | 20 | 20 |

questions with 4 categories of questions like single-select questions, multi-select questions, numeric punch questions, and open text questions. Survey 2 consisted of 25 questions with 5 categories of questions like single-select questions, multi-select questions, numeric punch questions, open text questions, and grid (scale) questions. The results are reported on the input sample of surveys in Table 22.1.

The above results are also reported graphically in Fig. 22.6. The graph shows if the impact of change is less then it is better to use regression test selection than rerunning the entire test suite.

Thus if we compare the above automated framework with manual test selection or rerunning entire test suite then there is a significant improvement. We can't cover all possible permutation and combinations using a manual approach for regression testing.

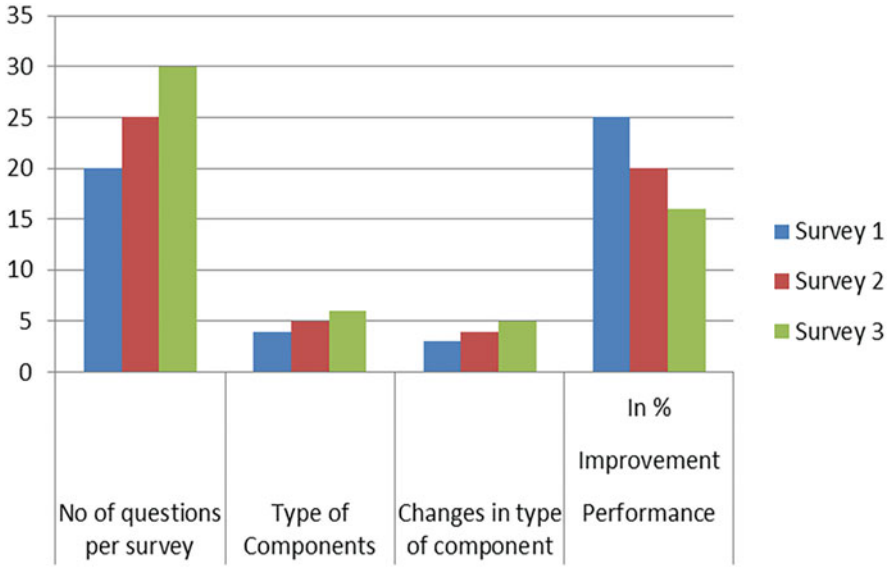


**Fig. 22.6** Performance based on component vs. change request

## 22.5 Conclusion

The paper proposes a new framework for test selection to reduce the regression test suite. The framework is automated which gives faster results with less effort. The validation of the approach is performed on sample web application and the results are presented graphically. The result proves that test selection is a better choice if done judiciously. The framework is validated for online web applications, but it can be generalized for other applications also.

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# Chapter 23
# End-to-End Secured Architecture for Internet of Things Information Kendra (IoT_IK) Integrating IoT-Enabled Smart Services and Applications


**A. Vimal Jerald and S. Albert Rabara**

## 23.1 Introduction

Internet of Things (IoT) is a convergence of devices, things, and objects by using sensor devices and related hardware for intelligent identification and tracing by data exchange using communication techniques [1]. IoT is so popular today because of some potential applications such as smart health, smart agriculture, smart traffic, crowd monitoring, smart city projects, etc. [2]. The existing IoT-based applications and services are bound to a single domain or a sector. The user needs to request different service providers geographically diverse to access these services. It is vital to integrate various IoT-based smart services and applications.

Security issues at large arise when millions of objects, devices, and things communicate using wireless technology in an integrated environment for deploying various smart applications and services. Any leakage of information from any of the IoT devices/sensors could severely damage the privacy and authenticity of the users and data. Even if the wireless technologies are secured on their own, their integration generates new security requirements. The creation of end-to-end secure channels could be one of the steps in the creation of security integration in IoT architecture [3]. Confidentiality and integrity are few other major security concerns that need to be addressed. Security solutions for IoT environment are entirely different from the conventional techniques as IoT is a network of tiny devices. So, energy-efficient encryption and decryption techniques are to be used. It becomes essential to mitigate the security threats of IoT smart applications and services in an integrated environment. Proper remedies in an integrated perspective are devised

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envisaging a multilevel security architecture for integrated IoT-based smart services and applications.

## 23.2 Related Work

Fugen Li et al. have proposed a heterogeneous encrypting homeworks online/offline to establish secure data communications over sensor node of IoT and Internet host. It is concluded that the proposed method provides a solution for security issues when integrating WSNs into the Internet as part of the IoT [4]. Xuanzia Yao et al. have put forth a scheme of lightweight multicast authentication mechanism for small-scale IoT applications. Other security concerns like privacy, authorization, and integrity are not addressed in the article [5]. R. Shadid et al. have designed a lightweight scheme for secure constrained application protocols (CoAP) by compressing the header of Datagram Transport Protocol Security (DTLS) messages. The different types of security attacks have not to be addressed when constrained devices are connected by CoAP [6]. Sherin P. et al. have proposed a multilevel authentication system for smart home applications. The proposed system facilitates various security properties such as data confidentiality, integrity, forward security, privacy preservation, and mutual authentication [7]. B. Vaidya et al. have come out with a secure device authentication mechanism for smart energy home applications. This system does not provide enough information to prove that it is better than other authentication mechanism and how it is secure against attacks. Hence, it is essential to improve the authentication scheme which should satisfy the security factors like data confidentiality and integrity [8]. Xu Xiaohui has explored the various security mechanisms in the Internet of Things such as safety certification and control technology supported with equipment authentication mechanisms [9]. Q. Wen et al. have presented a technique for ID authentication at sensor nodes of IoT. It is a dynamic variable cipher that is deployed using pre-shared metrics between the communication parties. In the work presented, the insulation of the pre-shared metric needs to be secured for the work, and it should be implemented for a large number of IoT devices. Only then the presented work can be applied for the real-time deployment of IoT-based application where the dynamic variable cipher security certificate is applied [10].

P.N. Mahalle et al. have dealt with identity authentication and capability-based access control (IACAC) for the Internet of Things. The authors have attempted to match the integrated protocol with both authentication and access control capabilities to realize mutual identity implementation in IoT [11]. R. Mahmoud et al. have explored the challenges in IoT security with the prospective measure. They have presented the security issues and mitigations to be taken in each layer of IoT. Confidentially, integrity, availability, and authentication are these security measures that must be lightweight and heterogeneous in nature [12]. Prem et al. have proposed a novel technique for privacy preservation of IoT and introduced privacy preserving in IoT architecture. The authors have implemented the proposed system

which is proved to be an efficient system ensuring IoT data privacy. Like privacy, the other security concerns like confidentiality, authentication, and integration are not addressed [13]. Don Chen et al. have presented a secure architecture for the Internet of Things to analyze the security challenge and threats [14]. Qi Jing et al. have explored security problems of each layer of IoT architecture and have put forth solutions [15]. Quardeng et al. have analyzed the security issues of the layers in IoT architecture such as the perception layer, network layer, and application layer. The authors have presented the construction of secure IoT and security strategies for fixing the security threats existing [16]. K. Jaswal et al. have proposed a security securing Internet of Things. The article has listed various IoT protocols used, security challenges in IoT systems, network layers of IoT architecture, and IoT security threats [17]. A white paper on security in the Internet of Things by Wind River System has explored the security constraints in the IoT environment [18]. The literature has revealed that there are many IoT-enabled applications and services work independently. Seldom there are literature cited the integration of IoT Smart Services into one architecture with end to end security.

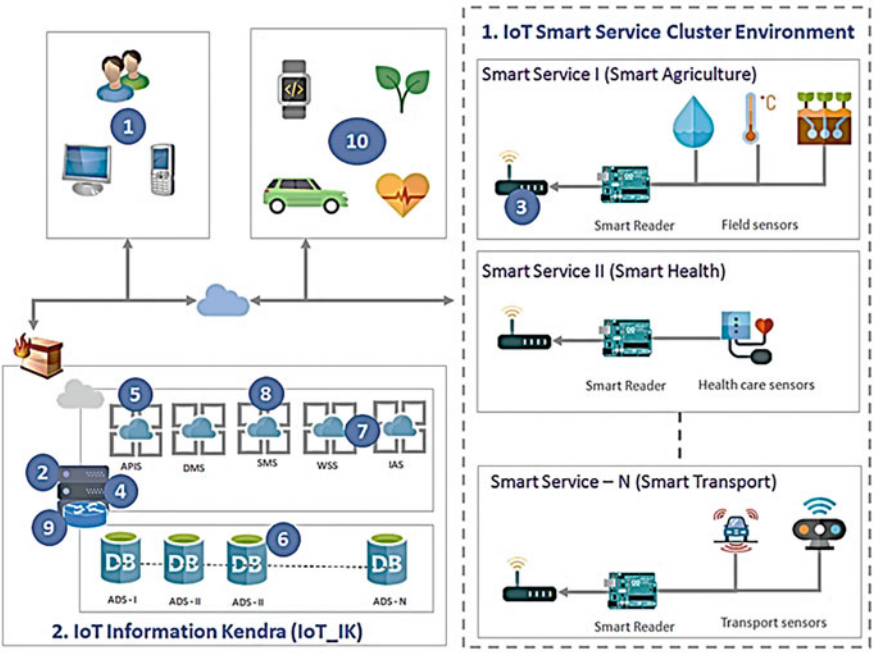
## 23.3 Proposed Security Architecture

The proposed secured architecture integrating Internet of Things smart services and applications is designed with end-to-end strong multilevel security factors such as confidentiality, mutual authentication, integrity, and privacy. The user authentication, device authentication process, and service authentication process at SG of IoT_IK ensure the mutual authentication and other security factors with support of the security algorithms. The security support for proposed architecture is enhanced by adopting various security mechanisms by incorporating ECDSA-based certificate, elliptic curve cryptosystems [19].

The three different levels of security are adopted with multilevel authentication using ECC. The security architecture proposed with the various security processes is depicted in Fig. 23.1. The architecture ensures stronger security for the integrated IoT smart applications and services. The security processes at the various levels of the proposed architecture such as secure user registration, secure device registration, secure user and device authentication, secure service registration and secure service authorization which are explained subsequently in detail.

### *23.3.1 Major Components*

The proposed architecture comprises three units such as IoT smart services environment (IoT SSE), IoT Information Kendra (IoT_IK), and IoT client. IoT smart services environment consists of sensor devices (SD), Smart Readers (SR), and field gateway (FG) which are connected appropriately in IoT SSE. IoT Information




1. Secure User and User Device Registration
2. Secure User and Device Authentication
3. Sensor Device Registration and Authentication
4. Field Data Authentication
5. Decrypted data for Processing
6. Data Storage
7. Presentation of data using HTTP/SMTP
8. Decryption of data
9. Authentication using x.509 digital certificate (ECDSA)
10. Decrypted data as Alerts, Messages, Actuators information

**Fig. 23.1** Proposed end to end security architecture

Kendra (IoT_IK) is designed for data aggregation and data analysis appropriately with respective applications. IoT_IK comprises of server cluster (SC), Application Data Server Cluster (ADS), and Smart Gateway (SG). The service cluster (SC) in IoT_IK comprises of different servers such as Application Programming Interface Server (APIS), Security Management Server (SMS), Application Data Server (ADS), Data Management Server (DMS), Web Services Server (WSS), and Information Alert Server (IAS). IoT clients are mobile devices, IoT-embedded

alarms, emergency alerts system, smart watches, IoT-connected vehicles, actuators, etc.,

### *23.3.2 Functionality of the Security Architecture*

The proposed architecture enables the integration of IoT smart applications and smart services which facilitate the user to access the IoT services securely anytime, anywhere and with registered devices. The user establishes a connection with Smart Gateway (SG) at the Internet of Things Information Kendra (IoT_IK) using Hypertext Transfer Protocol (HTTP) via the Internet. The user with the help of user interface (UI) at the user's device requests the SG for secure user authentication and user device registration. The user through UI feeds the user details such as name, DoB or age, Aadhaar number, mobile number, and email id. The user device credentials such as MAC id or IMEI and IP address are extracted automatically. The user is primarily authenticated using OAuth at SG by sending a one-time pin (OTP) to the mobile number entered by the user for the primary verification. On successful verification of mobile number, user id (U_id) and device id (D_id) are generated by the SG using user and device credentials. The certificate registry at SG generates the user certificate based on ECDSA by encrypting U_id and D_id using ECC. Key pairs such as public key (PuK) and private key (PtK) are also generated using the ECC cryptosystem. The generated user certificate is stored in the certificate registry at SG along with PuK. The same user certificate is sent to the user device along with PtK for further authentication.

The sensor devices, objects, and Smart Readers (SR) at smart service environment (SSE) are registered with corresponding field gateway (FG) of SSE. The inferred raw data by the sensor devices are read by Smart Reader (SR), and the same is sent further to the FG. Network communication is established between FG and SG of IoT_IK using the Constrained Application Protocol (CoAP). FG using the UI requests SG for service registration. The service credentials such as service name, service type, and IoT devices id allocated by FG, MAC id, and IP address of FG are used to generate S_id and IoTD_id after fundamental authentication using Oauth at SG. The certificate registry at SG generates a service certificate using S_id and IoTD_id along with PuK and PtK generated using ECC. The service certificate generated is stored in the certificate registry along with its PuK. The same certificate is sent to FG along with PtK.

The raw sensed data from SSE are sent by FG along with the corresponding service certificate that is sent to SG using CoAP over the established connection between FG and SG. The service is authenticated securely at SG using credentials in-service certificate with the stored credentials at the certificate registry. The PuK at SG and PtK are sent by FG and are used to decrypt the data in the certificate. On successful authentication, the sensed data are sent by FG and are further sent to the Application Programming Interface Server (APIS) for data analysis. The sensed data is received at APIS at a fixed time interval after the secure authentication of

services. APIS aggregates and processes the data based on the service using the respective algorithms. Data Management Server (DMS) supports the APIS with the GPS information and other information related to the SSE. Web Service Server (WSS) helps the APIS with web-based services on demand to supplement data processing. The processed data are stored at the Application and Data Server (ADS) regularly. If the processed data reaches a threshold state based on the algorithm, the data is to be sent to the IoT client as alerts or messages. Information Alerts Server (IAS) facilitates APIS for message formatting based on the IoT client. The Security Management Server helps to encrypt the alert information with the help of the ECC cryptosystem. The encrypted form of alerts and messages to IoT client is sent with PuK from SG. The PuK is sent along with the message or alert, and the PtK with the user or IoT client will decrypt the data. Hence, only the appropriate user or IoT client will receive the alerts or messages securely.

When the user requests SG at IoT_IK for a service using UI at the user's device, the service certificate is sent along with the PtK; SG will validate the credentials in the certificate decrypted by respective PuK. The secure user and device authentication are carried by matching the credentials of the certificate and the credentials stored at the certificate registry. On successful authentication, the user request is further sent to APIS for the requested data. APIS, in turn, processes the request and with the help of other servers of service cluster (SC) at IoT_IK. SG establishes secure communication between IoT_IK and IoT client or the user device using HTTP. The requested service information is sent to the user or to the IoT client through SG. The service information in an encrypted form with PuK is sent to the user devices. The user device with the help of PtK decrypts the data. So, it is possible only for the appropriate user device to receive the requested service information securely. Figure 23.2 illustrates the functional components of the proposed secured architecture.

### *23.3.3 Multilevel Security at the Proposed Architecture*

The research proposes stronger security for the proposed architecture in different levels such as client, IoT smart services environment (IoT_SSE), and IoT data transaction and processing.

#### 23.3.3.1 IoT Client and Device Level

The registered IoT client and IoT devices used are authenticated and authorized at the client level security with the help of ECDSA certificate and message exchange using ECC. All the data transferred from the SSE level to the client level through the IoT_IK are encrypted and decrypted with ECC. Digital certificates are also used to authenticate registered IoT devices to ensure the integrity and confidentiality of the information. User authentication is carried out to assure users' privacy. Only the

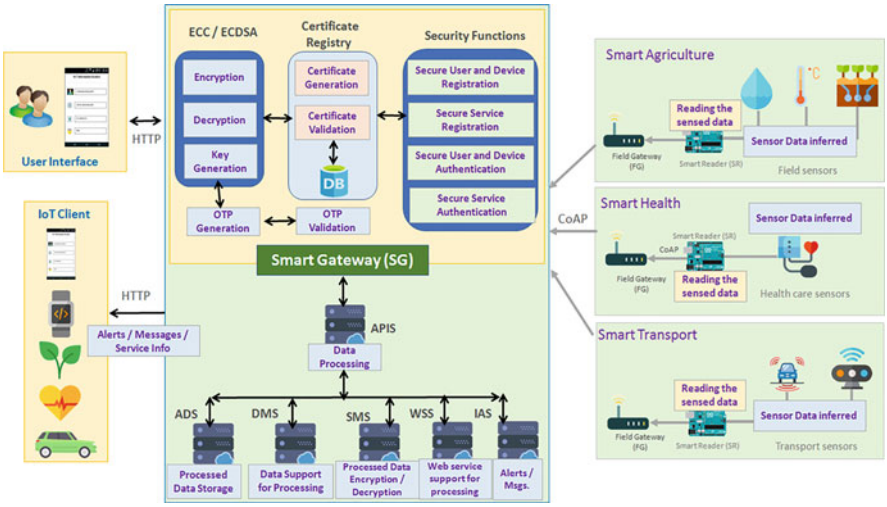



**Fig. 23.2** Functional components of the proposed architecture

registered user may avail of the authorized service using the registered device. So, there is no possibility of unauthorized access to service, and it is not feasible for the unauthorized service to communicate the user.

### 23.3.3.2 IoT Smart Services Environment Level

All the smart devices and sensors connected in an SSE are to be registered and authenticated in the FG by obtaining their IoTD_id (device id) and MAC ID. The FG receives the information from the IoT devices and encrypts the information and establishes a secure communication using CoAP with the SG of IoT_IK using a digital certificate. The SG verifies the credentials in digital certificate generated during the registration process and receives the encrypted data for further analysis. This phase ensures that only the registered IoT devices may send raw data and through which confidentiality is achieved. It is not feasible for the intruders to access the IoT devices like FG.

### 23.3.3.3 Internet of Things Information Kendra Level

The Smart Gateway establishes secure communication using **HTTP** with the **APIS** using mutual authentication and forward the encrypted data to **APIS** for data aggregation and analysis of information. The **APIS** decrypts the information and processes the data based on the algorithms according to the services and applications. The **APIS** then establishes communication with **IAS** through the **SMS**

for sending messages or alerts to the registered users and the smart devices. The service authentication process assures the integrity, and thus there is no chance of authorized service providers to influence the actual data inferred from **SSE**. The messages or alerts are sent to the appropriate user who requested the service, based on the user credentials in the certificate attached.

### *23.3.4 Secure Data Communication Between FG and SG*

The proposed architecture lays a secure connection between the FG and SG after successful authentication using the X.509 digital certificate via Secure Socket Layer (SSL) protocol. CoAP protocol is responsible for secure data communication between FG and SG. FG requests a connection with SG by sending PtK and ECDSA service certificate X.509. SG checks the authenticity of the certificate using the corresponding PuK and other stored credentials of FG. If the authentication is successful, the FG can be trusted, and further data transaction is permitted. The session keys are exchanged securely between the SG and FG. The sensor data from the IoT SSE can be securely transmitted over the established channel. The raw data or the inferred information from SSE via FG are taken to the Application Programming Interface Server (APIS) of IoT_IK for data aggregation via SG. The data transaction between FG and SG takes place securely by service authentication, i.e., by verifying the credentials stored in the certificate of the respective service. If the credentials in the certificate and the credentials of service fetching raw data from the FG match, the data fetched from the service environment is taken to APIS securely.

### *23.3.5 Architecture Level Secure Data Processing*

The user registered with a registered smart mobile device using the UI requests for any service to SG at IoT_IK. The request from the user is sent using HTTP along with the user and device certificate which consists of the user and device credentials. Use and user device certificate authentication at SG based on the OAuth authentication method are carried out with the credentials extracted from the certificate registry. If the credentials extracted from the service registry and the credentials with certificate match, the user and device are authenticated successfully. On successful authentication, the user request is further sent from SG to APIS for the necessary action rather than a process. Similarly, the raw data from SSE are sent through FG to SG at IoT_IK for data aggregation. The raw data is attached with the service certificate which comprises of service credentials and credentials of SG along with PtK. The CoAP protocol is used for data communication between SSE, FG, and SG. If the credentials with the service certificate, PtK, and the credentials extracted from the certificate registry for the corresponding SSE match, the service

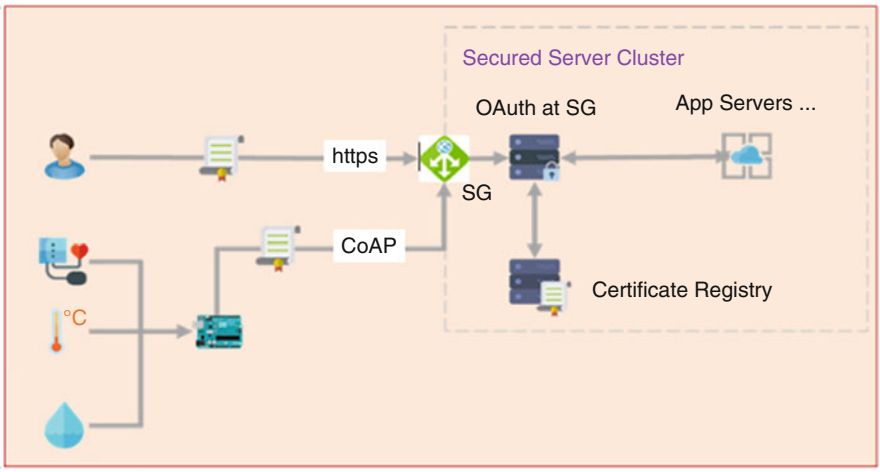



**Fig. 23.3** Secure data communication at the architecture level

is then authenticated. On successful authentication, the raw data fetched from SSE is forwarded to APIS by SG for further action. The communication channel from SSE to SG through FG and the communication channel from the user to SG are secured using the proper security mechanism proposed in the architecture. The process of secure data communication at the architecture is depicted in Fig. 23.3.

## 23.4 Experimental Study

A test bed has been designed using an experimental setup for the proposed work. Secure user registration, device registration, secure service registration, secure user and device authentication, and secure service authentication are performed to ensure the end-to-end security of the proposed architecture. The performance analysis on ping response time, system throughput, and latency analysis guarantees that the proposed architecture functions efficiently with the enhanced performance.

### *23.4.1 Performance Analysis of Security Functions*

Ping response time for the proposed architecture, using ECC cryptosystem and self-signed ECDSA generated over SSL, with respect to the security functions such as User Registration, Device Registration, Service Registration, User and Device Authentication and Service Authentication. Ping response time was calibrated using the inferred data set for the simultaneous requests range from 20 to 200 with the

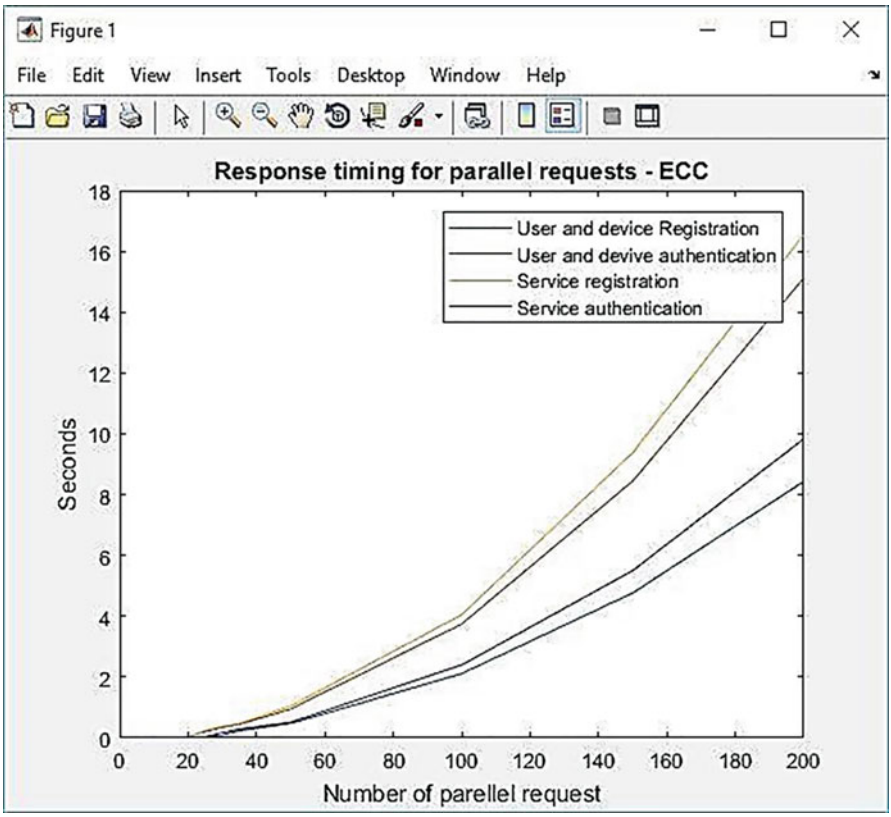



**Fig. 23.4** Response time taken for parallel requests

increase of 20 requests respectively. The Ping response time for various security functions for parallel requests are tabulated in Table 23.1, and the Ping response time taken for the security functions are graphically represented in Fig. 23.4.

### *23.4.2 Analysis of Overall System Throughput*

Performance analysis is done to compute overall system throughput which is the total work done by the proposed system at a given time. Table 23.2 presents the obtained overall system throughput for the system model based on the proposed architecture. An analysis is made of system throughput for 1000 to 10,000 parallel service accesses with an increase of 1000 requests. Time consumed and bandwidth utilized are presented in the table. According to the obtained results given in the table, the time is taken to increase gradually when the service requests or access increases. It takes **261.600 s** for 10,000 service accesses/requests to complete all the

**Table 23.1** Response time for various security functions for the parallel requests

| Response timing for parallel requests for the functions | No. of parallel requests | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 |
| User and device registration | 0.4643 | 0.71786 | 1.04643 | 1.6643 | 3.44643 | 3.84643 | 4.69976 | 5.69976 | 6.69643 | 7.69643 |
| User and device authentication | 0.4731 | 0.74731 | 1.04731 | 2.0731 | 3.74731 | 4.94731 | 6.30731 | 8.30731 | 15.12231 | 15.12231 |
| Service registration | 0.5144 | 0.8858 | 1.05144 | 2.9144 | 4.35144 | 5.15144 | 7.52477 | 9.52477 | 17.97644 | 17.97644 |
| Service authentication | 0.4823 | 0.84823 | 1.04823 | 2.20823 | 3.83823 | 3.98823 | 5.71490 | 6.71490 | 7.49323 | 8.49323 |

**Table 23.2** Overall system throughput

| No. of parallel requests | Time taken in seconds | Bandwidth utilized (Mbps) | Failed requests (%) |
|---|---|---|---|
| 1000 | 2.943 | 29.30 | 0.20 |
| 2000 | 11.005 | 58.59 | 0.15 |
| 3000 | 25.645 | 87.89 | 0.13 |
| 4000 | 42.245 | 117.19 | 0.15 |
| 5000 | 68.426 | 146.48 | 0.14 |
| 6000 | 98.130 | 175.78 | 0.18 |
| 7000 | 128.582 | 205.08 | 0.17 |
| 8000 | 173.254 | 234.38 | 0.16 |
| 9000 | 215.623 | 263.67 | 0.19 |
| 10,000 | 261.600 | 292.97 | 0.20 |

operations of the proposed architecture. Bandwidth utilized for the service accesses or requests proportionately increases. It takes **29 Mbps** for 1000 service accesses on an average. It is proved from the results given in the table that the failed requests are very minimum, i.e., it is only **0.15%** on an average for every 1000 service requests. Figure 23.5 Illustrates the overall system throughput for the proposed system based on the architecture.

The overall performance of the proposed architecture proves to be efficient and secured based on the different performance tests conducted. Performance analysis results of various security functions establish a secure communication between the user and the **IoT_IK**. Similarly, the data communication between **FG** at **SSE** and **SG** of **IoT_IK** and the communication between **SG** and IoT clients take place securely. The time taken for various security processes and the time taken for accomplishing the service requests are very less. The service requests failed are very minimal.

## 23.5 Conclusion

Secured architecture integrating Internet of Things (IoT)-enabled smart services is proposed to actualize the vision of availing IoT-based smart services and applications by integrating heterogeneous devices and objects in diverse environments anytime, anywhere and in any device in a secured manner. This proposed architecture is adaptable and unique for the users to have secure access over diversified IoT smart applications and smart services. The proposed novel IoT Information Kendra (IoT_IK) will certainly help the government to provide smart services that may benefit a billion of the general public particularly people living in rural areas if it is established in every mandal or divisions. The proposed system will be a means of achieving the Digital India mission of the Union Government of India.

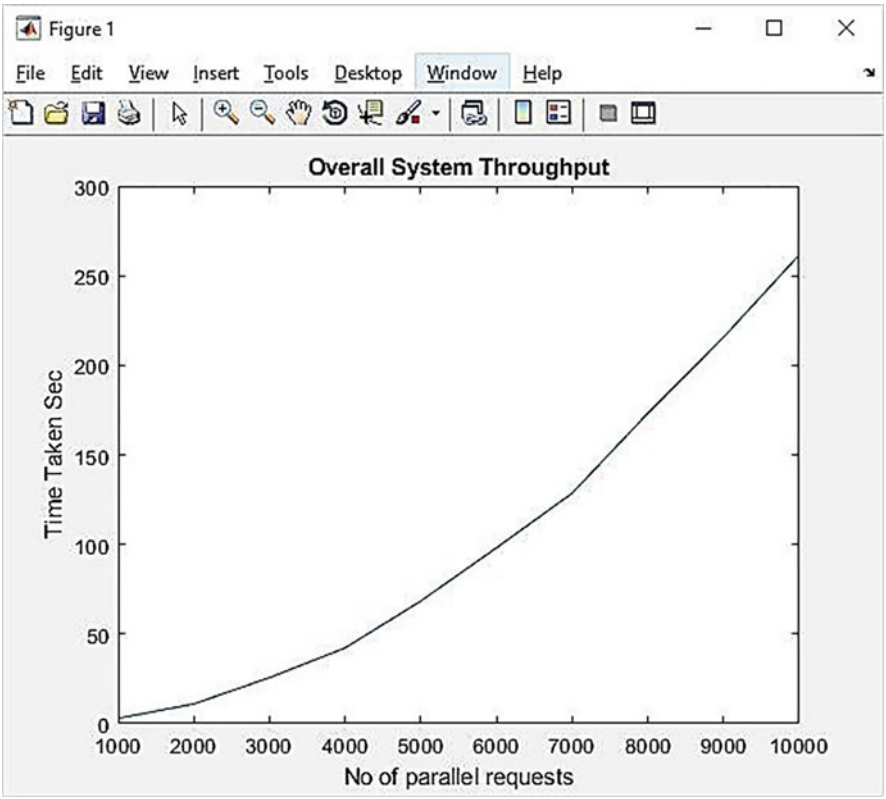



**Fig. 23.5** Overall system throughput

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# Chapter 24
# The Repaschine: A Robot to Analyze and Repair Roads Using Cutting-Edge Technologies


**Ayngaran Krishnamurthy, Bhavan Kumar, and S. Suthir**

## 24.1 Introduction

Nowadays commerce and transportation are driving the world especially in developing countries like India transportation through roads which are the most important base toward developing the country's economy. But as always there was and is an issue that has a massive effect on the transportation of people; the reason is the presence of potholes. Potholes are caused due to pressure and immense load over a drenched road. These potholes affect the suspensions of heavy-moving vehicles, and not only that, it also kills the civilians every day. In recent times almost every road in India have potholes, none to blame for as government as always is doing great measures to improve the quality of roads and to repair roads, but before they do, everything would be over as current manual practices for repairing roads are time-consuming and affect transportation to a great extent. This is the cause that drove toward framing a solution, the Repaschine. Repaschine is a small compact device planned to be built over the most precise and high-level engineering technologies such as machine learning and IoT. The Repaschine is a robotic device that can scan over the roads and detect potholes across the road, not just that it also identifies the depth and shape of potholes and fills the potholes by the use of the cutting-edge technology. The use of cutting-edge technology makes the machine work precisely at a faster rate of speed [4, 5].

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https://doi.org/10.1007/978-3-030-49795-8_24

## 24.2 Literature Survey

Before making a solution for the problem, the problem was studied much deeper to gain insight that is to be met to overcome the issue. Here are some articles shortlisted as a part of the literature survey for your convenience:

**Article1**
Source: India Today [1].

Date established: 24 July 2018.

Title: Over 9300 deaths, 25,000 injured in 3 years due to potholes.

Description: As per the reports, it is stated that there are around 9300 deaths caused, and nearly 25,000 were injured. The main reason behind it is the potholes on the roads which cause serious damage for drivers who travel on roads with high speeds. This leads the government to appoint a committee of engineers to work on this subject and come up with a solution.

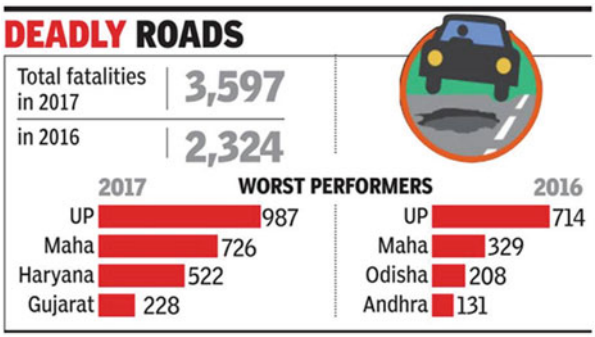
Reference: This Road Safety Audit is being done by independent road safety auditor at every stage and the finding of which are being compiled by the concessionaire/contractor of the project. Beside this Ministry and National Highways Authority of India (NHAI) have its own websites. An independent engineer/authority engineer appointed by NHAI and the concerned project directors of NHAI inspect the project highways under their respective jurisdictions.

**Article2**
Source: Times of India [2]

Date established: 15 July 2018

Title: Potholes killed 3597 across India in 2017, terror 803.

Description: It is stated that the situation is getting worse year by year as the death rate due to accidents caused by potholes on roads is drastically increasing by 726 people a year. The NHAI and government of Maharashtra have taken this issue as serious and are combinedly working on to reduce the thing to a greater level.



## 24.3 The Repaschine

Repaschine is a machine that could work with a higher rate of speed and accuracy. The Repaschine is being built with the concepts of machine learning, IoT, and 3D printing. Let's stop before we guess; 3D printing is done using carbon nanotubes, yes it's CNT that will be used to print as they can withstand a lot of tensile strength (Fig. 24.1). The device uses an image processing technique under the machine learning concept for detecting and analyzing potholes. The product development is still in process, and the product is developed with the idea in mind that it must be able to withstand the heaviest trucks and do the job in a precise, faster, and efficient manner. The Repaschine will be fed with datasets for analyzing any data. It scans the roads with the help of a rapid imaging concept, and the images are simultaneously scanned to find various depths over a particular image; each image taken will have a location stamp denoting the area at which it was taken. The images taken will help the machine prepare a preprinting model as a visualization before printing to decide the pattern for filling a particular pothole as we know that not only the material but also the structure of the construction helps and contributes to the strength of the construction [6, 7, 8].

### *24.3.1 Methodologies Used*

As discussed the use of cutting-edge technology is what makes Repaschine a great product. The major techniques are:

(1) Machine Learning – The image recognition used in machine learning concept not only helps to analyze an image; it also helps to detect various depths in images, and this is what is needed to find potholes faster; the analyzing

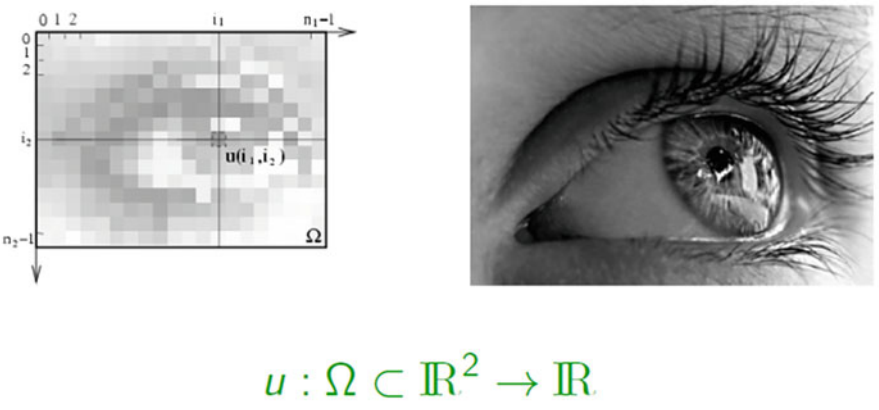



**Fig. 24.1** An image is seen as a function defined in continuous space

potentiality helps to get the shape of the pothole and helps design a preprinting model in the device, not just that the machine learning concept helps facilitate and decide dynamically the structural construction of pothole which helps in holding up larger amounts of stress and pressure.

(2) IoT – The IoT concepts help the machine in locating the way it scans the road and helps keep a note of the region scanned earlier added to its use of IoT helps to improve the functionality of the device.

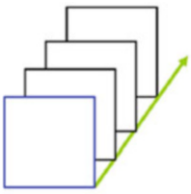
(3) 3D printing – One of the hot topics of recent times is that the 3D printing is used to get designs of models that help gain overview of a design at a lower cost; the designing is done usually with the help of predesigned sketch, but in this device, the 3D printer will gain input from machine learning concepts that provides the size and shape to be printed. The printing is done using carbon nanotubes as they can withstand a large amount of pressure and have high levels of tensile strength estimated at 63gigapascals (Fig. 24.2).

### *24.3.2 Scope of Repaschine*

The project has a great scope in today's scenario as it is only one of its kinds. There are no such prevailing systems to face this issue; moreover, it is fully automated and hence does not require the involvement of human resources; this will be a major revolutionary product. In the future, this will play a major role in reducing the deaths of civilians and improving the comfort of transportation. This will eventually reduce the cost of repairing the roads, and when modified it can also be used as an enhanced technology to lay roads and bridges (Fig. 24.3).

### *24.3.3 Design of Repaschine*

The design of Repaschine was initially hand-drawn and was refined several times to make it sleek and cost-efficient. One such refinement was the use of machine



$$u(t,x) \;/\; \frac{\partial u}{\partial t} = H(t,x,u,\nabla u,\nabla^2 u) \;\rightsquigarrow\; v(x) \equiv u(\infty,x)$$

**Fig. 24.2** A PDEs evolution

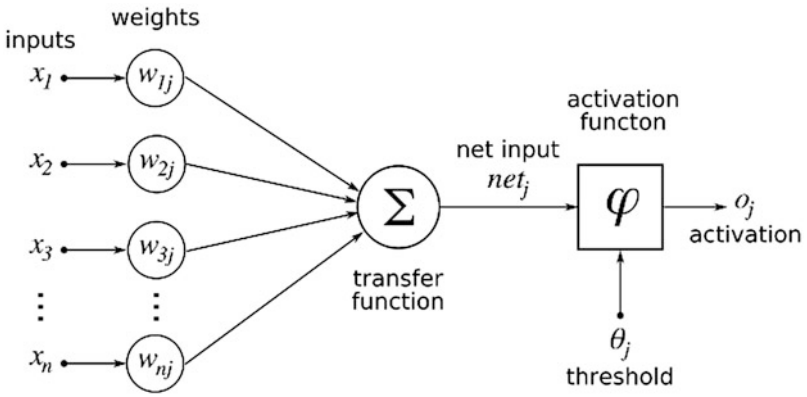



**Fig. 24.3** 3D depth reconstruction: The goal is to reconstruct the depth of a single monocular image; this is achieved by training a dataset with several inputs under the supervised learning of machine learning concept [3]

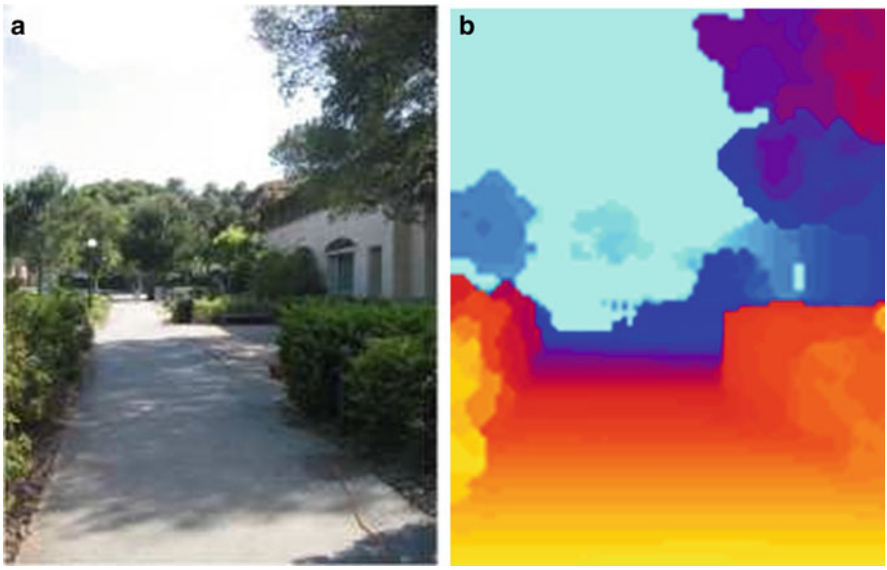



**Fig. 24.4** (**a**) A still image and (**b**) the corresponding (ground truth) depth map. Colors in the depth map indicate estimated distances from the camera

learning instead of artificial intelligence in the place of image analysis as machine learning provides more precise and accurate results in a shorter period. The exoskeleton of Repaschine is made of heavy-duty alloys to prevent and overcome unexpected scenarios like a vehicle running over the device and so on (Fig. 24.4).

## 24.4 Innovative Usefulness

Innovation in this device is providing a solution to an issue that people always didn't mind would have such a large impact. Not just that as we all know tar is the usual component used to lay roads, but before being poured on to the surface, tar needs to be heated, and tar when heated produces toxic gasses that may cause serious health issues, as said earlier, in later time when the modified versions of Repaschine are used, then the use of tar can be completely avoided, hence also playing a smaller part in improvising the countries health.

## 24.5 Conclusion

The stated system is in its designing stage where the technologies are utilized and uses of the machine are minimal. We can take this concept to a greater stage and wield machine for multiple purposes. The proposed system is constantly being worked upon, and various other methods and designs are constantly being improvised in terms of usage of the image processing concept and also the material used. Apart from this the concept stated has great usage, and multiple users can be benefitted from it. These pros can be eventually increased by undergoing constant research. To conclude we say that the concept of designing a machine for reconstructing the roads is a novel approach and has a great future scope in developing this system to the next level, so its purposes and other technical aspects are improved.

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# Chapter 25
# Learning Parameters for Hybrid Bayesian Network


**B. Naveen Kumar and P. V. Kumar**

## 25.1 Introduction

Bayesian network is a directed acyclic graph that encodes the conditional dependencies among random variables. BN is a graphical representation of the joint probabilistic distribution of the model. A Bayesian network contains nodes and edges. Each node represents a random variable, and edge captures conditional dependency between two random variables. If there exists an edge (A- > B) in the graph between random variables A and B, it means P(B/A) is one of the factors in the joint probability distribution. Each node is assigned with one conditional probability distribution (CPD) that contains all the probability values depending upon its parent values. Estimating such probabilities is called parameter learning [3]. Maximum likelihood estimation (MLE) is one of the parameter estimation techniques which optimizes the parameter values based on the data. In general, most of the nodes in BN have few parents relative to the overall size of the network, and this property is referred to as conditional independence, and it is greatly used to simplify the computation [4].

## 25.2 Linear Gaussian Bayesian Network

Bayesian network with continuous random variables is called linear Gaussian Bayesian network; CPDs' linear Gaussian distribution and they represent multivariate Gaussian distributions. The theorem of linear Gaussian model: Let X be

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a linear Gaussian of parents {Y1,..Xk}: P(X|Y) N(β0 + βTy;σ2). Assume {Y1,..Xk} are jointly Gaussian with distribution N(μ,σ). Then distribution of X is a normal distribution P(X) = N(μX;σX2) where μX = β0 + βTμ,σX2 = σ2 + βTσβ. The joint distribution over {X, Y} is a normal distribution where Cov(Yi; X) = Pj σjβj [5]. Example of linear Gaussian BN in which all variables are Gaussian and all CPDs are linear Gaussian distribution.

## 25.3 Parameter Estimation for HBN

In this work, CPDs for continuous random variables have been estimated based on multivariate Gaussian distribution [13]. HBN can contain both discrete and continuous random variables multinomial or Gaussian in nature; learning parameters for HBN are divided into the following tasks based on the type of the random variable [6].

### *25.3.1 Continuous and Discrete Parents*

In the case of HBN, parent nodes are a mixture of both continuous and discrete random variables with an assumption that the child node has a linear Gaussian distribution. Consider a random variable X with parents U = {U1,U2, . . . . . Uk} then the probability distribution P(X/U) = N(β0 + β1u1 + . . . . . .. + βkuk;σ2), and the goal is to learn the parameters θX/U = < β0,β1, . . . ..,βk,σ2 > using MLE technique the definition of Gaussian distribution P(X) = (1/$\sqrt{2}$πσ)(exp(x − μ)2/2σ2) [1]. Assume M data samples D = {ζ [1],ζ [2],.....ζ[m]}, the likelihood function for the given data D is taking the log of the equation for simplification and differentiating w r t to μ and equating to zero [7].

$$L\,(\theta X/U;\,D) = P\,(D/\theta X/U) = MYm = 1\left(1/\sqrt{2}\psi\right)(\exp\,(x\,[m] - \mu)\,2/2\sigma 2) \tag{25.1}$$

$$\log\,(\theta X/U;\,D) = \log MYm = 1\left(1/\sqrt{2}\psi\right)(\exp\,(\,x\,[m] - \mu)\,2/2\sigma 2) \tag{25.2}$$

$$\log\,(\theta X/U;\,D) = M\;X\;m = \log\left(1/\sqrt{2}\psi\right) + \log\,(\exp\,(x\,[m] - \mu)\,2/2\sigma 2) \tag{25.3}$$

$$\log\,(\theta X/U;\,D) = M\;X\;m = 1$$

$$\log(1) - 1/2 \log(2\psi) + (x[m] - \mu)\, 2/2\sigma 2 \tag{25.4}$$

$$\partial/\partial\mu\ (\mathrm{MXm} = 1 \log(1) - 1/2 \log(2\psi) + (x[m] - \mu)\, 2/2\sigma 2) = 0 \tag{25.5}$$

$$\partial/\partial\mu\ (\mathrm{MXm} = 1 \log(1) - 1/2 \log(2\psi) + (x[m] - \mu)\, 2/2\sigma 2) = 0 \tag{25.6}$$

$$\partial/\partial\mu\ \ (x[m] - \mu)\, 2/2\sigma 2\Big) = 0 \tag{25.7}$$

$$\mathrm{MXm} = 12/2\sigma 2\,(x[m] - \mu)\,(-1) = 0(8)\ \mathrm{M\ X\ m} = 1x[m] = \mathrm{M\ X\ m} = 1\mu \tag{25.8}$$

$$\mu = (1/\mathrm{M})\ \mathrm{M\ X\ m} = 1x[m] \tag{25.9}$$

Similarly, differentiating w r t to $\sigma 2$ and equating to zero

$$\sigma 2 = (1/\mathrm{M})\ \mathrm{PM\ m} = 1\,(x[m] - \mu)\, 2$$

Now probability distribution of a new instance [M + 1] can be estimated by using $\mu$ and $\sigma 2$

$$\mathrm{P}\,(\mathrm{X}[\mathrm{M} + 1] = \mathrm{x1/U}) = \left(1/\sqrt{2\psi}\right)(\exp(x[m + 1] - \mu)\, 2/2\sigma 2)$$

### *25.3.2 Continuous Parents for a Continuous Random Variable*

Consider a simple case of two continuous random variables X and Y and data instances D = {(x[m],y[m]): m = 1, . . . M}; the MLE estimate for the joint Gaussian distribution of X and Y can be derived as mean vector < ED[X],ED[Y] > [2] and covariance matrix; < ED[X] and ED[Y] > are the mean values of random variables X and Y, respectively. Joint multivariate Gaussian distribution of two random variables is $(1/2\pi n/2|P|1/2)\exp.\{-(1/2)(x - mx)TP - 1(x - mx)\}$ [8] where mx = E(X) is the mean vector of the random vector = {X,Y}PX = E[(x − mx)(x − mx)T] is the covariance marix n = dimX is the dimension of the random vector = {X,Y}PX = PT X = [E(X − mx)2E(X − mx)(Y − m y)E(Y − my)(X − mx)E((Y − my)2)] Likelihood function L(D;mx,PX) = Q M m = $1(1/2\pi n/2|P|1/2)\exp.\{-(1/2)(xm - mx)TP - 1(xm - mx)\}$ [3] taking log of the above equation and differentiating w r t to mx and equating to zero [9].

$$\log (\mathrm{D};\ \mathrm{mx},\ \mathrm{X}\ \mathrm{X}\ ) = \mathrm{M}\ \mathrm{X}\ \mathrm{m} = 1 \log ((1/2\pi\mathrm{n}/2\ |\mathrm{X}|\ 1/2) \exp \{-(1/2)\ (\mathrm{xm} - \mathrm{mx})\ \mathrm{T} - 1\ \mathrm{X}\ (\mathrm{xm} - \mathrm{mx})\}) \tag{25.10}$$

$$= \mathrm{M}\ \mathrm{X}\ \mathrm{m} = 1 \log(1) - \left[\log(2\pi\mathrm{n}/2 + \log (|\mathrm{X}|\ 1/2)\right] + \log (\exp \{-(1/2)\ (\mathrm{xm} - \mathrm{mx})\ \mathrm{T} - 1\ \mathrm{X}\ (\mathrm{xm} - \mathrm{mx})\}) \tag{25.11}$$

$$= \mathrm{M}\ \mathrm{X}\ \mathrm{m} = 1 \log(1) - \left[\log(2\pi\mathrm{n}/2 + \log (|\mathrm{X}|\ 1/2)\right] + \log (\exp \{-(1/2)\ (\mathrm{xm} - \mathrm{mx})\ \mathrm{T} - 1\ \mathrm{X}\ (\mathrm{xm} - \mathrm{mx})\}) \tag{25.12}$$

$$\partial/\partial \mathrm{mx}\mathrm{M}\ \mathrm{X}\ \mathrm{m} = 1 \log(1) - \left[\log(2\pi\mathrm{n}/2 + \log (|\mathrm{X}|\ 1/2)\right] + \log (\exp \{-(1/2)\ (\mathrm{xm} - \mathrm{mx})\ \mathrm{T} - 1\ \mathrm{X}\ (\mathrm{xm} - \mathrm{mx})\}) \tag{25.13}$$

$$0 + \mathrm{M}\ \mathrm{X}\ \mathrm{m} = 1$$

$$\partial/\partial \mathrm{mx}\ [\{-(1/2)\ (\mathrm{xm} - \mathrm{mx})\ \mathrm{T} - 1\ \mathrm{X}\ (\mathrm{xm} - \mathrm{mx})\}] \tag{25.14}$$

by applying vector differentiation we get

$$\partial/\partial \mathrm{X}\ (\mathrm{XTAX}) = 2\mathrm{AX} \tag{25.15}$$

$$\mathrm{M}\ \mathrm{X}\ \mathrm{m} = 1\partial/\partial \mathrm{mx}\ [\{-(1/2)\ (\mathrm{xm} - \mathrm{mx})\ \mathrm{T} - 1\ \mathrm{X}\ (\mathrm{xm} - \mathrm{mx})\}] = \mathrm{M}\ \mathrm{X}\ \mathrm{m} = 1 - 2 - 1\ \mathrm{X}\ (\mathrm{xm} - \mathrm{mx}) \tag{25.16}$$

$$\mathrm{M}\ \mathrm{X}\ \mathrm{m} = 1 - 2$$

$$-1\ \mathrm{X}\ (\mathrm{xm} - \mathrm{mx}) = 0 \tag{25.17}$$

$$\mathrm{mx} = 1/\mathrm{M}\ \mathrm{M}\ \mathrm{X}\ \mathrm{m} = 1\ \mathrm{xm} \tag{25.18}$$

Similarly, differentiating w r t to PX and equating to zero, covariance matrix is obtained using the probability distribution of a new instance X[M + 1] which can be estimated by using mx and PX.

**Algorithm**
ContinuousParent()
begin
Step 1: Read the input D data instances
Step 2: Calculate Sufficient statistics
Step 3: for (each node i in Bayesian Network)
Step 4: If(parents(node)) = Discrete and Continuous
Step 5: Call DiscreteandContinuousParent(i)
Step 6: ElsIf parents(node) = Continuous
Step 7: Call ContinuousParent(i)
End

## 25.4 Result Analysis

Test data is collected from the source Kaggle (Heart Disease UCI https://archive.ics.uci.edu/ml/datasets/Heart+Disease) on heart disease patients with the set of field sage, sex, cp, trestbps, chol, fbs, restecg, thalach, exang, oldpeak, slope, ca, thal [10], target, and the data which is divided into test and training sets. Oldpeak is the continuous variable, and it depends upon parameters that were estimated by updating CPD of the target variable in the training data [11]; the cross-validation on the test set gives the distance between estimated CPD and actual CPD of the target variable; it is one way of evaluating the result. Another way is to predict the unseen instances based upon the estimated CPD.

## 25.5 Conclusion

CPD for continuous child node in HBN is estimated by using MLE which works on optimization of the parameter values based on the observed data. In this work, MLE and multivariate Gaussian distribution are combined together for parameter estimation; however, MLE sometimes overfits the observed data, and parameters are estimated to fixed values [12]. In future work, Bayesian score can be used along with multivariate Gaussian distribution to estimate parameter values which avoid overfitting, and thereby estimation is near to actual underlying distribution.

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# Chapter 26
# Authorship Attribution Using Regression Model


**S. Lakshmisridevi and R. Devanathan**

## 26.1 Introduction

Big data analytics has been applied to authorship attribution especially in the identification of authors in the social media texts. [1, 2]. Authorship attribution [3, 4] essentially involves assigning an unknown text to a particular author from a group of authors. In terms of modeling, authorship attribution inherently attempts to capture the stylometry of an author [5, 6]. Authorship attribution has been applied to many languages besides English [7, 8]. Authorship attribution has many applications including medical diagnostics and forensics [9, 10], detecting [11] in social media and detecting the writing styles, etc.

In its simplest form, authorship attribution involves identifying the author of an anonymous text from a group of authors. In the early authorship attribution methods, the unitary invariant technique was used based on the length and frequency of words in a given text [12]. Zipf formulated a model for word frequency in a text [13]. Koppel [14] has been attributed to the pioneering work in the area of authorship attribution using the methods of statistics. Burrows's delta [15] technique has been shown to have significant success in authorship attribution. The other methods used for authorship attribution involve the maximum likelihood method based on Bayesian classification, entropy based on information theory, and techniques based on decision tree [16].

A multivariate analysis approach for authorship attribution involves a vector of multiple textual clues from a given text. Assuming the documents of different authors are points in space, assigning a text to an author involves finding the shortest distance between two points representing the unknown text and the author.

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Since multivariate analysis leads to high-dimensional analysis and techniques, such as PCA, SVM is used to reduce the dimension to a lower level so as to make authorship attribution practicable [16, 17]. Distribution of words in texts based on entropy has also been studied using the distance metric such as Kullback-Leibler (KL) divergence. Machine learning approaches such as neural networks, K-nearest neighbor algorithm, and Bayesian regression are also used for authorship attribution [18, 19].

In terms of features used for authorship attribution, function words have been predominantly used for the reason that they are generally invariant with respect to topic and they cannot be consciously controlled. Notable among the techniques using function words is the method proposed by Burrows which is based on the multidimensional Laplacian distribution of function words [20]. Syntax and parts of speech (POS) have also been used for authorship attribution. Taxonomies of parts of speech have been used to build trees whose roots are labeled by the text of POS. The taxonomy is to construct the stylistic feature of text classification. Character n-grams are also found to be useful for the classification of styles of documents.

In this paper, we propose a method of authorship attribution in which a text is characterized by a regression vector derived from the word frequency-rank distribution of function words in the text. Forming Z-score vectors using the regression vectors, authorship attribution is proposed based on a minimum distance metric between the unknown text and a group of authors.

The main contribution of this paper is as follows:

(i) A linear regression method based on function word frequency distribution is used to characterize the text in terms of regression coefficients.
(ii) Authorship attribution technique is proposed based on the distance measure between the Z-score vectors derived through regression coefficient vectors.
(iii) Favorable comparison of authorship attribution results with that of well-known Burrows method.

To summarize the rest of the paper, in the following section, we discuss the regression model used. Section 26.3 describes the application of the regression model to authorship attribution. Section 26.4 compares the performance of the proposed model with that of the Burrows method and Sect. 26.5 concludes the paper.

## 26.2 Regression Model Development

In this section, we propose a regression model for characterizing a text developed earlier by the authors [21]. Zipf [22] modeled the text using the frequency distribution of words in a text. He ordered the frequency in decreasing order.

Let f(r, N) denote the frequency in N tokens, of a word with Zipf rank, $r = 1, 2, \ldots n$ where n is the maximum rank considered. Zipf formulated the following model:

$$f_r\,(r, N) = \frac{C}{r^{\alpha}} \tag{26.1}$$

where $\alpha$ is a free parameter, C is a normalizing constant, and

$$N = \sum_{r=1}^{n} f_r\,(r, N) \tag{26.2}$$

Equation (26.1) is known as Zipf's law.

To account for the drop in frequency for the higher ranks, a modification is made to Zipf's law by Mandelbrot, and it is called ZM law [22] which is stated as

$$(r + m)^B f = C \tag{26.3}$$

where m > 0 is introduced.

**Proposition 1:** Taking the natural logarithm of (26.3)

$$B \ln (r + m) + \ln(f) = \ln(C) \tag{26.4}$$

One can write (26.4) as

$$B\left[\ln(r) + \ln\left(1 + \frac{m}{r}\right)\right] + \ln(f) = \ln(C) \tag{26.5}$$

We now state the following proposition.

Proposition 1: Equation (26.5) can be written in the form

$$B\left[Q_0 + \sum_{i=1}^{p} Q_i \left(\frac{1}{r^i}\right)\right] + \ln(f) = \ln(C) \tag{26.6}$$

*Proof: See Appendix* Equation (26.6) can now be put in the form

$$(\ln C - B Q_o) - \left[B \sum_{i=1}^{p} Q_i \left(\frac{1}{r^i}\right)\right] = \text{In } f$$

Or,

$$\delta_0 + \left(\sum_{i=1}^{p} \delta_i \rho^i\right) = \ln f \tag{26.7}$$

where

$$\delta_0 = (\ln C - B Q_o)$$

$$\delta_i = -BQ_i, \mathrm{i} = 1, 2 \ldots\ldots \mathrm{p}$$

Generalizing (26.7) into a regressive formula, we can write

$$\mathrm{Y} = \mathrm{X}\beta + \varepsilon_0 \tag{26.8}$$

where

$$\mathrm{Y} = [\ln f_1, \ln f_2 \ldots\ldots \ln f_i \ldots\ldots \ln f_n]^t$$

$$\beta = [\delta_1, \delta_2, \ldots\ldots\ldots\ldots \delta_j \ldots\ldots\ldots\ldots \delta_p, \delta_0]^t,$$

t stands for transpose,

$$\mathrm{X} = \left[\mathrm{x_{i,j}}\right]; \mathrm{i} = 1, 2, 3, \ldots \mathrm{n}, \mathrm{j} = 1, 2, 3, \ldots..\mathrm{p} + 1$$

$$\mathrm{xi, j} = \frac{1}{i^j}; \mathrm{i} = 1, 2, 3, \ldots..\mathrm{n}; \mathrm{j} = 1, 2, \ldots\ldots\ldots\ldots..\mathrm{p}$$

and

$$\mathrm{x_{i,p+1}} = 1, \forall \mathrm{i} = 1, 2, 3 \ldots..\mathrm{n}$$

$\varepsilon_0 \approx N_n(0, \sigma_n)$ corresponds to a noise term assumed to be a multivariate normal I .i.d distribution of n variables with zero mean and variance $\sigma_{\mathrm{n}}$.

Maximum likelihood solution of β in (26.8) is given as

$$\hat{\beta} = \left[\left(X^t X\right)^{-1} X\right] Y \tag{26.9}$$

Equation (26.9) is the solution to the regression Eq. (26.8).

## 26.3 Application of Regression Model to Authorship Attribution

The principle of the proposed method is to first convert Zipf word frequency vector into a regression vector which in turn is transformed into a Z-score vector. The author of the unknown text is identified using a metric between the unknown text vector and that of the author's texts.

### 26.3.1 Z-Scores, Manhattan Distance, and Metric

In order to compare our proposed authorship attribution method with that of Burrows, we proceed as follows. The frequency data for 25 common words appearing in English are extracted for each of the 12 texts which are written by six authors with two texts corresponding to each author. The frequency of words is given in Table 26.1. Using the regression method outlined in Sect. 26.2, we determine the maximum likelihood solution of regression model coefficients (eighth-order model) for each of the 12 texts (Table 26.1). Each text is now identified with a 9-tuple vector. The Z-score is then calculated as follows:

$$z = \left( \frac{x - \overline{x}}{\sigma} \right) \tag{26.10}$$

where x is the data, $\overline{x}$ is the mean, σ is the variance of the data, and Z is the Z-score. We computed Z-score for every coefficient considered which resulted in Zq score, q = 1,2,... 0.8,0, which is essentially Z-score corresponding to each element of Q vector given as

$$\mathrm{Q} = [\mathrm{Q1}, \mathrm{Q2}, \mathrm{Q3} \ldots . \mathrm{Q8}, \mathrm{Q0}]$$

In the case of Burrows's method, data x in (26.10) corresponds to the frequency of the word in the text and $\overline{\mathrm{x}}$ and variance σ are calculated based on the frequency of a particular word in all the 12 texts. The mean and the variance are calculated for each of the 25 words. Each text will then correspond to a 25-tuple Z-score vector (Table 26.2).

Given two Z-score vectors x and ywhere

$$x = (x_1, x_2, \ldots . . x_n)^t$$

$$y = (y_1, y_2 \ldots . . . y_n)^t,$$

the Manhattan distance is defined as

$$\mathrm{M_{XY}} = \sum_{i=1}^{n} |x_i - y_i| \tag{26.11}$$

Metric between unknown text and an author is defined next. Suppose we have an unknown text U, with Z-score vector Zu and an author with two texts A1 and A2 with the corresponding Z-score vectors ZA1 and ZA2. A metric between text U and author A is defined as

$$\mathrm{D_{ua}} = \min \{\mathrm{Mua_1}, \mathrm{Mua_2}\} \tag{26.12}$$

**Table 26.1** Frequency of the words of 12 texts

| Words | A1 | A2 | B1 | B 2 | C 1. | C 2 | R1 | R2 | S1 | S2 | E1 | E2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| The | 2449 | 5895 | 11,821 | 14,906 | 2265 | 7323 | 31,241 | 12,282 | 2371 | 9896 | 7636 | 4540 |
| Be | 1578 | 3704 | 8233 | 9525 | 1365 | 4508 | 23,047 | 8716 | 1245 | 6247 | 3713 | 2617 |
| To | 2513 | 6343 | 9181 | 9163 | 953 | 3253 | 25,268 | 16,332 | 1245 | 4855 | 4631 | 3141 |
| Of | 664 | 1718 | 2955 | 3138 | 394 | 1377 | 14,348 | 5021 | 332 | 1780 | 1803 | 1154 |
| And | 604 | 1548 | 3240 | 3470 | 265 | 947 | 9420 | 4809 | 304 | 1354 | 1736 | 947 |
| A | 882 | 1970 | 4258 | 4482 | 605 | 2102 | 13,813 | 5855 | 752 | 3595 | 2171 | 1479 |
| In | 2334 | 5534 | 12,098 | 12,936 | 878 | 3205 | 38,137 | 15,212 | 1135 | 4309 | 5042 | 3099 |
| That | 1260 | 2779 | 4927 | 6278 | 1146 | 3697 | 17,134 | 7458 | 987 | 4018 | 3101 | 1770 |
| Have | 558 | 1631 | 2037 | 2295 | 398 | 1116 | 7764 | 3258 | 534 | 1842 | 1487 | 675 |
| I | 882 | 1970 | 4258 | 4482 | 605 | 2102 | 13,813 | 5855 | 752 | 3595 | 2171 | 1479 |
| It | 245 | 638 | 1588 | 1961 | 122 | 457 | 4004 | 1283 | 121 | 623 | 479 | 389 |
| For | 254 | 590 | 2034 | 2016 | 126 | 516 | 4764 | 1742 | 183 | 850 | 684 | 439 |
| Not | 426 | 1696 | 3433 | 3877 | 331 | 2164 | 6015 | 2548 | 413 | 2342 | 1840 | 1073 |
| On | 391 | 966 | 2002 | 2166 | 256 | 918 | 4308 | 1781 | 227 | 904 | 1106 | 652 |
| With | 148 | 465 | 1528 | 1597 | 154 | 407 | 5440 | 2210 | 150 | 960 | 847 | 469 |
| He | 391 | 966 | 2002 | 2166 | 256 | 918 | 4308 | 1781 | 227 | 904 | 1106 | 652 |
| As | 147 | 370 | 483 | 451 | 33 | 146 | 1754 | 813 | 71 | 254 | 417 | 219 |
| You | 595 | 2190 | 3192 | 2522 | 257 | 824 | 10,552 | 6198 | 116 | 644 | 2133 | 1102 |
| Do | 648 | 1450 | 2121 | 2580 | 293 | 1082 | 11,200 | 5256 | 457 | 2165 | 1383 | 822 |
| At | 571 | 1976 | 3882 | 4382 | 557 | 2955 | 7546 | 3674 | 351 | 1562 | 2307 | 1161 |
| This | 589 | 1512 | 3508 | 3731 | 367 | 1311 | 7407 | 3365 | 390 | 1523 | 1312 | 828 |
| But | 374 | 712 | 1640 | 1678 | 99 | 316 | 5140 | 3149 | 257 | 854 | 629 | 356 |
| His | 164 | 530 | 1144 | 718 | 34 | 79 | 6113 | 2773 | 62 | 398 | 477 | 305 |
| By | 346 | 985 | 2028 | 1668 | 119 | 447 | 9399 | 4098 | 252 | 1099 | 951 | 556 |
| From | 480 | 1065 | 2274 | 2084 | 118 | 440 | 10,948 | 4478 | 175 | 1013 | 1096 | 702 |
| Words | A1 | A2 | B1 | B 2 | C 1. | C 2 | R1 | R2 | S1 | S2 | E1 | E2 |
| The | 2449 | 5895 | 11,821 | 14,906 | 2265 | 7323 | 31,241 | 12,282 | 2371 | 9896 | 7636 | 4540 |
| Be | 1578 | 3704 | 8233 | 9525 | 1365 | 4508 | 23,047 | 8716 | 1245 | 6247 | 3713 | 2617 |
| To | 2513 | 6343 | 9181 | 9163 | 953 | 3253 | 25,268 | 16,332 | 1245 | 4855 | 4631 | 3141 |
| Of | 664 | 1718 | 2955 | 3138 | 394 | 1377 | 14,348 | 5021 | 332 | 1780 | 1803 | 1154 |
| And | 604 | 1548 | 3240 | 3470 | 265 | 947 | 9420 | 4809 | 304 | 1354 | 1736 | 947 |
| A | 882 | 1970 | 4258 | 4482 | 605 | 2102 | 13,813 | 5855 | 752 | 3595 | 2171 | 1479 |
| In | 2334 | 5534 | 12,098 | 12,936 | 878 | 3205 | 38,137 | 15,212 | 1135 | 4309 | 5042 | 3099 |
| That | 1260 | 2779 | 4927 | 6278 | 1146 | 3697 | 17,134 | 7458 | 987 | 4018 | 3101 | 1770 |
| Have | 558 | 1631 | 2037 | 2295 | 398 | 1116 | 7764 | 3258 | 534 | 1842 | 1487 | 675 |
| I | 882 | 1970 | 4258 | 4482 | 605 | 2102 | 13,813 | 5855 | 752 | 3595 | 2171 | 1479 |
| It | 245 | 638 | 1588 | 1961 | 122 | 457 | 4004 | 1283 | 121 | 623 | 479 | 389 |
| For | 254 | 590 | 2034 | 2016 | 126 | 516 | 4764 | 1742 | 183 | 850 | 684 | 439 |
| Not | 426 | 1696 | 3433 | 3877 | 331 | 2164 | 6015 | 2548 | 413 | 2342 | 1840 | 1073 |
| On | 391 | 966 | 2002 | 2166 | 256 | 918 | 4308 | 1781 | 227 | 904 | 1106 | 652 |
| With | 148 | 465 | 1528 | 1597 | 154 | 407 | 5440 | 2210 | 150 | 960 | 847 | 469 |
| He | 391 | 966 | 2002 | 2166 | 256 | 918 | 4308 | 1781 | 227 | 904 | 1106 | 652 |

(continued)

**Table 26.1** (continued)

| Words | A1 | A2 | B1 | B 2 | C 1. | C 2 | R1 | R2 | S1 | S2 | E1 | E2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| As | 147 | 370 | 483 | 451 | 33 | 146 | 1754 | 813 | 71 | 254 | 417 | 219 |
| You | 595 | 2190 | 3192 | 2522 | 257 | 824 | 10,552 | 6198 | 116 | 644 | 2133 | 1102 |
| Do | 648 | 1450 | 2121 | 2580 | 293 | 1082 | 11,200 | 5256 | 457 | 2165 | 1383 | 822 |
| At | 571 | 1976 | 3882 | 4382 | 557 | 2955 | 7546 | 3674 | 351 | 1562 | 2307 | 1161 |
| This | 589 | 1512 | 3508 | 3731 | 367 | 1311 | 7407 | 3365 | 390 | 1523 | 1312 | 828 |
| But | 374 | 712 | 1640 | 1678 | 99 | 316 | 5140 | 3149 | 257 | 854 | 629 | 356 |
| His | 164 | 530 | 1144 | 718 | 34 | 79 | 6113 | 2773 | 62 | 398 | 477 | 305 |
| By | 346 | 985 | 2028 | 1668 | 119 | 447 | 9399 | 4098 | 252 | 1099 | 951 | 556 |
| From | 480 | 1065 | 2274 | 2084 | 118 | 440 | 10,948 | 4478 | 175 | 1013 | 1096 | 702 |

**Table 26.2** Metric between unknown text and author (proposed method)

| | Authors | | | | | |
|---|---|---|---|---|---|---|
| Unknown text | Abronte | Burney | Conrad | Edge | Richard | Stern |
| A1 | 9.287551 | 15.2268 | 4.600985 | 4.163741 | 25.43824 | 3.883777 |
| A2 | 9.287551 | 19.89171 | 4.281479 | 13.45129 | 34.72579 | 3.852605 |
| B1 | 15.2268 | 3.758693 | 18.65296 | 9.378856 | 13.52786 | 14.13694 |
| B2 | 17.42025 | 3.758693 | 20.84642 | 10.55381 | 14.85948 | 16.29978 |
| C1 | 13.56903 | 28.79583 | 10.14287 | 17.73277 | 39.00727 | 0.888879 |
| C2 | 3.488556 | 18.65296 | 10.14287 | 7.74772 | 28.8644 | 6.030929 |
| E1 | 5.894536 | 10.60373 | 7.589902 | 9.934735 | 21.55077 | 5.190053 |
| E2 | 14.09848 | 9.378856 | 17.52464 | 9.934735 | 16.37892 | 12.978 |
| R1 | 79.31194 | 61.89169 | 31.36925 | 65.21347 | 53.8737 | 78.19146 |
| R2 | 25.43824 | 14.15134 | 28.8644 | 16.37892 | 53.8737 | 24.31776 |
| S1 | 3.852605 | 26.24807 | 0.986006 | 17.3039 | 16.12065 | 14.26063 |
| S2 | 4.859182 | 16.29978 | 4.54664 | 4.76281 | 24.31776 | 14.26063 |

where $\text{Mau}_i$, i = 1,2, corresponds to the Manhattan distance between Zu and ZAi vector, i = 1,2.

## 26.4 Comparison of Results

To investigate the use of the proposed method for authorship attribution and compare it with that of the Burrows method, we proceed as follows. Table 26.4 shows the distance between the unknown text (each of the 12 texts, in turn, is considered as the unknown text) using the proposed method. We derive the metric between the unknown text and each of the authors using (26.11) and (26.12). The metric between the unknown text and its own author, for example, between A1 and author A, is taken as the Manhattan distance between A1 and A2 both of author A. Examining Table 26.3, considering Abronte1 (A1) as the unknown text, the metric between A1 and all six authors in the row gives Abronte as the least. Hence, Abronte1 is assigned

**Table 26.3** Metric between unknown text and author (Burrows)

| | Authors | | | | | |
|---|---|---|---|---|---|---|
| Unknown text | Abronte | Burney | Conrad | Edgeworth | Richardson | Stern |
| A1 | 2.261048 | 3.361087 | 14.94231 | 6.418857 | 17.20816 | 6.190078 |
| A2 | 2.261048 | 1.100039 | 15.22276 | 5.465715 | 15.18287 | 6.470521 |
| B1 | 17.20087 | 17.66773 | 3.017894 | 9.761468 | 15.56685 | 9.561772 |
| B2 | 14.94231 | 14.92735 | 3.017894 | 7.502909 | 15.9497 | 6.662913 |
| C1 | 3.361087 | 0.850492 | 15.40918 | 5.875438 | 14.16183 | 7.079541 |
| C2 | 1.950531 | 0.850492 | 14.92735 | 1.561119 | 13.32998 | 7.790976 |
| E1 | 7.439405 | 6.275275 | 7.502909 | 2.621825 | 10.1868 | 2.653279 |
| E2 | 5.689019 | 5.39361 | 9.533737 | 2.621825 | 9.319498 | 7.038581 |
| R1 | 18.19497 | 10.96374 | 15.56685 | 14.65328 | 3.027607 | 21.69186 |
| R2 | 6.922072 | 13.32998 | 16.05834 | 11.62568 | 3.027607 | 18.66426 |
| S1 | 5.546845 | 7.079541 | 6.345388 | 5.569234 | 18.66426 | 2.503459 |
| S2 | 8.693538 | 9.160399 | 6.549214 | 5.884191 | 19.49556 | 2.503459 |

**Table 26.4** Metric between unknown text and author (Burrows)

| | Authors | | | | | |
|---|---|---|---|---|---|---|
| Unknown text | Abronte | Burney | Conrad | Edge | Richard | Stern |
| A1 | 9.287551 | 15.2268 | 4.600985 | 4.163741 | 25.43824 | 3.883777 |
| A2 | 9.287551 | 19.89171 | 4.281479 | 13.45129 | 34.72579 | 3.852605 |
| B1 | 15.2268 | 3.758693 | 18.65296 | 9.378856 | 13.52786 | 14.13694 |
| B2 | 17.42025 | 3.758693 | 20.84642 | 10.55381 | 14.85948 | 16.29978 |
| C1 | 13.56903 | 28.79583 | 10.14287 | 17.73277 | 39.00727 | 0.888879 |
| C2 | 3.488556 | 18.65296 | 10.14287 | 7.74772 | 28.8644 | 6.030929 |
| E1 | 5.894536 | 10.60373 | 7.589902 | 9.934735 | 21.55077 | 5.190053 |
| E2 | 14.09848 | 9.378856 | 17.52464 | 9.934735 | 16.37892 | 12.978 |
| R1 | 79.31194 | 61.89169 | 31.36925 | 65.21347 | 53.8737 | 78.19146 |
| R2 | 25.43824 | 14.15134 | 28.8644 | 16.37892 | 53.8737 | 24.31776 |
| S1 | 3.852605 | 26.24807 | 0.986006 | 17.3039 | 16.12065 | 14.26063 |
| S2 | 4.859182 | 16.29978 | 4.54664 | 4.76281 | 24.31776 | 14.26063 |

to Abronte correctly. Proceeding similarly, all the 12 unknown texts are assigned correctly to the respective author except in the case of Abronte2 which is assigned to Burney incorrectly. This gives an accuracy of 11 out of 12 correct assignments or 91.7% for the proposed method. Table 26.4 gives a metric between the 12 unknown texts and the 6 authors using the Burrows delta method, using word frequencies directly. Proceeding similar to Table 26.3, it is seen that unknown texts are assigned correctly only in the case of Burney1 and Burney2 giving an accuracy score of 2 out of 12 or 16.7%, for the data considered.

Moreover, as the Burrows method takes the actual frequency of more than 100 most frequent words, the processing becomes difficult and complex.

## 26.5 Conclusion

This paper proposes a new method of authorship attribution based on regression model coefficients derived from frequencies of common words in a text. The results of the proposed method compare favorably with that of Burrows for the same data. The poorer performance of the well-known Burrows method compared to the proposed method is perhaps due to an insufficient number of words for analysis used in the example considered. Typically, Burrows has produced good results for 150 words or more. Nevertheless, our proposed method, even with 25 functional words, is able to give a higher success rate in assigning unknown text to an author. This provides empirical evidence that regression coefficients could be a viable candidate for use in authorship attribution.

## A.1 Appendix

Taking natural logarithm of (26.3)

$$\log(\mathrm{r}) + \log\left(1 + \frac{m}{r}\right) = \sum_{n=1}^{\infty} \frac{1}{n}\left[\left(\frac{r-1}{r}\right)^n + (-1)^{n+1}\left(\frac{m}{r}\right)^n\right] \tag{26.13}$$

$$= \sum_{n=1}^{\infty} \frac{1}{n}\left[\left(1 - \frac{1}{r}\right)^n + (-1)^{n+1}\left(\frac{m}{r}\right)^n\right]$$

Approximating up to p terms only

$$\log(\mathrm{r}) + \log\left(1 + \frac{m}{r}\right) \approx \sum_{j=1}^{p} \frac{1}{j}\left[\left(1 - \frac{1}{r}\right)^j + (-1)^{j+1}\left(\frac{m}{r}\right)^j\right] \tag{26.14}$$

Using binomial expansion, one can write

$$\log(\mathrm{r}) + \log\left(1 + \frac{m}{r}\right) = \mathrm{Q}_0 + \sum_{i=1}^{p} Q_i\left(\frac{1}{r^i}\right) \tag{26.15}$$

where

$$\mathrm{Q}_0 = \sum_{n=1}^{p} \frac{1}{n}$$

and

$$Q_{i=}(-1)^i \left[ \left( \frac{1-m^i}{i} \right) + \sum_{k=1}^{p-i} \frac{1}{i+k} (i+k)_{C_i} \right] i = 1, 2..... p,$$

Substituting A3 into (26.5), (26.6) follow.

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# Chapter 27
# Survey on Various Actuator Technologies for Refreshable Braille E-book Reader

**D. Kavitha and V. Radha**

## 27.1 Introduction

According to a study [1] in 2015, around 3.6 million people were totally blind, 217 million people were moderately impaired, and 188 million people were mildly impaired. Visually impaired students account for around 12%, and they need to be educated for reading, writing, and communicating, so there is a need to develop assistive technology for them. Braille is a code system found by Louis Braille in 1821 for assisting visually impaired [VI] peoples. Braille cell has six raised dots for each character arranged in two columns of three dots in each row as in Fig. 27.1a. Currently single line Braille display system is available in market. According to the Braille standard [2] the dot base diameter should be 1.4–1.5 mm, dot height – 0.5 mm, dot height for adjacent dots – 0.05 mm, distance between dots vertically within same cell – 2.5 mm, and distance between dots horizontally within same cell – 6.4 mm as represented in Table 27.1 and Fig. 27.1b.

In order to access largely available sources of e-books and text materials freely on the internet, there is a need for Refreshable Braille Display (RBD) for converting text in computer to Braille display system. There are two main types based on which touch sensation is made: surface haptic display and shape display technologies. Surface haptic technologies do not use any moving parts, but a user can touch and feel virtual elements. Bau et al. [3] used electrovibration for tactile display and squeeze film effect by Winfield et al. [4]. Those technologies are not successful for

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https://doi.org/10.1007/978-3-030-49795-8_27

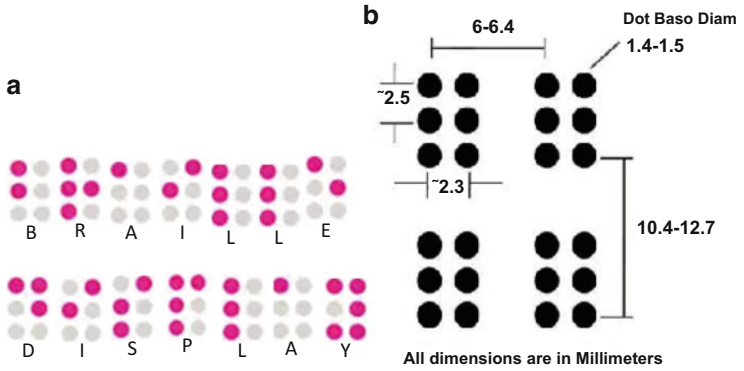


**Fig. 27.1** (**a**) BRAILLE DISPLAY word in six dot cell structure (**b**) Braille cell dot dimensions

**Table 27.1** Braille dot specifications

| Specification | Range |
|---|---|
| Dot base diameter | 1.4–1.5 mm |
| Dot height | 0.5 mm |
| Dot height uniformity of adjacent dots | 0.05 mm |
| Center distance of two vertical dots within same cell | 2.5 mm |
| Center distance of two horizontal dots within same cell | 6–6.4 mm |

multi-line RBD. The shape display technologies are where deflections of actuators are used for tactile sensation. In this survey we focus on working mechanisms of each actuators based on shape display technologies.

## 27.2 Piezoelectric Actuator

Piezoelectric actuators are simple to design with fast response rate and lower power consumption, also less failure rate and hence a popular choice for designing RBD. The piezoelectric reeds react to the applied electric voltage which is converted into mechanical movement. As we need to control six pins to form a single Braille character, for making a single line of Braille characters, it would require us to control 'n' number of individual piezoelectric actuators. These requirements create more complexity in the design and hence the price for the resulting device zooms high to US$1000 for a single line refreshable Braille display. Stacking six piezoelectric actuators within a single standard Braille cell dimension is again a challenging task that is yet to overcome. The piezoelectric material which is small in size requires a lever to push the Braille pins upward when an electric current is applied which in turn occupies more space. The piezoelectric reeds are replaced by piezoelectric bimorph which produces vibration for pin displacement [5] (Fig. 27.2). To overcome piezo bimorph, piezoelectric linear motors [7] were developed which will generate

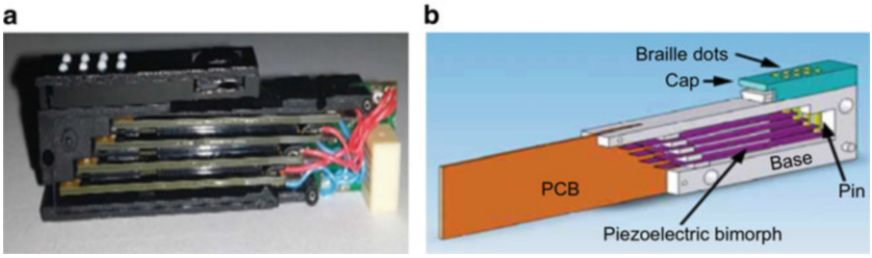


**Fig. 27.2** (**a**) Piezoelectric Braille cell as implemented in [6] (**b**) Piezoelectric bimorph implemented in [5]

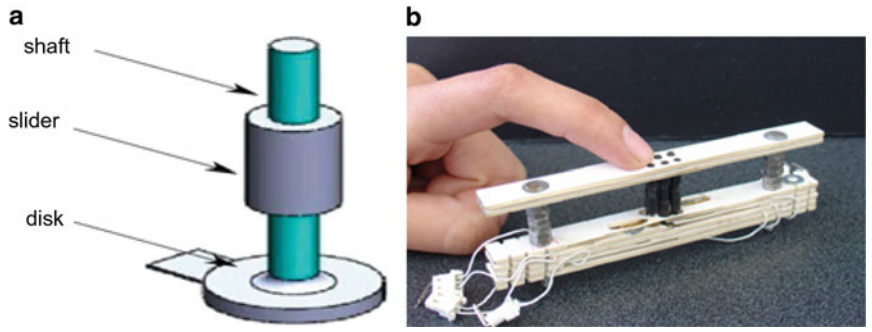


**Fig. 27.3** (**a**) Piezoelectric ultrasonic linear motor as in [7] (**b**) Piezoelectric ultrasonic linear motor as demonstrated in [8]

a linear movement that will push the pins upward. These were later replaced by more sophisticated piezoelectric ultrasonic motors [8] which are more responsive and compact when compared to the earlier predecessors (Fig. 27.3).

## 27.3 Electromagnetic Actuator

It has a permanent magnet surrounded by a pair of electric coils. When an electric current is applied to the coils, a magnetic flux is created in the middle where the permanent magnet is placed. Depending on the polarity, the magnetic flux pushes the permanent magnet up or down. By repeatedly alternating the polarity of the applied voltage, it is possible to control the movement of the pin by pushing it up or pulling it down. Since it generates a powerful mechanical force, which is robust and easy to scale, it became a popular choice of mechanism used in the design of RBD, and many models are designed [9]. But again, this too faces the same problem of piezoelectric actuators. It requires six different electromagnets to control a single Braille character for machine, and hence they need to be stacked in a small space [10]. These approaches require mini electromagnets to be placed close to each other, and the resulting magnetic flux produced by the

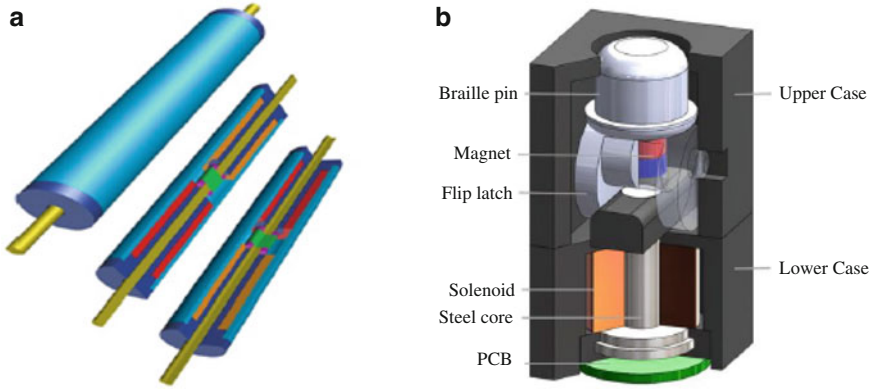


**Fig. 27.4** (**a**) Permanent magnet linear actuator as demonstrated in [11] (**b**) Single Braille pin using electromagnetic actuator as in [12]

individual electromagnets interferes with the neighboring pins' movements. The Braille character formation became highly unreliable and error prone. Each and every electromagnet requires considerable amount of power to operate a full-scale refreshable Braille; the required power went up to multiple factor. The bulky size of electromagnets and the electrical mechanisms to route power to individual entity became more complex too. To reduce the magnetic interference permanent magnets [11] are replaced by soft iron materials, ferro magnets, etc. Because of the above discussed limitations, it was impossible to achieve a full-page Braille display. Rotating latch structure was used in some works which lead to limitations which were overcome by flip-latch structure for minimizing friction and stability [12] (Fig. 27.4).

## 27.4 Shape Memory Alloys

They are a special type of steel alloy materials; when formed in the shape of thin coil rod or spring, they can change their state of shape when energized. They are in miniature form and can be used in any handheld devices. This mechanism is increasingly popular among researchers worldwide who are working on RBD. SMA has two physical states and has the ability to retain their position when energized or de-energized. Their movement axis is set to the Braille pin movement direction so that they can be used directly to drive a Braille pin without the need of any additional lever thereby saving space requirement. Electricity or thermal energy is used to stimulate an SMA (Fig. 27.5).

When stimulated they change their physical state by moving in the upward direction, and when powered off, they retain their ideal state. So, to retain the position of any pin, SMA must be kept in constant energized state and hence continuous power supply is required. Since the axis of mounting of the SMA

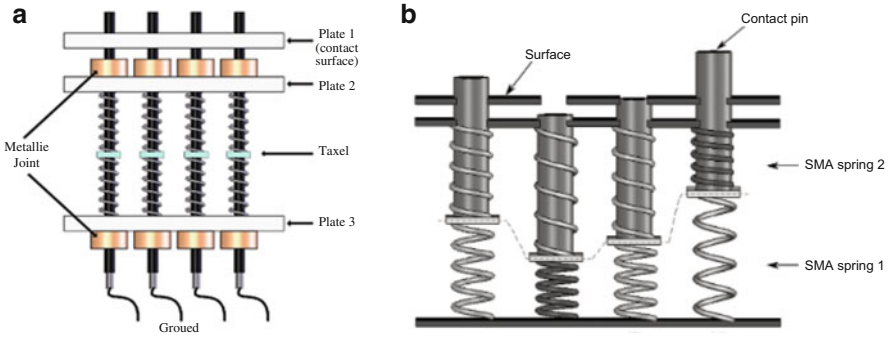


**Fig. 27.5** (**a**) Tactile display using SMA as in[13] (**b**) SMA tactile actuator as implemented in [14]

is in line with the axis of the pins, the height of the device tends to be higher when compared to other forms of RBDs which impact the portability factor of the device. To lift a pin physically, some amount of power is required which is to be generated by the SMA, but they have a limitation in generating the required amount of mechanical force. These SMAs are made of copper-zinc-aluminum alloy, copper-aluminum-nickel alloy, and/or nickel-titanium alloy combinations, and they subtly vary in their performance characteristics. Using shape memory alloy micro coil actuator along with magnetic latch will result in good pin displacement and reduced power consumption [13, 14] (Fig. 27.5).

## 27.5 Thermopneumatic Actuator

These are the type of actuators that works by creating pressure difference inside a sealed cylinder. The miniature cylinder is filled by a gas which can move a piston connected to a Braille pin up or down. When pressure inside the cylinder and outside ambient pressure are the same, the pin remains in the half position, that is, the pin is in the suppressed state. By increasing pressure inside the cylinder, the piston is moved upward pushing the Braille pin up which is the on-state. By controlling the pressure of different cylinders through pneumatic solenoid valves, the Braille pins are actuated and different characters are formed. But clustering six cylinders in a small Braille character dimension is practically a challenging task. The number of valves to control individual cylinder makes the design more complex. For the pins to remain high, constant pressure needs to be maintained in the chamber. This again demands more energy and power. Moreover, all these auxiliary parts need to be leak proof is a daunting practical challenge. A small amount of leakage in the pressure somewhere in the pipeline will lead to pressure drop inside the cylinder thereby losing the power to lift the pins. These practical limitations are yet to overcome to form a successful RBD. Vidal-Verdú et al. [15] Thermopneumatic actuator implemented concept in RBD. But it is confined to two line Braille display (Fig. 27.6).

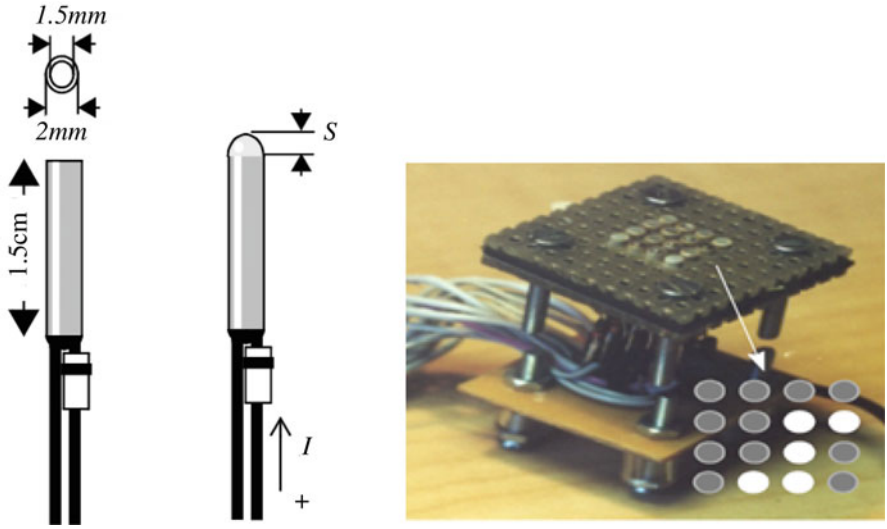


**Fig. 27.6** Thermopneumatic actuator for single cell Braille and for two cell Braille as demonstrated in [15]

## 27.6 Electro Active Polymer

These are the special type of polymers which can modify their shape, when an electric or thermal force is applied. Compared to SMA, electro active polymers are more efficient and highly responsive with little power, and they produce large deformation with significant mechanical strength. The Braille cell pins can be easily lifted up or retreated back by this polymer which makes them an effective solution for a RBD. A thin polymer film of dielectric elastomer [16] can convert electric energy into large mechanical force even by occupying small space. The electrostatic force squeezes the polymer between the electrodes which in turn morphs into significant mechanical force to push the pins up. On the other hand, the ionic elastomer works by movement of ions inside the polymer when an electric current is applied. Ionic metal polymer composites and reactive gels are a few of their types. They require a considerable amount of fire to generate a hold on a pin and constant power to retain its fold. The elastic model is of these, and dielectric elastomers are to be kept at very lower side to generate a large Maxwell strain. Because of its gel-like nature, they lack the required mechanical stiffness to move or hold a mechanical weight. They are not bistable, which means when an applied electric power is switched off, they will return to their inactive state. They are not suitable for the places to retain a hold on something for a longer time period. The property of rigidness in an EAP directly affects its reactive strain. The more they are rigid, they produce less strain. There is a need for bistable elastomer actuation as in [17]. The DE elastomer actuator has more attractive properties like stability, fast, small size,

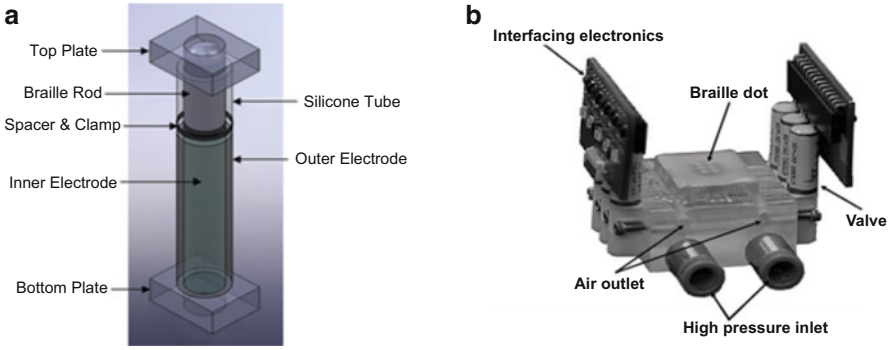


**Fig. 27.7** (**a**) Dielectric elastomer Braille dot as demonstrated in [19] (**b**) pneumatically actuated with micro bubble actuator as presented in [20]

weightless, less power consumption, and less overheating [18], but high voltage components lead to lower the dielastomer technology to be replaced by silicone elastomer. The unstableness of elastomeric membranes used in pneumatic actuation has been overcome by using endoskeletal bubble as demonstrated in Fig. 27.7b.

## 27.7 Conclusion

Piezoelectric actuator is the popular technology adopted in most of the commercially available refreshable Braille display as they are reliable, fast responsive, and scalable and have low power requirements. Even though piezoelectric bimorph is better than latching solenoids, but they fail due to contamination issues. Still then, they are relied upon by developers as they are more efficient. Another major disadvantage about piezo is that it renders single-line text when compared to their predecessor technologies. EAPs later replaced piezoelectric bimorphs because they consume lesser power remarkably. Shape memory alloys and thermopneumatic actuators have their own disadvantages like more power consumption, bulky size, and less portability.

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# Chapter 28
# An Approach of Searching Mobile User Location with QoS Provisioning in 5G Cellular Networks


**Kalpana Saha (Roy) and Riyanka Hazra**

## 28.1 Introduction

The wireless devices and 5G mobile technologies provide the various services in mobile networks with high volume of data and quality of service (QoS) improvement. Generally, compared to 4G networks, 5G will work more faster, and it provides up to 20 Gbps [1, 2]. 4G LTE provide high QoS service based on the data transfer classification. 5G technologies gives high speed for data communication and low latency compared to 4G technologies, because 4G techniques require high frequency bandwidth to connect all users during their busy environment [3]. Due to the lesser latency level of 5G technologies, it provides immediate response with successful delivery rate. So the 5G technologies is most concentrated on the quality of service (QoS) and quality of experience (QoE) for the real-time applications such as video calls, games and secure transactions. Quality of experience is mostly focus on the high quality with end-to-end successful data transmission with service providers. Delays and backhaul load can be reduced by using the cache system available in the base station, and this will be helpful to reduce the delay in 5G networks [1, 2, 4]. 5G techniques provide the best handset and offer a priceless offer to the users [5]. To overcome the macrocell issue and increase the signal strength, small cell deployment with a limited cell radius is necessary. Frequency reuse helps to increase the network capacity [6], and it achieves high throughput with the help of bandwidth estimation technique [7]. To obtain high QoS, traffic measurement is required with high traffic control strategies [8]. By using all these services, 5G networks provide the high reliability and scalability, and it controls the network traffic with QoS [9]. This technology utilizes less power, and that

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leads to reduce the requirement of power and energy consumption. Radio access technology (RAT) helps to access different users at the same time. Policy routers [10] are the routers which introduce the software agents for newly defined device. Next-generation network (NGN) is the most important component to measure the performance of terminals and devices in the wireless network. To obtain high RAT performance, mobile user-assisted technology should be created [11, 12].

Here, 5G technology supports all mobile centric techniques like secure transactions, cloud storage, authorization, network lifetime, authentication, and successful data transmission [13]. IP-based model will be imposed in 5G system, and all IP network (AIPN) also provide high Qos with lesser error TAE [14, 15]. These enhanced 5G technologies are used for high network capacity by expanding the spectrum level and reuse process. The cost will be very low, but it provides the high spectral efficiency with lesser complexity due to the utilization of millimeter wideband techniques in 5G networks [16]. This proposed work is mainly focused on the quality of services and quality of experience, and it helps to maintain the quality of quantity of network users with high throughput, packet delivery rate, and lesser delay, routing overhead, and latency [17].

## 28.2 Proposed Works

5G technology covers a lot of different technologies. 5G networks ensure a fast connection with high data rates. 5G network is widely used for private networks. Wireless networks have limited resources and shared medium compared to wired networks. Emerging of 5G applications and services meets new challenges that are not possible with traditional QoS models and parameters. Minimum call blocking probability and minimum handoff call dropping probability improve QoS for multi-class traffic. The relative locations among base stations and mobile users affect dynamically the channel conditions which degrade QoS. In our proposed work, our aim is to trace the location of a maximum number of mobile users with the provision of better QoS.

## 28.3 Software Used for Implementation

Our proposed work is based on a network simulator. We have used simulator ns3.25 which only works on the Ubuntu version. We develop our program using C++ and python language. We run our simulator in Netanim 3.107 version and python. The simulator ns3.25 version is installed by www.namsan.org. and runs Ubuntu 14.04 version which is a very robust architecture. The working of the mobile user tracking technique is similar for the ns3 point to point module and CSMA module.

## 28.4 Simulated Result with Graphical Representations

Our simulated results depict node and their IP and MAC addresses which are shown in Table 28.1. In this case, their IP and MAC address are different. The simulated results depict which nodes are connected with other nodes at the same time duration. In Table 28.2, we show that base node 0 and node 5, node 6, and node 7 are all connected. We try to define node 5, node 6, and node 7 are mobile users which are tracked by node 0. It is clear in another way that node 5, node 6, and node 7 are working as a connector or mobile tracker. We also show these nodes are connected with different time durations.

In our paper, we try to map the number of ports to nodes. In our proposed work, Netanim shows there are seven nodes. Every node has own IP address and MAC address. In this simulation nodes 0 and 1 are connected from start. There are permanent node 0 and permanent node 1. There IP and MAC addresses are different. Our simulated results from Netanim are shown in Figs. 28.1, 28.2, 28.3, 28.4, 28.5, 28.6, and 28.7. Our simulated results from python are shown in Figs. 28.8, 28.9, 28.10, and 28.11.

## 28.5 Conclusions and Future Work

In our paper, we have searched the maximum number of mobile users and given them better QoS with low latency and high data rates because a maximum number of mobile user connections is desirable. We try to develop an approach to trace the maximum number of mobile users with better QoS in 5G cellular networks. In this paper, we try to show trace mobile users in the nearest destination with no path loss. In the future, we will introduce a better end-to-end performance analysis and ns-3-based channel matrix generation.

**Table 28.1** Node and their IP and MAC address

| Node | IP | MAC |
|---|---|---|
| Node 0 | 10.1.3.4 | 00.00.00.00.00.0a |
| Node 1 | 10.1.2.1 | 00.00.00.00.00.03 |
| Node 2 | 10.1.2.2 | 00.00.00.00.00.04 |
| Node 3 | 10.1.2.3 | 00.00.00.00.00.05 |
| Node 4 | 10.1.2.4 | 00.00.00.00.00.06 |
| Node 5 | 10.1.3.1 | 00.00.00.00.00.07 |
| Node 6 | 10.1.3.2 | 00.00.00.00.00.08 |
| Node 7 | 10.1.3.3 | 00.00.00.00.00.09 |
| Another node 0 | 10.1.1.1 | 00.00.00.00.00.01 |
| Another node 1 | 10.1.1.2 | 00.00.00.00.00.02 |

**Table 28.2** Node-to-node connection and their time duration

| N | From node | To node | Time duration |
|---|---|---|---|
| 1 | 0 | 5 | 2.5e-05 |
| 2 | 0 | 6 | 2.5e-05 |
| 3 | 0 | 7 | 2.5e-05 |
| 4 | 6 | 5 | 0.000212037 |
| 5 | 6 | 7 | 0.000212037 |
| 6 | 6 | 0 | 0.000212037 |
| 7 | 0 | 5 | 0.000324074 |
| 8 | 0 | 6 | 0.000324074 |
| 9 | 0 | 7 | 0.000324074 |
| 10 | 0 | 5 | 0.000324074 |
| 11 | 0 | 6 | 0.000324074 |
| 12 | 0 | 7 | 0.000324074 |
| 13 | 6 | 5 | 0.000502111 |
| 14 | 6 | 7 | 0.000502111 |
| 15 | 6 | 0 | 0.000502111 |
| 16 | 6 | 6 | 0.000625127 |
| 17 | 5 | 7 | 0.000625127 |
| 18 | 5 | 0 | 0.000625127 |
| 19 | 5 | 5 | 0.00073716 |
| 20 | 0 | 6 | 0.00073716 |
| 21 | 0 | 7 | 0.00073716 |
| 22 | 0 | 5 | 0.00073716 |
| 23 | 0 | 6 | 0.00073716 |
| 24 | 0 | 7 | 0.00073716 |
| 25 | 5 | 6 | 0.000924193 |
| 26 | 5 | 7 | 0.000924193 |
| 27 | 5 | 0 | 0.000924193 |
| 28 | 7 | 6 | 0.00103823 |
| 29 | 7 | 5 | 0.00103823 |
| 30 | 7 | 0 | 0.00103823 |
| 31 | 0 | 5 | 0.00115027 |
| 32 | 0 | 6 | 0.00115027 |
| 33 | 0 | 7 | 0.00115027 |
| 34 | 0 | 5 | 0.00127327 |
| 35 | 0 | 6 | 0.00127327 |
| 36 | 0 | 7 | 0.00127327 |
| 37 | 7 | 6 | 0.00137332 |
| 38 | 7 | 5 | 0.00137332 |
| 39 | 7 | 0 | 0.00137332 |
| 40 | 0 | 5 | 0.1024 |
| 41 | 0 | 6 | 0.1024 |
| 42 | 0 | 7 | 0.1024 |
| 43 | 0 | 5 | 0.2048 |
| 44 | 0 | 6 | 0.2048 |
| 45 | 0 | 7 | 0.2048 |
| 46 | 0 | 5 | 0.3072 |
| 47 | 0 | 6 | 0.3072 |
| 48 | 0 | 7 | 0.3072 |

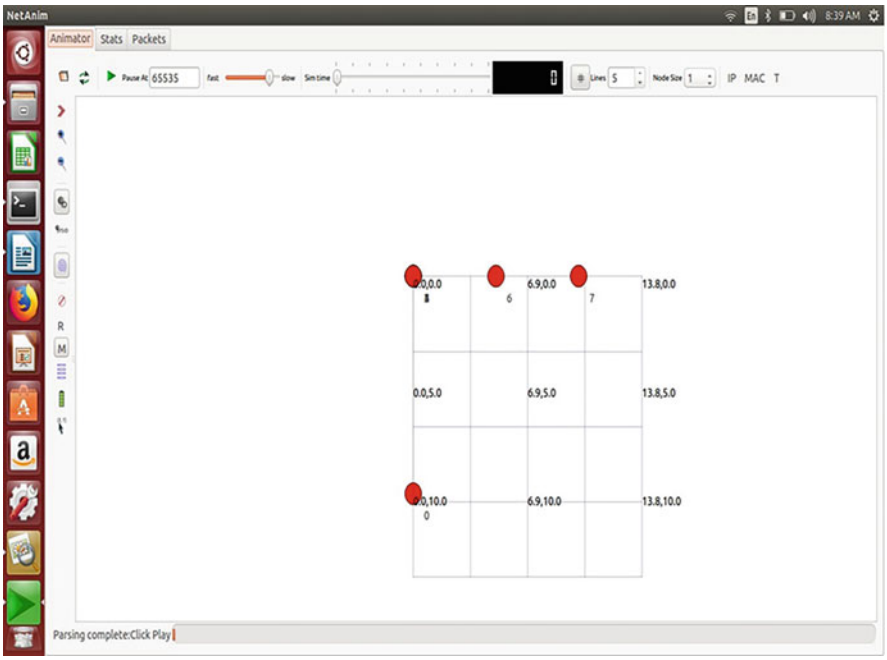


**Fig. 28.1** Two odes are initial state

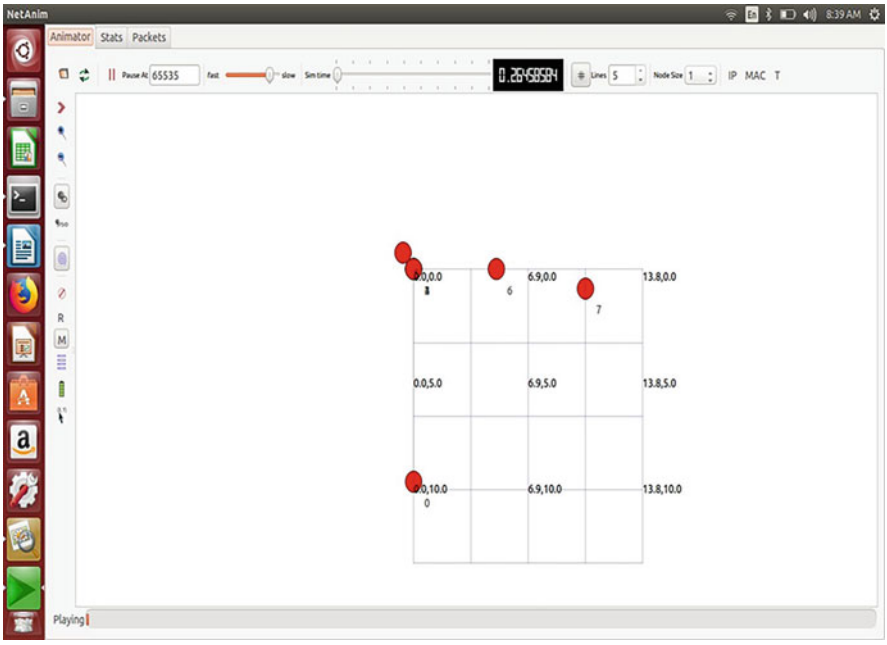


**Fig. 28.2** Three nodes start to moving another direction

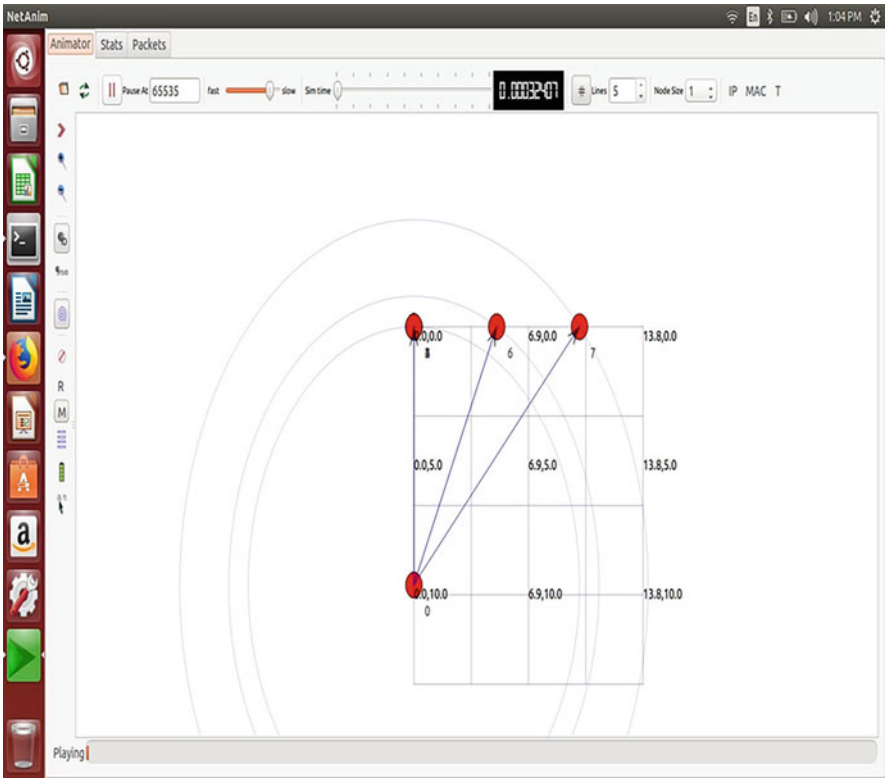


**Fig. 28.3** Node 0 connected with other node in 0.0002037

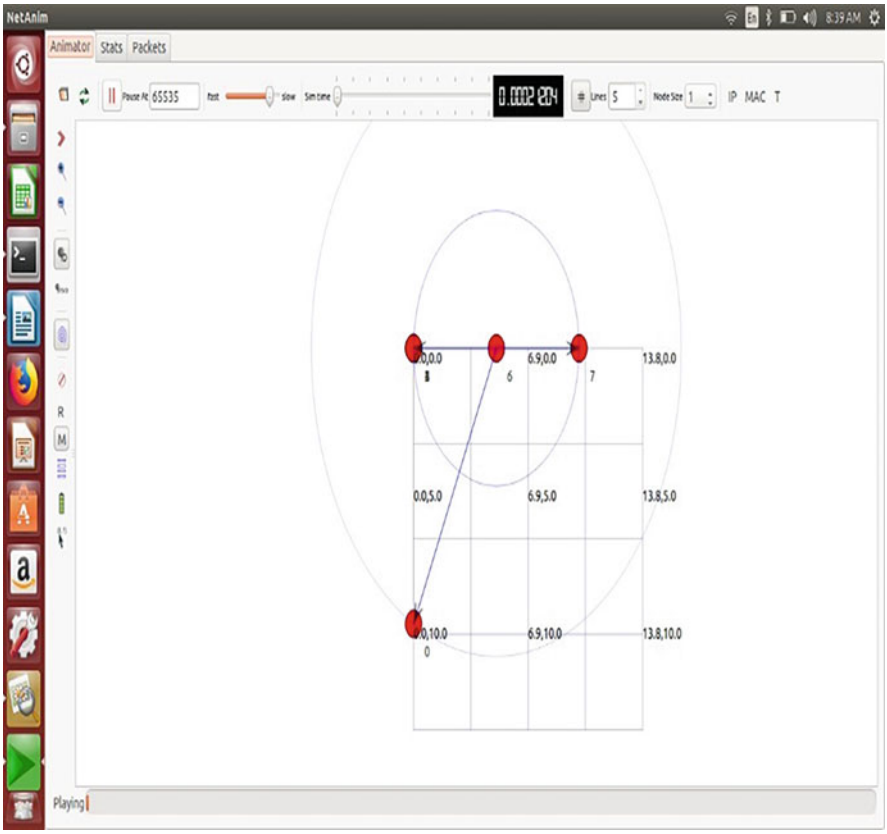


**Fig. 28.4** Node 0 connected with other node in 0.000202034

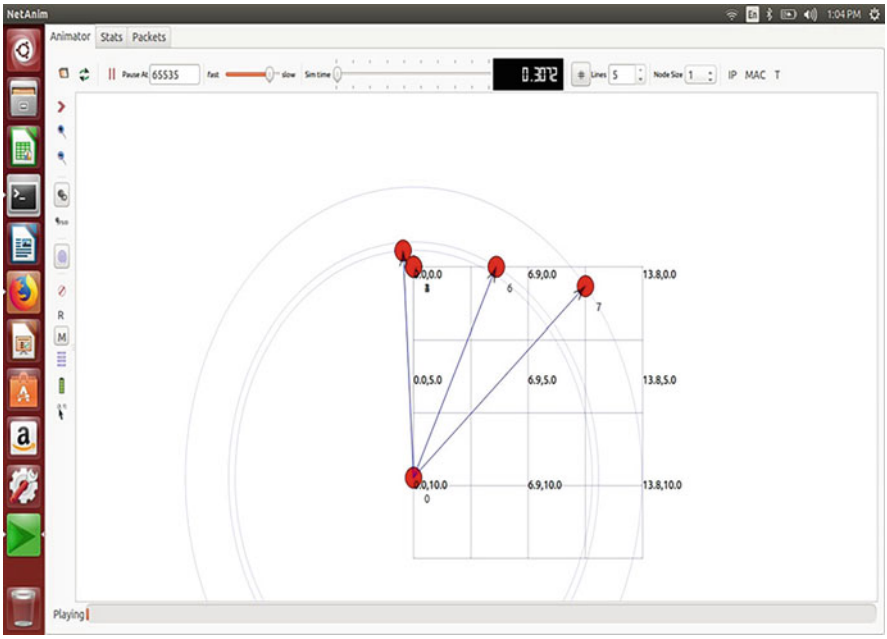


**Fig. 28.5** Node 0 connected with other node in different time duration

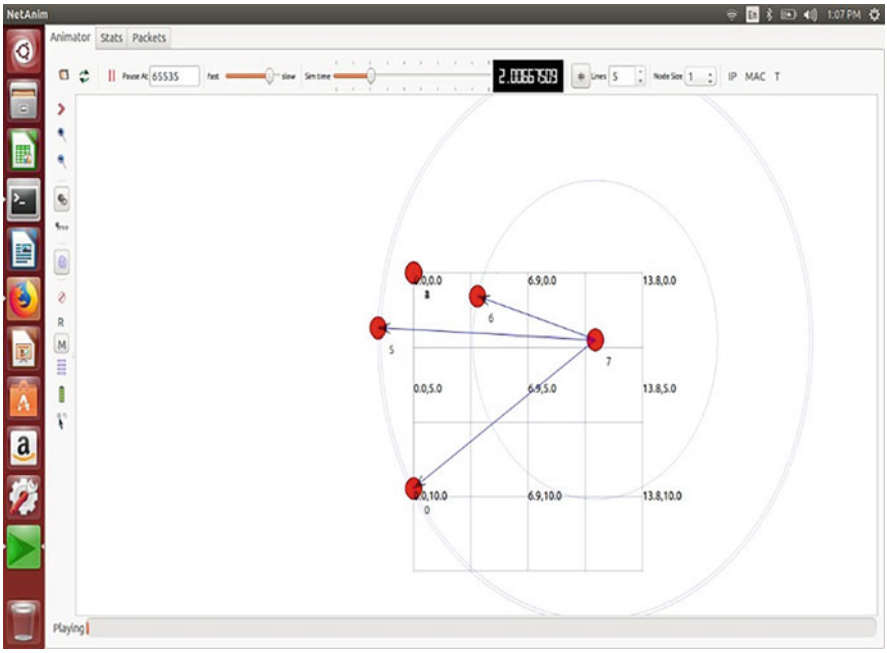


**Fig. 28.6** Node 7 connected with different node in 0.06574 time duration

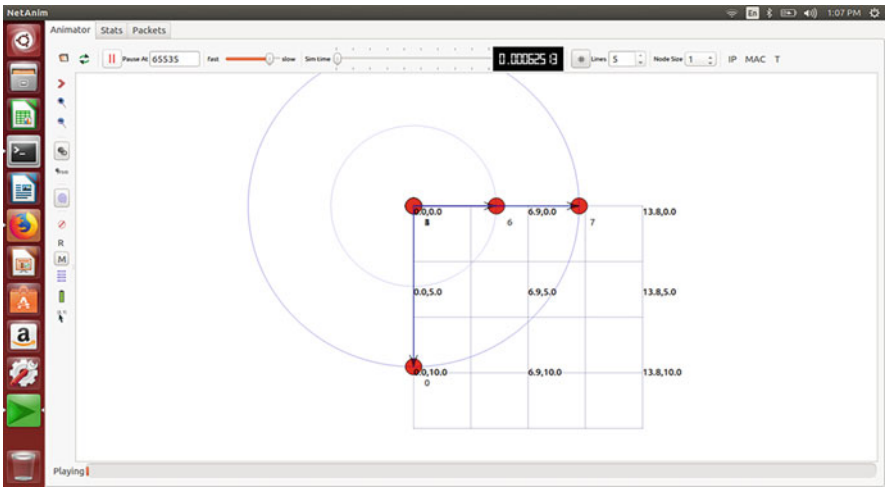


**Fig. 28.7** Node 5 connected with other node in 0.00062513 time duration

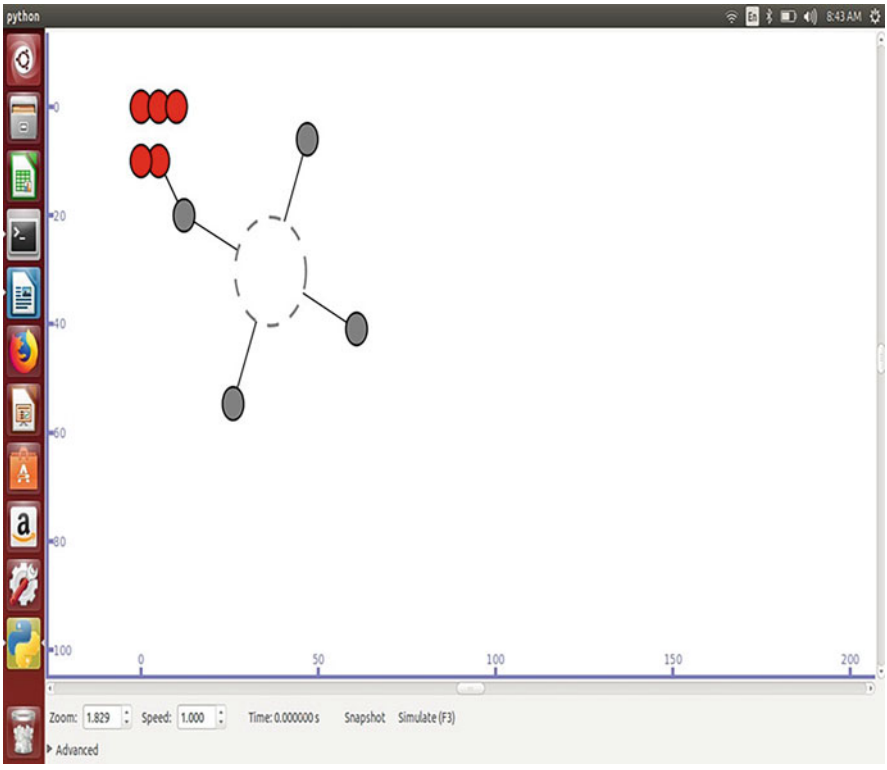


**Fig. 28.8** Five nodes are initial state

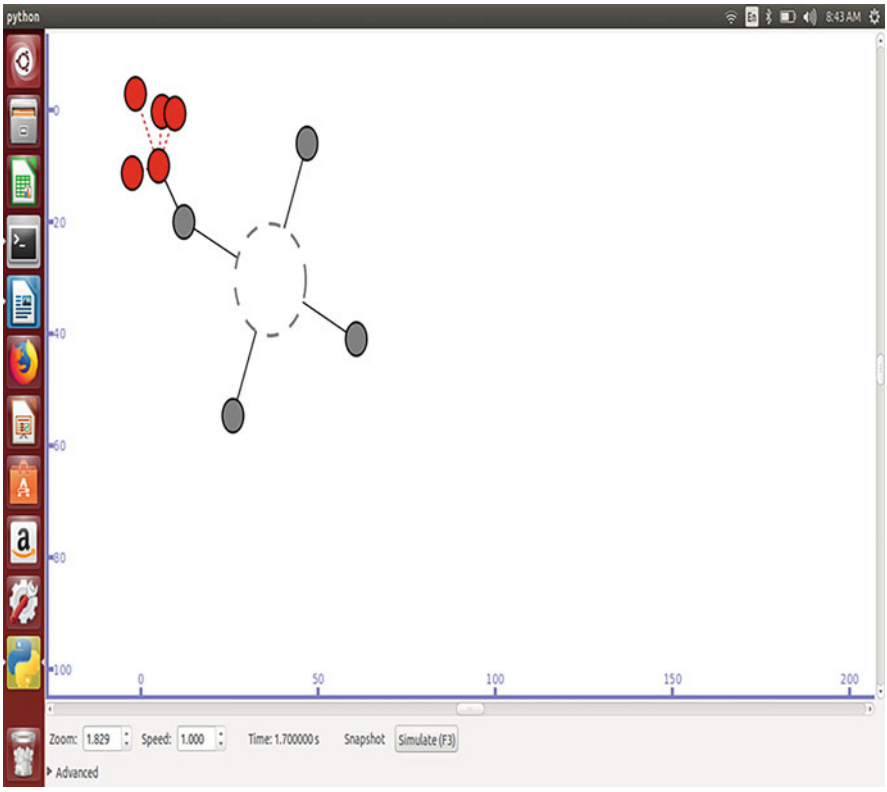


**Fig. 28.9** Three nodes start to moving another direction

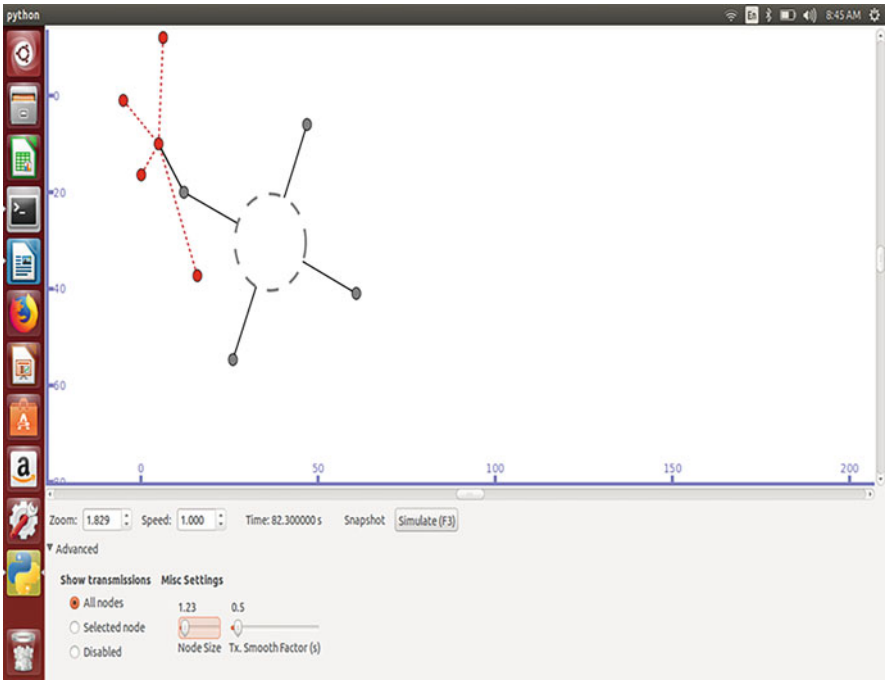


**Fig. 28.10** Node 0 connected with other node in 0.000202034 ns

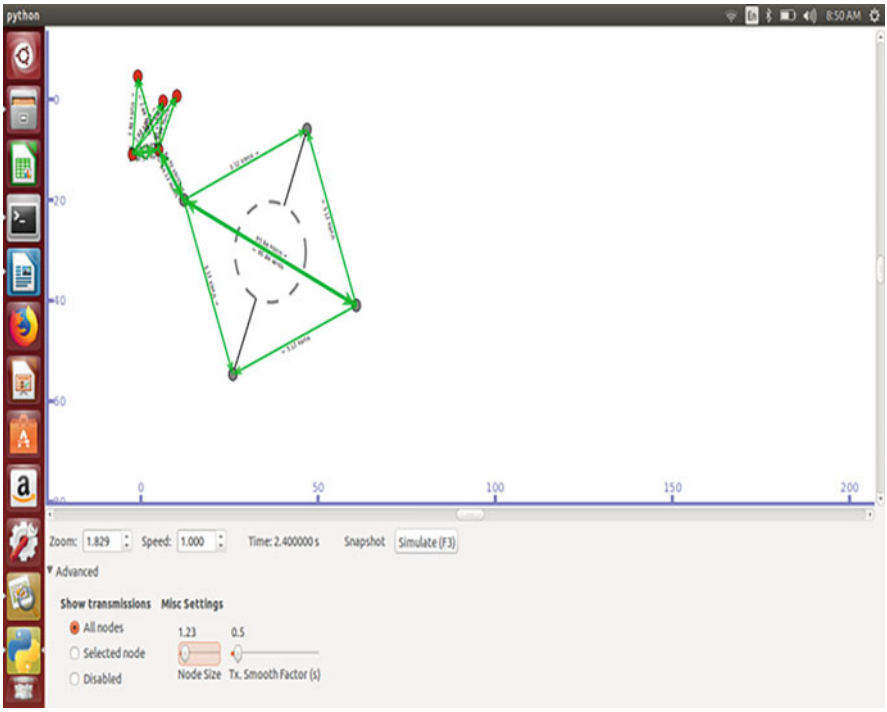


**Fig. 28.11** Node 0 connected with other node in different time duration

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# Chapter 29
# Arduino-Based Alcohol Sensing Alert with Engine Locking System


**J. Gowrishankar, P. PushpaKarthick, G. Balasundaram, E. Kaliappan, and N. Prabaharan**

## 29.1 Introduction

Nowadays, mishaps are brought about by drink-driving. Intoxicated drivers are in a precarious condition; thus, careless choices are made on the roadway which imperils the lives of street clients, the driver comprehensive. The hugeness of this danger rises above race or limit. In Nigeria, the issue is being handled by giving laws restricting the demonstration of drivers getting alcohol previously or while driving just as designating law implementations specialists to capture and oppress guilty parties. Be that as it may, viable checking of plastered drivers is a test to the police officers and street security officials. The explanation behind this stems from the characteristic failure of people to be inescapable just as omniscience inside a similar existence. This constrained capacity of law requirement operators undermines each manual exertion planned for checking drink – drinking. There is in this manner the requirement for a programmed liquor recognition framework that can work without the confinement of existence. The Nigerian Bureau of Statistics announced 11, 363 street mishaps in 2016. Despite the fact that the report expressed speed infringement as the first reason for these mishaps, it can securely be deduced that a large portion of the cases would have been because of driver's unsteady conditions brought about by drivers getting alcoholic before they drive. The examination done by the World Health Organization in 2008 shows

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that about half 60% of autocollisions are identified with drink-driving. All the more along these lines, WHO information on street traffic passings uncovered 1.25 million traffic passings were recorded universally in 2013 with the low and center salary nations having higher casualty rates per 100,000 populace (24.1 and 18.4 separately). Information gathered demonstrated that 67.2% of business vehicle drivers in Nigeria confessed to drinking liquor during working days. This shows most drivers, particularly business and uncompromising truck drivers, take part in drink-driving, which can prompt mishap. Nigeria sets a lawful utmost of 0.5 g/100 mL blood liquor fixation (BAC), any level over that is said to be unlawful. In this paper, as far as possible is taken as 0.4. The BAC portrays the amount of liquor in a specific volume of blood. It is estimated as either gram of ethanol per deciliter of blood (g/fdl, normally utilized in the United States) or milliliters of blood (mg/ml, utilized in a lot of Europe). For BAC level from 0.4 to 0.6, drivers feel stupified/befuddled or generally muddled, and it is commonly undependable for a driver to drive a vehicle under such condition. Likewise, the BAC level for 0.7 to 0.8 makes a driver's psychological, physical, and tactile capacities to be seriously hindered. At this stage, a driver is latent and unequipped for driving. BAC level of 0.2 to 0.3 is as yet undependable; however the driver still has a little level of poise. Our model framework incorporates the accompanying equipment segments in the plan: An LCD, the MQ-3 liquor sensor, DC engine, Buzzer, and two LEDs are coordinated to ATmega328 microcontroller. The proposed framework was planned and recreated utilizing the Proteus VSM test system. The product code to be scorched into the Arduino board was written in the Arduino IDE sketch. Many research endeavors have been coordinated to the plan of productive frameworks that will screen drink-driving [1]. Propose a liquor identification and engine locking framework. They utilized the AT89S51 controller, MQ-3 liquor sensor, and an LCD to tell the occupiers of a vehicle. The AT89S51 controller has an onboard streak memory which permits quick advancement and reconstructing in a matter of seconds [2]. Utilize an infrared (IR) liquor recognition framework to give persistent observation of a driver's BAC. An IR source LED-894 was utilized to coordinate IR vitality through an IR sensor (TSOP 1736) mounted on the guiding wheel. The initiation of the transfer circuit is made conceivable by an interface of IC-4538B and transistor-BC 547 [3]. Embrace the Arduino ATMEGA328 controller board interfaced with the MQ-3 liquor sensor module, GPS, GSM, LCD, and DC engine. The GPS module catches the area of a vehicle and advances it as a troubling message through the GSM module. The LCD goes about as the presentation, while the DC engine was utilized as a model for determining the capacity of the system to bolt the motor each time ethanol is detected [4]. Proposed a programmed vehicle motor-bolted control framework utilizing virtual instrumentation. The proposed framework utilized LabVIEW to execute a liquor breath analyzer. The technique utilized an Arduino as the control unit interfaced with the MQ-3 sensor as a breathalyzer. Different modules interfaced with the Arduino are bell, LED, LCD, and DC engine. The LED and LCD filled in as the yield gadget. ZigBee, IoT, and LabVIEW programming are different instruments executed. IoT empowers e-mail to be sent to concerned people of captured alcoholic suspects [5]. The proposed

system incorporated the utilization of a GPS for following the vehicle's area and heartbeat sensor to tell the typical or anomalous state of the driver and guard change to recognize the impact of a vehicle. Other practical modules interfaced with the ATmega328 controller are GSM, GPS, LCD, MQ-3 liquor sensor, hindrance sensor, fuel blocker, alert, and transfers [6]. The proposed system depends on ARM7 LPC2148 microcontroller which gives the persistent observation of a driver's BAC. PAS 32 U liquor sensor was used to persistently check the presence of alcohol, while the Global Positioning System and Global System for Mobile correspondence units send where the vehicle is arranged by means of SMS [7].

## 29.2 Proposed System

### *29.2.1 Proteus Model of Proposed System Using Arduino*

In this Arduino Alcohol Detector Shield, we have utilized an MQ3 sensor to identify present liquor level in the breath [8].

The whole framework embraced the Arduino Uno Microcontroller Board (in light of ATMEGA 328), the standard of the equipment diagram as appeared in Fig. 29.1. The center capacities modules are Arduino Uno, Alcohol Sensor module (MQ-3), GPS Module GSM Module, 16 × 2 LCD Display, and DC Motor [9].

### *29.2.2 Block Diagram*

Liquor detector venture has GSM innovation and alcohol discovery framework with vehicle controlling system (Fig. 29.2). At whatever point liquor rate crosses a limit level, the venture sends SMS to the proprietor of the vehicle or to his/her relatives. Simultaneously vehicle controlling is finished by halting the vehicle motor or some other manufacturing plant. Liquor recognition framework in a car expands the security of people going through the vehicle. We have given a relay and a DC engine to show the demo of the vehicle controlling system. At the point when the liquor level detected by the sensor is underneath the thrush hold level, at that point, no message is moved to the proprietor. Also, the message is shown at the display "Typical DRIVING DRIVER ALERT" in our venture. Additionally, the showing LED is kept off during the nonattendance of the liquor, and the engine continues running [10] (Table 29.1).

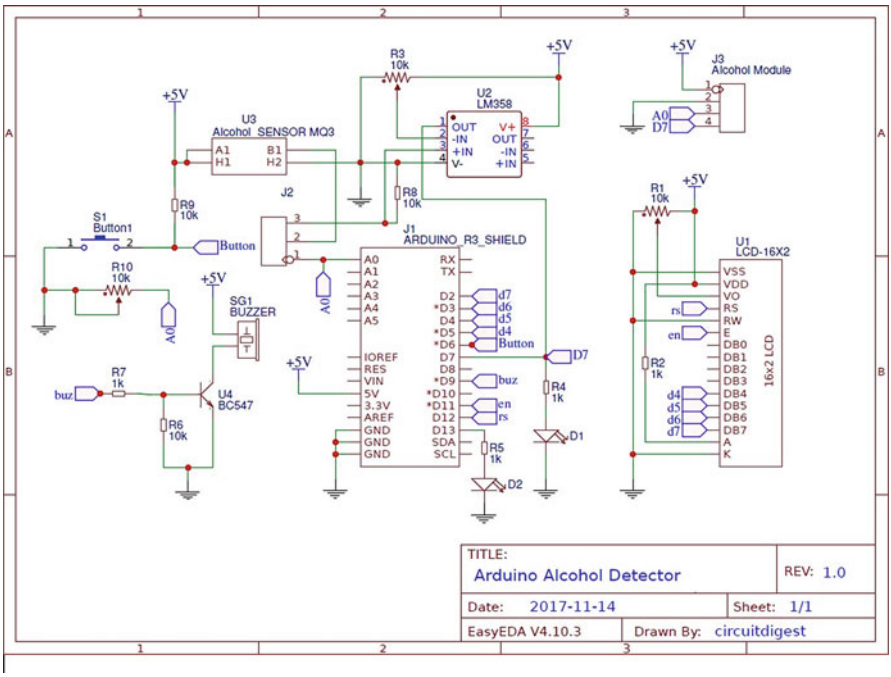


**Fig. 29.1** Proposed model system Arduino in Proteus

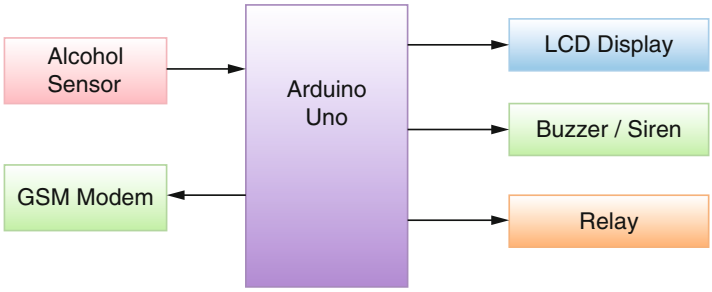


**Fig. 29.2** Block diagram of proposed system

**Table 29.1** Alcohol sensor reading

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Normal sensor readings | 16 | 20 | 24 | 26 | 27 | 30 | 35 | 40 |
| Experimental readings | 17 | 23 | 26 | 28 | 30 | 34 | 37 | 41 |

**Table 29.2** Sensitivity level characteristics

| Voltage(V) | PPM(part per million) | Percentage(%) |
|---|---|---|
| 0 | 0 | 0 |
| 0.5 | 100 | 10 |
| 1 | 200 | 20 |
| 1.5 | 300 | 30 |
| 2 | 400 | 40 |
| 2.5 | 500 | 50 |
| 3 | 600 | 60 |
| 3.5 | 700 | 70 |
| 4 | 800 | 80 |
| 4.5 | 900 | 90 |
| 5 | 1000 | 100 |

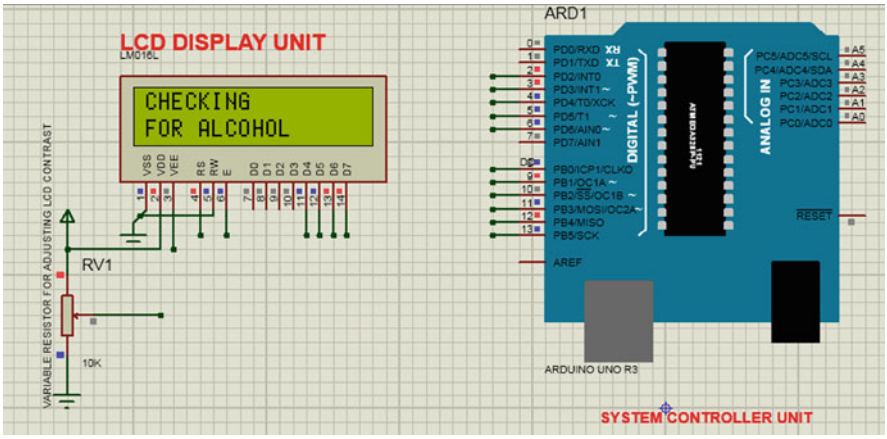


**Fig. 29.3** Measuring alcohol level

### *29.2.3 Alcohol Checking Stage*

In alcohol checking stage, when the vehicle is turned on the gauges the degree of liquor from the driver's breath to check whether the driver is inebriated, marginally alcoholic and whether on the off chance that he is amazingly smashed (Table 29.2). In view of this, the microcontroller possibly bolts the motor when the level surpasses 40% in which case motor stops with the goal that the driver can figure out how to gaze the vehicle to the street side. The unit for estimating the liquor level is delineated in Fig. 29.3 [11].

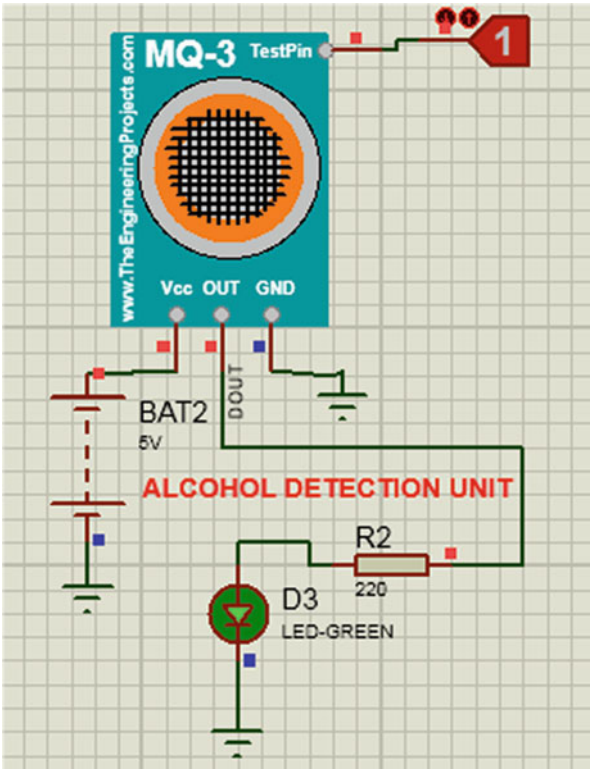


**Fig. 29.4** Detection stage

### *29.2.4 Alcohol Detection Unit*

The alcohol sensor unit has four pins: test pin, vcc, dout, and ground. The test pin is used to accept logic signals of 0 or 1 by using the logic state pin as shown in Fig. 29.4. The LED is used to show when the sensor detects alcohol. in the simulation, when the logic state is 1, the led goes on to indicate that alcohol is present and off to show the absence of alcohol [12] (Fig. 29.5).

## 29.3 System Flow Chart

The stream outline of the system has appeared in Fig. 29.6. The system calculation contains three fundamental advances. First is to boot up the framework, and next is the estimating state; this stage measures the liquor level from the drivers. An endorsed set cutoff will be given as a contribution to the microcontroller when the liquor level surpasses the point of confinement the vehicle won't begin [13].

- *Step 1* Power on the system

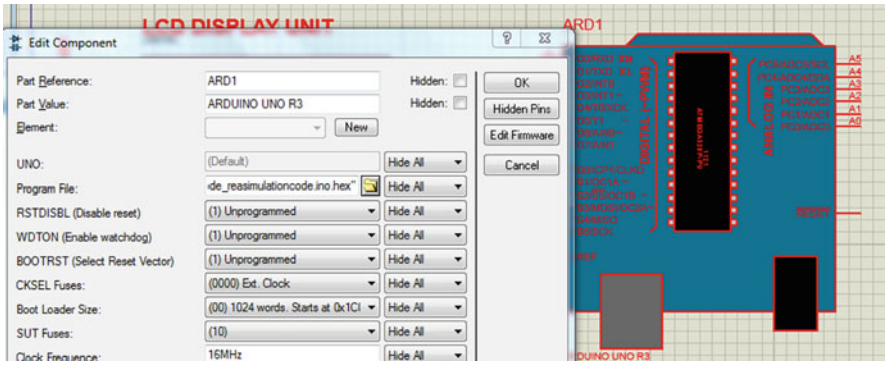


**Fig. 29.5** Location of hex file

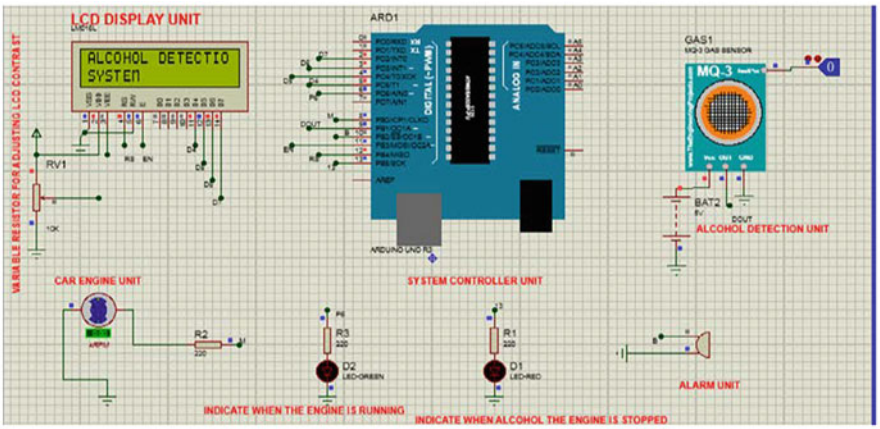


**Fig. 29.6** Complete alcohol detection and the engine locking design

- *Step 2* Checks for alcohol concentration
- *Step 3* If alcohol is detected
- *Step 3.1* Turn off the car engine
- *Step 4* Else
- *Step 5* Car engine running
- *Step 6* Goto step 1

### *29.3.1 System Operation*

The distinguished simple voltage esteems are perused by the microcontroller; the Arduino Uno board contains eight channels, a 10-piece gadget that changes a simple

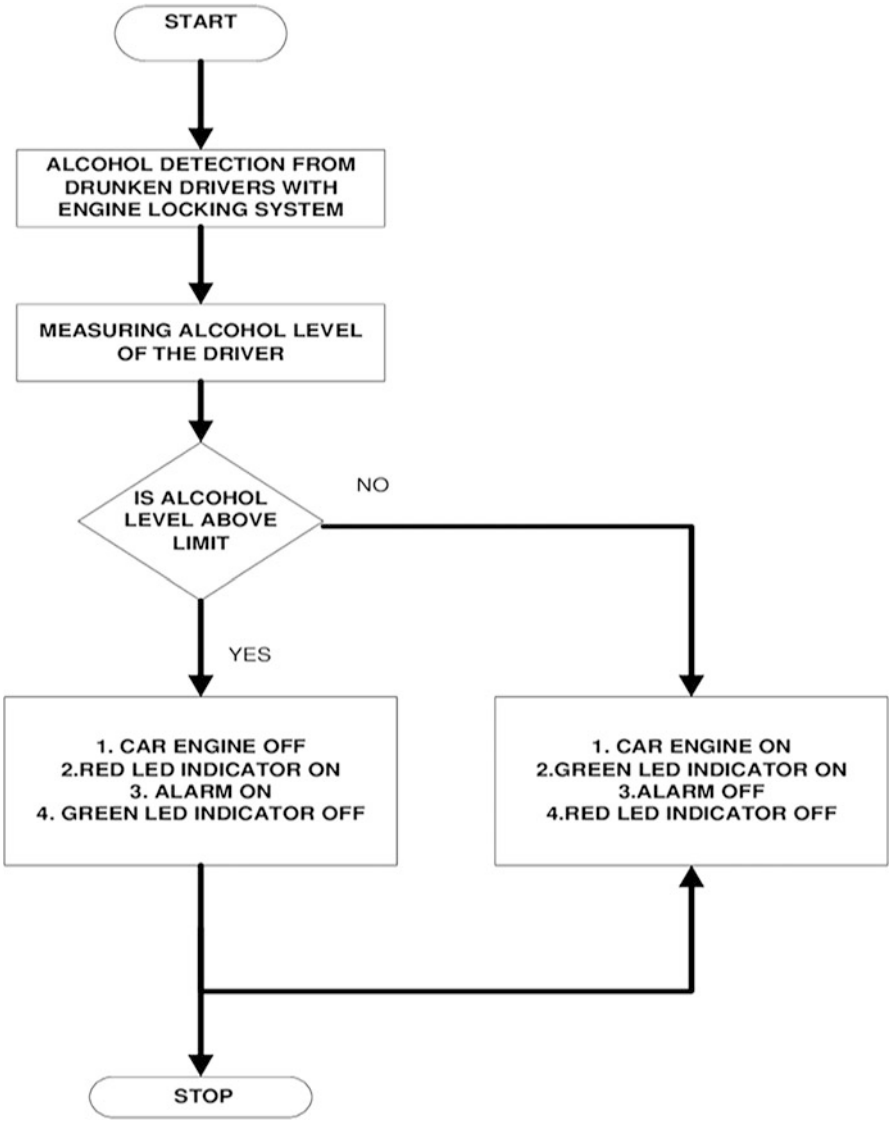


**Fig. 29.7** System flow chart

voltage on a pin to an advanced number. The system will connect input voltages from 0 to 5 V with qualities from 0 to 1023 V to create 5Vs for every 1024 units. The framework will process the simple sign and convert it to an advanced estimation of 0 or 1 (Fig. 29.7). Additionally, the simple qualities from the liquor sensor will be scaled to rate, and this rate is proportionate to the simple voltage esteems in ppm (part per million). The main condition is the inebriation arrange; the subsequent

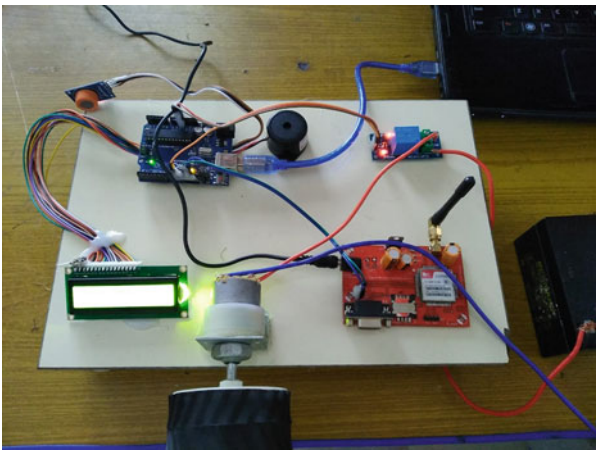

**Fig. 29.8** Hardware for Arduino-based vehicle locking system


**Fig. 29.9** NO Alcohol is detected

condition is the somewhat flushed stage, and the last stage is tipsiness organize (Fig. 29.8). Each stage will be a condition to play out an undertaking dependent on the degree of liquor. In the inebriation arrange, the LED marker will be initiated just the caution will be OFF and the motor will be ON. In organize two, the caution and the green LED pointer will be ON, just as the motor. At last, the driver is rationally and physically inert in arranging three, so the motor will be OFF, while the caution and red LED will be ON. Subsequently, when the framework recognizes liquor in organize three, the vehicle will be halted, and the driver can leave by the roadside [14] (Figs. 29.9 and 29.10).

## 29.4 Experimental Results

The graph in Fig. 29.11 shows the output voltages for alcohol detection in ppm obtained with the help of the above readings for different alcohol content samples. The response of the different samples is in parts per million (PPM) vs alcohol sensor operating voltages in volt [15].


**Fig. 29.10** Alcohol is detected

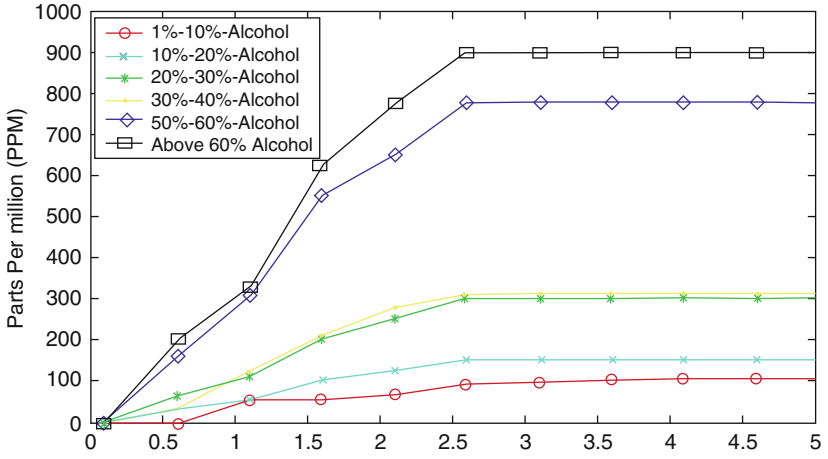


**Fig. 29.11** Response of ppm (in percentage) via alcohol sensor output voltages value

## 29.5 Discussion

We tried the sensor's precision utilizing an antiperspirant fragrance to reproduce its reaction to the liquor focus level. To check the usefulness of our framework, we utilized breadboard, advanced multimeter, LEDs, Arduino sketch IDE, and Proteus VSM programming. The last breadboarding of the whole framework has appeared in Fig. 29.12.

### *29.5.1 Alcohol Sensor Accuracy*

Accuracy is the measurement of an instrument to give equivalent value to the true value or the quantity being measured. The accuracy can be related to the percentage

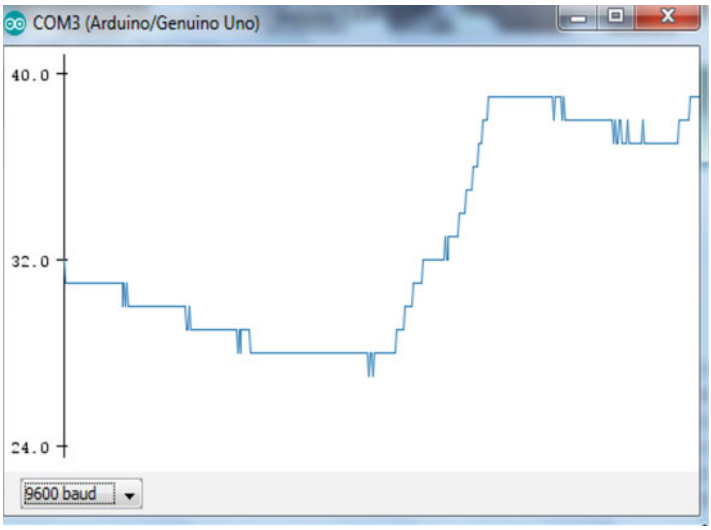


**Fig. 29.12** serial plot of the detection limit

**Table 29.3** Level of drunkenness

| | 200–300 ppm<br>1–1.5 v<br>20–30% | 300–400 ppm<br>1.5–2 v<br>30–40% | 400–500 ppm<br>2–2.5 v<br>40–50% |
|---|---|---|---|
| Voltage output | | | |
| LCD display | Intoxicated | Slightly drunk | Drunkenness |
| Alarm | Off | Off | On |
| Ignition system | On | On | Off |
| Indicator | LED green on<br>LED red off | LED green on<br>LED red off | LED red on<br>LED green off |

error as.

$$\text{Error} = \text{Actual reading–Experimental reading}$$

$$\text{Percentage error} = \text{Error}/\text{Actual reading} \times 100\%$$

From the experimental results obtained as shown in Table 29.3, the total percentage error for the whole table = 45%. Therefore, overall percentage error = total percentage/total sample reading = 45/20 = 2.25%. The average accuracy of the alcohol sensor used is obtained as Ave % accuracy = 100–2.25% = 97.75%. Thus, our calculation above shows that the alcohol sensor is 97.75% accurate.

### *29.5.2 Sensitivity Level Characteristics*

Table 29.3 shows the liquor levels in ppm, voltage, and rate. The qualities in ppm compare to the voltage and rate. Our framework shows the rate of liquor level to the driver. The ppm values are the fixation level, that is, the BAC level. The voltage esteems increment or diminishes dependent on the obstruction of the liquor sensor. Utilizing this table, the locking idea was accomplished by programming guidance to the microcontroller to bolt the motor when the liquor sensor perusing is above 40%. The microcontroller utilizes the simple voltage esteems originating from the sensor to decide if the sensor perusing is over as far as possible. Once the microcontroller gets a simple incentive above 2 V, it consequently contrasts it, and as far as possible, in the event that it isn't the equivalent, the motor will stop.

### *29.5.3 Level of Drunkenness*

Exploratory outcomes were acquired dependent on the three pre-assigned conditions for alcoholic driving. In inebriation arrange, the motor will be running as the driver can at present control himself. Likewise in the somewhat tanked express, the system will at present enable the motor to run. At last, in the inebriated express, the driver will lose soundness and can't decide. All things considered, the motor naturally bolts off.

## 29.6 Conclusions

In this paper, we proposed a technique to detect the nearness of liquor from the breath of drivers and reduce the cataclysmic impacts it can have on people groups' lives. The framework was planned and actualized effectively through the utilization of Arduino Uno ATMEGA328 microcontroller and MQ-3 sensor. Trial assessment of the framework demonstrated that the liquor sensor had the option to convey a quick reaction when liquor is distinguished. Likewise, the capacity of the liquor sensor to work over quite a while is an element of the proposed system.

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# Chapter 30
# Ad Hoc Multicast Routing Protocol Utilizing Increasing ID Numbers in MANETs


**J. Vijayalakshmi and K. Prabu**

## 30.1 Introduction

The majority of MANET applications are under rapid exploitation, where energetic reconfiguration is necessary and wired network is not available. In a wireless medium, it is essential to condense the broadcast overhead and power authority consumption [1].

Multicast routing protocol plays a main in the emergency seek and salvage operation of the military communication framework. By using single-link connectivity along with the nodes, the multicast group results in a tree-shaped topology.

*The major issues in designing multicast routing protocols are* [2]:

- *Robustness* – To recover and reconfigure the potential link breaks.
- *Efficiency* – Smallest no. of transmissions for delivering the messages to all the group members.
- *Control Overhead* – It has a minimal control overhead for multicast sessions.
- *QoS* – Data transferred time-sensitive is more important for the multicast session.
- *Efficient Group Management* – It is the process of connectivity that maintains and accepts multisession members until the session expires.
- *Scalability* – It scales for a large number of nodes present within a network.
- *Security* – Security plays the main role in military communication for authentication of session members and deterrence of nonmembers.

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https://doi.org/10.1007/978-3-030-49795-8_30

- *Resource Management* – Each node has limited battery supremacy and memory. An ad hoc wireless multicasting protocol has minimum supremacy by tumbling the number of packet transmission. To condense memory usage, the minimum state information.

## 30.2 Classification of Protocols: Multicast Routing

There are two types of multicast routing protocol; they are application-dependent and application-independent. The application-dependent protocols are merely for literal applications in which they are premeditated. Application-independent protocols are used only in conventional multicasting and are based on three different dimensions as follows:

- **Based on topology**: The following types are based on multicast topology.

**Tree-based**: Is more proficient and utilizes only selected paths between the source and destination. The following are types of tree-based protocols.

**Sourcetree-based**: The root is the source of tree in multicast protocols and various protocols are MCEDAR [3], BEMRP [3], MZRP [3], ABAM, DDM, WBM, and PLBM [4, 5].

In **shared tree-based** multicast protocols, *core node* means rooted node, and a particular tree is shared by all the sources inside the multicast group. These are divided into various protocols as AM Route [6], MAODV, and AMRIS [6]. The source tree is a better performance than a shared tree because of efficient traffic distribution.

**Mesh-based**: Mesh-based multicast routing protocols [7, 8] have too much of a path between a source and receiver pair. Many paths between the source and receiver have the availability of robust. These are divided into various protocols as ODMRP [3], DCMP [3], FGMP [3], NSMP, and CAMP [6, 9].

Some protocols supported by this model are BEMRP [3], ABAM [2], WBM [10], PLBM [4], AMRIS [6], and CAMP [9].

## 30.3 Ad hoc Multicast Routing Protocol Utilizing Increasing ID Numbers

It is one of the source-initiated protocols, where the shared tree is built with the capability of carrying more number of sources and receivers. The foremost thought every node in the tree comprises a session-specific MSM-ID by indicating the tree's logical height and the loop formation.

*Initialization – It* is done with the generation of the broadcast message from the source (SID).

- **Based on the initialization of the** *NewSession* message. The *New Session* message.

**Multicast session**

They are divided into two main types:

(a) Source initiated cluster formation is initiated by the source node. In this session support, some protocols used are MZRP [11], ABAM [2], AMRIS [6, 7], ODMRP [12, 13], DCMP, and NSMP [12, 14].
(b) Receiver initiated model initiated by the receivers of the multicast group. Some protocols used in this are BEMRP [3], DDM [2], WBM [10], PLBM [4, 5], FGMP-RA [7], and CAMP [9].

- **Based on the topology maintenance mechanism**: It can be done either by the soft state approach or by the hard state approach.

(c) In **soft state**, control packets are swapped sporadically to energize the route, causing an enhancement PDR and control overhead. The supported protocols are MZRP [11], DDM [2], ODMRP [12], DCMP [3], FGMP-RA [7], and NSMP [2].
(d) In **hard state**, it transmits control packets on link breakage and in turn suffers from the reduced PDR and control overhead.

It is constituted with the multicast session ID, the routing metrics, and the MSM-ID, As all the tree nodes are delivered with the *NewSession* message, the information in it is stored in the in their neighbor status tables up to a certain amount of time and generates its own MSM-ID. If the generated ID is superior to the prevailing one, then the IDs are arranged sequentially to avoid local errors. In AMRIS, every node holds the particulars of the neighbors and their IDs in MANET the nodes periodically convey information in order to indicate its presence. In Fig. 30.1, the corresponding nodes MSM-ID is represented in form of the number into the circle. Some of the nodes may not poses MSM-ID that is valid due to its nonappearances in the time of *NewSession* dissemination as it might be erased due to time out.

When a node wishes to connect the multicast group, a list of *potential parent nodes* is received from the neighbor status table to initiate a join request control packet to any one of the neighbors. Here in Fig. 30.1, node S1 sends the *JoinReq* to its potential parent node I2. Since node I2 is not a multicast tree, it will repeat a similar process by sending the *JoinReq* to node I1.

It searches for possible paths and sends acknowledgment from I2 after identifying an optimal path; the other nodes join the cluster in a similar way.

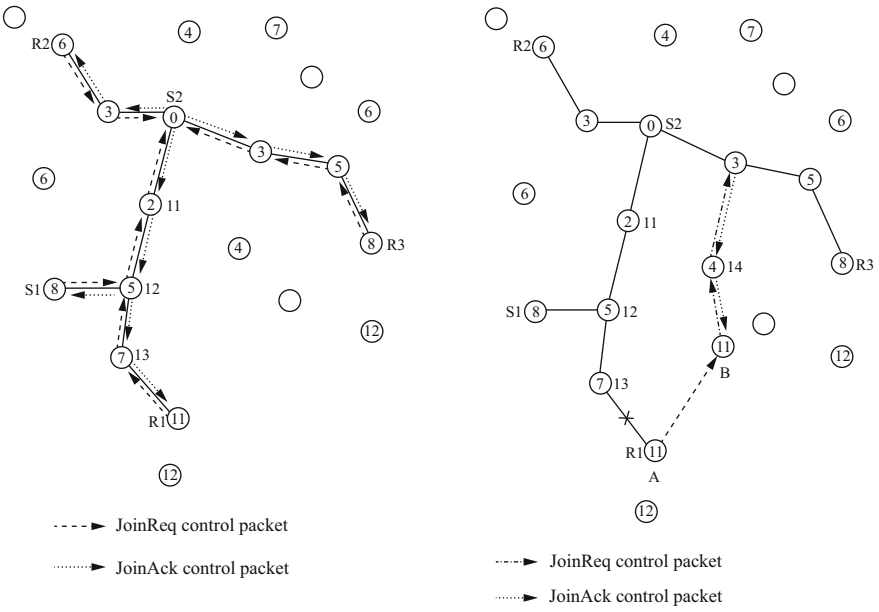


**Fig. 30.1** A node joining the multicast tree in AMRIS

### *30.3.1 Tree Maintenance Phase*

The broken links of the tree are renovated in the maintenance phase. In AMRIS, reconstructs the tree back on identifying the node failures, the subroutine BR1. The node has adjoining potential parent nodes when the subroutine BR1 is executed.

### *30.3.2 Advantages and Disadvantages*

The simplicity of the AMRIS and the lowest control overhead are the major advantages of the AMIRS. The increased bandwidth usage, end-to-end delays, and packet loss due to collision are the main drawbacks of the AMRIS.

## 30.4 Conclusion

The paper presents the major issues involved in the design, and various classifications of multicasting protocol for ad hoc networks were described. The main purpose of this paper is that all the tree nodes should have a session-specific MSM-ID to indicate the shared tree logical height and avoid the loop formation as well as

repair the broken links. The major goal of this multicasting ad hoc wireless network is to provide heftiness, competence, control overhead, quality of service, scalability, security, as well as a proper management of resources.

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# Chapter 31
# Classification of Technical Debts in Software Development Using Text Analytics


**V. Rajalakshmi, S. Sendhilkumar, and G. S. Mahalakshmi**

## 31.1 Introduction

Technical debt (TD) portrays principally specialized trade-offs that may create momentary advantages however may influence the long haul well-being of the product framework. The idea was at first worried about programming usage, yet it was bitten by bit stretched out to incorporate programming engineering, design structure, documentation, requirements, and testing. Despite the fact that the technical debt representation was proposed two decades prior, it has recently just gotten noteworthy consideration from researchers. TD can do both great and mischief to a product venture. In the event that the expense of the TD is monitored unmistakable, then the TD that is intentionally brought about to accomplish some momentary advantage can be productive. At times, the software group may decide to take some TD so as to get business esteem. For example, causing TD can accelerate the improvement of new development, hence helping the organization push forward of the challenge. Then again, TD can likewise be brought about accidentally, implying that the module leads and software group don't know about the presence, area, and results of the TD. Whenever left undetectable and uncertain, TD can be aggregated gradually, which thus brings about difficulties for support and enhancement errands.

Technical debt frequently alludes to the results of powerless software improvement. Cunningham [1] presented the term technical debt as an illustration where the

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software team takes a quicker implementation method rather than an effective way of implementing the software. Uncontrolled TD negatively affects the maintenance phase of the software where the team must struggle to fix the issues and to implement the new features. So it is very much essential to identify and manage TD earlier for the software project team.

Management of technical debt comprises recognizing the wellspring of the additional cost when changing software and investigating when it is beneficial to put exertion into improving the product framework. In handy terms, great administration of technical debt implies activities will have a measure of technical debt that won't block the management from accomplishing its business destinations. If not, enhancement productivity and supportability and even the association's key objectives might be truly undermined. In any case, the objective of technical debt management isn't to make progress toward zero obligation. Some technical debts are compelling when it is required to achieve the target with a limited set of assets. However, as per the business need, it is required to pay off technical debt from time to time in order to increase productivity. Also, an excessive amount of technical debt would drive the organization to simply keep up the old programming instead of including new functionalities. In a couple of words, if technical debt isn't dealt with, an organization could quit being productive.

Accessible technical debt procedures have developed to scatter, and developers need direction with regard to building a suite that supports the correct arrangement of systems for recording technical debt, remembering issues, for example, hierarchical objectives, business methodologies, time skylines, chance variables, money-related limitations, and assessment contemplations. These issues have made that recognizing technical debt at the prior phase of the product life cycle can increase the value of the advancement of the product.

Technical debt is classified based on the life cycle of the project where the debt occurs. Sometimes it could be due to the requirement gathering phase, sometimes while defining the architecture for the project implementation and few times when the documentation is not complete. So dependent on the project stage where the debt happens, it is named as document debt, test debt, build debt, design debt, code debt, requirement debt, infrastructure debt, versioning debt, and mainly architectural debt. The significant reasons for the technical debt are deficient in advance definition by the clients, business strain to deliver the solution, lack of documentation by the architects, lack of joint effort between the teams, and last moment specification changes.

## 31.2 Related Work

Because of the significance of technical debt, various studies experimentally investigated different ways to deal with identifying and prioritizing technical debt. Avgeriou et al. meant to gather different research on TD and TD management [2]. A systematic mapping study was performed to distinguish and break down research

on TD and TD management activities. A portion of this research was focused on utilizing source code investigation procedures to distinguish technical debt. Code smells and automatic static analysis (ASA) are two most-utilized source code examination strategies for recognizing technical debt [3]. Code smells were first presented by Fowler et al. to depict the object-oriented design principles violation (e.g., abstraction, inheritance) [4], while ASA procedures target recognizing breach of recommended programming practices that might degrade a few software quality attributes (e.g., maintainability, efficiency).

Certain research targeted to recognize the technical debt of a huge scale that is not found by source code review strategies, for example, design, architecture, and requirement technical debt [5–7]. Contrasted with code-level technical debt, the identification of non-code-level technical debt isn't examined adequately because of the trouble in recognizing them. Numerous researches are done to recognize technical debt in source code. This sort of technical debt can be distinguished by utilizing the static program investigation tools built on the estimation of different source code metrics. Marinescu proposed metric-based identification methodologies to help engineers directly localize classes or techniques influenced by the breach of object-oriented design guidelines and validated the methodology on different huge modern contextual analyses [8]. Munro et al. refined Marinescu's location methodologies by presenting some new metrics, provided an explanation for those metrics, and assessed the performance in recognizing two sorts of code smells (lazy class and temporary field) in two contextual investigations [9]. Olbrich et al. examined the connection between two sorts of code smells (god class and shotgun surgery) and maintenance cost by investigating the historical information of two significant open source projects, Apache Lucene and Apache Xerces [10]. Wong et al. proposed a methodology to distinguish modularity violations and assessed the methodology utilizing Hadoop and Eclipse [11]. Also, a few scientists investigated recognizing technical debt from the comments placed in source code [4, 12].

Certain work planned for creating techniques to characterize certain types of technical debt, for example, software architecture debt. Brondum et al. proposed a demonstrating way to deal with architecture technical debt visualization based on the examination of the structural code [5]. Li et al. proposed to utilize two measured quality metrics, Index of Package Changing Impact (ICPI) and Index of Package Goal Focus (IPGF), as pointers of architecture TD [6]. They also mentioned about architectural TD using the architectural decisions and change scenarios [7]. Bellomo et al. used four-issue trackers from open source and government ventures. There were 1264 issues, and 109 instances of technical debt were recognized using the categorization method they created [13]. Ke Dai et al. utilized NLP and AI methods to recognize technical debt through issue trackers [14]. Our examination is to distinguish whether the incident is because of technical debt or not and furthermore the sort of technical debt utilizing the distinctive AI algorithms random forest [15] and support vector machine [16]. The investigation is stretched out to utilize the Hadoop distributed architecture and MapReduce framework to preprocess the documents and thereby speed up the classification and prediction of technical debt on the new software requirements.

## 31.3 Method

The proposed model architecture is shown in Fig. 31.1. The model uses incident tracker data set as input to train the model and comprises of the following components: (1) text preprocessor and (2) classification model.

### *31.3.1 Text Preprocessor*

Initially, the data set undergoes preprocessing where the special characters' stop words are removed, and the data set is cleaned using the stemming algorithm. In the data set, there are a total of 15 columns which are incident number, reassignment count, reopen count, description, short description, category, assignment group, priority value, state, opened at, created, created by, closed at, close code, and close notes. Out of them, category is the labeled data, Description and short description have the information about the problem of incident issues. So these two columns are used further for the process. The cleaned preprocessed data set is given as input to the model. The model is built using the random forest and support vector machine, machine learning algorithms.

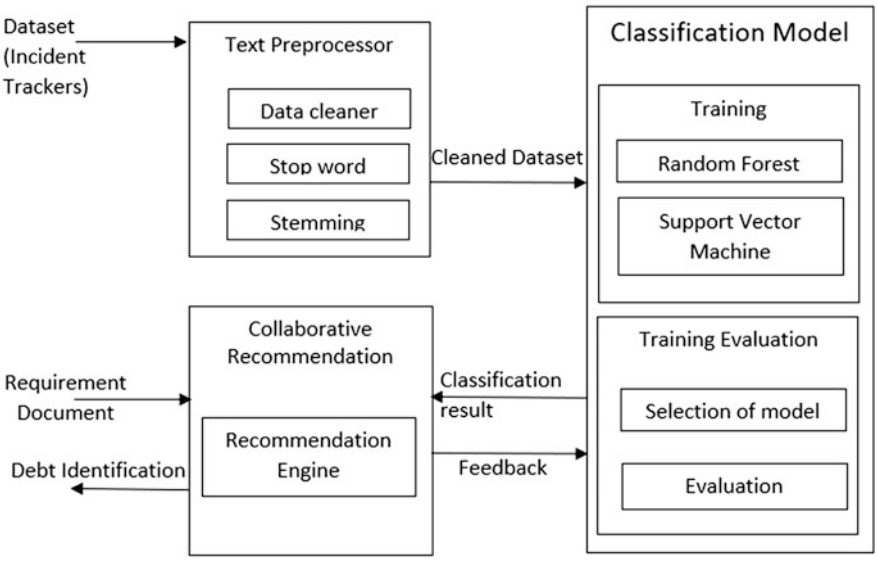


**Fig. 31.1** Proposed TD classification framework

### *31.3.2 Classification Model*

The incident tracker data set contains the data collected from the project defect tracking tool where the different defects are reported by the customers. Some defects could be due to the actual fault in the system, and some defects could have occurred due to the technical debt. Subject matter experts have analyzed this incident tracker data set and categorized the incident descriptions as not a technical debt, design debt, code debt, architecture debt, or UI debt. This data set is given as input to the random forest and SVM models.

Random forest algorithm defines a margin function for classification problems. It uses a set of simple uncorrelated trees and a set of random predictor variables. The random forest has trees that are not only trained with a different set of data but also use different features to make decisions. Hence, even if some trees predict wrong, other trees would have predicted correctly, and hence the overall predictions of the model would be positive with a higher confidence measure. SVM uses a linear model for classification. For every class in the high-dimensional space, it uses all attributes and creates parallel lines (support vectors) which separate the classes clearly. Then it draws a hyperplane that has maximum margin with all classes.

### *31.3.3 Collaborative Recommendation*

The classification model with the higher F1 score is used to classify the requirement document. In this step, the project team receives a requirement or enhancement document and design document from the customer for the new enhancements. The project team can use this classified trained model to identify whether there exists any technical debt in the document. On identifying the technical debt, the project team can ask the concerned module owners to correct them before it is propagated to the other phase of the project.

This model can be used by the project at any stage to know whether the requirement given by the customer has technical debt and they can avoid future debts. Here once the model is ready, the new requirement document of the project is given to the model to know whether the requirement document has technical debt. The model reads each requirement and gives results as technical debt or not based on the previously trained features. The project team can spend time on those requirements which are reported as technical debt and can take steps to avoid them in the implementation. The overall maintenance cost of the projects can be reduced and kept under control.

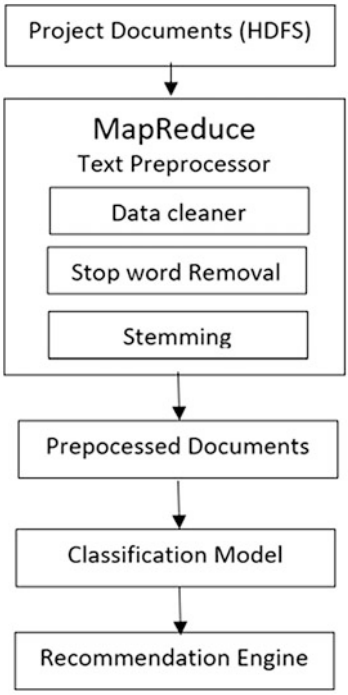


**Fig. 31.2** MapReduce based text preprocessor

### *31.3.4 Distributed Framework*

The text preprocessing takes more time when there is a huge volume of the documents to be analyzed. So, we propose a distributed Hadoop framework where the documents will be stored in the Hadoop Distributed File System (HDFS) and text preprocessing functionality will be done by the MapReduce programming model as shown in Fig. 31.2. Thus, multiple documents will be processed in a parallel manner using this framework, and it is expected to save the time spent on preprocessing the documents.

## 31.4 Experimental Results

The identification and management of technical debt are mainly comprised of the following modules. The recommendation engine is to be addressed for effective feedback during the software development process about technical debts and hence is out of the scope of this paper.

### *31.4.1 Text Preprocessor*

The incident tracking data set has been taken as input, and a sample is shown in Table 31.1. In this data set, category is the labeled data. Description and short description have information about the problem of incident issues. So, these two columns are used further for the process. The given data set has a total 14,422 rows, which means there are a total of 14,422 issues for the given project. The first step in text preprocessing is to remove the stop words using the MapReduce framework, and the MR_Text_Preprocessing steps are given in Algorithm 1. Once the good words are collected then, the root keywords are identified using stemming methods available in using the python NLTK package.

**Algorithm 1: MR_Text_Preprocessing**

```
INPUT: Design document with the set of descriptions
1. Method Map (key, doc, stopword_filepath)
2. for each term x ∈ doc d do
     2a. read the location of stop word file
      2b. if term x is in stop word file
      2c. Output (term x, stop_word_count 1)
      2d. otherwise
      2e. Output (term x, good_word_count 1)
3. Method Reduce (term x, good_word_counts [ct1, ct2, ct3 ...])
4. sumcnt ← 0
5. for each count cnt ∈ counts [ct1, ct2, ct3 ...] do
    5a. sumcnt ← sumcnt + cnt
6. Output (good_term t, count sumcnt)
```

**Table 31.1** Sample input data

| Incident number | Description | Short description | Category | Status |
|---|---|---|---|---|
| IN72001 | The database fetch module is unable to recognize French characters in the user name | Redesign the database fetch module | Design debt | Closed |
| IN72005 | It takes long time to load the login page now. User has waited for more than 2 min | Performance issue in login page | Architecture debt | Closed |
| IN72006 | Unable to enter the pin code in the pin code field | Pin code field is uneditable | Not a debt | Closed |
| IN72008 | User should be able to add multiple items to the shopping cart. Currently when user adds the second item, first item disappears | Change to allow multiple items to cart | Requirement debt | Closed |

## 31.5 Output (good_term T, Count Sumcnt)

The MR_Text_Preprocessing algorithm reads the file path of the stop word list and verifies for each token as stop_word or good_word using the Map() method. Also, the count for each good_word is also calculated and stored locally in the node in which the input file is made available by the distributor in HDFS. The Reduce() method then creates the aggregated list of good_word and its count. Later the root words are identified for each good_word list using NLTK methods in python. A sample preprocessed input data using Algorithm 1 is given in Table 31.2.

### *31.5.1 Classification Model*

In the supervised classification model, the description and short description shown are used as the input features and type of debt as the output class. It is a multi-class classification problem. In this model, we do the following processes:

(i) Training: The cleaned data set after the text preprocessing is given as input for the training model. The model is trained by the help of the random forest algorithm and support vector machine. A total of 80% of the data set is used for the training, and 20% of the data is used for the testing. All the features are stored in a.sav file which is used for the testing.
(ii) Training Evaluation: After the training of the model, testing is performed on the 20% of the data, while performing the testing process through random forest and support vector machine of an F1 score is calculated for both algorithms. Here the algorithm is selected which has a better F1 score.

**Algorithm 2:Random forest**
INPUT: Data Set

Step 1: Select "x" features from all "n" features, where x < < n

Step 2: Among the "x" selected features, utilizing the best split point, calculate the root node "t" utilizing the best split point.

Step 3: Split the node" t" into child nodes utilizing the best split.

**Table 31.2** Preprocessor data

| Incident number | Description | Short description | Category | Status |
|---|---|---|---|---|
| IN72001 | Database 1 Fetch 1 module 1 unable 1 recognize 1 French 1 character 1 User 1 name 1 | Redesign the database fetch module | Design debt | Closed |
| IN72006 | Unable 1 enter 1 pin 2 code 2 fields 1 | Pincode field uneditable | Not a debt | Closed |

Step 4: Repeat 1 to 3 stages until the "m" number of nodes has been reached.

Step 5: Build forest by repeating steps 1 to 4 for "p" number of occasions to form "p" trees.

The random forest algorithm begins with choosing "x" features from total "n" features at random. Then the selected "x" features are used to find the root node "t" by making use of the best split approach. In the next step, child nodes are identified using the same best split approach. Repeat the steps 1 to 4 to form "p" trees. These randomly created trees form the random forest.

During prediction, the test features are given to the model; it uses the rules which are generated in each of its trees to predict the class label for the given test feature. The output from each of the tree is considered, and the prediction which is highly voted is considered as the final prediction for the given test feature. Thus, the algorithm would be able to give the correct predictions.

Testing of data is done with the help of features generated after training of the model; the feature of the model is saved in an SAV file. Comparing the F1 score for random forest and SVM as given in Table 31.3, it is clearly shown that SVM gives a better result.

The final testing ROC for the SVM was 0.87 compared to 0.67 for the random forest. Although the SVM overfits (i.e., performing better on the training data than on the testing data), it generalizes much better to the testing data than the random forest. But random forest produces a lower variance which is essential while maintaining the same low bias (also good) of a decision tree. The ROC curve for the SVM (red color curve) and the random forest (green color curve) is given in the graph shown in Fig. 31.3. The ROC curve (red color) for SVM is on the top and hence considered as a better model when compared with random forest.

Finally, the F1 score (also known as F-measure) which is a metric to evaluate the accuracy of the model is used. It considers both the precision p and the recall r of the test to compute the score. p is the quantity of right positive outcomes divided by the quantity of every single positive outcome returned by the classifier, and r is the quantity of right positive outcomes divided by the quantity of every applicable example. The F1 score is the average of the precision and recall, where an F1 score value is between 0 (worst) and 1 (best).

The requirement document is given as input to the classification model. The model was able to find the technical debt items and its type in the new requirement document. The comparative analysis of the F1 score for random forest and SVM is done and shown in Table 31.3. Comparing both F1 scores (random forest and SVM), it is clearly shown that SVM gives a better result. Thus, the proposed SVM-based

**Table 31.3** F1 scores for random forest Vs SVM

| Data | Random forest | SVM |
|---|---|---|
| Incident tacking data (training data) | 0.1924 | 0.5727 |
| Requirement specification data (test data) | 0.8255 | 0.9458 |

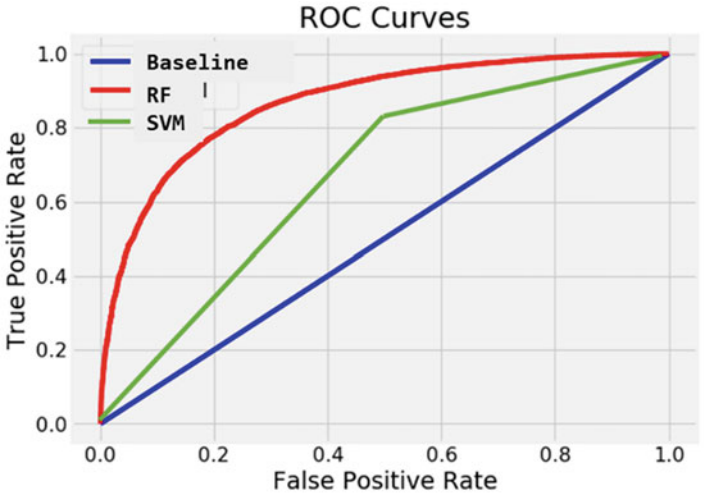


**Fig. 31.3** ROC curve random forest Vs SVM

classification of required documents for the presence or absence of technical debts and its type may be used for fine-tuning the overall software development process.

## 31.6 Conclusion and Future Work

This paper introduces an exploratory study on applying NLP and machine learning techniques to identify technical debt issues from the incident tracker data set. It has proposed a method to use a distributed Hadoop framework where the project documents can be stored in the Hadoop Distributed File System (HDFS) and text preprocessing functionality can be done by the MapReduce programming model. This method will help to save the time spent in preprocessing the project documents. We have demonstrated that the proposed model can automate the process of detecting technical debt issues from the incident tracker and achieve an acceptable performance using NLP and machine learning techniques. There are some common words in software engineering that are directly or indirectly related to technical debt, and these words can be used as features to decide whether a certain issue is a technical debt or not.

The performance of the classifier will improve further when more sophisticated feature extraction and classification techniques are applied. This paper was based on a rather limited data set of 14,412 incidents. Our approach can be validated with incident data sets from a wider range of software projects. Furthermore, the performance of the classifier can be improved when the input data set has less noise and when semantically meaningful information is extracted based on the context and applying other classification techniques such as deep learning. In addition, we

can also model to identify a specific type of technical debt and its sub-type. Also, the recommendation engine is to be addressed for effective feedback during the software development process about technical debts.

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# Chapter 32
# 5G-Green Wireless Network for Communication with Efficient Utilization of Power and Cognitiveness

**Devasis Pradhan and Rajeswari**

## 32.1 Introduction

Until 4G networks, mobile communication has experienced a tremendous journey from analog voice calls to mobile broadband service by providing Mbps of data. During the last few years, data traffic volumes have been increased due to the usage of new smartphones and tablets with the associated smart applications. This trend is expected to continue at a higher rate in the near future. In addition to that IoT is more and more becoming a reality. As we are moving toward the fifth-generation network environment in which unlimited access to information and sharing of information is possible. It is expected that by 2024 mobile subscription is to reach 8.9 billion; at the same time, these types of connections may reach 4.2 billion with the help of cellular data traffic, and it utilize 138 EB per month. For 5G Network utilization of data traffic is done with 74% for video and remaining 26% used for text or message transmission and reception. Figure 32.1 shows that the process of cellular generation is based on the mobile users and mobile Internet usage.

Green communication is used to increase the efficiency of the devices with less consumption of energy or power. It provides a better quality of service (QoS). During the last few years, there is a drastic increase in the level of $CO_2$ in the environment. According to a survey report made by $CO_2$ Information Analysis Center, Oak Ridge National Laboratory, Tennessee, in the United States, the $CO_2$ emission from fuel consumption in India was highest of all for the past 55 years in 2019. The need for people has to be satisfied, but at the same time, ecological balance is to be maintained. A fifth-generation communication system enables the

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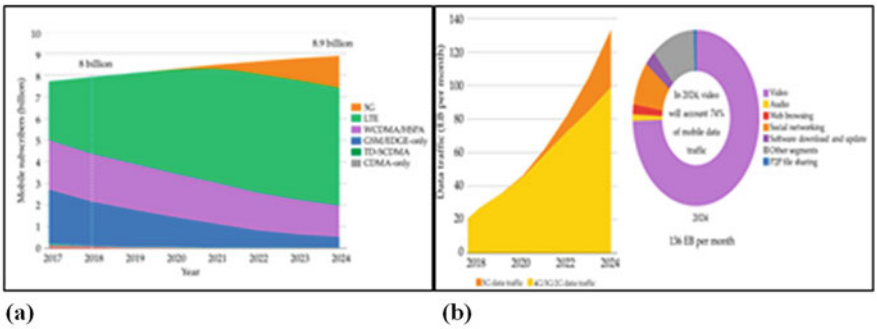


**Fig. 32.1** Expected growth of mobile users and mobile Internet data usage based on cellular generation. (**a**) Expected growth of global mobile users and (**b**) expected growth of Internet data usage and the percentage of each type of data

subscribers with large bandwidth to provide high data rates with low consumption of power or energy with a better quality of service (QoS) [1–5].

Due to continuous enhancement in the utilization of network communication link established between things of the network. A better power management system has to be established, where it would be beneficial for both the environment and to people's point of interest. The basic block of IoT is effective power consumption, and QoS will make a city to be a smart city where everything is connected. IoT with green communication leads to an eco-friendly communication network [6, 7]. The structure of this paper is as follows: In-depth discussion on major challenges of future network utilization, potential solutions are outline, energy-efficient 5G wireless networks, enhanced cognitive ability while detecting free communication channels, and minimization of interference to the other users. Hence cognitive radio offers a potential solution for exploding traffic, with random and diverse traffic to tackle by 5G technology [8].

## 32.2 5G Technology

In this technology, a large amount of data was collected from the real-world, processed in the cloud, and sent feedback at a faster rate. It also accelerates the realization of the hyperconnectivity of a network that tends to connect all people and things. As compared to 4G technology, 5G provides better QoS with less consumption of energy [9, 10]. In 4G, the voice- and IP-based system were present as a separate unit, while in 5G these units are to be combined in order to ensure a better QoS. For better QoS, the main requirement is for a network to be efficient and cognitive in nature. The network layer is divided into different layers such as the application layer, open transport layer, upper network layer, lower network layer, and open wireless architecture. The topmost layers are in touch with the user and act as a turn to affect other layers. For efficient operation, this layer is set to be free from error. Figure 32.2 shows the different layers in 4G with respect to 5G.

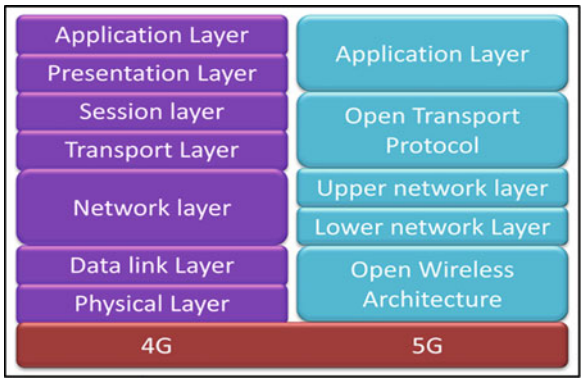


**Fig. 32.2** Different layers in 4G and 5G

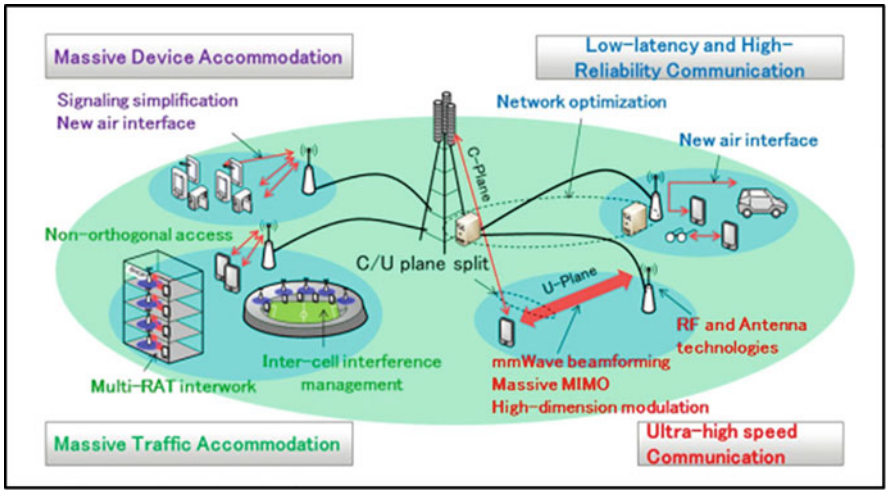


**Fig. 32.3** Whole picture of 5G technology

The dense network can be accomplished by usage of small cells which is a huge challenge. Massive MIMO is a technique which was adopted for spatial dimension when multiple antennas are available in base station [11]. 5G networks is open, provide flexibility, and are able to evolve more easily than a traditional network which is better than the traditional network using routing and switching technology. It is a convergent network which provides communication across the multi-technology network and provides an open communication system to cooperate with satellite system, cellular networks (cloud and data centers), home gateways, and many more open networks and devices. For design of future networks, the priority must be given to security, resiliency, robustness, and data integrity for better enhancement of network utilization. It handles user mobility to guarantee the connectivity and also manages the call drop for any such situation. The end user terminal makes the final choice among different access networks for the best connection. The infrastructure of the wireless network is based on SDN, which provides a linkage between the application and service in the cloud with the user mobile terminal. Figure 32.3 shows the whole picture of 5G.

## 32.3 The Amalgamation of 5G and Cognitive Radio

The characteristics and future of 5G and CR are having many similarities between them. The main similarities between both the system is that they are capable of interworking with other systems or networks and also are capable of adaptation of ability to work with a new and flexible protocol. 5G is integrated with cognitive radio environment; thus it adapts, and ideal use of 5G terminal is common for the high capability of work with a different type of wireless system which uses various methods, algorithms (genetic algorithms (GA), particle swarm optimization (PSO)), and other bioinspired algorithms. MIMO, massive MIMO, and nanoscale processing are some of the examples of advanced technology which helps in employing the implementation of the cognitive engine [12, 13].

5G technology promises to offer personalized services; in personalized services, the issue such as identity, location, and privacy needs to be addressed. Cognitive radio is capable of sharing various information, monitoring, and adaptation features which all are incorporated with 5G technology. The main focus of 5G is to provide a wireless network for interaction with D2D or D2U (Device to User) with higher data rate. The architecture provides flexibility and is capable of operating dynamically. In order to be such a system, cognitive radio is the best way to adapt. The presence of cognitive radio in 5G will bring the wired and wireless paradigms together and work toward a global efficient environment. For establishing real 5G network, cognitive radio-based 5G is an amalgamation that has to outperform existing arrangements.

## 32.4 Efficient Software-Defined Network for Energy Deployment

It facilitates energy utilization optimization in the 5G network and also helps in flexible energy scheduling. The architecture of the SDN for energy harvesting and deployment is divided into four planes: control, data, plane, and user plane. For typical EHN (energy harvesting network), there are two queues in a node: data and energy queue [14–16]. Figure 32.4 shows the detail architecture and component of SD-EHN. The integration of SDN enables harvesting of a network which includes the following properties:

- **Flexibility**: Data flow and energy flow are based on flow instead of the destination.
- **Programmability**: Highly reconfigurable and programmable to the network device and convenient to debug, verify, and test.
- **Controllability**: The network configuration and dynamic network state significantly improved controllability.

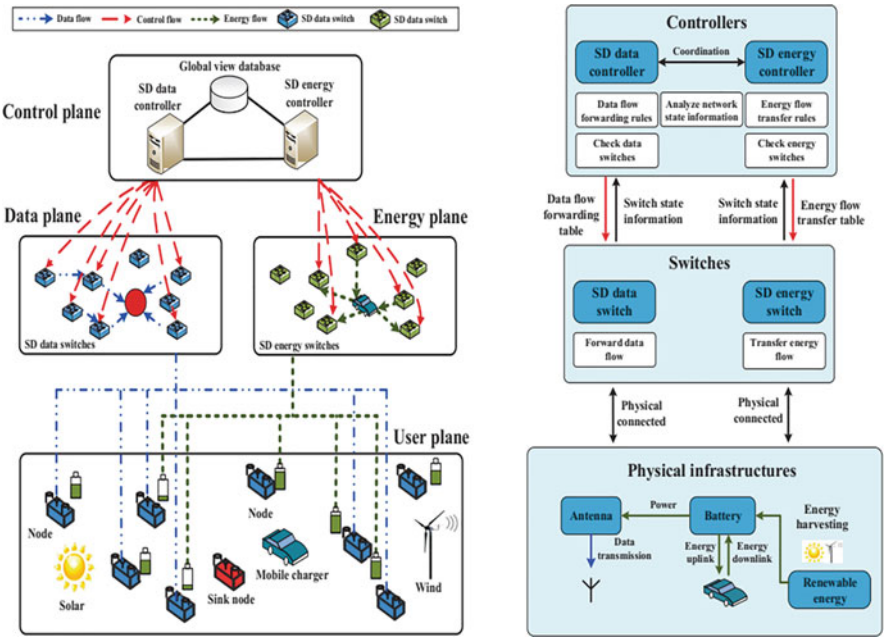


**Fig. 32.4** The architecture and fundamental blocks of the software-defined enhanced network (SD-EHN)

- **Control Region**: In this plane data controller and energy controller are deployed. The database stores reference to the previous state, i.e., network traffic and characteristics of the node. Based on the collection of data and analyzing, its software-defined network (SDN) data and energy controller dynamically monitor and control the flow of data and energy from a global point of view. This controller works together in order to ensure the centralized control of the network [21].
- **Data Region**: The nodes are connected to switch data, through which data is forwarded into the data region of the plane. According to the protocol of forwarding data designed by the SD data controller, the nodes help to optimize the data packet while routing in a network. These data packets were routed among those nodes with sufficient energy for reliable communication which increase network efficiency.
- **Energy Region**: Software-defined (SD) energy switch gets connected to node and energy content in the nodes which is scheduled in an energy plane. In this region, energy flows in bidirectionally between mobile charger unit and nodes. As per the protocol of controlling energy, nodes were identified whether in a state of idle or in working condition for uplink and downlink mechanism.

- **User Region:** Basically this plane of interest includes all physical network elements. SDN identifies the optimal path to flow energy or from the elements according to their position, attributes, type of ambient renewable energy, and routing of the mobile charging unit. The control region of the plane breaks the flow of energy from data to the energy region of the plane and infrastructure to develop independently.

## 32.5 How SD-EHN Helps in 5G Green Communication?

It helps in network function and rationalizes the working of the network. The protocols of the flow of energy are integrated as per the global perspective of the network. With prime control of the flow of energy and data, it helps while scheduling energy and is utilized in an efficient manner, so with the help of the above analysis, 5G green communications can be benefited [17–19]. Figure 32.5 shows scenarios of the collection of mobile data and bidirectional energy carryover in SD-EHN in green communication.

- **Energy scheduling** is a flexible manner to enhance the transfer of energy in the energy region of the plane. With the help of this scheduling energy, more nodes join together in order to exchange the energy content in them.
- **Energy utilization** is an efficient manner through which data and energy controller control all connected nodes and identify the level of energy and status of the assignment.
- **Sustainable development** – The demand for scheduling and utilization of energy in an efficient manner ensure improvement in network efficiency and serve with sustainable energy to work for a lifetime.

## 32.6 Challenges and Requirement

Few important ones for a green design perspective such as:

- **Mobile Data Traffic**: Till date, there are 8.9 billion broadband subscription available worldwide. Figure 32.1 shows growth of mobile user and Internet data about 40% annually over last 6 years, forecast predict the data traffic volume exponentially going to increase in coming years. In order to design, a green network should avoid the risk of incoherent setup of network delivering in a significant manner at a higher rate than today. This experimental growth implies cost network deployment.
- **Device to Device Communication** (D2D): Most of the IoT devices used by humans and thus to be used in future are predicted to change into smart devices, sensor, and intelligent monitoring systems connected to the network. Basically, it

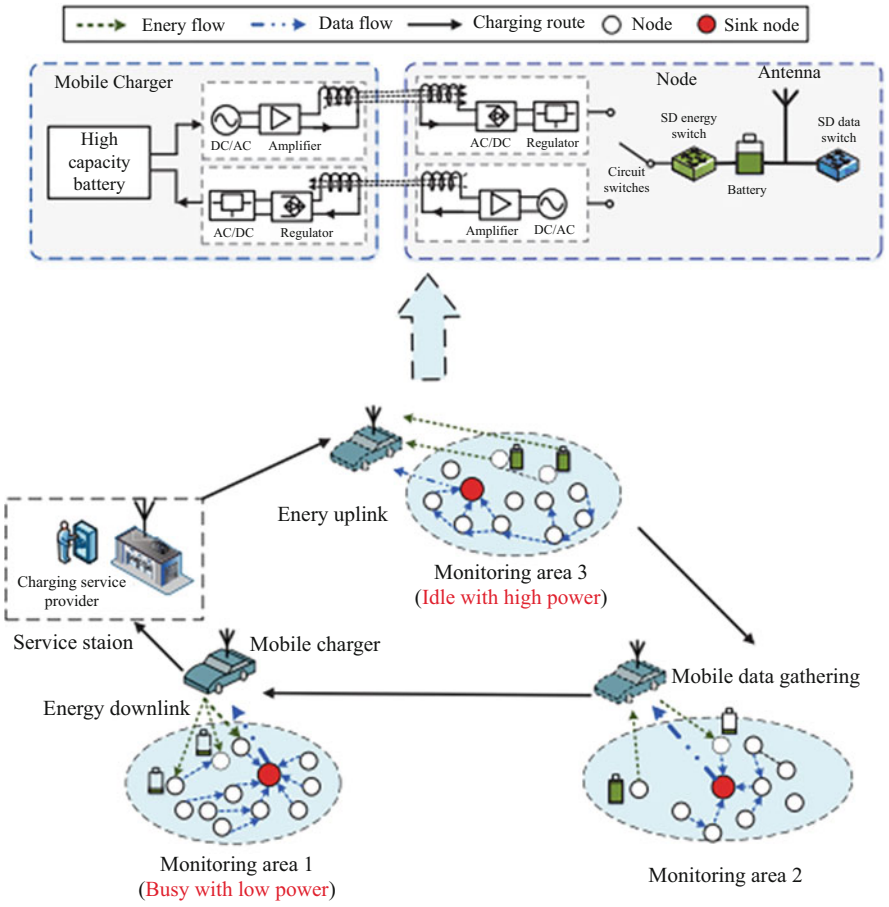


**Fig. 32.5** **Energy** transfer in SD-EHN in green communication

refers to IoT or device to device communication, and everything can be benefited from wireless communication. For example, one can realize that the number of connected devices in normal home utilization in the future will be 100 or 1000 times higher than today [20]. It also introduces traffic in the network due to the presence of a large number of devices that need efficient signaling management. Figure 32.6 shows the complete view of a D2D communication traffic which will introduce additional challenges assisted by the mm-wave network.

- **Requirements**: A wide range of requirements and characteristics with different cases in the cellular system in today's scenario. In some applications, it may require low latency during critical control function toward industrial application which requires high reliability, and sensors require lower reliability while designing such systems in order to meet the better Quality of Service (QoS).

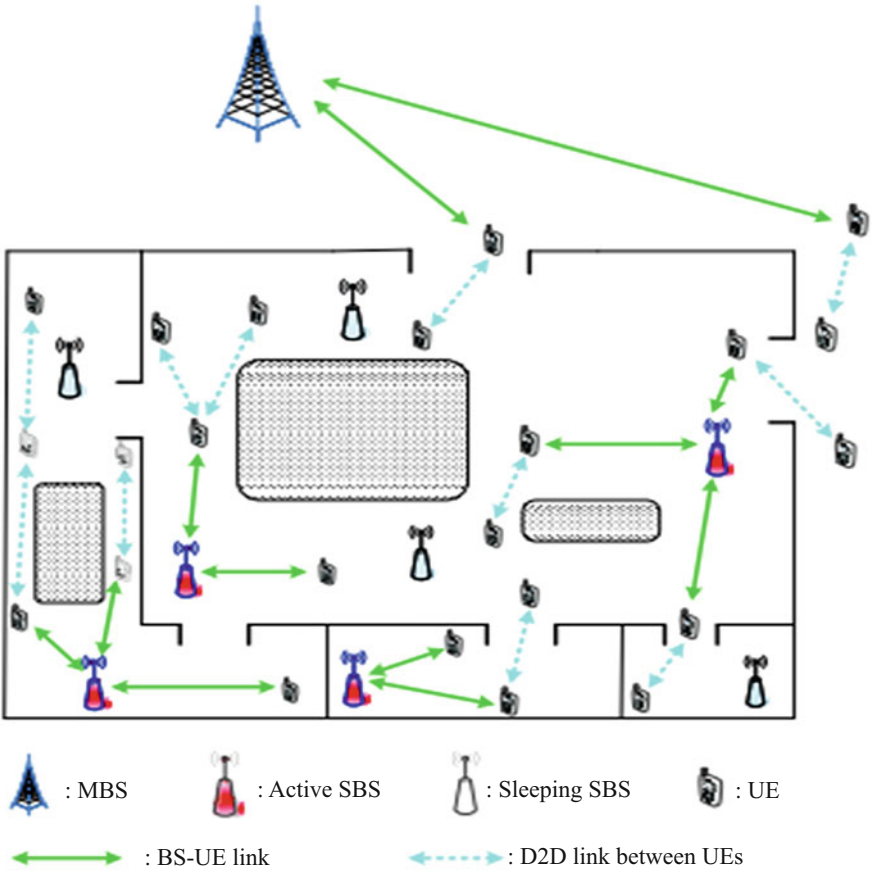


**Fig. 32.6** An example of BS ON-OFF scheduling in a D2D assisted mm-wave network

- **Energy Consumption**: Low consumption of energy is very important which helps to reduce traffic growth in future requirements and expectations. Cost-effectiveness is an important issue to be considered and also provides services at reasonable end user price which creates an attractive business opportunities. In 4G cut of energy consumption per gigabit transported by a factor 4 with 2015 as a base line and recently for 5G current system by factor of 10.

## 32.7 Green Wireless Network (GWN)

It is to be expected that the 5G wireless network is more energy-efficient. In order to achieve this, the solar panels and the batteries are to be deployed in remote radio head (RRH) for efficient usage of energy by which transmission loss is expected to

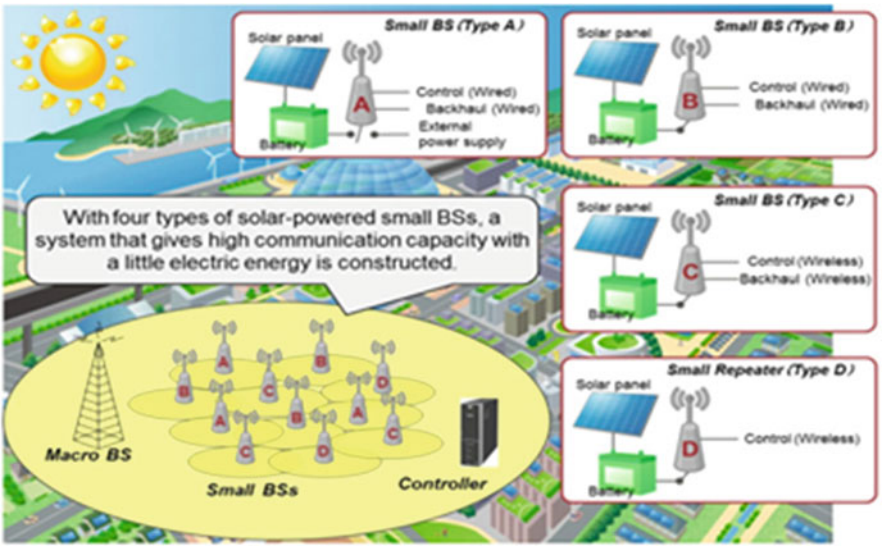


**Fig. 32.7** Green wireless networks

be reduced and would create an eco-friendly network by reducing the level of $CO_2$ emission and is disaster-resistant [2, 3]. For example, a solar panel of 0.2 $m^2$ would supply sufficient power to run RRH of 8 W power consumption for 8 h per day. On the other hand, due to weather conditions, stable system operation is difficult to set. Figure 32.7 shows the green wireless network (GWN).

### *32.7.1 Architecture of System*

It is based on cognitive SDN which consists of three basic layers, i.e., RAL, CTL, and ICL. Basically, RAL connects with CTL via a base station, in between CTL and ICL through interfacing SDN controller. For the rapid response controller in ICL, directly connect to the base station in RAL.

### *32.7.2 Deployment of Network*

Network deployment strategies are based on distinct topography of cells and distributed antenna systems with the cooperation of BTS. A diverse network deployment under macrocell coverage presents a solution for improving efficient utilization of power for LTE. As per the future demand for massive amounts of devices and an increase in demand for capacity, an ultradense network deployment is

required [20]. This deployment includes control management and user plane access point.

### *32.7.3 Interoperability*

New emerging technologies in the 5G system with additional features and constraints emerge and are necessary to adjust with ON-OFF of base station switching strategies [22].

## 32.8 Conclusion

This paper presents the perspective of green aspects and solutions to 5G wireless network design. Traffic mass is supposed to rise 1000 times, and a number of associated devices will be 100 times greater than today in network society when the connection of data and sharing of data are available all over and at any moment to everyone. Low energy consumption is only the basis to attain this. The areas were discussed to meet future challenges and the need for the 5G green network designing process; this network will hold a broad number of devices, applications, and technologies. Sharing the spectrum along with bandwidth over every single LAN among better users brings more flexible networks along with high data rate throughput. The achievement, power saving, security, and development problem derived from the interconnection of the controller and two-layer policy should be analyzed with great achievement in the future.

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# Chapter 33
# An Integrated Model of Sustainable Management Systems for Start-ups


**Srirang K. Jha and Shweta Jha**

## 33.1 Introduction

Management systems are said to be formal, information-based routines and procedures that the managers apply in order to maintain or rework specific patterns in organizational activities [1]. They evolve alongside the growth of the organizations in an organic manner. It is possible that the management systems become somewhat rigid and best exemplify a bureaucratic model with all the negative connotations. However, all said and done, management systems remain a bulwark for the smooth functioning of most of the large organizations having a presence in several countries for over a hundred years now. In the meantime, management systems have also evolved and become all the more flexible and innovative in the wake of improvements in information and communication technologies. In the volatile, uncertain, complex, and ambiguous business environment, the organizations cannot attain economies of scale or competitive advantage without adopting management systems.

Sustainable management systems are based on the principle of integrating the concept of sustainability into management systems. Major concerns of sustainability are the impending dangers and concomitant fallout of climate change across the globe, rapid depletion of natural resources infused with the perpetual fear that there would be none for future generations, and how to balance development with sustainability before it is too late for any course correction. Hence, an ideal sustainable management system would absorb the fundamental spirit of sustainability so that any negative fallout might be minimized or creatively neutralized as in a circular economy.

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However, the promoters of start-ups are generally reluctant to bring in professional and state-of-the-art management systems and sustainable management systems. Their unwillingness towards adopting professional management systems rests on their unfounded apprehension that bureaucratic structure with the multiple layers of decision making and obscure countability centres might stifle the start-ups. Besides, the promoters have a constant fear of losing control of the business enterprise as there are several such examples where the founders were thrown out by professional management teams. Besides, there is a general perception that management systems are rather damaging for the unshackled growth of the start-ups [2].

## 33.2 The Rationale of Sustainable Management Systems for Start-ups

It is imperative to look at the basic nature of start-ups in order to understand the general disinclination of their promoters toward early adoption of management systems. It is interesting to note that most of the start-ups have the advantage of easily accessible, affordable and highly advanced information and communication technology around which they conceive, build, and implement their ideas. So the most critical capital they invest today is creativity. There is hardly any other investment. Promoters of the start-ups often bring in path-breaking innovations. If the idea is scalable, the angel investor, venture capitalists, and private equity firms make a beeline to infuse capital.

Start-ups are characterized by an open attitude to the external world, happily learning from everywhere, and intentional process of discovery leading to radically new business models as compared to the incremental approach favored by most of the existing market leaders who delegate innovation to inconspicuous business units [3]. Moreover, the start-ups thrive by way of leveraging divergence and convergence stages: The divergence stage encourages thinking outside the already set boundaries, challenging assumptions, exploring opportunities, and dreaming up new ideas, while the convergence stage focuses on synthesizing the outcomes [3]. The start-ups have a unique entrepreneurial ecosystem within the organization where every member takes a risk without fear of failure and concomitant fallout like losing the job or being held responsible for damages by an experiment which went wrong or did not yield desirable outcomes.

The biggest fear of the promoters/founders of start-ups is the loss of entrepreneurial ecosystem if such organizations adopt the management systems from the very inception. Probably this is the reason why the founders/promoters of start-ups stick to their guns and react with abhorrence at any suggestion regarding management systems and processes even at the risk of compromising with growth potentials of their enterprises amounting to the entrepreneurial crisis [4, 5]. A general perception held by the entrepreneurs that the bureaucratic nature

of management systems kills the entrepreneurial spirit may be attributed to their preference for a personal management style [6]. Unfortunately, the first thing the venture capitalists do after investing in any start-up is to bring in professional managers to put formal systems in place. On several occasions, such moves lead to irreparable conflict between the founders and the venture capitalist, often leading to the unceremonious exit of the former.

Incidentally, the start-ups cannot attain economics of scale and capitalize on their breakthrough innovations without professional management systems, and the breakthrough innovations are nearly impossible in watertight bureaucratic work organizations characterized by complex decision-making processes and diffused accountability centers. The ideal scenario is the adoption of management systems just after the breakthrough innovation is ready for the market [7]. With a small team of creative people, the start-ups cannot reach out to the customers or end-users, and in case they fail to attain economies of scale too quickly, there is a greater risk of their breakthrough innovation being copied by other major players in the market.

There is enough evidence which links the failure of the start-ups to the entrepreneurial crisis [5, 6]. Indeed, an increased number of employees cannot be managed exclusively through informal and ad hoc systems, thus making room for the organization's development by bringing in a professional manager [8].

It is widely believed that organizations can attain grander performance by way of occupying leadership positions in the market and that competitive advantage can be achieved through management decisions that transform uniqueness in resources into a market offering that is valued by one or more market segments [9]. Start-ups do have tremendous potential of being the market leader by virtue of their breakthrough innovations and developing a range of goods or services that can delight the customers beyond their imagination. Hence, it is important that to scale up, the start-ups adopt management systems geared for informed decision-making in place of decisions based on the impulses and discretion of the founders.

However, merely adopting management systems may not work in current times. As significant numbers of consumers today are aware of the impending dangers of climate change, they expect companies of their choice to focus on sustainable business practices. Therefore, it becomes all the more important for start-ups to go for sustainable management systems as part of their growth-oriented strategies. Also, the adoption of sustainable management practices is becoming increasingly important for organizations worldwide [10]. Several types of research have indicated that adoption of sustainable management practices leads to positive environmental outcomes [11–13].

## 33.3 Proposed Model

Corporate environmental sustainability policies are based on three criteria, viz., economic prosperity, social equity, and conservational sustainability [14]. Here, we present an integrated model of sustainable management systems which might enable

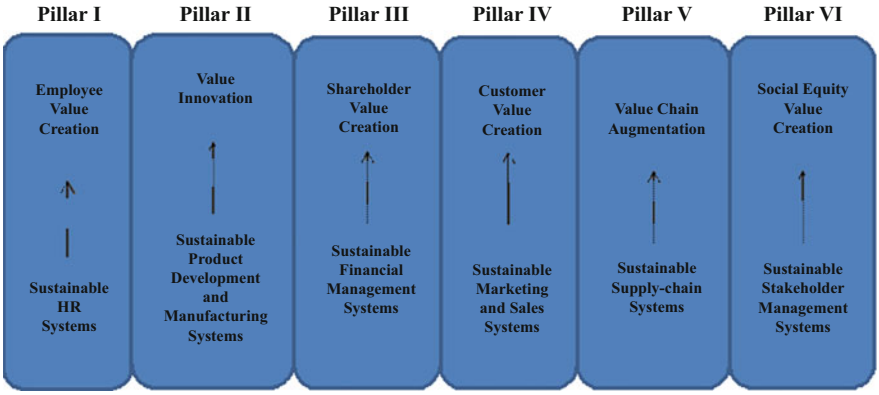


**Fig. 33.1** Integrated model of sustainable management systems proposed by the authors

the organizations to attain all the three goals, i.e., economic prosperity in terms of value creation for the shareholders, employees, and consumers, social equity in terms of social capital formation, and conservational sustainability in terms of the reduced carbon footprint of the organization.

In the proposed model of integrated sustainable management systems, there are six pillars with specific outcomes. Pillar 1 relates to sustainable HR systems which might help the organizations in augmenting employee value proposition which in turn will enhance their involvement with the organization, and they would contribute toward strengthening other pillars in the system out of their own volition. Sustainable HR systems include process automation, efficiency enhancement, and empowerment. Pillar 2 relates to sustainable product development and manufacturing systems which would help the organization in value innovation. This is the second stage after the breakthrough innovation where the organizations keep improvising on products through continuous innovation aimed at lowering the overall cost to the organization as well as the customers.

Pillar 3 relates to sustainable financial management which is aimed at shareholder value creation by a concerted effort at reducing the cost of resources as well as capital. Pillar 4 relates to sustainable marketing and sales systems which might catch the imagination of the consumers through innovative ways of reaching out to them and packaging the products in an eco-friendly manner. Pillar 5 relates to sustainable supply chain systems which would have a lasting impact in terms of value chain augmentation, and it would also help the organization reduce its carbon footprints. Pillar 6 relates to sustainable stakeholder management systems which might help the organization in developing a synergistic and collaborative relationship with the communities aimed at social equity value creation (Fig. 33.1).

## 33.4 Discussions and Conclusion

An integrated model of sustainable management systems may be adopted by the start-ups before the venture capitalists approach them for funding. In case the start-ups already have management systems in place that too imbued with the holistic principles of sustainability, before infusion of funds, it is possible that they might get a better value and they are also able to retain their control over the organization. Founders of start-ups, who are capable of attracting some of the finest team members to usher breakthrough innovations with meager resources, can easily adopt sustainable management systems without any hue and cry. But this is possible, only if they see value in adopting sustainable management systems. Hence, there is an urgent need to reiterate the rationale of sustainable management systems, especially for start-ups, so that it becomes an integral part of the business plan. When the founders of the start-ups are conceptualizing an idea for a breakthrough innovation, they should also visualize the wherewithal of attaining economies of scale and sustain the business for years to come.

Often the founders ignore the brass tacks of running the business in a holistic manner as they are too preoccupied with their breakthrough innovations or unique business idea. Sometimes, their creativity and unusual thought process become counterproductive in the wake of their idiosyncrasies that alienate the employees, shareholders, investors, and all other stakeholders. Hence, it is imperative that they seek professional help or mentoring by seasoned entrepreneurs or corporate leaders so that they are able to go a long way in running their unique enterprises while exceeding the expectations of all the stakeholders and surprisingly many of them by unorthodox offerings of services and value. Although there is no empirical evidence to suggest the efficacy of the six pillars of sustainable management systems, the common sense indicates that the adoption of these pillars in true spirit by the entrepreneurs, especially the promoters of start-ups, might yield phenomenal results. The six pillars are capable of holding the entire edifice of business or social enterprises so as to ensure zero possibility of collapse or failure. The sooner the promoters of start-ups realize the value of these pillars, the better.

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# Chapter 34
# Diagnosis of Retinal Disease Using Retinal Blood Vessel Extraction


**B. Paulchamy, S. Chidambaram, J. Jaya, and R. Uma Maheshwari**

## 34.1 Introduction

Glaucoma is a second leading eye disease that causes permanent blindness. The other name of glaucoma is "Silent Thief of Sight" [1]. It could actually handiest be identified by means of ordinary eye examinations. Glaucoma most, in general, happens in adults over age 40; however, it may additionally occur in young adults, children, and even toddlers. In African-American citizens, glaucoma happens more by and large at a prior age and with a higher loss of vision. So, early detection can prevent imaginative and prescient loss. According to the various surveys in India, diabetics are mostly affected by the youngsters. Diabetic retinopathy is the most severe and difficult problem all over the world. As per the information gathered by the world well-being group, around 366 million peoples will be suffering from diabetes in the year 2030. So the early detection of diabetic retinopathy is essential on the planet [2]. Retinoblastoma affects newborn toddlers and kids as much as 5 years old. Many people at the age of 20 to 70 have a blindness disorder. Recent studies show that many people are affected by macular degeneration in India. Macular degeneration is a type of eye disease that often affects adults worldwide [3, 4]. The swelling of the optic disc causes papilledema [5].

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## 34.2 Problem Statement

Eye disease causes permanent blindness. Therefore, it is necessary to diagnose the retinal problems at an early stage to prevent the loss of vision. Glaucoma, papilledema, diabetic retinopathy, age-related macular degeneration (ARMD), and retinoblastoma are some of the retinal diseases which cause vision loss. Early diagnosis assists the physician to give effective treatment. Vision loss can be avoided if the disease is identified at an early stage [6]. The cup-to-disc ratio (CDR) measurement is required to identify the glaucoma. But CDR evaluation done by a physician is subjective. In order to get this measurement, Heidelberg retinal tomography (HRT) which is a highly expensive hardware equipment is used by the ophthalmologist, and some of them are measuring manually. HRT is limited in use due to cost.

The diabetic retinopathy is diagnosed by the ophthalmologist by using popular methods including fluorescein angiography, optical coherence tomography (OCT), and Amsler grid test sometimes. The age-related macular degeneration (ARMD) is detected by the Amsler grid test and optical coherence tomography (OCT). But these diseases can be diagnosed via eye examination that seeks early symptoms of eye disease by the manual analysis with the best practitioner.

The papilledema diagnosed by the ophthalmologist uses the measurement of the optic disc diameter. The fundus autofluorescence (FAF) and enhanced depth imaging OCT (EDI-OCT) are often used to distinguish papilledema from pseudopapilledema due to optic disc drusen (ODD), but these techniques are unavailable at a majority of ophthalmologists [7].

In this paper, we proposed image processing techniques for blood vessel extraction with ANN classifier to facilitate the ophthalmologists in order to classify the fundus in the eye to determine the retinal diseases glaucoma and papilledema and SVM classifier to detect diabetic retinopathy instead of using high-cost equipment and manual analysis.

## 34.3 Methodology

The methods to find the various retinal diseases are shown in Fig. 34.1. As there are various retinal diseases, the major four retinal diseases are glaucoma, diabetic retinopathy, retinoblastoma, and age-related macular degeneration.

Ophthalmic images are generally analyzed and diagnosed by an expert or ophthalmologist. But it is a time-consuming process. The final diagnosis heavily relies on the experience of an expert. To address the problems of manual diagnosis, automatic analysis has been introduced. This analysis helps the ophthalmologist to diagnose retinal diseases with high accuracy. A fundus camera is one of the most commonly used devices to acquire images [8]. Several preprocessing methods have been used to improve the quality of the image. After preprocessing, a suitable classification is employed to detect the disease.

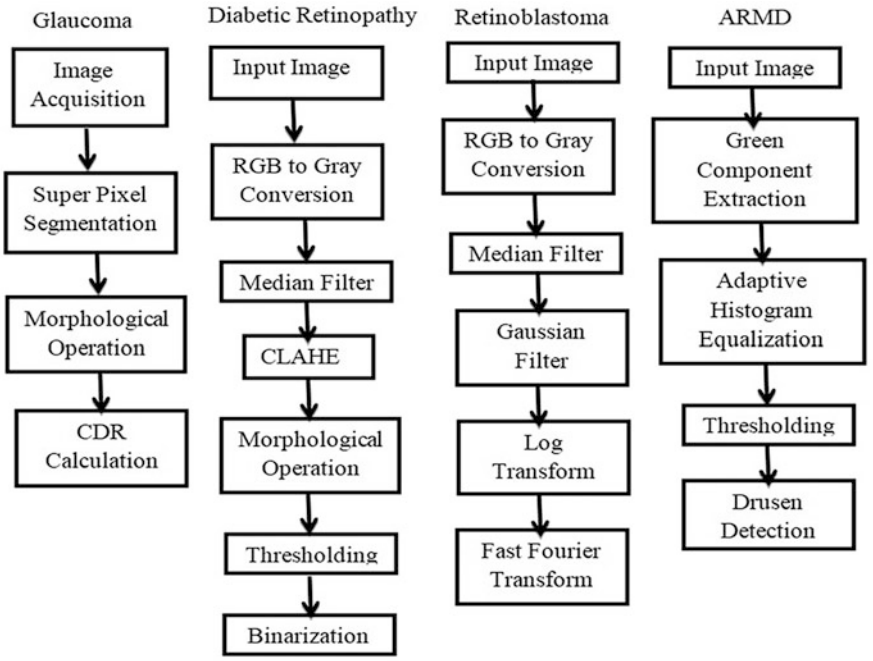



**Fig. 34.1** The methodology of the proposed work

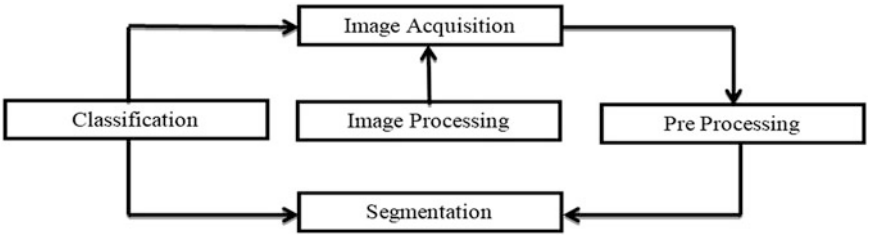



**Fig. 34.2** The basic block of image processing

## 34.4 Proposed Work

Image processing consists of various stages of processing as shown in Fig. 34.2.

Image processing involves the following operations:

(1) Acquisition of an image
(2) Image preprocessing
(3) Image partition
(4) Feature extraction and the selection
(5) Classification

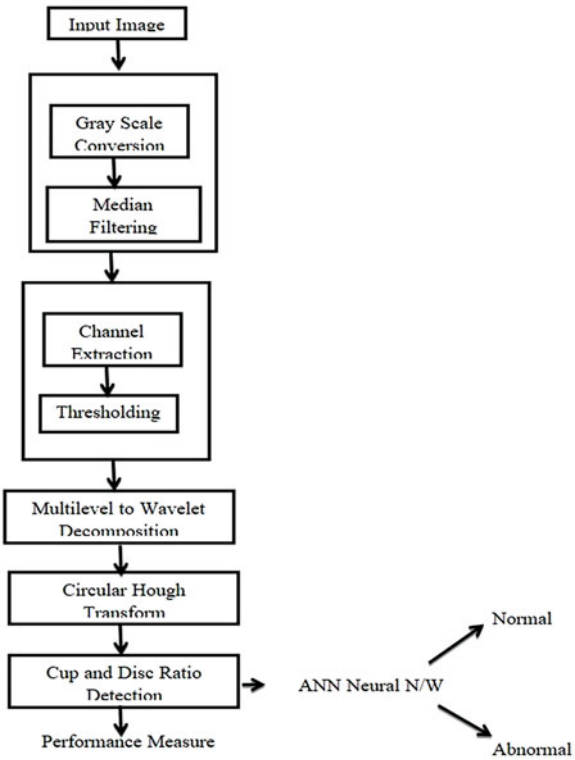



**Fig. 34.3** Proposed block diagram for glaucoma

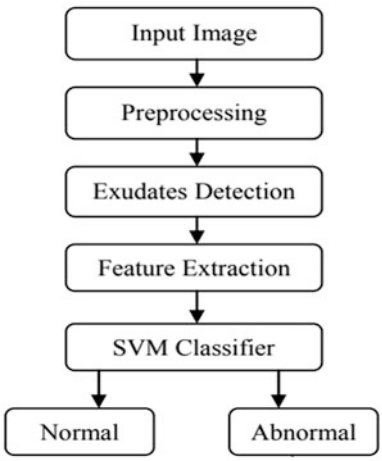



**Fig. 34.4** Proposed block diagram for diabetic retinopathy

The flowchart of the proposed classifier is shown in the Fig. 34.3. The proposed classifier uses CNN to detect eye disease, glaucoma (Fig. 34.4).

Image acquisition is the first step in any image analysis. The retinal image is acquired utilizing the fundus camera. The camera is placed close to the face in order

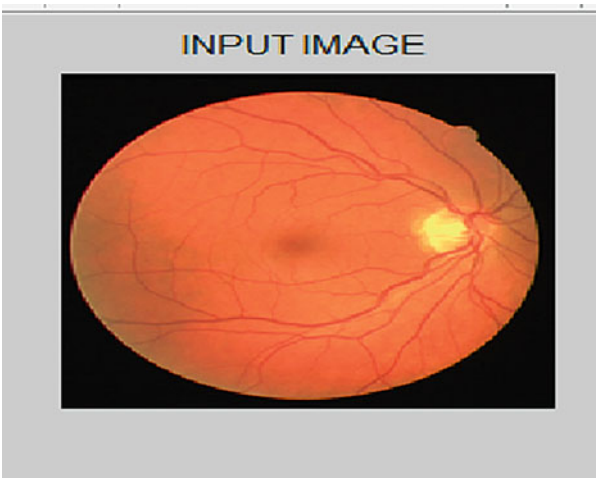



**Fig. 34.5** Input image with glaucoma

to get a high-quality image. Subsequently, the acquired 3D image is converted into a 2D grayscale image. The intensity value of the pixels in an 8-bit grayscale images can have a range between 0 and 255. Several methods are available to convert 3D images to 2D images. After conversion, the feature extraction method is applied to extract most important features from an image. The necessary and important factors for the CDR calculations are separated from ROI. The factors include a range of optic cup (OC) and optic disc (OD). OC and OD areas are calculated by using contrast information of the retinal image. Superpixel classification method is used to differentiate OC from OD. It is a kind of iterative clustering algorithm, easy to implement, faster, and memory efficient. In this method, center pixels are shifted toward the least significant edge boundary [9, 10]. The algorithm iteratively seeks its best pixel and then forms a cluster point using the detected pixel (Fig. 34.5).

Preprocessing is an essential step in image analysis. It is used to eliminate redundant information from the image. Examples of commonly used preprocessing methods are filtering, enhancement, and histogram adjustment. After preprocessing, ROI is extracted using color channel separation. All the operations are performed using MATLAB. The proposed method uses a retinal image acquired with the help of a fundus camera. The green channel is separated from the RGB image (Fig. 34.6). The preprocessing method is adopted to improve the contrast of the image. The blood vessel image quality is improved. Finally, the essential features are extracted. The proposed method utilizes green channel information which provides a better vessel foundation. Blood-containing points are detected based on the difference in the green component (Fig. 34.7).

**Fig. 34.6** Grayscale conversion


**Fig. 34.7** Filtered image

### *34.4.1 Image Acquisition*

The image acquisition stage consists of acquiring the input images. The input images are collected from the databases. The DRIVE database is used to collect the retinal images. It has 110 retinal images in digital form [7]. The fundus images of 124 patients are taken from the Ophthalmology Service at Miguel Servet Hospital (Fig. 34.8). The database consists of patients with 46% male and 53% female. The retinal images can be represented in the form of a two-dimensional axis and three-dimensional axis. The DRIVE database consists of three-dimensional retinal images (Fig. 34.9).

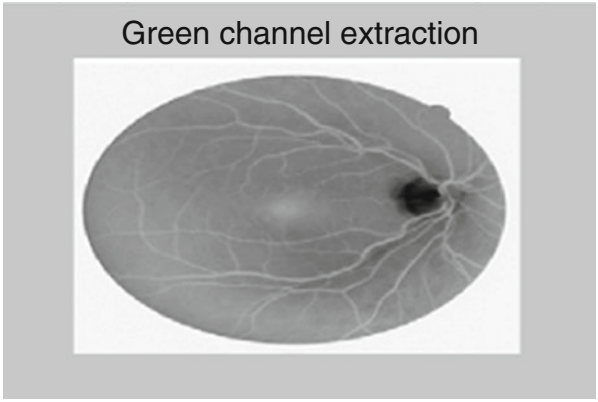



**Fig. 34.8** Green channel extraction

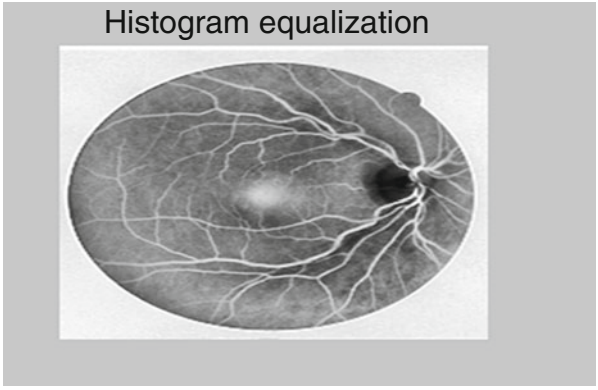



**Fig. 34.9** Histogram equalization

### *34.4.2 Preprocessing*

The preprocessing color conversion and noise filtering are the important steps of preprocessing. The acquired retinal image can be a 3D image. These images are converted into a 2D image for further process (Fig. 34.10).

Noise filtering is the process of removing unwanted information from the image. In this work, the median filter is employed to remove the noise and to smoothen the image (Fig. 34.11).

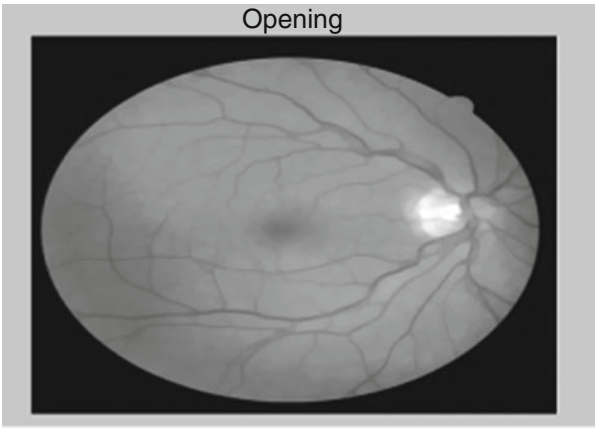



**Fig. 34.10** Opening

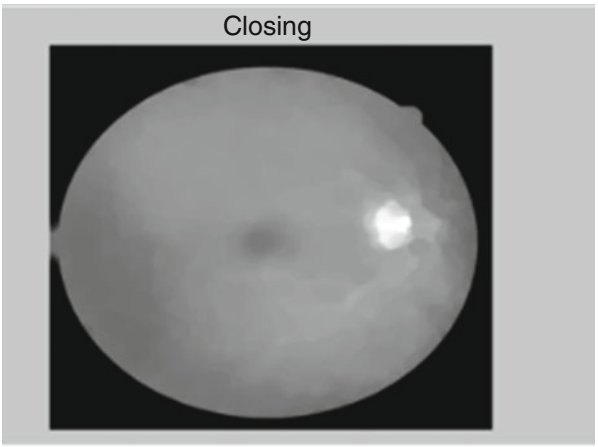



**Fig. 34.11** Closing

### *34.4.3 Segmentation*

The segmentation process is carried out after the color separation of retinal images. The green channel has been extracted from the retinal images to undergo the segmentation process. The modified fuzzy c-means algorithm is used to separate the minute blood vessels (Fig. 34.12). The segmentation process is used to separate the meaningful regions of the retinal images [11, 12]. This segmentation process can be undergone with the histogram equalization techniques. It consists of two stages, namely, channel extraction and morphological operations (Fig. 34.13).

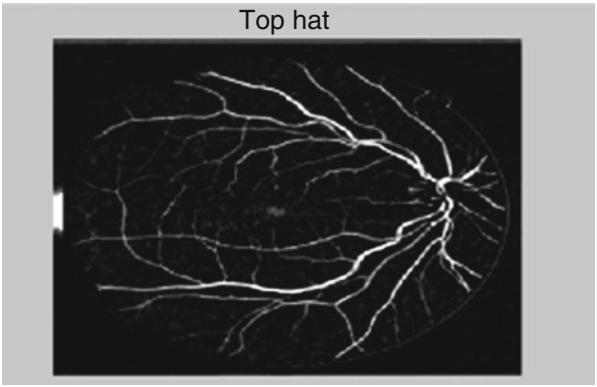



**Fig. 34.12** Top hat

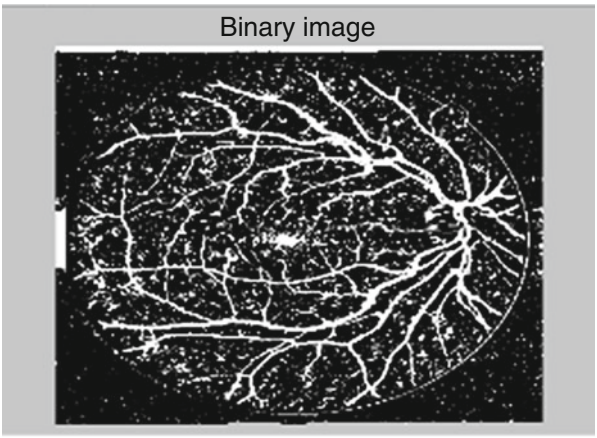



**Fig. 34.13** Binary image

### *34.4.4 Channel Extraction*

Channel extraction is defined as the process of separating the green channel or green component from the input 3D image. In this work, the green component is used to identify blood vessel information (Fig. 34.14).

The histogram equalization is utilized to adjust the pixel intensity of the converted grayscale image (Fig. 34.15).

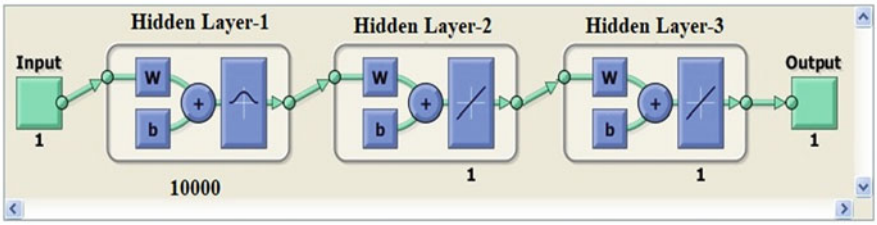



**Fig. 34.14** Artificial neural network (ANN) classifier training

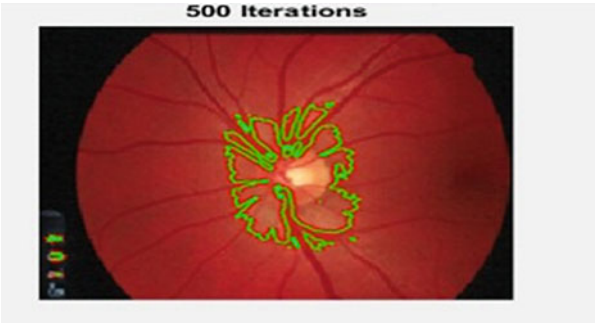
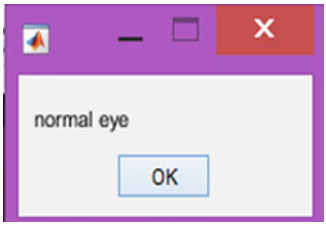



**Fig. 34.15** Artery vein classification with ANN classifier

**Fig. 34.16** Result of classification




### *34.4.5 Morphological Operations*

There are several morphological operations present in image processing techniques. The main morphological operations used in the proposed work are opening, closing, top hat, and binarization (Fig. 34.16).

### *34.4.6 Opening*

The opening of the binary image is used to carry out the separate minute blood vessels from the image. Morphology is a group of nonlinear processes. It is used to increase or decrease the image size. Commonly used morphology operations are

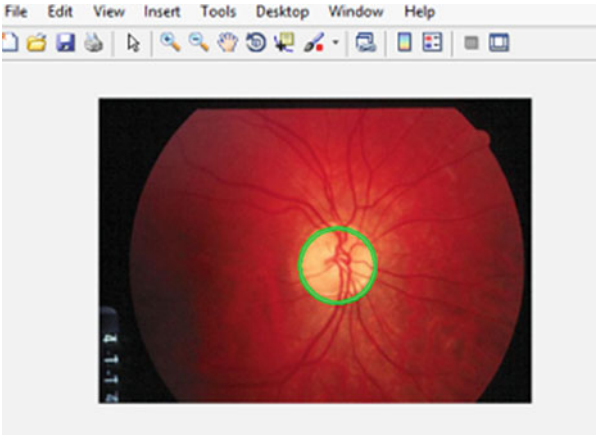



**Fig. 34.17** Hough transform for optic disc separation

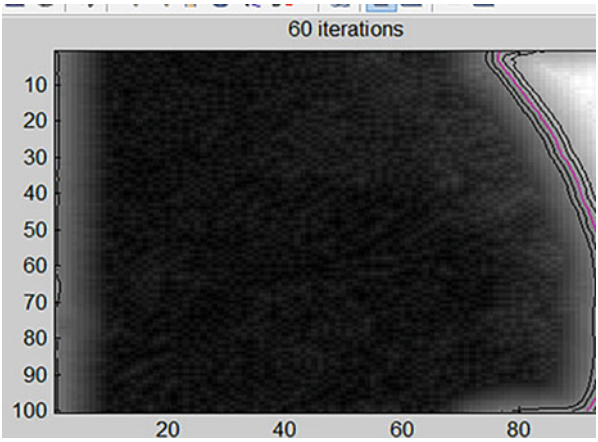



**Fig. 34.18** Separated optic cup

opening, erosion, closing, and dilation [13]. It is utilized to eliminate small objects from an image while preserving the important features such as shape and size (Fig. 34.17).

### *34.4.7 Closing*

Closing is used to smoothen the edges and increase the sharpness of the grayscale-converted retinal images. Closing is dilation followed by erosion process. Both the processes use the same structuring element (Fig. 34.18).

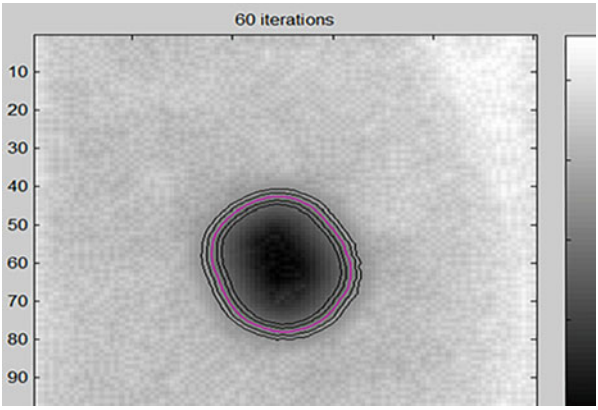
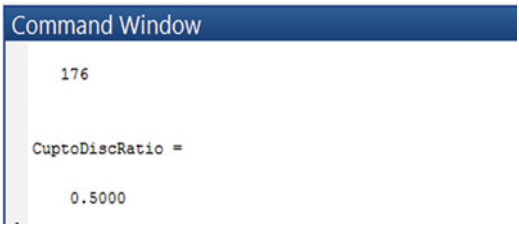



**Fig. 34.19** Separated optic disc

**Fig. 34.20** Optic disc to cup ratio




### *34.4.8 Top Hat*

The top hat process which is one of the important morphological operations is used to carry out the segmentation process. The top hat filter is a morphological filter that can be used for baseline removal. Top hat transform is used for extracting small objects and its details from the image (Fig. 34.19).

### *34.4.9 Binarization*

The grayscale images are converted into binary scales as their pixels' value ranges from 0's to 1's. These pixel values are used to separate the meaningful parts from the unnecessary parts in the fundus image (Fig. 34.20).

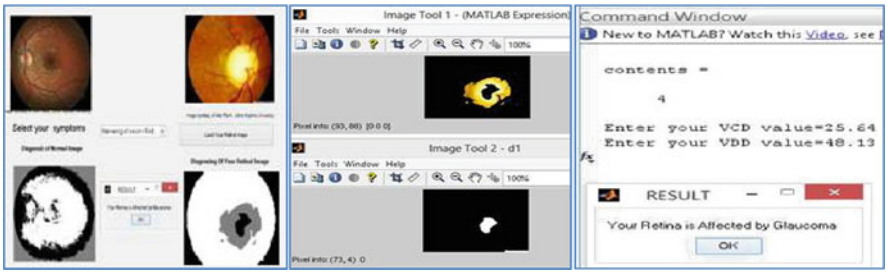



**Fig. 34.21** Diagnosis of glaucoma using CNN classifier

### *34.4.10 Classifier*

Artificial neural network (ANN) is employed to perform a classification task. The proposed classifier consists of 3 layers and 10,000 neurons.

The SVM classifier is fundamentally a binary classification algorithm. It falls under the umbrella of machine learning. SVM might be used to perform image classification. SVM is a type of supervised ANN. It is mainly used for classification and regression analysis (Fig. 34.21).

### *34.4.11 Classification*

From the extracted blood vessels, we can detect artery veins. These extracted blood vessels are used to classify the person having the disease or normal persons. This classification is carried out using the ANN classifier [14].

### *34.4.12 Optic Cup and Disc Measurements*

The OD and OC are identified using the Hough transform method. The Hough transform is used for the automatic identification of OD in the image. The size of the OD may vary from normal person to the diseased person. By the segmentation of OD and OC, the CDR can be calculated. The CDR ratio can be determined using Eq. (34.1).

$$\text{Cup to Disc Ratio (CDR)} = \frac{\text{Vertical Cup Diameter (VCD)}}{\text{Vertical Disc Diameter (VDD)}} \tag{34.1}$$

Thus by extracting the OD and OC, the size of the OD and OC can be calculated in terms of rows and columns (Fig. 34.22).

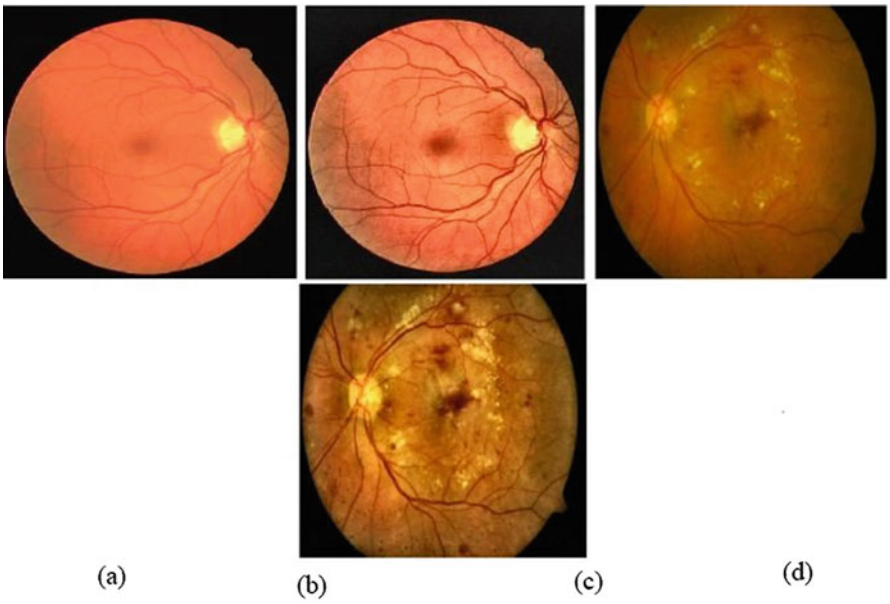



**Fig. 34.22** Retinal image enhancement. (**a**) Normal retinal image. (**b**) Abnormal retinal image. (**c**)-(**d**) Enhanced retinal image

### *34.4.13 Performance Measures*

The effectiveness of the proposed glaucoma is calculated using the Eqs. (34.1), (34.2), (34.3), and (34.4). The accuracy, sensitivity, and specificity can be calculated from the true-positive number (TPN), true-negative number (TNN), false-positive number (FPN), and false negative number (FNN) values of the classified and nonclassified images. The TPN gives the number of glaucoma images detected by the best practitioner and proposed method. The TNN gives the number of normal images detected by the best practitioner and method which is proposed here. The FPN gives the number of normal images detected by the best practitioner, but the proposed method detects those images as glaucoma [15]. The FNN gives the number of glaucoma images detected by the best practitioner, but the proposed method detects those images as normal. The performance measures are defined in the following equations (Table 34.1):

$$\text{Accuracy} = \frac{\text{TPN} + \text{TNN}}{\text{TPN} + \text{TNN} + \text{FPN} + \text{FNN}} \tag{34.2}$$

$$\text{Specificity} = \frac{\text{TNN}}{\text{TNN} + \text{FPN}} \tag{34.3}$$

**Table 34.1** Performance measures by CNN classifier in glaucoma detection

| Images | CDR ratio | Accuracy | Sensitivity | Specificity |
|---|---|---|---|---|
| Normal | 0.3150 | 82% | 10% | 90% |
| Diseased | 0.500 | 81% | 0% | 100% |

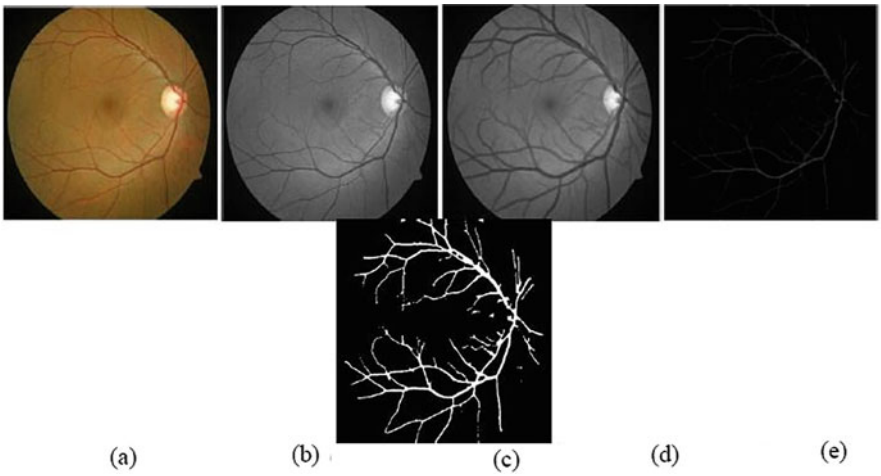



**Fig. 34.23** Blood vessel segmentation of normal retinal image. (**a**) Normal retinal image. (**b**) Green channel image. (**c**) Morphologically processed image. (**d**) Absolute difference image. (**e**) Blood vessel segmented image

$$\text{Sensitivity} = \frac{\text{TPN}}{\text{TPN} + \text{FNN}} \tag{34.4}$$

## 34.5 Results and Discussion

The proposed method for blood vessel detection and segmentation was validated on DRIVE and STARE datasets. Segmentation results are compared with ground truth images to prove the efficacy of the proposed method (Fig. 34.23).

### *34.5.1 Papilledema Detection*

After finding OD, the image is transformed into a binary image. Binarization is done by thresholding method. In binary, the foreground (OD) is a white color, and the background is black (Fig. 34.24).

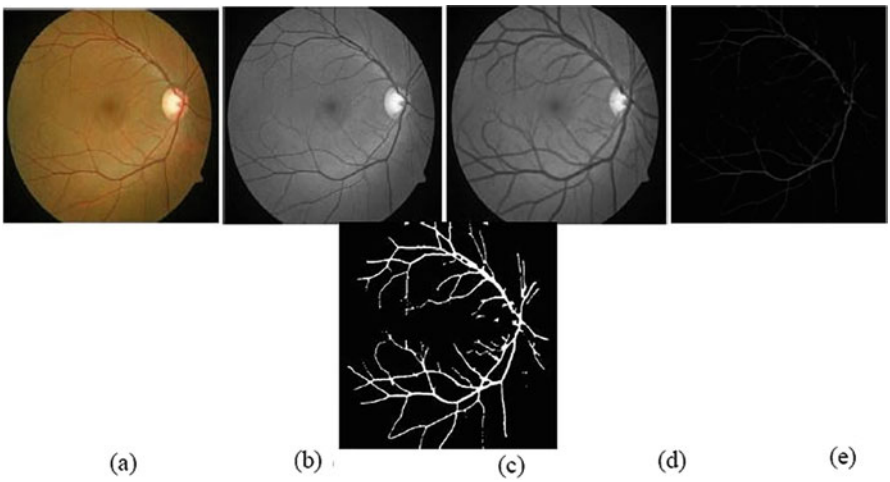



**Fig. 34.24** Blood vessel segmentation of abnormal retinal image. (**a**) Abnormal retinal image. (**b**) Green channel image. (**c**) Morphologically processed image. (**d**) Absolute difference image. (**e**) Blood vessel segmented image

**Table 34.2** Performance measures by SVM classifier in diabetic retinopathy

| Methodology | Accuracy | Sensitivity | Specificity |
|---|---|---|---|
| Proposed | 0.9960 | 0.7800 | 0.9799 |
| Soares et al. [14] | 0.9466 | 0.7283 | 0.9788 |
| Mendone et al. [15] | 0.9452 | 0.7344 | 0.9764 |

## 34.6 Conclusion

Blood vessel detection and segmentation play a vital role in the diagnosis of glaucoma and diabetic retinopathy. This paper presented a method for blood vessel detection and segmentation. The proposed method is based on morphological, ANN and SVM classifier. GLCM features and local binary patterns are obtained from the preprocessed image and used as blood vessel features (Table 34.2).

The proposed method with ANN classifier detected the blood vessels with a 10% sensitivity, 90% specificity, and 80% accuracy. 99.6% accuracy, 78% sensitivity, and 97.99% specificity are obtained by using the proposed method with SVM classifier.

Thus, the various retinal diseases are identified using an image processing process. These image processing techniques help to reduce the time consumption and reduce the cost of identification of retinal diseases. In the near future, a number of dates are adapted to test the performance of the proposed method.

### *34.6.1 Scope for Further Studies*

SVM has shown outstanding performance in many tasks including image retrieval, object detection, and text and speech recognition. It is also used for regression analysis. SVM is suitable for image classification. It provides better results than ANN.

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# Chapter 35
# Smart and/or Mobile: An Investigation Within Czech University Students


**Ivana Simonova, Zuzana Prochazkova, and Vladimir Lorenc**

## 35.1 Introduction

Currently, both our private and professional lives can be hardly imagined without the 24/7 exploitation of information and communication technologies (ICT). Reflecting on the latest technical and technological development, the attributes of smartness and mobility have been gaining increasing importance [1]. Identically to the step-by-step implementation of ICT into human lives years ago, these days, smart and mobile devices and technologies are widely required and exploited.

Moreover, when the latest economic trends are under consideration, the smart and sustainable urbanization is another feature characterizing the decade-long economic processes running in the world society. As forecasted by United Nations in 2006 [2], in 2030, around 80% of population is expected to live in cities in Europe, Latin America and the Caribbean, and in Northern America, 70% in Oceania; amounts of city inhabitants in Africa and Asia will be close to 50%. From the current 55% of the world's population in urban areas, the proportion is expected to increase to 68% by 2050. The 2018 Revision of World Urbanization Prospects notes that future increases are expected to be highly concentrated in a few countries, particularly India and China, whereas Africa mostly remains rural reaching 43% of urban inhabitants [3]. The population living in cities uses 75% of nonrenewable natural resources and participates in the production of three-quarters of world pollution. It is not surprising that the predicted state will result in increased demands for food, water, and energy, which will imply further pressure on land, water, air, and raw materials. Consequently, demands on medical care, including the care for the elderly and people with disabilities, will be increasing [4]. And, of

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course, education will play an irreplaceable role and have a firm position in this process as a tool enabling people to acquire necessary competencies, including the latest technological knowledge and skills [5]. Thus it is clearly seen that ICT and smart and sustainable urbanization will be two factors (instead of others) of crucial importance in the near future. Regarding this finding, when considering the role/impact of the latest (i.e., smart) technologies and the process/results of urbanization, two basic questions (as a minimum) appear: Can the smart approach, particularly smart cities, be the solution of future challenges? However, do people, particularly university students as those who are expected to be a mover of future development, really know what the word *smart* means? Do they consider the feature of *mobility* to be an inseparable part of the smart approach?

Reflecting the abovementioned, no matter how much the smart devices/technologies are popular among users, the purpose of this survey is addressing the gap in the literature when providing a closer insight in perceiving the term *smart* through investigating selected university students' opinions paying special emphasis on the feature of *mobility* within the word content.

## 35.2 Theoretical Framework

Despite that the term *smart* is widely exploited (e.g., [6]), the definition has not been clearly and precisely set. As with every new matter, the terminology has been under the development since the very beginning for some time, before finally being set and defined. Various approaches and views have been applied, numerous recognized institutions being the authors. However, the final solution has not been introduced.

### *35.2.1 Smart: Setting the Term*

Within the Czech language, the adjective *smart* is synonymous with clever (chytrý) or intelligent (inteligentní) [7]. This content was first applied on devices, technologies, and applications; later on, the term of the *Smart City* appeared. As the research described below was conducted within the European project Smart City – Smart Region – Smart Community, the investigation was held within this context.

The concept of Smart City was first introduced in the 1990s, driven by the development strategies implemented in cities in the Asia-Pacific area, in which technologies played a crucial role and electronic networks formulated a city model. As stated by Giffinger [8], two main concepts appeared: the techno-centric approach, where urban processes and services can be more efficient and effective in a connected city based on massive collection of data and their transformation into information through powerful analysis tools. Compared to this model, the holistic approach created balance between social, economic, environmental, human,

cultural and technological factors as a response to the challenges the cities must respond to, such as climate change, economic development, efficiency in the use of resources, etc. As a result, the idea of Smart City is today associated with a connected, efficient, innovative "green city", which is the driving force of technology-based entrepreneurship. A model of six axes that all correspond to a set of attributes which help to identify a smart city has been proposed and widely adopted [8].

As the key player, European Commission [9:1] understands smart cities as those using technological solutions to improve the management and efficiency of the urban environment, particularly emphasizing that "*A smart city is a place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and business. A smart city goes beyond the use of information and communication technologies (ICT) for better resource use and less emissions. It means smarter urban transport networks, upgraded water supply and waste disposal facilities and more efficient ways to light and heat buildings. It also means a more interactive and responsive city administration, safer public spaces and meeting the needs of an ageing population*." European Commission. Smart cities.

The IEEE definition of smart city [10] arises from the fact that the world urbanization continues to grow; the total population living in cities is expected to increase even by 75% by 2050 (comp. [2]). Therefore, there is an increased demand for intelligent, sustainable environments that offer citizens a high quality of life. This is a typical characteristics of a Smart City which brings together technology, government and society when includes but is not limited to smart economy, smart energy, smart mobility, smart environment, smart living and smart governance IEEE [10].

Definition set by the Government of UK, Department for Business, Innovation and Skills [11:7], is wider, when stating "*However, the concept of a Smart City goes way beyond the transactional relationships between citizen and service provider. It is essentially enabling and encouraging the citizen to become a more active and participative member of the community, for example, providing feedback on the quality of services or the state of roads and the built environment, adopting a more sustainable and healthy lifestyle, volunteering for social activities or supporting minority groups. Furthermore, citizens need employment and "Smart Cities" are often attractive locations to live, work and visit*."

To sum up, features of being connected, efficient, innovative, using technological solutions, and intelligent, sustainable environments towards increasing the quality of life were in the definitions of *smart* concepts. However, the feature of *mobility* was not mentioned. Each definition relates to one concept, each one being the aggregate of several specific indicators. From the sphere we are in, i.e. higher education, *smart education* is not explicitly mentioned in the definitions and concepts. It mostly appears under the categories of Smart Living [12], Smart People [13], Smart Education [14], Quality of Life [15], Social Case [16], or it is not explicitly mentioned at all [17].

### *35.2.2 Smart City Project*

Since 2018 the 4-year project Smart City – Smart Region – Smart Community has been conducted at Jan Evangelista Purkyne University in Usti nad Labem, Czech Republic. The main objective of the project is to contribute to the theory and practice on how to increase the effectiveness of smart attributes of the Smart City Approach toward improving the sustainability and quality of life and human sources. The project concept is based on four pillars:

1. Smart administration, covering communication with the public, city management, and local impact assessment
2. Smart public services and infrastructure, focusing on areas of transport, energy, and wastes
3. Smart environment and quality of life, dealing with adaptation to climate changes in towns and villages, quality of air, floods/disaster management, and building the green and blue infrastructure
4. Smart people, targeting smart community development, and smart education

As the project is conducted in the university environment and follows the motto "Smart region arises from smart people," pillar four focuses on the field of education which is for the purpose of this project defined as:

- A student-initiated and student-directed, motivated, adaptive, resourceful, and technology embedded
- Customized to student's need and context through providing them with digital textbooks which reflect learning objectives and preferences (learning style, pace, etc.)
- Supported by expert lectures and hands-on experience
- Applying the distance approach if more effective for students and learning content acquisition

Reflecting these characteristics, from the authors' view, the feature of *mobility* is considered to be an inseparable part of the term smart. The respondents' approach was expected to be identical. To prove this expectation, the survey was conducted.

## 35.3 Survey Design

### *35.3.1 Question, Objective, and Expectations*

We have been living in the e-society for more than two decades. Starting from the use of rather expensive and technologically simple mobile phones for making phone calls and sending a short message, huge amounts of the Earth inhabitants have been using their own smart devices available for reasonable prices which provide a wide range of e-services. The feature of the mobility of devices, technologies, and users is

highly required. The offer is steadily increasing, which requires acquiring the latest knowledge and skills so that the technological potential could be exploited. Any time of the day, we can see all age group users keep a smart device in their hands paying full attention to the activities running on the display. However, what do they exactly do? What smart services do they use? To what extent and for what purpose do they exploit them? Are the users' activities focused on special fields, or are they active, e.g., on social networks only? Do they instead of others use the e-services and devices for educational purposes? Are there, if any, differences between users of different age groups, professions, levels of education, gender, etc. And last but not least, do the users really know what the term *smart* means; particularly do they consider the feature of *mobility within the smartness*?

The above-listed questions belong to those which should be researched properly so that to get a deeper insight into the field of *smartness* in general. However, before discovering answers to them through other researches, in this survey we focused of the last question, i.e., how users understand the term *smart*, particularly whether they are able to translate the word into their native language (i.e., Czech language), define the content, what they call *smart* in their common lives, which smart technologies they exploit, and whether they find any positive and negative features relating to the smart attributes.

Therefore, the main objective of the survey is to get a deeper insight into perceiving the term *smart*, including the feature of *mobility*, and thus discover whether respondents, despite that they frequently use the devices and technologies, understand the terms correctly, in the full range. Having the terminology clearly defined and explained is the first step toward receiving valuable data and thus getting the opportunity to reach appropriate conclusions. The conducted survey is the pilot activity within the above-described project.

With respect to wide exploitation of smart and/or mobile devices and technologies in common everyday life, we expect respondents to have precise and deep knowledge of what the term *smart* means.

### *35.3.2 Methods and Tools*

The method of the questionnaire was applied for data collecting on the comprehension of the term *smart*. Students were face-to-face informed about the purpose of investigation and agreed with their participation. The questionnaire, distributed at the first lesson of the ESP (English for Specific Purposes) course, was structured into two parts: (1) collecting respondents' personal data and (2) consisting of six questions requiring open answers of the maximum extent of three lines. The language of questions and answers was Czech, i.e., the respondents' mother tongue. Despite that the feature of *mobility* within the term smart was under the focus, it was not intentionally mentioned in the questions so as not to make an impact on respondents' answers. They answered the following six questions:

1. Translate the word *smart* into the Czech language.

2. List what you consider *smart* in everyday life.
3. Define the term *smart*.
4. What do you use which can be called *smart*?
5. What are the positive features relating to the term *smart*?
6. What are the negative features relating to the term *smart*?

### *35.3.3 Sample Group*

Totally 97 respondents, students of Jan Evangelista Purkyne University in Usti nad Labem, Czech Republic, participated in the survey. They were enrolled at two faculties: Faculty of Education (FE) or Faculty of Natural Sciences (NS). They all were also involved in the Smart City – Smart Region – Smart Community project. The structure of the sample was as follows:

- Gender: Male 7%; Female 93%
- Age: 19–23 yrs
- Faculty of Education 82% (M 1%; F 99%) in the following study programs:
  - Teaching at primary schools 26%
  - Teaching at primary and SEN (special educational needs) schools 13%
  - Teaching at pre-primary schools 39%
  - Czech language for media and communication 22%
- Faculty of Natural Science 18% (M 76%; F 24%) in the following study programs:
  - Information technologies 46%
  - Toxicology 18%
  - Chemistry and Biochemistry 12%
  - Geography and History 12%
  - Biology 12%
- Degree: Bachelor 66% (FE 75%; NS 25%) and Master (FE 100%; NS 0%)

## 35.4 Results

Collected data were processed by the method of frequency analysis and presented in two joint figures. The results of Question 1 were not included in the figure; they were described separately. Data collected from FE and NS students were not distinguished because the survey did not target at comparing the groups. Some items within questions can be considered together (e.g., smart devices, others); however, they are presented separately in figure description.

### 35.4.1 Question 1

Question 1 (Q1) dealt with the plain translation: Translate the word *smart* into the Czech language. We expected all respondents would be sure about how to translate such a widely exploited word. Most of them (N = 94) translated the word into the Czech language correctly. However, a few respondents' answers were not so clear; they translated the words as:

- Úsporný (saving, N = 2).
- Or malý (small, N = 3).
- Or vyspělý (advanced, N = 3). Multiple answers from one student were accepted.

The option *small* was added to the translation *clever* in both cases. It was not specified in *saving* what field of savings the respondent had in mind (energy, costs, size, etc.). Respondents of options *saving* and *advanced* were not identical ones.

### 35.4.2 Questions 2–4

Question 2 (Q2), Question 3 (Q3), and Question 4 (Q4) focused on the feature of *smartness* in practice, i.e., in common, everyday lives of people in general (Q2) and in respondents' personal lives (Q4), whereas the explanation/definition of the term *smart* (Q3) was intentionally situated between these two questions – this position was expected to help the respondents more easily recognize and become aware of the word content, including the term of smart education which is in close connection to the entire project and is expected to be applied in current teaching/learning. Collected data are displayed in Fig. 35.1.

The results showed that within everyday life (Q2):

- Both the *smartphones* (73%) and *mobile phones* (40%) were mentioned, as well as *smart devices* (32%) and *mobile devices* (19%) and *smart technologies* (33%) and *mobile technologies* (8%).
- Other types of smart devices were included under smart devices, others, e.g., *smart cars* (26%), *smart households* and *houses* (30%), *smart cities* (6%), *smartwatch* (11%), *smart games* (9%), etc.
- Contrary to these, *smart people* (16%) and *smart ideas* (2%) were mentioned.
- And last but not least, 8% of respondents agreed on *nearly everything* can be called *smart* these days.

The occurrence of smart attributes in respondents' personal lives (Q4) was detected:

- Mainly with *smartphones* (84%).
- But also *mobile phones* were mentioned (37%) when some respondents were users of both types of phones.
- Mobile devices were more frequently mentioned than smart devices.

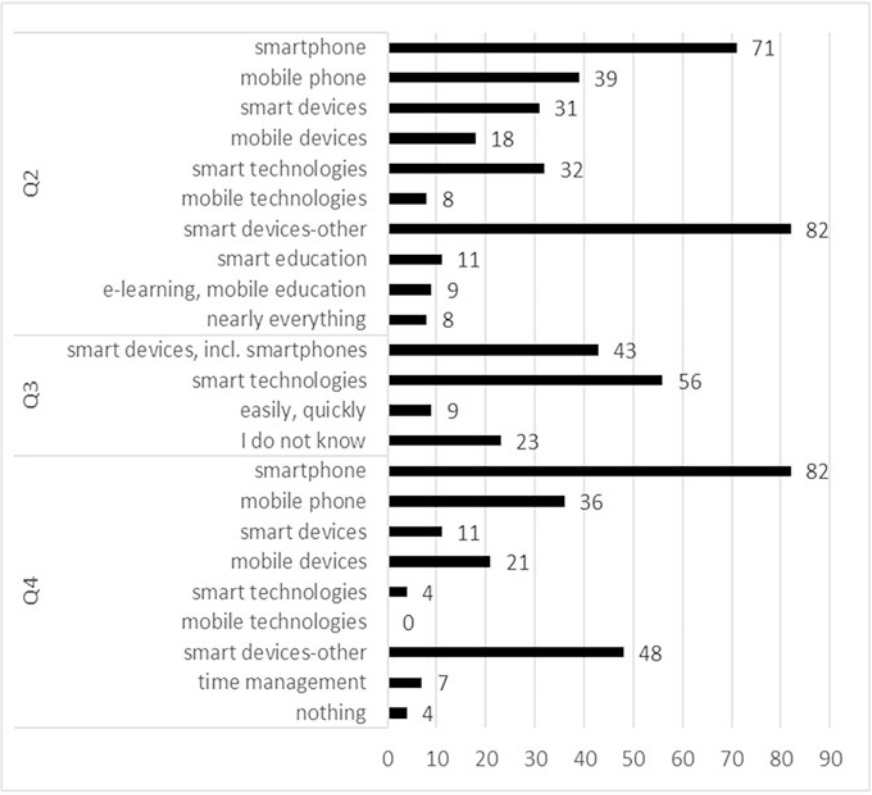


**Fig. 35.1** Results: Question 2, Question 3, and Question 4 (N = 97). (Source: authors' own)

- *Smart technologies* were rarely exploited (4%), whereas *mobile technologies* were not mentioned at all.
- *Smart devices, others* (as defined above), were used nearly by half of the respondents (49%).
- Additionally, *time management* (i.e., devices helping manage students' schedules and leisure) was rarely mentioned (7%).

The term *smart* (Q3) was defined as:

- The exploitation of *smart technologies* (57%).
- *Smart devices* (44%).
- *Smart education* rather rarely occurred (4%).
- While *being smart* appeared as the synonym for *easily and quickly* (9%).
- However, 23% of respondents were not able to define the term at all.
- None of them mentioned any *mobile* feature within the definition of the *smart*.

- And last but not least, not a single student mentioned any *smart services* which are frequently exploited in common life, e.g., shopping, banking, customized offers, Internet of Things, and others.

### *35.4.3 Questions 5–6*

Questions 5 and 6 dealt with positive (Q5) and negative features (Q6) relating to the term *smart* from respondents' views. Collected data are displayed in Fig. 35.2.

Characteristics students consider being positive include:

- Making things easier (60%).
- Improving various processes (15%).
- Availability of data and information (31%).
- However, one-fifth of respondents did not detect any positive features (23%).

Features students consider being negative cover:

- Making things too much easier (16%).
- Being in danger of addiction on the use of smart devices/technologies (20%).
- Placing users in the risk of cyberattack (25%) or cyberbullying (8%).
- However, one-fifth of respondents did not detect any negative features (23%).

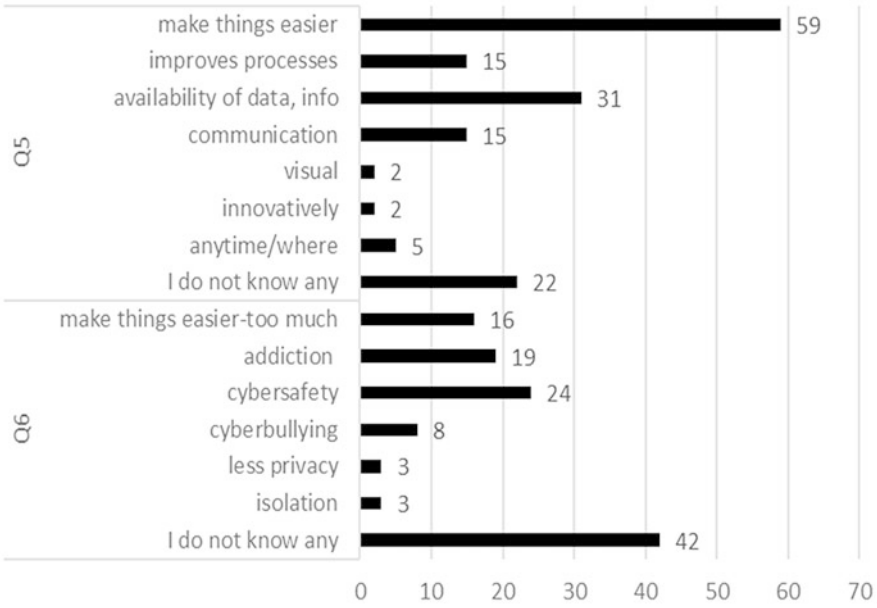


**Fig. 35.2** Results: Question 5 and Question 6 (N = 97) (Source: authors' own)

- And last but not least, user isolation (3%) and less privacy (3%) were rarely mentioned.

The feature of mobility was mentioned, neither under positive nor among the negative characteristics.

## 35.5 Summary, Discussions, and Conclusions

As clearly seen from the collected data, the wide exploitation of smart devices and technologies in the society is not reflected in the deep and proper knowledge of the term *smart*, starting from its translation, when 5% of respondents did not translate the term correctly, i.e., they did not fully understand the core of the word content.

This finding is supported by the fact that 23% of respondents were not able to provide a definition of the term smart. Additionally, 4% did not find anything to be smart in their lives, one-fifth of respondents did not detect any positive features (23%), and 43% of respondents were not able to name any negative features relating to the term smart.

*Based on these findings, we can conclude that the expectations on the deep and proper knowledge of the term* smart *were not met. This result also means that the* feature of mobility *is not firmly connected with the* smartness *within this research sample.*

However, it should be taken into consideration that the collected data are limited by several facts:

1. Data were collected in ESP lessons where methods and approaches stated as *smart* within the Smart City – Smart Region – Smart Community project (i.e., TED talks, MOOC, problem-solving method) are considered standard for years, as well as the exploitation of mobile devices, applications, etc.
2. The research sample was imbalanced from the view of participating faculties: three faculties (FE, NS, F. of Social and Economic Studies) out of eight (Faculty of Art and Design, F. of Arts, F. of Environment, F. of Health Studies, F. of Mechanical Engineering) are participating in the Smart City – Smart Region – Smart Community project. The reason is that the project content relates to the learning content they provide; two faculties out of eight (FE, NS) participated in this survey.
3. The total amount of NS respondents was much lower compared to FE because there is a lack of NS applicants and the general interest in studying natural sciences is generally low in the whole Czech Republic.
4. The total amount of FE female respondents was much higher compared to male ones; this fact follows the state in the Czech teaching staff where amounts of women teachers highly outnumber the men teachers [18].

Reflecting the fact that preservice teachers were included in the research sample, we appreciate that when considering negatives of smart attributes, they mentioned

some psychological aspects of the problem (isolation – both from other people and real life, danger of addiction to work with smart devices and technologies, cyberbullying, and the need of cyber safety).

From the view of other works relating to the objective of our survey, only a few researchers focused on the definition of the word *smart* in relation to the feature of smartness and the comprehension of the word content, e.g., Uskov et al. [19]. Others paid more attention to the process of teaching and learning supported by smart and mobile tools like what the Smart City – Smart Region – Smart Community project is doing, particularly the efficiency [20] or designing smart education [21, 22].

In relevance to our findings, privacy was investigated by Chen and Wen [23] who discovered students' positive attitudes toward online targeting ads without any evidence of protective behavior. So that to increase learners' activity in the process of teaching/learning, the constructivist approach in smart classrooms is recommended by Li, Yang, and MacLeod [24] in case the respondents' (i.e., preservice teachers') connectedness is high.

To sum up, not only results of our survey but also the lack of works and findings devoted to investigations on understanding the term *smart* in relation to *mobile* leads us to the simple recommendation to increase efforts in the field. As smart devices, technologies, services, etc. are widely spread and exploited on an everyday basis, it should not be automatically expected that respondents, either student or any other groups, deeply understand the word meaning. This survey, even though not large, showed the expectations were not met, and further attention should be paid to the problem.

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# Chapter 36
# Two-Factor Human Authentication for Mobile Applications


**Vasaki Ponnusamy, Khalid Rafique, Liang Xian Liang, Aun Yichiet, and Gan Ming Lee**

## 36.1 Introduction

An information asset is a piece of information owned by an individual or an organization that has a monetary value [1]. Authentication, authorization, and accounting known as "AAA" is an architecture that has been in use for asset protection since before the days of the internet [2]. These three processes combined can provide effective information assets management and security. In this research, we are focusing on authentication. Authentication is the process of identifying an individual to ensure that the individual is who he claimed to be. To ascertain that users are who they say they are, the operating system or the application requiring authentication requires users to provide evidence to prove themselves which is known as user credentials [1]. Authentication credentials can be "Something you know" like a password, "Something you have" like an identity card, or "Something you are" like a fingerprint. Today, information assets are stored all over the Internet and, hence, Information Technology security plays a major role to protect the confidentiality, integrity, and availability of these assets. Many network authentication protocols have been introduced to meet different requirements by the industry such as AAA architecture protocols, Challenge-Handshake Authentication Protocol (CHAP), Extensible Authentication Protocol (EAP), and Kerberos. Kerberos is a computer network authentication protocol designed to provide strong authentication for client/server applications by using secret-key cryptography [3]. In this protocol,

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authentication is granted through tickets generated. The client is required to get a ticket from the key distribution center (KDC) through the authentication server and stores it locally so that they can present it to a file server to access data from the application server.

Nowadays, a single-step authentication can be easily compromised, therefore a two-step verification scheme comes in. Two-step verification requires two credentials from the same category "Something you know," "Something you have," or "Something you are." Google, Sony PlayStation, and Apple are implementing two-step verification (2SV) to add extra security for their users. For example, Gmail requires its user to provide a one-time password (OTP) sent to the phone after providing the user account password. OTP sent to the phone may appear to be "Something you have," but from a security perspective it is considered as "something you know" because the key to the authentication is not the device itself, but it is the information stored on the device [4].

## 36.2 Background

### *36.2.1 Problem Statement*

Authentication using only "Something you know" is very vulnerable to social engineering. Social engineering in the context of information security is a technique that cybercriminals use to trick victims to divulge their confidential information. For example, shoulder surfing is a type of social engineering that does not require technical skills, it is performable by anyone. Phishing is another type of social engineering technique, which tricks users usually through phishing emails or chats. It is hard to notice a phishing site once you get in there, as it is almost identical to a legitimate one. Basic authentication protocols using only passwords are also vulnerable to many other threats such as eavesdropping, keylogging, man-in-the-middle attacks, replay attack, and dictionary attacks.

In multistep authentication, more steps mean more security but it could also mean poor user experience. It could be monotonous and annoying to the users, as they need to go through extra steps and effort in order to log in. Let us take two-step verification as an example. In the first step, the user is required to enter his password, and then in the second step, the user is required to enter the one-time password (OTP). Although it is for security purpose, sometimes users might find it annoying especially when they are performing time-critical transactions.

### *36.2.2 Related Works*

Two-factor authentication, also known as 2FA is a method of authentication using two credentials from at least two of the following categories:

- Knowledge factors ("Something you know") such as a password
- Possession factors ("Something you have") such as a device
- Inherence factors ("Something you are") such as a fingerprint

A typical 2FA uses the combination of "Something you know" and "Something you have" or "Something you know" and "Something you are." Two-factor authentication is widely implemented in current practice to resolve the problems of traditional single-factor authentication and two-step authentication. This is because two-factor authentication requires two different factors of credentials and therefore, it can protect an account even when the password is compromised as a physical or biometric component is required along with the password in order to log in successfully.

There are limitations in two-factor authentication. One of the most common limitations is the factors can get lost. Here are some examples:

- You can forget your password.
- Your 2FA-registered device can be stolen.
- A second-degree burn can deform the pattern of your fingerprint

This research, reviewed the four examples of the existing authentication system and Kaspersky Lab results to test the reliability of the passwords. Steam Mobile App developed by Valve Corporation has a feature called Steam Guard Mobile Authentication. Steam Guard Mobile Authentication implements two-factor authentication with a combination of "Something you know" and "Something you have." Only one authenticator can be activated on one account at a time [5]. When a steam user has this feature enabled on their phone, this user is required to enter the generated code after he has entered his username and password. Hence, the first factor of authentication will be "Something you know" which is the password, while the second factor will be "Something you have" which is the phone, which generates the Steam Guard code. The authenticator generates a unique code, which expires in 30 s. A new code will be generated after the old one expires and a code can be used only once ("Steam Guard Mobile Authenticator," Valve Corporation) [5]. The screen captured is shown in Fig. 36.1.

Before Steam introduced the Steam Guard Mobile authenticator, the Steam Guard email is used to authenticated unrecognized device by providing special access code sent to the registered email in order to verify its owner. This approach is still being used as an alternative to Steam Guard Mobile Authenticator. This code will be sent to the registered email of the user account and the user are required to retrieve this code from his mail box and provide this code as 2FA as shown in Fig. 36.2.

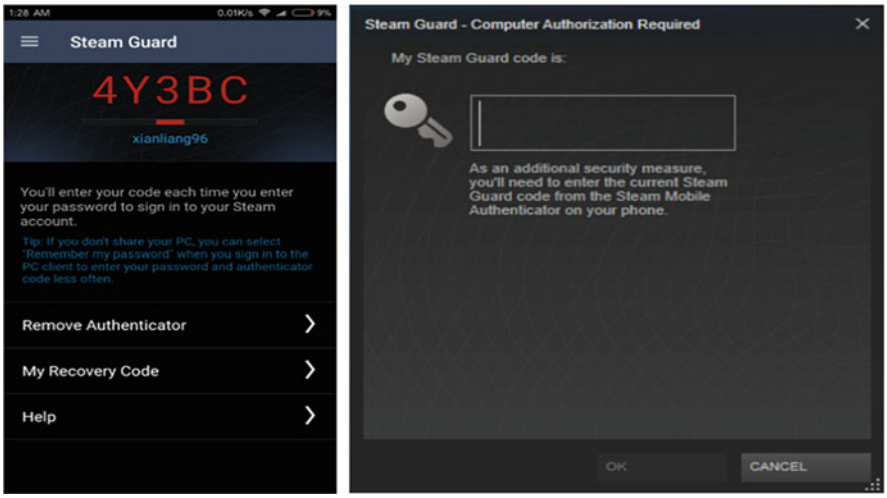


**Fig. 36.1** (Left) Screen capture of Steam Guard Mobile Authenticator generates a code. (Right) Screen capture of computer authorization request for Steam Guard code [5]

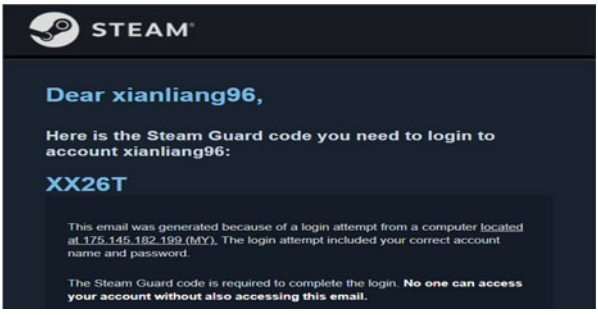


**Fig. 36.2** Screen capture of Steam Guard email code [5]

Public Bank e-commerce Purchase One-Time Password (OTP) allows users to perform secure payments to online merchants through Public Bank e-commerce, upon making an online purchase through PB credit/debit card, the user will receive a verification SMS to his registered phone number containing the OTP [6, 7]. The user then is required to provide this code in order to complete the online payment he made as shown in Fig. 36.3.

HSBC implements two-factor authentication by adding Digital Secure Key into their HSBCnet Mobile app and HSBC Mobile Banking application. This app implements Touch ID supports users with Apple iPhone 5 s or above to authenticate themselves with their Touch ID stored in their phone settings (HSBC, 2018). If the Touch ID authenticated, a 6 digits long numerical security code will be generated to the user used for 2FA verification as shown in Fig. 36.4.

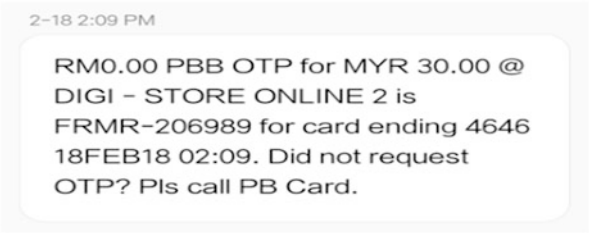


**Fig. 36.3** Screen capture of Public Bank e-commerce Purchase One-Time Password [6, 7]

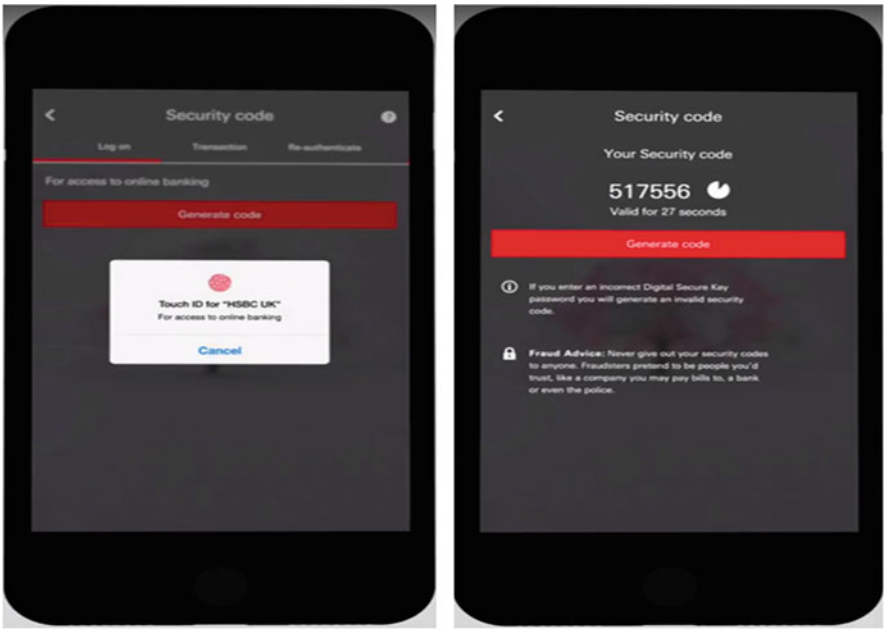


**Fig. 36.4** HSBC UK mobile banking security code [8]

The authors presented in [9] password strength calculations using Kaspersky Lab length calculator for various lengths of passwords including eight, ten and sixteen as shown in Figs. 36.5, 36.6, and 36.7, respectively. The Kaspersky Lab elaborates on the strength of passwords based on its complexity and length. As the figures present, the time it takes for a below-average computer to crack them increases steadily. The Kaspersky Lab test results show that the complexity and the length have a very strong relation with password reliability. However, it is hard to remember a lengthier password of length 16 characters with a different combination. Please take into account that these Kaspersky results are for the guidelines not the accurate expected results, but only the guidelines.

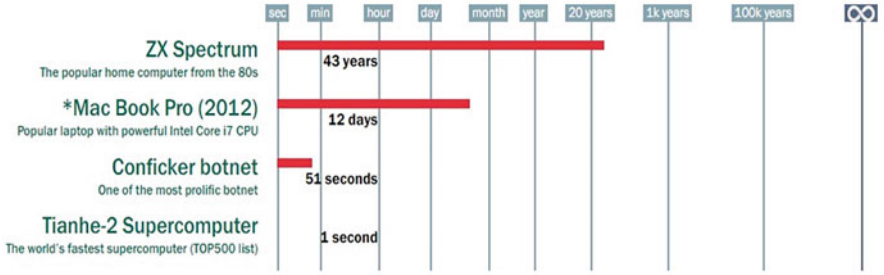


**Fig. 36.5** Password strength: Vq3216*9 – length of eight [9]

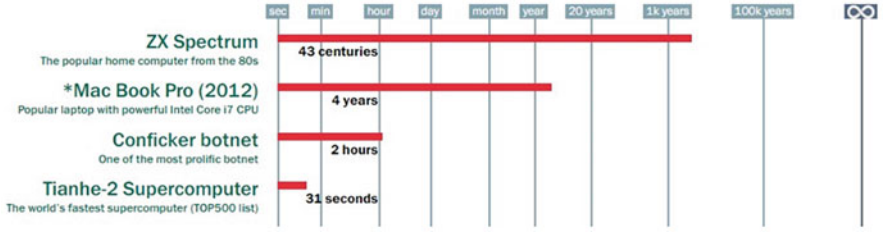


**Fig. 36.6** Password strength: p8340CA2!r – length of ten [9]

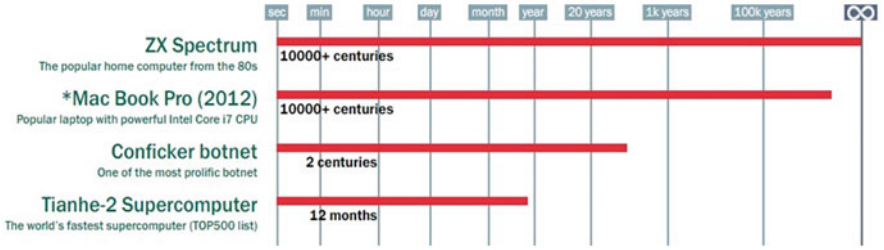


**Fig. 36.7** Password strength: 74365@l0$fiARXPb – length of sixteen [9]

Figure 36.6 shows the Kaspersky Lab tests for password reliability and the theoretical duration require to break the password with the password length of eight with the different combinations for different machine combinations.

Figure 36.7 depicts the results for the same machines as of the previous experiment. However, the complexity and length of the password are different from the previous case, here the length of the password is ten. The length difference of 2 days brings a great difference such as for Mac Book Pro it goes to 4 years from 12 days.

Figure 36.8 depicts results again for the same machines as of earlier experimental devices. However, the complexity and length of the password are different from the previous case, here the length of the password is sixteen. The length difference brings a great difference in results such as, for Mac Book Pro now it reaches to

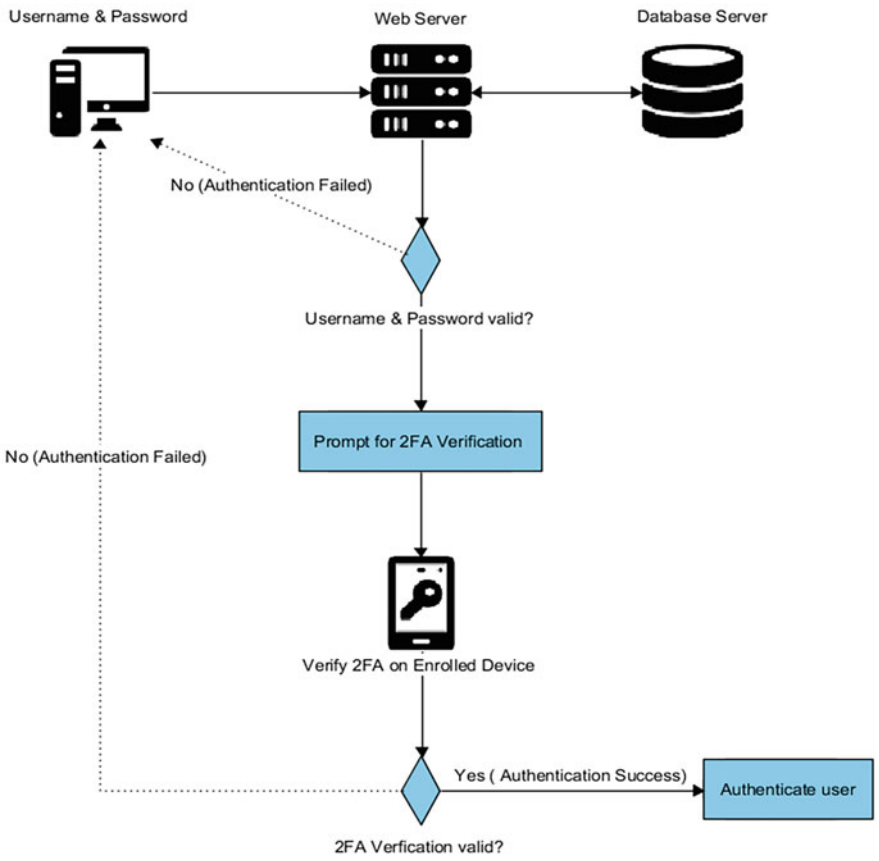


**Fig. 36.8** System flow diagram

10,000+ century's in years. It shows how password length directly links with the reliability of the passwords.

## 36.3 Two-Factor Authentication

This research focused on an improved version of two-factor authentication system, which can be grouped into three main parts:

- A mobile application
- A webserver
- A simple website

Android is selected as the development platform for the mobile application because of its low barrier of entry, which meets the budget of this research and which is most popular and common in use. This research targets Android 6.0 Marshmallow (API level 23) [10, 11] to implement fingerprint authentication, which is provided in the new APIs release. This research is developed with Android Studio, the official IDE for Google's Android operating system. During the development phase, the app is tested on Samsung Galaxy S6 SM-G920F via Android Debug Bridge (ADB). At the end of this project, generate a self-signed apk of this project for distribution and installation to other supported phones. Apache TomEE web server chosen as the back-end of this project. Apache TomEE supports many Java Enterprise Edition (Java EE) technologies, which are extremely useful for this project. The Java EE technologies that were applied are Java Servlets, Java server pages (JSP), Java Persistence API (JPA), Java Contexts, and Dependency Injection (CDI), and Enterprise JavaBeans. On the other hand, this research used MySQL as its database. A simple website is created for demonstration purposes. This website used to perform some user actions, which will trigger a 2FA request to the registered mobile device. The website created using HTML, CSS, JavaScript, jQuery, and Ajax. An overview of the system design described in Fig. 36.8.

The main challenge in this research is the 2FA algorithm to generate a unique passcode that expires every 30 s. Assume that if every passcode generation happens on 0 to 29 s and 30 to 59 s of every minute, if the passcode on the client-side is at the 29th seconds, due to some latency, by the time the passcode reaches the server, it is already at the 30th seconds. In this case, the server will reject the authentication. In order to address this issue, some methods were taken into consideration, such as making a timeout at the 29th and 59th seconds.

The proposed system works in the following fashion; the user sends his username and password as parameters to the web server in an HTTP POST request. The web server validates the request by comparing the parameters with the database server. The web server logs this record into the database. Web server prompts the user for 2FA in his web browser. The user registered dynamic mobile app retrieves the 2FA request together with the action description. A user places his fingerprint on the fingerprint scanner of his mobile device. The app generates a String token using a private key assigned only to the user, mac address of the mobile device, and time and date from the server. The app sends this token to the webserver. The web server receives and validates this token by comparing it with a server-generated String using the same algorithm and same parameters. The web server verifies the user and sends the user a JWT to his browser's local storage. Alternatives: (a) Validation fails. The server rejects the login request. (b) Fingerprint authentication fails. The app prompts for user's fingerprint again. (c) Validation fails. The server rejects the login request, disable the account, and notify the user that his username and password have been compromised.

This research has a system as an outcome that provides a better, easy and extra layer of security to online banking users by involving an authenticating through a private key assigned to user mobile phone prior to his use of fingerprint authentication step. This system authenticates you by using your password (Something

you know), a private key assigned to your mobile app (Something you have), and your fingerprint (Something you are). These credentials are from three different categories but it only takes you two steps to authenticate yourself. This can increase online banking users' experience, save time, and provide them an extra layer of security. A variant of authentication systems can be found in [12–14].

## 36.4 Conclusion

Using only something you know like a password is very vulnerable to basic hacking skills especially social engineering. However, multifactor authentication processes are often monotonous. This two-factor authentication system is a user-friendly authentication system, which can be an alternative for the online banking authentication system. This system authenticates you by using your password (Something you know), a private key assigned to your mobile app (Something you have), and your fingerprint (Something you are). These credentials are from three different categories but it only takes you two steps to authenticate yourself. This can increase online banking users' experience, save time, and also provide them an extra layer of security. This extra layer of security provides more reliability to the user for password protection compared to the existing systems such as Steam Guard Mobile Authenticator, Steam Guard email coder, Public Bank e-commerce Purchase One-Time Password (OTP), and HSBC Digital Secure Key.

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# Chapter 37
# Microcontroller-Based Semiautomated Pineapple Harvesting System


**Krishnamurthy Bhat and C. L. Chayalakshmi**

## 37.1 Introduction

Agriculture is the backbone of India. It is the cultivation of land for producing food. It is also related to the breeding of animals and plants to provide food, fiber, medicinal plants, and other products to sustain and enhance life. Agriculture provides a basic necessity of life. Technology has improved the method of conventional farming so as to enhance profits without disturbing nature [1].

Vegetables and fruits provide vital ingredients to the human body. Vegetables and fruits contain important vitamins, minerals, and plant chemicals. They also contain fiber. The nutrients present in fruit are essential for human health and preserving our bodies. The development of kidney stones is a common problem in developing countries. The possibility of the development of kidney stones can be minimized due to the presence of potassium in fruit. Potassium also reduces bone loss. Folate (folic acid) is a vital component that assists the human body to produce red blood cells [2].

The pineapple (*Ananas comosus*) is a plant which can be produced in tropical areas. It consists of coalesced berries and the most reasonably important plant in the Bromeliaceae family. It is a marvelous, seedless fruit called a syncarp. This fundamentally means that the fruit is produced from the combination of several flowers into one large fruit. Pineapples can be easily cultivated in sandy loam soil. But pineapple can be grown in any type of soil which is well-drained. Clay soil is also suitable for pineapple cultivation as clay soil has good drainage capacity. Soils that store water are not preferable for pineapple cultivation. These herbaceous perennials are simple to produce, and the height of a plant is between 2(1/2) and 5 ft.

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https://doi.org/10.1007/978-3-030-49795-8_37

Due to its popularity in the world, it is widely cultivated. They may be cultivated from the offset produced at the top of the fruit, possibly flowering in 5 to 10 months and fruiting in the following 6 months. In India, these plants are grown in Maharashtra, Kerala, Tamilnadu, Goa, Karnataka, Assam, Rajasthan, Nagaland, West Bengal, Orissa, Tripura, Himachal Pradesh, Manipur, Telangana, Gujarat, Mizoram, and Chhattisgarh [3].

The pineapple helps:

- In boosting the immune system, respiratory health, and strengthening bones
- To improve blood circulation
- To improve vision capacity of eyes
- To prevent cancer and heart diseases

Pineapple fruit has many applications. Pineapple is used to make varieties of delicious foods. It can be used to make juice and slices. They are added to make cookies, chocolates, cakes, sauce, fruit cheese, beverages, and pepper jelly. It can be used in making pharmaceutical products to control diarrhea, skin debridement. Its waste product bromelain is used as meat tenderizer and dietary supplement in the food industry. The leftover of pineapple after extraction is used to feed livestock [4].

### *37.1.1 Problems in Plucking Pineapple*

With the development of technology nowadays, almost all the fruits are harvested using either semiautomated or fully automated harvesters. But pineapple fruit is the one which is not yet harvested through semi- or fully automated harvesters. It is done manually with the help of laborers. Plucking pineapple manually may cause injuries to the human hand and leg due to the presence of sharp thorns on the leaves. Getting labors for fruit harvesting is becoming difficult day by day.

To overcome such problems, the paper aims at the design and implementation of the semiautomatic robotic arm for pineapple plucking.

## 37.2 Literature Survey

Till today the automation of pineapple harvesting is in the infant stage. Nowadays, researchers are using robots to pick the fruit in many countries. These picking robots basically contain systems such as manipulators, end effects, visual recognition system and movement of devices. These robots can be used for harvesting pineapple in ideal conditions where the size of the fruit is assumed as same. But these cannot be used effectively for various sizes and shapes of pineapple fruit.

A shutter mechanism for pineapple harvesting is designed to pick the pineapple of different sizes and shapes. The designed system consists of opening and closing of shutters, holding mechanism to hold the pineapple and picking mechanism to

separate the pineapple fruit from the plant. This system of shutter mechanism provides a train of thought for plucking other fruits also. It also offers a reference for the design and development of automation in the pineapple picking system. The shutter mechanism is almost similar to the robotic mechanism that the paper deals with.

Pineapple harvesting is an attractive and intense occupation. There is an immense requirement to mechanize the harvesting procedure. The paper explained a type of manipulator designed for pineapple harvest. Tests were conducted to authenticate their viability. Growth features of the fruit are studied, and based on this, two steps were finalized for fruit harvesting. They are catching of the fruit and gripping it gradually in a horizontal direction, and then collecting it by rotating in a vertical direction. Pro/E, which provides professional design for mechanical engineering, was used to design a manipulator for the system.

This system contains three major mechanisms: holding, hand driving, and rotating.

A system for controlling the stepping action of motors was designed with AT89C51 microcontroller. These motors take care of the complete process of fruit harvesting. The results obtained from experiments showed that the manipulator designed for this system is in accordance with the requirements. The motor was rotated for an angle of 180°, and the time taken for harvesting is about 21 to 24 s [5].

One more effort was made by the researchers to design a movable strawberry harvesting robot. This system was an improved version of the previous design. It was designed to reduce production costs. The robot was molded on the movable platform. It was developed and operated for harvesting fruits in the greenhouse. There were basically two major parts of this system: movable platform and the robot. These parts can be separately taken away for improvement. Hence, the design was considered as modular but was effective only for greenhouse [6].

The gear box of the shaft present in DC motor is driven by the Johnson motor. It is a simple motor, which is mechanically commutated electric motor. It works with DC power supply. These motors are compact in size, high torque, and speed. The input voltage range is 6 to 18 V DC with 600 RPM at 12 V supply. It can produce a torque of 1.2 kg-cm at its maximum speed. Since these motors are reliable, they are best suited for electromechanical systems [7]. A novel and effective method of pineapple harvesting are discussed in this paper.

## 37.3 Robotic Gripper

In order to hold any object in an automation process, a gripper is essential. It is a device that helps to hold an object of our interest. It works similar to a human hand. It performs the operations which can be performed by a human hand such as holding on an object, tightening, and releasing an object.

Usually, a gripper is attached to a robot or robotic arm for pick and place purpose in many automation industries. The design and selection of gripper for a robot depend upon the application. The following aspects need to be considered while a selection of a type of gripper for the purpose in the application:

- The gripper should reach the surface area/part of the object which it has to grip.
- The size of gripper should be selected in such a way that even when the object size varies, it has to grip an object.
- It is usually assumed that the type of gripper selected holds the area of an object in such a way that it ensures more stability and control in gripping.
- The shape of the gripper should be selected in accordance with the shape of an object. For example, if the object is round in nature then the concave gripper can be used so as to ensure an efficient grip. If the surface of an object is square then a plain gripping surface provides more efficiency.
- While selecting the type of gripper, the weight of the gripper and the object to be gripped comes into picture. Sometimes the robot may take more time in gripping action because of an increase in weight above the maximum limit.
- While deciding the type of gripper, the distance between the robot flange and center of mass may be important and need to be maintained as less as possible.
- Robots that are used for automation of any process in an industry may work in a harsh environment also. In such cases, the gripper should withstand the high temperatures, dusty environment. In some cases, the presence of chemicals in an industry may require special gripper materials or special designs as well.
- In some cases, feedback for providing corrections to the measurements is essential. In such cases, the gripper needs to be inserted with a proximity sensor or such things between the jaws of the gripper.
- Friction is the main force acting on the body lifted by the robotic arm even though there are many forces acting on it. Hence, the surface of the gripper can be made with a soft material and high friction coefficient to ensure that the surface of the object will not be damaged.

The arm of the robot must withstand the weight of an object along with the acceleration/motion because of the object movement. Equation 37.1 provides the formula of the force necessary to grip the object.

$$F = \frac{ma}{\mu n} \tag{37.1}$$

Where:

"F" is the force required to grip the object
"m" is the mass of the object
"a" is the acceleration of the object
"μ" is the coefficient of friction
"n" is the number of fingers of the gripper

Equation 37.1 is not complete. The direction of lift/movement is also important while gripping the object. For example, the force required to grip the object is more if the robotic arm needs to lift the object upward against gravity, and it is less if it is toward gravity. One more term comes into picture in the equation and it becomes:

$$F = \frac{m\,(a+g)}{\mu n} \tag{37.2}$$

"g" is the acceleration due to gravity, and "a" is acceleration because of movement.

Traditional grippers have the following features:

### *37.3.1 Gripper Motion*

The motion of the gripper can be angular or parallel.

***Angular:*** The fingers of a gripper close toward one another by rotating around an axis.

***Parallel:*** In this type of gripper, the fingers will move toward each other in parallel. The range of jaw displacement is around 0.25 inches in small parallel jaw gripper, and the displacement is 8 inches in larger grippers.

### *37.3.2 Gripper Action*

There are basically two types of gripping action: single and double. The single-acting gripper contains drive in only one direction, whereas double-acting gripper has driven in two directions. A spring is used in a single-acting gripper to bring it back to an unpowered position. In double-action gripper, there are two varieties based on whether the spring opposes the drive or assists the drive: open or close. In double-acting gripper, the drives can be actuated in two directions. In the case of double-acting spring assist gripper, the spring assists in the open direction and opposes close direction. Whereas in double-acting spring close gripper, the spring assists close direction and opposes open direction.

### *37.3.3 The Number of Fingers*

The grippers may be two-fingered or three-fingered depending upon the application. Fingers either two or three are configured to securely grip the fruit, and these fingers may be articulated or concentric.

### 37.3.4 Actuation

The gripper can be electrically actuated, pneumatically actuated, or hydraulically actuated based on the requirements of applications.

### 37.3.5 Gripper Mechanism

One of the types of classification of grippers is based on the actuating mechanism. Fingers of the gripper can be actuated by pivoting or linear/translational movement to open or close for holding and gripping the object.

### 37.3.6 Cam Actuation

There is a wide range of designs for opening and closing action of the gripper fingers using cam actuation. A gripper with a cam actuation mechanism with spring-loaded follower is used to provide open and close actions. The spring forces the gripper to close if the cam is moved in one direction, while the moving cam on the other direction causes the gripper to open as shown in Fig. 37.1.

This type can be useful for holding various sizes of work parts. Figure 37.2 shows the actual cam designed for gripping and plucking of pineapple fruit. Cutter for cutting pine apple is as shown in Fig. 37.3.

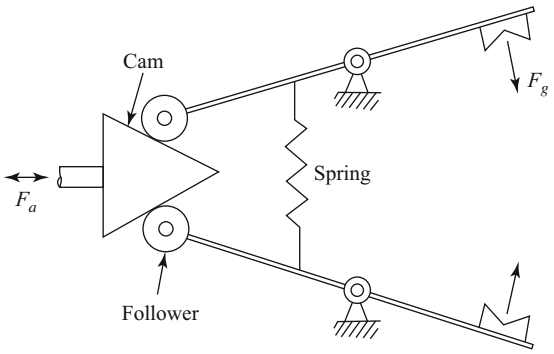


**Fig. 37.1** Cam actuation


**Fig. 37.2** Cam design for pineapple gripping

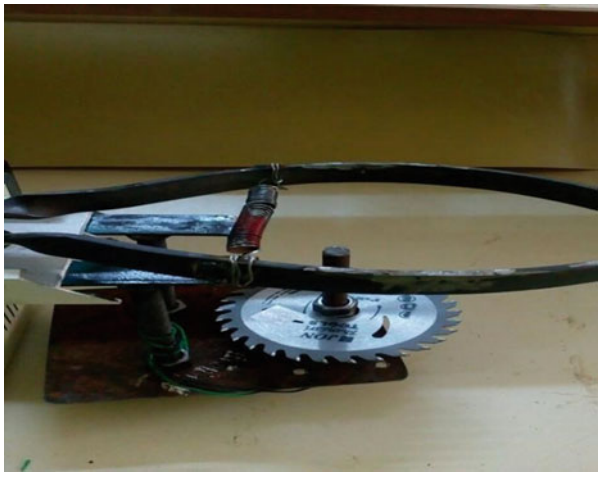

**Fig. 37.3** Cutter design for a pineapple cutting

## 37.4 Block Diagram Description

The block diagram for the system is shown in Fig. 37.4. It consists of two switches S1 and S2 that are inputted to the microcontroller. Switch S1 is used to start the action of gripping, and S2 is to start the action of cutting. Initially, the two inputs are low, the gripper is in open position, and there is no action. When the S1 switch becomes high, the gripper motor will be turned on, and it starts closing to grip the fruit.

It takes 14 s. After gripping, the gripper motor will automatically stop and cutter motor starts. The cutter motor runs continuously until the command given to it. After

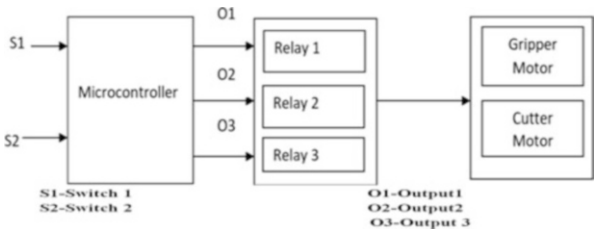


**Fig. 37.4** Block diagram of the system


**Fig. 37.5** Photograph of the developed system

cutting, the S2 switch is made high, so that the gripper motor again restart in reverse direction, in order to place the fruit in the basket.

- The implemented system is safe for the workers and also to the fruit
- This system replaces the workers
- It creates employment for skilled workers

Figure 37.5 shows a photograph of the developed system. Figure 37.6 shows the circuit diagram of this system. Electromechanical relays are used for turning on-off of the motors.

## 37.5 Flow Chart

The software developed is depicted as a flow chart in Fig. 37.7. When the system is powered up, first it checks the status of switch S1. If S1 is not pressed, again and again, the software checks the status of S1, until it is pressed. When S1 is pressed, the microcontroller provides the actuation signal for gripper motor, so that the action of gripping starts. This action is continued for 14 s, which is sufficient to grip the

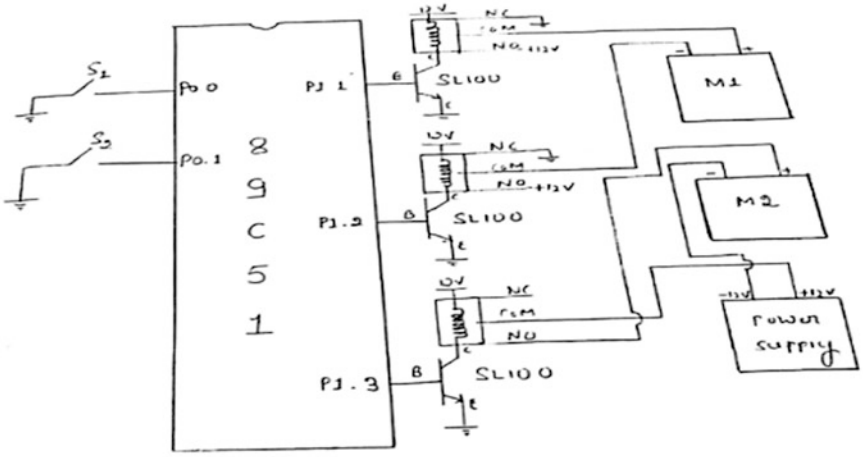


**Fig. 37.6** Circuit diagram

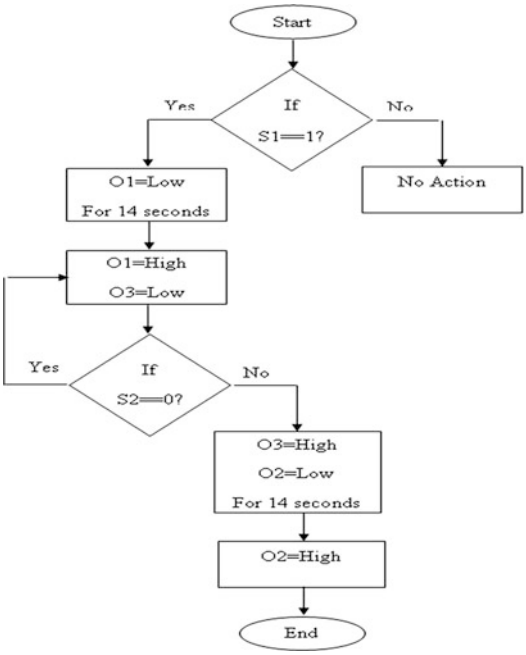


**Fig. 37.7** Flow chart of the system

fruit. After 14 s, the gripper motor stops. After 2 s, the microcontroller provides information to cutter motor and the cutter starts cutting the fruit at the bottom. The cutter motor is turned on for 14 s. Then the cutter motor stops. Now, the software waits until the operator presses the switch S2. Whenever the switch S2 is pressed,

the gripper motor starts to rotate in opposite direction, and the gripper unfolds so that the fruit is collected in the basket (Fig. 37.7).

## 37.6 Conclusion

In the early days, fruit harvesting was done manually with the help of labors. Plucking pineapple manually may cause injuries to the human being (hand and leg) due to the presence of sharp thorns on the leaves. So the system is developed to grip and cut the pineapple fruit from the plant semiautomatically. This system is developed on an 8051 microcontroller. It provides safety for workers and fruit.

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# Chapter 38
# Microcontroller Based System for Preserving Vegetables


**C. L. Chayalakshmi and Krishnamurthy Bhat**

## 38.1 Introduction

Plant-derived products such as vegetables and fruits can be consumed in raw form without processing or cooking. Fresh-cut vegetables and fruits are usually cleaned, peeled, sliced, cubed, or cooked for convenience. The word vegetable was first recorded in English in the early fifteenth century. It derives from Medieval Latin vegetabilis "growing," "flourishing," a semantic change from a Late Latin, meaning "to be enlivening quickening". Vegetables are certain part of the plant that are consumed by human as food as part of spicy meal. Some commonly used vegetables are cabbage, turnip, radish, carrot, parsnip, beetroot, lettuce, beans, peas, potato, tomato, cucumber, pumpkin, onion, garlic, and many more.

### *38.1.1 Nutritional Importance of Vegetables*

Vegetables play an important role in human nutrition. Hence, these must be compulsorily included in the daily diet. Most are low in fat and calories. They supply dietary fiber and are important sources of vitamins and minerals. Particularly important are the antioxidants, folic acid, and vitamins A, C, and E. The United States Department of Agriculture suggests and encourages human beings to have a half plate of vegetables and fruits. Chances of chronic diseases such as cancer, cardiovascular disease, stroke, and other chronic ailments can be reduced. Consum-

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ing vegetables and fruits in the daily diet increases the body's resistance against diseases. Potassium helps to maintain blood pressure. The dietary fiber present in vegetables helps in reducing blood cholesterol levels and also reduces the risk of heart attacks. Folate (folic acid) helps to form healthy red blood cells in the body. Folic acid is essential at the time of pregnancy in the first trimester, which reduces the risk of neural tube defects and spina bifida during the development of fetal inside mother's womb [1]. The study recommends that the 30% of our food should be vegetables and fruits. Research reveals that the risk of developing coronary heart disease is lowered by 20% in those people who eat more than 5 servings of fruits and vegetables compared with those who eat 3 servings of fruits and vegetables.

## 38.2 Literature Survey

In recent decades, ready to use fresh vegetables has to gain popularity as a result of a busy schedule of working people. One of the methods is to sanitize fresh and cut fruit and vegetables with chlorine solutions. However, the use of chlorine forms the carcinogenic chlorinated compounds in water which may lead to serious problems [2]. It is also possible to maintain the freshness of vegetables and fruits by modification of the sensorial properties. Wounding of tissues includes a number of physiological disorders that need to be taken care of [3]. Another usual method is to refrigerate the cut vegetables and fruits. But the quality, texture, and taste will reduce if they are refrigerated. However, none have yet gained widespread acceptance. The following are some of the methods used for preserving fresh-cut vegetables and fruits.

### *38.2.1 Canning*

In this method, fruits and vegetables are placed in an airtight container so that it is prevented from bacteria. The food with the canning process can be preserved for years, if necessary. One method of canning requires a specialist machine and hence it is not practical and is of high cost, not affordable by common people. Another is the pressure canning method, in which the temperature of food is maintained above the boiling point of that food and low acidity so as to neutralize the bacteria. This method is popular and requires a pressure canning machine. The jars in which the vegetables and fruits are placed need to be sterilized.

### *38.2.2 Salting*

This is one of the oldest methods of preserving food. This technique can be used for non-vegetables also such as meat and fish. There are two methods in salting. In one method, a low salt to vegetable ratio is maintained between two and five percent salt for every weight of vegetables. This ratio of salt enhances the growth of lactic acid bacteria which controls the growth of other bacteria that spoils the food. In another method, a higher percentage of salt is used between 20–25%. If the second method is adopted, even when vegetables are water washed, the salty flavor still remains. In both methods, after salting the food need to be stored in refrigeration.

### *38.2.3 Drying*

This method involves removing all water content from vegetables and fruits along with bacteria, yeast, and mold which live in the moisture environment. The texture is altered; the taste is modified. Dried food is easy and safe to store. Drying of vegetables and fruits can be carried out in two ways either in sunshine or oven. Dried vegetables and fruits are safe to store, and refrigeration is not necessary. Drying in the sunshine is an essential part of life in some countries. If an area receives a constant level of solar energy, then the drying of fruits and vegetables can be carried out under sunshine. The oven can also be used for drying in the other areas. This technique involves low temperature and good air circulation.

### *38.2.4 Freezing*

This method preserves the flavor and freshness of fruits and vegetables. The method of freezing and melting a vegetable or fruit provides an end product that almost similar to the flavor of fresh food. While freezing care must be taken to avoid spoiled samples. Plastic jars, plastic boxes, or wax-coated cardboard with thick glass can be used for freezing. The fruits and vegetables have to be washed in hot water for a minute which restricts the enzyme activity, which may spoil the product if stored for a long time. For long-term storage, the temperature has to be maintained below freezing point. It is recommended to use the food once it reaches room temperature.

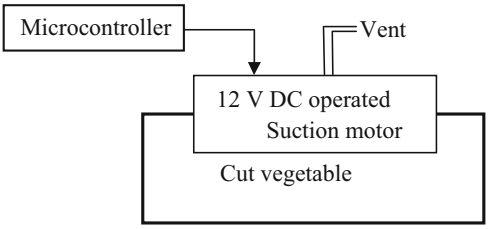


**Fig. 38.1** Block diagram of the system

For the said reasons, the development of an alternative is necessary. In this paper, an idea to maintain the freshness of cut vegetables and fruits by removing the excess air released by the cut vegetables and fruits is proposed. This method consists of container for storing the cut vegetables, and suction motor to pump-out the liberated gases. The suction motor ensures the regulation of gases inside the container (Fig. 38.1).

## 38.3 Block Diagram Description

The primary objective of design of this system is to preserve the cut vegetables for minimum of 2 days without compromising on the loss of freshness, minerals, and other qualities. The other objective is to implement it as a kitchenware at a very low and affordable cost so that the product finds mass customers in the market. Contamination and rotting of the cut vegetables are mainly due to interaction with the open air. The proposed unit consists of an airtight chamber made up of food-grade plastic or glass.

Plastic is preferred over the glass in view of durability and handling. A miniaturized suction pump operated by 12 V DC motor is used to deplete the gases liberated by the cut vegetables. The motor is controlled by a microcontroller, so that at a regular and predetermined time interval, the suction takes place [4]. The frequency of switching on the suction pump is determined by the amount of gas released and the type of vegetable. The overall consumption of electric energy is negligible because of the fact that the motor is intermittently switched on and miniaturized suction pump. The whole system can be operated by a 12 V battery/solar panel without depending on the electricity supply. Generally, switching on the motor for every 30 min for a time duration of 2 min is enough to preserve the freshness of vegetables in a chamber with a capacity of 2 kg.

The flow chart of the entire system is shown in Fig. 38.2. Initially, the microcontroller starts the suction motor for 2 min to deplete the gases liberated inside the chamber. If these gases are not taken out of the chamber, then the cut vegetables

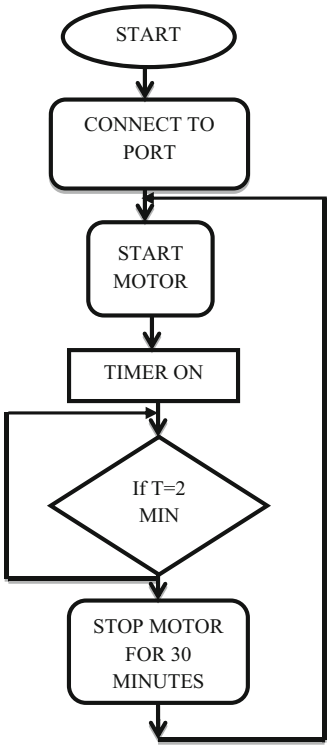


**Fig. 38.2** Flow chart

or fruits will rotten slowly. So for every half an hour, the microcontroller starts the suction motor for 2 min. The internal timer is used for the purpose of getting delays.

## 38.4 Experiments and Discussion

A glass chamber of dimensions 20 cm × 15 cm × 15 cm is used. A suction pump operated at 12 V DC is connected to the chamber. The operation of the suction pump is controlled by 8051microcontroller [4]. A small vent of size 2 cm radii is provided to deplete the gases liberated by the vegetables out of the chamber. The suction pump is turned on for every 30 min for a duration of 2 min. The cut vegetable kept inside the chamber remained fresh for a period of 3 days, while the vegetables kept outside the chamber were rotten.

Thus it is concluded that cut vegetables can be preserved for a minimum duration of 3 days through this system. The gases liberated by vegetables are ethylene gas, carbon dioxide gas, and chlorine compounds (Fig. 38.3).

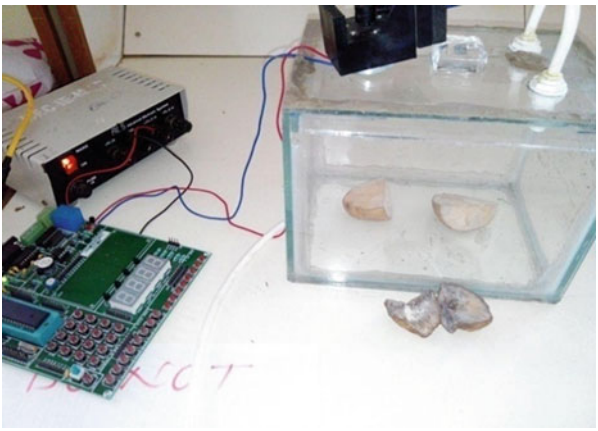

**Fig. 38.3** Snap Shot of Implemented System

## 38.5 Market Potentiality and Competitive Advantages

Though the hygiene and freshness of food and vegetable cannot be compared with the cost, the product is going to stand in the market due to the fact that this system has several advantages. Such products are not available in the market. Some airtight containers and preservation chambers are available, but they are not effective and hence a compromise has to be made on the freshness.

This system has a unique feature of automatically venting the chamber to deplete the gases, which overwise, will rot the cut vegetables. After thorough research, design, and first implementation, our aim is to send this product to the market at a quite affordable price, so that all the classes of society can purchase it. The product is targeted in the range of 5-8 USD for a medium size of 2 kg capacity with the food-grade plastic container.

## 38.6 Innovation and Usefulness

Presently the cut vegetable is either wasted or preserved in an orthodox way which is nonviable and unhygienic. The proposed product is targeted to be used by working class people due to its cost effectiveness and other obvious advantages. A portable and cost affordable preserving system is the need of hour and currently not available in the market. It is quite useful to every kitchen.

## 38.7 Conclusion

The technology has an important role in all walks of life. This is an effort to add a facility to the kitchen. The proposed fresh vegetable chamber is to be effective in its function, affordable in its cost, and hygienic. The product must find a general market and must be a useful unit to save precious time of the working class.

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# Chapter 39
# The Problem of Rank Reversal in Combination with AHP and TOPSIS Applied to Image Fusion


**M. Shanmuganathan and C. Nalini**

## 39.1 Introduction

Selecting a right method or solution from a set of methods or solutions is crucial. Moreover, selecting a method or a solution consists of a variety of conflicts. Criteria like the image, the sensors, and the resources are considered for selecting a method. Therefore, it is a MCDM issue which combines both quantitative and qualitative factors, with some of the factors conflicting with each other. If more number of criteria are considered, then the final outcome may be subjected to change. This manuscript illustrates relevant criteria which affect the process of algorithmic selection. Based on analytic hierarchy process (AHP), the weights are evaluated for each criterion and inserted to the TOPSIS method to categorize alternatives. The main benefits of using TOPSIS method are the following:

(a) It is easy to use.
(b) It takes into account all different types of yardsticks (subjective and objective).
(c) It is easy and explicit.
(d) The determination processes are straight forward.
(e) It minimizes a tremendous problem into more pragmatic approach.

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## 39.2 Concept of TOPSIS and AHP

### *39.2.1 Concept of AHP*

AHP is a MCDM approach, stabilized by Thomas L. Saaty in the year 1972. This is slightly an intuitive method trying to include science of reasoning, attitude of a person, and past incidents. It attempts to minimize an intricate problem into an organized one set out that is easier to perceive. It incorporates intention, criteria, and other substitutes. AHP comprises a set of principles which assists in defining matrices and allocates preference through pairwise comparisons to criteria (Table 39.1).

The steps for implementing the AHP process are illustrated as follows:

a. Define the target.
b. Identify the yardsticks.
c. Choose the substitutes.
d. Establish the hierarchy.
e. Develop two at a time comparison matrices using Saaty's 9-point scale
f. Calculate the priority using the power method:

Algorithm of power method [1]:

(i) Square the judgement matrix.
(ii) Normalize the sum of the rows, i.e. divide each row element for a particular column by the sum of the row element of the same column.
(iii) Repeat steps (i) and (ii) until you get the identical column for the judgement matrix.
(iv) Calculate the consistency index (CI) and consistency ratio (CR) using the formula

$$\text{Consistency index (CI)} = (\lambda_{\max} - n) / (n - 1)$$

$$\text{Consistency ratio (CR)} = \text{CI/RI}$$

RI (random index) can be fetched from Table 39.2.

**Table 39.1** Basic scale of Thomas L. Saaty

| Strength of Importance | Definition |
|---|---|
| 1 | Equal value |
| 3 | Slightly more value |
| 5 | Strong value |
| 7 | Very strong value |
| 9 | Extremely strong value |
| 2,4,6,8 | Intermediate values |

**Table 39.2** Random Index Values

| | |
|---|---|
| 01.00 | 00.00 |
| 02.00 | 00.00 |
| 03.00 | 00.58 |
| 04.00 | 00.90 |
| 05.00 | 01.12 |
| 06.00 | 01.24 |
| 07.00 | 01.32 |
| 08.00 | 01.41 |
| 09.00 | 01.45 |
| 10.00 | 01.49 |
| 11.00 | 01.51 |
| 12.00 | 01.53 |
| 13.00 | 01.56 |
| 14.00 | 01.57 |
| 15.00 | 01.59 |

### *39.2.2 Concept of TOPSIS*

TOPSIS is a comprehensible and a methodical MCDM expertise, established by Hwang and Yoon in the year 1981 [2–8]. This approach comprises a belief that the chosen substitute should have the closest distance from the effective optimum solution and the longest distance from the dismissive optimum solution. It is used in science, engineering, and other enterprise applications [9]. It denotes mxn matrix, m substitutes, and n yardsticks and allocates grade to substitutes. It is purely an objective-based approach for finding the substitute that is closest to the best solution. In this method, substitutes are graded based on the best solution. If a substitute is equivalent to the best solution, it has a higher grade [10]. The best solution is a solution that is perfect from any characteristic that doesn't exist pragmatically and tries to imprecise it.

## 39.3 Hybrid Method

This method which combines AHP and TOPSIS is made up of three steps. These are the following:

1. Determine the yardsticks.
2. Prioritize the criteria by using AHP through pairwise comparisons.
3. Assess the substitutes with TOPSIS and estimate the ultimate outcome.

In the first step, we try to recognize elements and fruitful criteria in image fusion, and the criteria which will be used in their evaluation are extracted. Thereafter, a list of practiced criteria is determined. In the second step, we allot weights to each criterion by using AHP. Finally, priorities are determined to utilize TOPSIS approach.

## 39.4 A Numerical Example

This manuscript demonstrates the image fusion refers to the process of combining more than one image into one composite image [11], and rapid increase in the demand for image fusion technology in various research and industrial areas has led to the development of various algorithms for implementing image fusion. Here, the researcher selects a suitable algorithm from image fusion such as discrete wavelet transform (DWT)-based image fusion, principal component analysis (PCA)-based image fusion, intensity hue saturation (IHS)-based image fusion, and Laplacian-based image fusion against criteria image, sensors, and resources. As stated by Saaty [12], the scale demonstrates a series, assumed from the researcher's point of view. It is crucial to emphasize that for Saaty impalpable factors like the resolution of an image or large scope of sensors are also eminently significant. An estimate of the similarities occurring in pairs is claimed to measure the intensity by which one algorithm is better than the other.

Consider Table 39.3.

The researcher differentiates the yardstick 'image' with another yardstick 'sensors', and she/he differentiates 'image' from 'resources'. The matrix specified in Table 39.3, for this particular researcher, is that the image yardstick 'is strongly important 'when differentiated from resources. The matrix given below is the yardstick image $= 5 \times$ (resources) and resources $= (1/5) \times$ image. The matrix specified in Table 39.3 is absolutely similar, if and only if the transitivity rule (1) and reciprocity rule (2) hold best for all the similarities of $a_{ij}$:

$$a_{ij} = a_{ik} * a_{kj} \tag{39.1}$$

$$a_{ij} = 1/a_{ji} \tag{39.2}$$

The judgement matrices with evaluated preferences with three substitutes in terms of a yardstick are given below.

**Table 39.3** Judgement matrix for criteria

| Criteria | Image | Sensors | Resources |
|---|---|---|---|
| Image | 1.000 | 9.000 | 5.000 |
| Sensors | 0.111 | 1.000 | 1.000 |
| Resources | 0.200 | 1.000 | 1.000 |

Algorithm for calculating priority for criteria using pairwise comparisons through AHP:

(1) Square the matrix.
(2) Regularize the sum of the rows.
(3) Repeat steps (1) and (2) until you get the identical column for the entire matrix.

Square the matrix given above.

| | | |
|---|---|---|
| 2.999 | 23.000 | 19.000 |
| 0.422 | 2.999 | 2.555 |
| 0.511 | 3.800 | 3.000 |

Square the matrix given above.

| | | |
|---|---|---|
| 28.409001 | 210.1540 | 172.74600 |
| 3.836761 | 28.4090 | 23.34544 |
| 4.669089 | 34.5492 | 28.41800 |

Squaring the matrix given above,

| | | |
|---|---|---|
| 2419.9485 | 17908.766 | 14722.775 |
| 326.9990 | 2419.948 | 1989.436 |
| 397.8873 | 2944.555 | 2420.715 |

Normalize the matrix given above.

| | | |
|---|---|---|
| 0.769 | 0.769 | 0.769 |
| 0.104 | 0.104 | 0.104 |
| 0.127 | 0.127 | 0.127 |

Calculate the sum of each row.

| | | | | |
|---|---|---|---|---|
| 0.769 | 0.769 | 0.769 | = | 2.307 |
| 0.104 | 0.104 | 0.104 | | 0.312 |
| 0.127 | 0.127 | 0.127 | | 0.381 |

Regularize the sum of the rows.

| Priority | = | Priority |
|---|---|---|
| 2.307/3 | | 0.769 |
| 0.312/3 | | 0.104 |
| 0.381/3 | | 0.127 |

The outcome is referred to as the preference matrix and is an estimation of eigenvalues of the matrix:

$$\text{CI (consistency index)} = (\lambda_{\max} - \text{n}) / (\text{n} - 1)$$

To determine $\lambda_{\max}$, multiply pairwise matrix comparison by the preference vector.

| 1 | 9 | 5 | x | 0.769 | = | 2.340 |
|---|---|---|---|---|---|---|
| 0.111 | 1 | 1 | | 0.104 | | 0.316 |
| 0.2 | 1 | 1 | | 0.127 | | 0.385 |

Then, divide the first element of the resulting vector by the first element in the priority vector, the second element of the resulting vector by the second element in the priority vector, and so on:

| 2.340/0.769 | = | 3.043 |
|---|---|---|
| 0.316/0.104 | | 3.038 |
| 0.385/0.127 | | 3.031 |

To calculate $\lambda_{\max}$, average over the elements in the resulting vector:

$$\lambda_{\max} = (3.043 + 3.038 + 3.031)/3 = 9.112/3 = 3.037$$

Now the consistency index (CI) can be calculated as

$$\text{C.I} = (\lambda_{\max} - \text{n}) / (\text{n} - 1) = (3.037 - 3) / (3 - 1) = 0.0185$$

$$\text{CR (consistency ratio)} = \text{C.I/R.I} = 0.0185/0.58 = 0.032.$$

In general, CR of 0.1 or less is considered acceptable. This indicates above outcome is less than the consummate.

## 39.5 Computation of TOPSIS

The steps are the following:

(1) From m × n matrix, m denotes the number of substitutes and n denotes the number of yardsticks. The matrix can be represented as

$$C_1\ C_2..C_n$$

$$Alt_1\ X_{11}\ X_{12}..X_{1n}$$

$$D = Alt_2\ X_{21}\ X_{22}..X_{2n}$$

$$Alt_m\ X_{m1}\ X_{m2}..X_{mn}$$

where $Alt_i$ indicates the feasible substitutes $i = 1 .. m$

$C_j$ indicates feasible yardsticks relating to substitute performance $j = 1..n$

$X_{ij}$ is a value indicating the rating of each alternative $Alt_i$ with respect to each yardstick $C_j$

(2) Find the regularized matrix mxn R(=rij). $r_{ij} = x_{ij}/\sqrt{(\Sigma {x_{ij}}^2)}$ for $i = 1 ..m, j = 1 .. n$.

(3) Find the weighted regularized matrix by multiplying the normalized decision matrix with its associated weights. $V_{ij} = W_j r_{ij}$, for $i = 1 ..m, j = 1 .. n$, where $W_j$ represents the weight.

(4) Determine the positive and negative means of solving a problem:

$$V^+ = \left\{{V_1}^+, \ldots, {V_n}^+\right\} = \left\{\left(\max\ V_{ij} | j \in J\right), \left(\min\ V_{ij} | j \in J^1\right)\right\}$$

$$V^- = \left\{{V_1}^-, \ldots., {V_n}^-\right\} = \left\{\left(\min\ V_{ij} |\ j \in J\right), \left(\max\ V_{ij} | j \in J^1\right)\right\}$$

(5) Calculate the measures of separation, ${D_i}^+ = \sqrt{(\Sigma(V_{ij} - {V_j}^+)^2}$, $i = 1..m, j = 1..n$.

Likewise, the negative ultimate solution $({D_i}^-)$ is ${D_i}^- = \sqrt{(\Sigma(V_{ij} - {V_j}^-)^2}$, $i = 1..m, j = 1..n$.

(6) Determine the relative closeness to the ultimate solution and grade the preferences:

$$C_i = {D_i}^- / \left({D_i}^+ + {D_i}^-\right), i = 1 \ldots .m$$

(7) Rank the preference order.

Begin a TOPSIS approach:

(1) Generate a matrix m x n, where m denotes the number of substitutes (DWT, PCA, IHS, Laplacian) and n denotes the number of yardsticks (image, sensors, cost). Step 1: the researchers use the linguistic weighting variables to assess the importance of the criteria. The verbal variables are converted into numbers as shown below.

| | | |
|---|---|---|
| VL | Very low | 00.00 |
| L | Low | 01.00 |
| ML | Medium low | 03.00 |
| M | Medium | 05.00 |
| MH | Medium high | 07.00 |
| H | High | 09.00 |
| VH | Very high | 10.00 |

The table below gives a series of substitutes and their respective yardsticks. Table 39.4 denotes various substitutes with their appropriate yardsticks.

The formation of the matrix denoted as

(2) Regularize the matrix mxn, R(rij). The rij is computed as

$r_{ij} = x_{ij} / \sqrt{(\Sigma x_{ij}^2)}$ for i = 1 ..m, j = 1 .. n. It is specified in Table 39.5

(3) Find the estimated regularized matrix. The estimates of the criteria are derived from pairwise comparison by using AHP approach. The priorities are 00.769, 00.104, and 00.127 for the image, the sensors, and the resources individually and in the order already mentioned (Tables 39.6 and 39.7).

($V_{ij}$ is computed as $V_{ij} = W_j r_{ij}$)

(4) Compute the positive and negative perfect answer to the problem, shown in Table 39.8

(5) Find the separation assessment, m – nearest distance (Table 39.9). The separation of each substitute from the feasible perfect answer to a problem ($D_i^+$) is specified in Table 39.10,

$$D_i^+ = \sqrt{\left(\Sigma \left(V_{ij} - V_j^+\right)^2, i = 1..m, j = 1..n\right.}$$

Likewise, the negative perfect answer to a problem ($D_i^-$) is specified in Table 39.11.

**Table 39.4** Matrix formation

| Substitutes | Image | Sensors | Resources |
|---|---|---|---|
| DWT | 7.0 | 9.0 | 8.0 |
| PCA | 8.0 | 7.0 | 8.0 |
| IHS | 9.0 | 6.0 | 8.0 |
| Laplacian | 6.0 | 7.0 | 6.0 |

**Table 39.5** Regularized matrix

| Substitutes | Image | Sensors | Resources |
|---|---|---|---|
| DWT | 0.462 | 0.614 | 0.530 |
| PCA | 0.527 | 0.477 | 0.530 |
| IHS | 0.593 | 0.409 | 0.530 |
| Laplacian | 0.396 | 0.477 | 0.397 |

**Table 39.6** Estimated regularized matrix

| Weight( Wj ) | 00.769 | 00.104 | 00.127 |
|---|---|---|---|
| Substitutes | Image | Sensors | Resources |
| DWT | 00.462 | 00.614 | 00.530 |
| PCA | 00.527 | 00.477 | 00.530 |
| IHS | 00.593 | 00.409 | 00.530 |
| Laplacian | 00.396 | 00.477 | 00.397 |

**Table 39.7** Computation matrix

| Substitutes | Image | Sensors | Resources |
|---|---|---|---|
| DWT | 00.355 | 00.064 | 00.067 |
| PCA | 00.405 | 00.050 | 00.067 |
| IHS | 00.456 | 00.043 | 00.067 |
| Laplacian | 00.305 | 00.050 | 00.050 |

**Table 39.8** Positive computation ($V^+ = \{00.456,00.064,00.050\}$)

| Substitutes | Image | Sensors | Resources |
|---|---|---|---|
| DWT | 00.355 | **00.064** | 00.067 |
| PCA | 00.405 | 00.050 | 00.067 |
| IHS | **00.456** | 00.043 | 00.067 |
| Laplacian | 00.305 | 00.050 | **00.050** |

**Table 39.9** Negative computation ($V^- = \{0.305,0.043,0.067\}$)

| Substitutes | Image | Sensors | Resources |
|---|---|---|---|
| DWT | 00.355 | 00.064 | **00.067** |
| PCA | 00.405 | 00.050 | 00.067 |
| IHS | 00.456 | **00.043** | 00.067 |
| Laplacian | **00.305** | 00.050 | 00.050 |

$$D_i^- = \sqrt{\left(\Sigma\left(V_{ij} - V_j^-\right)^2, i = 1..m, j = 1..n\right.}$$

(6) Evaluate the respective intimacy to the perfect solution (Table 39.12). $C_i = D_i^-/(D_i^+ + D_i^-)$

(7) Assign priority indicated in Table 39.13.

**Table 39.10** Separation assessment

| Substitutes | Image | Sensors |
|---|---|---|
| DWT | $(00.355–00.456)^2$ | $(00.064–00.064)^2$ |
| PCA | $(00.405–00.456)^2$ | $(00.050–00.064)^2$ |
| IHS | $(00.456–00.456)^2$ | $(00.043–00.064)^2$ |
| Laplacian | $(00.305–00.456)^2$ | $(00.050–00.064)^2$ |
| Substitutes | Resources | $\sqrt{(\Sigma(V_{ij}- V_j^+)^2}$ |
| DWT | $(00.067–00.050)^2$ | 00.101 |
| PCA | $(00.067–00.050)^2$ | 00.056 |
| IHS | $(00.067–00.050)^2$ | 00.027 |
| Laplacian | $(00.050–00.050)^2$ | 00.152 |

**Table 39.11** Negative perfect answer to a problem (Di-)

| Substitutes | Image | Sensors |
|---|---|---|
| DWT | $(00.355–00.305)^2$ | $(00.064–00.043)^2$ |
| PCA | $(00.405–00.305)^2$ | $(00.050–00.043)^2$ |
| IHS | $(00.456–00.305)^2$ | $(00.043–00.043)^2$ |
| Laplacian | $(00.305–00.305)^2$ | $(00.050–00.043)^2$ |
| Substitutes | Resources | $\sqrt{(\Sigma(V_{ij}- V_j^-)^2}$ |
| DWT | $(00.067–00.067)^2$ | 00.054 |
| PCA | $(00.067–00.067)^2$ | 00.010 |
| IHS | $(00.067–00.067)^2$ | 00.152 |
| Laplacian | $(00.050–00.067)^2$ | 00.018 |

**Table 39.12** Perfect solution

| Substitutes | $C_i = D_i^-/(D_i^+ + D_i^-)$ |
|---|---|
| DWT | $00.054/(00.101 + 00.054) = 00.348$ |
| PCA | $00.010/(00.056 + 00.010) = 00.152$ |
| IHS | $00.152/(00.027 + 00.152) = 00.849$ |
| Laplacian | $00.018/(00.152 + 00.018) = 00.106$ |

**Table 39.13** Assign priority

| Substitutes | Outcome | Priority |
|---|---|---|
| DWT | 00.348 | 2 |
| PCA | 00.152 | 3 |
| IHS | 00.849 | 1 |
| Laplacian | 00.106 | 4 |

IHS > DWT > PCA > Laplacian

## 39.6 Occurrence of Rank Reversal

The latest substitute contrast is added which is almost identical to IHS and then as a result of the decision matrix – five substitutes with regard to yardsticks specified in the table given below.

(1) Table 39.14

**Table 39.14** Substitute contrast

| Substitutes | Image | Sensors | Resources |
|---|---|---|---|
| DWT | 7.0 | 9.0 | 8.0 |
| PCA | 8.0 | 7.0 | 8.0 |
| IHS | 9.0 | 6.0 | 8.0 |
| Laplacian | 6.0 | 7.0 | 6.0 |
| Contrast | 9.0 | 6.0 | 8.0 |

**Table 39.15** Regularize the matrix m x n R(rij)

| Substitutes | Image | Sensors | Resources |
|---|---|---|---|
| DWT | 0.397 | 0.605 | 0.468 |
| PCA | 0.454 | 0.471 | 0.468 |
| IHS | 0.510 | 0.404 | 0.468 |
| Laplacian | 0.340 | 0.471 | 0.351 |
| Contrast | 0.510 | 0.404 | 0.468 |

**Table 39.16** Vij is computed as Vij = Wjrij

| Weight(Wj) | 00.769 | 00.104 | 00.127 |
|---|---|---|---|
| Substitutes | Image | Sensors | Resources |
| DWT | 00.397 | 00.605 | 00.468 |
| PCA | 00.454 | 00.471 | 00.468 |
| IHS | 00.510 | 00.404 | 00.468 |
| Laplacian | 00.340 | 00.471 | 00.351 |
| Contrast | 00.510 | 00.404 | 00.468 |

**Table 39.17** AHP approach

| Substitutes | Image | Sensors | Resources |
|---|---|---|---|
| DWT | 00.305 | 00.063 | 00.059 |
| PCA | 00.349 | 00.049 | 00.059 |
| IHS | 00.392 | 00.042 | 00.059 |
| Laplacian | 00.261 | 00.049 | 00.045 |
| Contrast | 00.392 | 00.042 | 00.059 |

(2) Regularize the matrix m x n R(rij). The rij is computed as

$r_{ij} = x_{ij} / \sqrt{(\Sigma x_{ij}^2)}$ for i = 1 ..m, j = 1 .. n. It is specified in Table 39.15

(3) Find the estimated regularized matrix. The estimates of the criteria are derived from pairwise comparison by using AHP approach. The preferences are 00.769, 00.104, and 00.127 for the image, the sensors, and the resources individually and in the order already mentioned in Table 39.16 ($V_{ij}$ is computed as $V_{ij} = W_j r_{ij}$).

(4) Find the positive and negative perfect answer to a problem (Tables 39.17, 39.18 and 39.19).

(5) Compute $D_i^+ = \sqrt{(\Sigma(V_{ij} - V_j^+)^2}$ indicated as shown in Table 39.20.

**Table 39.18** Positive results ($V^+ = \{00.392,00.063,00.045\}$)

| Substitutes | Image | Sensors | Resources |
|---|---|---|---|
| DWT | 00.305 | **00.063** | 00.059 |
| PCA | 00.349 | 00.049 | 00.059 |
| IHS | **00.392** | 00.042 | 00.059 |
| Laplacian | 00.261 | 00.049 | **00.045** |
| Contrast | 00.392 | 00.042 | 00.059 |

**Table 39.19** Negative computation results ($V^1 = \{00.261,00.042,00.059\}$)

| Substitutes | Image | Sensors | Resources |
|---|---|---|---|
| DWT | 00.305 | 00.063 | **00.059** |
| PCA | 00.349 | 00.049 | 00.059 |
| IHS | 00.392 | **00.042** | 00.059 |
| Laplacian | **00.261** | 00.049 | 00.045 |
| Contrast | 00.392 | 00.042 | 00.059 |

**Table 39.20** Compute Di + =√(S(Vij- Vj+)2

| Substitutes | Image | Sensors |
|---|---|---|
| DWT | $(00.305–00.392)^2$ | $(00.063–00.063)^2$ |
| PCA | $(00.349–00.392)^2$ | $(00.049–00.063)^2$ |
| IHS | $(00.392–00.392)^2$ | $(00.042–00.063)^2$ |
| Laplacian | $(00.261–00.392)^2$ | $(00.049–00.063)^2$ |
| Contrast | $(00.392–00.392)^2$ | $(00.042–00.063)^2$ |
| Substitutes | Resources | $\sqrt{(\Sigma(V_{ij}- V_j^+)^2}$ |
| DWT | $(00.059–00.045)^2$ | 00.088 |
| PCA | $(00.059–00.045)^2$ | 00.047 |
| IHS | $(00.059–00.045)^2$ | 00.025 |
| Laplacian | $(00.045–00.045)^2$ | 00.131 |
| Contrast | $(00.059–00.045)^2$ | 00.025 |

Likewise, the split-up of each substitute from the unfavourable answer to the problem

$(D_i^-)$ is specified in the table given below, $D_i^- = \sqrt{(\Sigma(V_{ij}- V_j^-)^2}$, i = 1..m, j = 1..n.

(6) Find the relative closeness to the perfect solution. The relative closeness of the alternative $A_i$ with respect to $V^+$ can be expressed as $C_i = D_i^-/(D_i^+ + D_i^-)$, i = 1....m where $C_i$ index value lies between 0 and 1. The higher the index value means the better the performance of the alternatives shown in the table given below (Tables 39.21 and 39.22).

(7) Assign priority indicated in Table 39.23.

**Table 39.21** Di- = $\sqrt{}$(S(Vij-Vj-)2, i = 1..m, j = 1..n

| Substitutes | Image | Sensors |
|---|---|---|
| DWT | $(00.305–00.261)^2$ | $(00.063–00.042)^2$ |
| PCA | $(00.349–00.261)^2$ | $(00.049–00.042)^2$ |
| IHS | $(00.392–00.261)^2$ | $(00.042–00.042)^2$ |
| Laplacian | $(00.261–00.261)^2$ | $(00.049–00.042)^2$ |
| Contrast | $(00.392–00.261)^2$ | $(00.042–00.042)^2$ |
| Substitutes | Resources | $\sqrt{}(\Sigma(V_{ij}- V_j^-)^2$ |
| DWT | $(00.059–00.059)^2$ | 00.049 |
| PCA | $(00.059–00.059)^2$ | 00.088 |
| IHS | $(00.059–00.059)^2$ | 00.130 |
| Laplacian | $(00.045–00.059)^2$ | 00.016 |
| Contrast | $(00.059–00.059)^2$ | 00.130 |

**Table 39.22** Relative closeness

| Substitutes | $C_i = D_i^-/(D_i^+ + D_i^-)$ |
|---|---|
| DWT | 00.049/(00.088 + 00.049) = 00.358 |
| PCA | 00.088/(00.047 + 00.088) = 00.652 |
| IHS | 00.130/(00.025 + 00.130) = 00.839 |
| Laplacian | 00.016/(00.131 + 00.016) = 00.109 |
| Contrast | 00.130/(00.025 + 00.130) = 00.839 |

**Table 39.23** IHS = contrast > PCA > DWT > Laplacian

| Substitutes | Outcome | Priority |
|---|---|---|
| DWT | 00.358 | 3 |
| PCA | 00.652 | 2 |
| IHS | 00.839 | 1 |
| Laplacian | 00.109 | 4 |
| Contrast | 00.839 | 1 |

IHS = contrast > PCA > DWT > Laplacian

## 39.7 Conclusion

AHP is one of the MCDM techniques. Its usefulness lies in the assessment of criteria that are useful in the evaluation of priorities of alternatives. TOPSIS is one of the MCDM practices applied in various areas notwithstanding undeniable limitations. It can be considered as a useful assistant in the decision-making method. In this illustration discussed above when four substitutes are examined, the preference becomes IHS > DWT > PCA > Laplacian for the initial observation. When a latest substitute contrast is included with an existing substitute that is comparable to IHS, then the preference becomes IHS = contrast > PCA > DWT > Laplacian. This manuscript clearly specifies that change in the rank ordering exists when recent algorithms are included with an existing fusion algorithms [13, 14]. In the opinion of TOPSIS approach, the verbal variables are transformed into numbers [15]. Human emotions cannot be quantified [16]. In spite of precise limitations,

this approach cannot be neglected because this approach comes up with acceptable practice for scholars to make recommended decisions. In this manuscript, focus is on hybridization of two familiar MCDM routines, namely, TOPSIS and AHP. Examine the effectiveness of hybridization betrays that there is no much advantage due to the combination.

**Compliance with Ethical Standards** All authors state that there is no conflict of interest.

We used our own data.

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# Chapter 40
# Sensitive Data Security over Network Through a Combination of Visual Cryptography and Data Hiding Mechanism


**Saurabh Sable and Prashant Adakane**

## 40.1 Introduction

Data security is a primary focus of each and every industry. Most of the industries are built up with data analysis and data science technologies. Data protection is generally implemented with concepts like cryptography, steganography, and digital watermarking. These concepts are good enough to protect data on the local server as well as on cloud storage. However, each technique has its own limitations. The proposed concept is built with the primary objective used to secure data behind the video as a carrier object irrespective of its position in sample value.

### *40.1.1 Steganography*

It is the art of hiding data behind another object. Based on the type of object, steganography is classified as image steganography, audio steganography, and video steganography. Steganography is a secure concept for a transmitting secret data from sender to receiver without giving any clue to unauthorized intruders about the existence of data. Most of the time, an intruder tries to intercept data based on its visibility and occurrence on a network. Steganography completely hind the existence of data on a network due to which intruder's main get failed intercept data and so data get security transmitted from one part to another. Different steganography technique is available like a least significant bit, spread spectrum, wavelet analysis, discrete cosine transform, and others. Care must be

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taken in steganography that results, and the original object should be similar to its audiovisual property. If the concept violet audiovisual similarity of an object then it is not called steganography. Generally invisible watermarking is also called steganography. Data carrying capacity of steganography where from one technique to another and highly depends on the size of the carrier object. It is said that video has a maximum data hiding capacity as it consists of two carrier channels, i.e., audio and video.

### *40.1.2 Watermarking*

Watermarking is generally used to protect the copyright of an object. Example channel logo is a watermark that indicates a channel belongs to a particular group or owner. Watermarking is classified as visible and invisible watermarking. Watermarking make changes in carrier object and it also shows the presence of secret data behind it that's why it is not a good choice for transmitting sensitive data from sender to receiver. Most of the time, the watermark is only used to protect copyright or ownership of an object. Watermark can be implemented with concepts like the least significant bit, spread spectrum analysis, discrete cosine transform, and other. It is a very powerful tool for protecting ownership.

### *40.1.3 Cryptography*

It is the art of converting readable data into an unreadable format. Cryptography is a powerful tool to protect data from unauthorized access. Any unauthorized use data is stronger protected with cryptographic techniques like data encryption standard, advanced encryption standard, RC2, and other. Cryptography hides the meaning of data whereas steganography existence of data. Cryptography is classified as symmetry cryptography and asymmetric cryptography. In asymmetric cryptography, a different key is used for data encryption and decryption. Sometimes asymmetric cryptography is also called as public-key cryptography due to intersecting data by two different keys.

In symmetric-key cryptography, send and receive use the same key for data encryption and decryption. Symmetric-key cryptography is considered the most secure type which is implemented with the key size of 128 bits, 256 bits, or with higher size. Cryptography techniques show the presence of data on a network, there is always a threat exist about intercepting data by an unauthorized user. Figure 40.1 shows the process of hiding data on the sender's side as well as extracting it on the receiver side. Input carrier object channels are extracted which are used to hide data. Input secret data is converted into its equivalent binary representation because in reality binary data get hidden behind carrier object not data in its equivalent ASCII character. Binary data individual bits are hidden behind the channels of carrier object

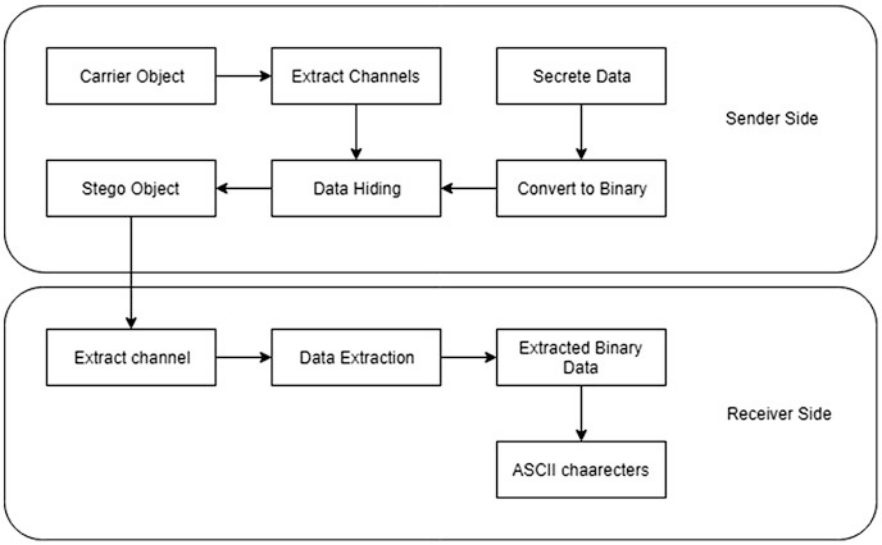


**Fig. 40.1** Introduction to steganography

and finally, a stego carrier object is generated which is transmitted over unsecured wireless media.

On receiver side channels of stego objects are again extracted from which secret information is taken out and convert it into its equivalent ASCII character.

### *40.1.4 Problem Statement*

To find out the existing technique drawbacks and limitations, a survey has been done from more than 50 standard IEEE and Scopus indexed journals. Propose data hiding technique is based on to illuminate the below given problem statements in existing methods:

1. Very low data hiding capacity.
2. More noise generation in the resultant stegano carrier.
3. Limitations of steganography techniques with types of carriers.
4. Existing techniques are more complex and do not concentrate on minimizing quantization error.
5. Almost all data hiding techniques create difference among original and result and stego object that gives hint to the intruder to intercept data on unsecured wireless media.

### *40.1.5 Objectives*

New method is required that should get the below mentioned objectives:

1. To minimize complex nature of existing systems
2. To achieve maximum data hiding capacity
3. To achieve optimal utilization of carrier channels
4. To minimize difference on original and result and carrier object
5. To use both the channels of video as a carrier with minimum quantization error

## 40.2 Literature Review

Dong-Oh Kang et al. [1] propose data hiding technique for social agent-based simulation model by reinforcement learning method. They use a hidden Markov model to estimate the state of the system during the process of learning. There proposed method improves the simulation model of social agent-based simulation when new real data is available. Their model is tested by applying to the housing market problem with real Korean housing market data.

Leonid Lyubchyk et al. [2] propose different hidden Markov model for hiding data behind a carrier object. Their main objective is to reduce transmission costs required for sensitive data transmission. The efficiency of this method is illustrated with several numerical examples.

Mehdi Sharifzadeh et al. [3] propose a novel Gaussian imaging model by maximizing detection error of most common optimal detector. It extends the formulation of cost-based data hiding that improves the empirical result of current cost and statistical model-based techniques. Every continuous hidden message remains the same for the entire data hiding scenario. After hiding data, close form detection error is derived for image steganography and further extended for batch steganography. Generally, it introduces adaptive batch size image merging which outperforms the state of art batch steganography technique.

Arnold Gabriel Benedict [4] propose a that have almost zero variability and a very low-cost computational time. Secret data is complement or noncomplement before hiding behind the carrier object. Steganography technique takes video as a carrier object and hides data in frames of video. The performance of their proposed system was calculated with the parameters like peak signal to noise ratio, cross-correlation, difference, and normalized absolute error. Their result shows that the technique they adopted is superior to other existing steganographic techniques. An algorithm is developed to have very great effectiveness for video data security management, especially on cloud storage.

Sunil Kumar Patel and Chandran Saravanan [5] discuss a scheme that is used for achieving embedding payload and to get better quality of image using least significant bit steganography technique which is entirely based on statistical analysis. This technique focuses on the image as a carrier object and not applicable to audio

or video carrier. A combination of steganography and cryptography techniques is used to protect data on insecure wireless media.

Abbas Darbani et al. [6] introduce text data hiding technique in compressed images. Text steganography is carried out with the least significant value in a discrete matrix. Embedding message insertion has very little impact on the visual perceptual quality of an image carrier. LSB bit is used to hide data behind the compressed image. It generates more noise as compared to the conventional LSB replacement method. This steganography technique has data hiding capacity of 2/8 which is higher than other steganography techniques.

Xiancheng Wu and Shunquan Tan [7] propose different image steganography techniques according to the texture of different images. For each carrier image, the bank of wavelet filter is given to achieve the smallest change of image with respect to features using stegoanalyzer after hiding the message behind it. Results are quite better but cannot hide more data than expected.

## 40.3 Conclusions

This paper did review on more than 50+ papers based on different data hiding strategies. The survey shows that the new system should dominate the problem statement that exists in the previous work and mention in the problem statement section of the paper. There should be required to focus on maximum data hiding capacity and minimizing quantization error. The survey shows that the acceptability of any steganography technique highly depends on data hiding and condition error property of carrier object. The new system should be simple and robust to handle and should have the capability to hide data irrespective of its type. The techniques used for data protection discussed in the introduction are not sufficient for data security, so a new system is required that overcomes their limitations and drawbacks.

**Compliance with Ethical Standards** All author states that there is no conflict of interest. We used our own data.

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# Chapter 41
# The Recapitulate Analysis of Image Mining Techniques Applications and Challenges Associated


**J. S. Nirmala, Gopalkrishna Joshi, and Prakash Hitremath**

## 41.1 Introduction

Images are by far the most widely used data form [1]. Image mining comes from a diverse field of data mining. Data mining means resolving useful or unproductive data/information. This has become one of those fields which have caught the attention of many of the scholars; a lot of work has been done in this field, and it is reflected in the research work. The mechanism of restoring suitable images from the data repository is called image mining [8]. This has evolved into advancements in automation, for example, in image data processing, its storage, and transmitting the information [3]. Contextual image classification and recouping systems are the extensive subjects of multimedia mining research works in the former years [2]. To describe an image, recurrently used characteristics are:

- Color attribute feature
- Texture attribute feature
- Shape attribute feature
- Spatial attribute feature

Images stored are procured, and the solution is claimed with respect to the inquired objective. This process is done by utilizing the existing image whose features are extracted in a particular pattern which matches the objective, and then the required information is displayed [4–6]. The intention of the process in image mining is to elude all the substantial patterns having no insight on the information of

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the image as mentioned before this can be done by different patterns that can be used for extracting the images which are description patterns recognition, correlation patterns recognition, temporal patterns recognition, and spatial patterns recognition. Multimedia image mining deals with the physiognomy of bulky image databases which includes indexing methods, image storages, and image retrieval, all related to an image mining system. The conferred paper deals with the surveying of discrete image mining methods and gives an insignificant tabloid for further research and its advancements.

## 41.2 Literature Review Based on

1. Image Characteristics/Features Used For Mining
2. Image Mining Framework
3. Image Mining Techniques

### *41.2.1 Image Characteristics/Features Used for Mining*

There are primarily three features of the image that are utilized to extract and store into a database for coordinating with query-request. These are color-shading, shape, and surface texture.

- Color attribute feature: A computer image is a matrix of pixels that are represented in the form of 0 s/1 s. Each pixel's value corresponds to the brightness of each analogous point in the scene. Color images are illustrated by three intensity components. These components generally correspond to red, green, and blue (RGB) or sometimes yellow, cyan, and magenta (YCM). An integer value can be incorporated in the image with each pixel that can be used as an index to a table that holds the intensity of each color component. The histogram is used to plot the number of pixels with an accurate brightness level against the predefined brightness level. For 8-bit pixels, the brightness ranges from zero (black) to 255 (white). The operations based on color characteristics include histogram normalization, histogram equalization, and thresholding.
- Shape or edge feature: Edge is simply a huge change in frequency. Many techniques of image analysis are based on edges since interpretation based on edge detection is unresponsive to change in the overall radiance level. Edge detection highlights image contrast. Detecting contrast, which is a difference in intensity, can highlight the boundaries of features within an image.
- Texture feature. The texture is defined as the proximity characteristics as a region or a block. The variation of each pixel with respect to its adjacent pixels defines texture. Texture feature is an important subsided feature in the image; it can be

used to describe the contents of an image or a region in addition to color features as just these features are not sufficient to identify the image since different images may have similar histograms.

### *41.2.2 Image Mining Framework*

- Image processing includes a domain-associated application where we focus on extricating the most important image attributes from an information knowledge bank. This is useful in getting to know the collaborative properties between high-level state human impressions of images and low-level highlights [3].
- Image mining generally refers to the extrication of image data relationships or other blocks of patterns that are not easily visible or recognizable to the user in the images. The dire need to preprocess images in image mining is to upscale the quality of images. These pictures experience different changes so as to grow essential attributes from the pictures. With these created highlights, mining is done utilizing data mining methods to investigate noteworthy examples. The then coming about examples are approved and translated to get the last learning, which is connected to applications [7].
- As of today, two of the most functional frameworks are as follows: (a) function-driven structure (b) and information-driven frameworks. It can be noted that most of the image mining process architectures fall under the category of function-driven frameworks. The goal of the function-driven framework is to build and clarify the roles and duties that ought to be carried out throughout image mining. Information-driven framework is an effective way of establishing low-level and pixel representation that is contained in a raw image that can be processed to identify high-level objects.
- Content-based image retrieval (CBIR) systems are being used in many commercial sites. The primary work of the CBIR system is to search for images in an image dataset according to the query being given by the user or the operator. They also aim at searching and going through large image libraries based on few automatically derived image features [10, 12].
- There are several ways to approach the image mining framework, but the process discussed in the paper is one of the most efficient ways to go by. We can see from results that advances in image acquisition and store technology have resulted in tremendous growth in the image mining and processing industry.
- The need for tools with proper analysis capabilities is very much important. Systems which can automatically retrieve data are the one with the highest demands. Here in this paper, we are discussing one such system which has the capability to do the same (Fig. 41.1).

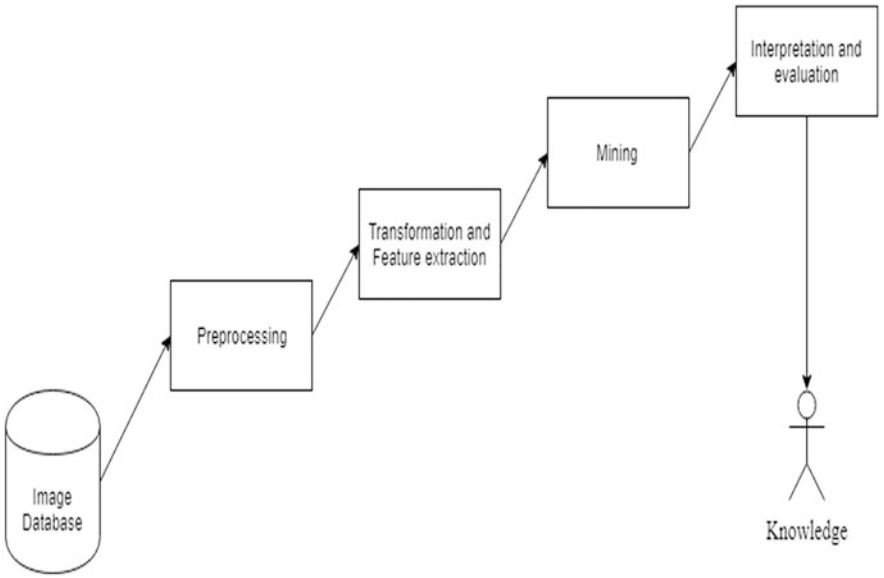


**Fig. 41.1** Image mining framework

### *41.2.3 Image Mining Techniques*

Image mining techniques can be broadly divided into object recognition, image indexing and retrieval, image classification and clustering, association rules mining, and neural networks [9, 11, 13, 14].

- *Object Recognition*
  Object recognition has been a dynamic field of the center with regard to picture processing. The process of object recognition programming identifies the different items from the test picture. This is a stage that prompts the fragmentation of pictures. The key concentration here is to recognize objects in a picture and part a picture into smaller zones which would then be able to be dissecting and process the pictures independently. This likewise may be alluded to as a controlled labeling issue as per the models of known things
- *Image Retrieval*
  Keeping in mind, the end goal to recover pictures from a database is we have to file them legitimately. For that, we require a legitimate ordering/indexing programming that does the activity for us. The motivation behind image mining is to recover pictures according to the particular prerequisite of the client. Necessities determination of a client can be named: (i) low-level highlights – shading, shape, or the spatial area of the picture component; (ii) high-level state highlights, recognize objects and bigger shapes in picture; and (iii) logical highlights, singular items or individual.

- *Image Indexing*
  Utilizing an effective ordering plan is fundamental to enhance the image recovery rate and characterization. A portion of the regularly utilized indexing plans is decreasing dimensions or ordering high-dimensional data. This may likewise incorporate the naming/indexing of pictures as indicated by a specific plan.
- *Image Classification*
  The motivation behind image clustering is to order pictures in view of key properties that are related to the picture. It might center on the distinguishing purposes of a picture which influences it to emerge from the others. Today image classification is the most looked into the area. The most part utilized techniques for image characterizations are (a) supervised classification and (b) image grouping.
- *Association Rules Mining*
  Association mining rules are produced just when the support and confidence are more noteworthy than preset limits. Similar works in two sections: (i) in the initial step, all significant item sets that match the support threshold are distinguished by the rule mining calculation. (ii) The second step creates decides that match the confidence edge.
- *Neural Network*
  Neural systems imply the correspondence of a few neurons. These neurons are characterized as straightforward handling units that are isolated into different separated layers with either full or fractional associations set up. The essential undertaking of a neuron is to get the yield that is passed on from the previous neuron and process and produce a yield that will be transmitted to the last neuron. The neurons speak with a few different neighbors keeping in mind the end goal to gather data required for additional preparation.

## 41.3 Applications

Explicitly analyzing images can reveal significant information to the user. Today, the process of image mining is widely used across various fields. Some of the most popular real-world applications are:

(a) Diagnosis and categorization of medical conditions like tumors: Systematic diagnosis is important for the successful treatment of tumors. Content-based medical image retrieval (CBMIR) can assist the radiologist in the investigation of brain tumors by recovering analogous images from the medical image dataset. Magnetic resonance imaging (MRI) is the most frequently used procedure for imaging of tumors [10, 12].
(b) The satellites revolving around the earth are regularly collecting data in the form of images. There is a huge amount of images being clicked every second;

therefore an efficient methodology is required to mine and store the images. Image mining comes of great help when it comes to satellite cloud imagery [19].

(c) Natural scene recognition: Natural scene recognition refers to the procedure where an agent (such as a human being) visually intakes and interprets scenes (images) that it typically encounters in natural modes of operation (e.g., busy streets, meadows, living rooms). This process has been described in several differentiated ways that are guided by different concepts based on preset rules [17, 18].

(d) Agriculture field: The image mining concepts can be used in order to detect the diseased stem, leaf, fruit, or flowers. It can also be used to define the degree of severity of the diseased part. It can also be used for the classification of different kinds of agricultural produce [15].

(e) Industrial work: The mining process can be carried out in the fields of space imagery or in the coal industry or say remote sensing which includes working with different kinds of sensors, mainly the camera sensor which is used for capturing images to be compared with the already existing images in the image repository [16, 19].

## 41.4 Challenges

Although image mining is a boon for human users, it possesses a few challenges considering the fact that it is a relatively new and emerging concept. They are as follows [7, 9, 14]:

1. The automatic classification and clustering of images are still not a cent percent accurate, and a lot of work still has to be done in the field of image mining.
2. There is a need for the unification of a clustering query language that can work with both textual and pictorial data format.
3. World Wide Web (WWW) is a huge database of unlabeled images. Whenever a need for images arises, the retrieval and classification of images become a tedious task for the processor.
4. The need of the hour is to come up with a self-sufficient indexing method which standardizes procedures to index and retrieves knowledge from the indexed images.
5. Image mining has problems related to interfaces that often require the involvement of both domain and technical experts. This might lead to wasteful time consumption and may also put extra load on the operators/experts [9].
6. Real-life images are not clean; there might be a lot of added external noise, or maybe the image can be overexposed or underexposed, or maybe the image is defocused [7].
7. There is a very rare scope of the software for image mining being reused as the software is mainly designed for a specific use or utility [3].

8. Bottleneck maintenance is not such a feasible process; therefore work has to be put in, in order to make advancements in the same [16].
9. The researches might solve the theoretical problem aspects, but the industry demands issues to be solved related to the practical aspects [16].
10. There is still a gap in the client-server technology when it comes to image mining, and this can be solved using other techniques like NLP, machine learning, AI, etc. [3, 4].
11. To distinguish influenced locale from woods fire, fire blazes, and fire conduct from wind course, expectations of flame spread [15].

## 41.5 Future Scope

Summarizing, image mining is an exciting field for examination and introspection. Image mining research is still in its early stages, and numerous issues stay inexplicable. In particular, image mining research in order to advance to another stature, the accompanying issues should be explored at a future scope [7, 9]:

(a) Propose new portrayal plans for visual examples that can encode adequate relevant data to take into account significant extraction of helpful visual qualities.
(b) Devise productive substance-based image ordering and recovery methods to encourage quick and successful access in vast image databases.
(c) Design semantically capable question dialects for image databases.
(d) Explore new revelation systems that consider the exceptional attributes of picture information.
(e) Incorporate new representation systems for the perception of image patterns.

## 41.6 Conclusion

Image mining is an advanced field that falls into the broader field of data mining techniques. The ulterior motive of image mining is to retrieve meaningful information hidden in images in accordance with the needs of the user. The intent of this paper is to understand the concept of image mining and its process, techniques, applications, and challenges that are explained in the paper. The notion of image mining is beneficial to human users. However, there is a huge scope for further research to be carried out in this emerging field of data science. To conclude, we have provided a brief review of current text and web mining research and discuss the issues and challenges in existing research methods. We observe that multimedia mining based on the extraction of complementary resources like overlay text for a specific domain can be very much useful for digital media assets management like annotation of image search.

**Compliance with Ethical Standards** All author states that there is no conflict of interest. We used our own data.

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# Chapter 42
# Energy-Efficient, Congestion Control, and Trust-Based Routing Techniques for MANET Using Sealed-Bid Auction Game Theory


**S. Shanthini and D. Devakumari**

## 42.1 Introduction

A mobile ad-hoc network is a structureless network that frequently changes the network topology and configures itself [4]. Nodes will be moving in any direction, so it should update their current location and their neighbor nodes' information. In MANET routing protocols are of three different types. The first type is reactive routing protocol which reacts when the signal is received otherwise the nodes are going to inactive modes. The second type is a proactive routing protocol which is in always active mode; it sequentially broadcasts the signal and updates their information also. The final type is a hybrid routing protocol which is a combination of both reactive and proactive routing protocol. It can perform depending upon the nodes' environment. Mobile ad-hoc network nodes exchange their information from one node to another node. Networks face some difficulties like energy, traffic, security of the network, etc.

Energy plays a main role in the mobile ad-hoc network [2]. Nowadays wireless networks are facing this problem. The mobile ad-hoc networks have some energy-efficient techniques to save energy, and extending the network lifetime nodes loses their energy mostly during transmission time and changing their location. Here the focus is to save the transmission time energy and control the load distribution and node active mode.

Congestion is a very big challenge in MANET [1]. The number of nodes is rapidly increased, and at the same time, packet transmission is also increased. So the network becomes very congested. Congestion control techniques are used to avoid congestion or control it. There are many congestion control algorithms available in

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MANET. The issue of the congested network is long delay: nodes are waiting in queue very long time. High overhead continuously finds an alternate route and the continuous communication with the neighbor node creates network overhead. Many packet losses occurs due to long delay, more number of nodes and propagation time out. These are the main reason for packet delivery.

The well-known congestion control algorithm is called random early detection (RED) [8]. The main advantage of the RED algorithm is different from the traditional one, and it can be modified by the nodes' queue length. Trust-based routing protocols maintain the table called MAT (minimum acceptable trust) which is mainly used for forwarding control and forwarding data packets.

Game theory is the study of mathematical models of statistical interaction to take a decision on the playing field. Here the action game is based on the economical world [11]. The auction game theory has the same rules and regulations for improving efficacy. There are two types of auction: (i) sealed-bid auction in this type of auction bidding value is maintained secret by till the auctioneer announcing the winner. (ii) Open-bid auction performs two different types; one is ascending auction, and another one is descending auction. In the open-bid auction, bidding values are publically bidding.

This paper is organized as the following sections: Sect. 42.2 Related Works, Sect. 42.3 Proposed Work, Sect. 42.4 Implementation Results, and Sect. 42.5 Conclusion of the Work.

## 42.2 Related Works

Chaker Abdelaziz Kerrache et al. implement an energy-efficient routing in mobile ad-hoc networks [3]. There are two levels: (i) trust establishment, create and improve the node relationship that helps to find trustworthy nodes. (ii) Link duration establishment index computation avoids the link failure and finds the misbehave node to isolate it. The packets to transmission are secured and save nodes' energy to increase network performance.

Maitri Bipinbhai Patel and Manish M. Patel [6] evaluated in energy-efficient routing MANET using a residual energy and node stability. They analyzed various energy-efficient routing techniques to review the pros and cons. In this paper, they proposed a new method to calculate every nodes' residual energy and stability based on that find in the multiple routes. Finally, calculate the average route energy level and route stability. Then select the route with the best cast.

Anush Chaturvedi, D.N Goswami, and Shivjay Singh [2, 4] proposed an energy-aware route selection algorithm for saving nodes energy and to extend the network lifetime. Energy is mainly used for transmitting and receiving the data packets or otherwise periodically broadcast the signal. Here the algorithm design is based on the control of the nodes' active mode when the data packets arrive and transmitting to the next node. That time only the nodes are active otherwise nodes are going to sleep mode. This technique saves nodes energy, and maximizing the network

lifetime, less link failure, less data drop, and less delay at the same time increases the throughput and packet delivery ratio.

Rashmi Hinge and Jigyasu Dubey evaluated the opinion-based trust-based routing protocol in mobile ad-hoc networks [8, 10]. Here calculate every nodes' trust value, and find the trustworthy nodes in the network. Then find a secure routing path based on the node's trust value and the neighbor node opinion. The opinion is calculated by the values 0 and 1. If the value is 1, the neighbors are given positive results otherwise if the value is 0 it is a negative value. Based on this, select the trusted routing path in the network.

Suparna Biswa, Tanumoy Nag, and Sarmistha Neogy [4, 12] described on the secure routing to avoid the black hole attack. Here a new technique is developed considering some parameters like nodes' stability, pause time, remaining battery level, and maximum velocity of the node. Based on these parameters, every transmission node adds points. This point of value must increase and not decrease. If the point is going down to 0, that node is considered as a malicious node. In this case, there is a limitation if a new node entered in the network there is no point in that node it's also considered as a malicious node. In the future need to find the solution to this issue.

Vinsh H. Patel et al. [13] implemented trust-based routing in mobile ad-hoc networks. Basically routing process consists of three levels: (i) route discovery, (ii) packet forwarding, and (iii) route maintenance. Most of the attacks happened in the packet transmission and route discovery time. In this paper, trust-based routing techniques focused on the load balancing of every node in the packet forwarding time, and it created a relationship between the nodes, so every node knows very well their neighbor. This technique works on two phases: trust formulation and trust usage for routing decisions. It is calculated by the packet drop, packet forwarding, and packet delay.

Poonam Gera et al. [9] focused on end-to-end delay secure data delivery in MANET using trust-based multipath routing. There are many attackers attacked in the time of transmission but here using self-encryption techniques. There is no need cryptographic key in this technique to help secure packet transmission from source. First find the path trust value route discovery at the source node, RREQ processing at intermediate nodes, RREP at the destination node and proceeding the intermediate node, and finally path decision at the source node.

Nagisetty Rachana and Kandi Sreeja et al. implemented trust-embedded ad-hoc on-demand vector (T_AODV); it extended in eT_AODV [7]. In AODV routing the protocol is facing some of the attacks. The attacks created by malicious nodes like (i) routing loop attacks: this attack modified the routing information; the packets do not reach the destination. (ii) Packet drop: malicious nodes or queue status having this type of issue. (iii) Gray-hole attack: dropping random packets, and it can forward a routing packet not the data packet and receive the packets without information. (iv) Packet modification: this type of attack can change the packet information, and packets are going to the wrong destination. These four types of attacks are overcome on this trust-based routing algorithm. It gives a better packet delivery ratio, trusted path distance, hop by hop cost, and trusted path hops.

Hala Mustafa and Noureldien A. Noureldien analyzed selfishness behavior and misbehavior nodes [5]. These types of nodes are non-trustable nodes; there are many classified methods available to detect the misbehaved nodes and selfishness node. These techniques are processed on first control of the packets based on detected method, trust-based detection method analyzing various methods, sequence number-based detection method, and finally method based on control packets and sequence number.

## 42.3 Proposed Work

In this paper, a sealed-bid auction-based energy-efficient route selection algorithm is proposed. This algorithm finds the best node in the network [11]. Sealed bid auction means every node bidding their bid amount (information of the node) secretly. So no one knows the bidding amount. The proposed algorithm first updates the neighbor list and then finds the best forwarding nodes. Update the neighbor list based on node drain rate, and then find the best node using parameters like residual energy and progressive value.

The nodes will initiate the destination, nearby nodes list, hop count, residual energy, threshold level of drain rate, maximum weight of neighbor nodes, and progressive value. Initially this value is identified as 0, and based on the remaining parameters, it will be upgraded. Now update the source node of neighbor list for broadcast the hello packet then the neighbor wiil be reponsed to a source with their information like node energy level, current location, progress value, etc., calculate the node drain rate value then fix the drain rate threshold value based on the drain rate value divide the 2. If the value is greater than 2.0 (approximate value), node will be selected; it's added in the candidate neighbor list. Then going to find the best forwarding node among the candidate neighbor list nodes. Finding the best forwarding node is based on their residual energy and the progressive value. Here the progressive value means nodes transmission ratio. If there is a failure in the previous packet transmission, that failure nodes also not considered. Finally, this technique helps to find out the best forwarding node.

Random early detection is an already existing congestion control algorithm [8]. This algorithm combined with our proposed SBA_EERS called as the Red congestion control with an energy-aware auction-based route selection algorithm (RED_EARS). In the previous algorithm, finding the best forwarding node and then transmitting the data packets. Now the red algorithm performs to compute the average queue length of the node based on this constant values that either be maximum or minimum. After calculating the packet dropping probability, the packet will transmit when the probability value is low otherwise it stops the packet forwarding. The importance of red algorithm is to achieve the high packet probability during the high node queue length and it will be reconsidered if the queue length will expand or not.

Here two algorithms are used: sealed-bid auction-based energy-efficient route selection algorithm and random early detection algorithm that is an already existing congestion control algorithm. Combined these algorithms for various trust based techniques, and it is implementing and analyzing the entire result.

### *42.3.1 Trust-Based Routing*

Trust-based routing in mobile ad-hoc routing has followed some metrics: first trust formation based on how much successful packet has been forwarded and dropped, and then it takes how long to transmit the packet [13]. Now find which node is the trustable node. Finally, the source node takes the decision based on the trust formation, and then the packets are transmitted to the destination. These trust-based routing techniques have some limitations: if the route link is disconnected again, it finds the trusted node. It takes a little bit more time, so it increases the delay.

### *42.3.2 Opinion-Based Trusted AODV*

In opinion-based trusted AODV trusted node is selected based on their neighbors' opinion [10]. The neighbor's opinion is based on the two values: if the node is trustworthy, the neighbor gives 1, or if it's not a trustworthy node, it gives 0. Now the sender calculates the neighbors' opinion and then deicide the trusted route for forwarding data packets from source to destination. This technique used more energy comparatively every time it calculates the neighbors' opinion. This is the only limitation of these techniques.

### *42.3.3 Trust-Based Multipath Routing*

The trust-based multipath routing selects the multipath-based encryption format [9]. It is used without cryptographic key nodes for encrypting their data packet. There are many attackers which attack in the time of transmission. But here self-encryption techniques are used. If the source node sends a request packet, it's divided into multiple parts and send the multiple paths to find the misbehaving node. If it finds any misbehaved node, automatically reconstruct the original packet information and send the packet on a secured path.

### *42.3.4 Trust-Embedded AODV*

Trust-embedded AODV does not select a trusted node or path since basically it has overall control and makes a trusted routing in the network [7]. It's also called as T_AODV control. These are four types of attacks: first is the routing loop attack; in this attack, route information is changed, so packets do not reach the destination. Second packet drops because of the malicious node. Third is gray-hole attack; in this type of attack, packets are dropped in a random manner. The fourth attack is packet modification; here the packets destination address will change, so the packets are received at the wrong destination (Fig. 42.1).

## 42.4 Implementation Results

The energy-efficient, congestion control, and trust-based routing techniques for MANET using sealed-bid auction game theory are implemented by using an NS2 Network simulator 2.34. The basic parameter and the values are given below: – Network dimensions are 890*900, assigned channel frequency is 2.4 giga hertz, the routing protocol used as AODV (ad-hoc on-demand distance vector) and data rate is 2 Megabits per second, number of nodes varies from 0 to 50, packet size is 512 bytes, intial energy of each nodes is 500 joules and the overall simulation time of the proposed work is 1200 meter per second. Here the results are analyzed based on four metrics: (i) energy consumption, (ii) end-to-end delay, (iii) packet delivery ratio, and (iv) throughput. The routing techniques are SBA_EERS, RED_EARS, trust-based routing called as trust, trust-embedded ad-hoc routing called as T_Embedd, opinion-based trusted routing called opinion, and trust-based multipath routing called as multipath (Fig. 42.2).

### *42.4.1 Energy Consumption*

Energy consumption is calculated by the amount/unit of electrical energy or power used.

Here the various techniques are compared as to how much energy is consumed in the packet transmission time. Figure 42.3 shows energy consumption with the number of nodes, nodes measured in 10, 30, and 50 nodes. The SBA_EERS routing technique is only initially stage of routing. It has some extra energy by using an auction game techniques nodes biding their amount then it will select the best forwarding nodes. RED_EARS routing technique uses the auction game technique and RED algorithm, so here it takes some energy. Trust-based routing technique almost uses some amount of energy in the previous technique. Here by using the RED_EARS technique with the trust-based routing so filtering the best node it takes.

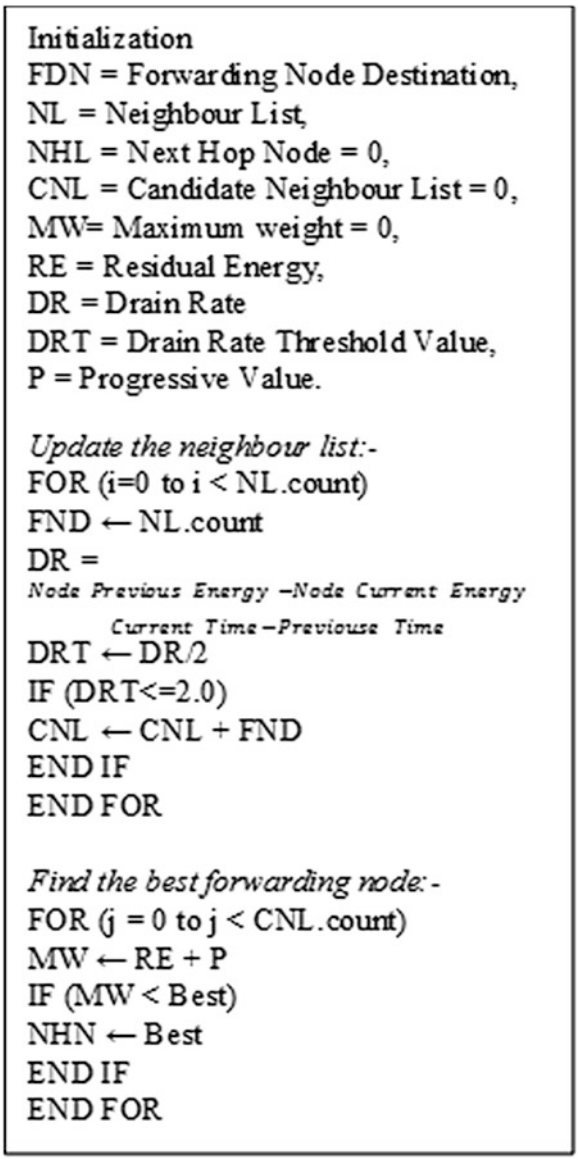



**Fig. 42.1** Energy-efficient algorithm

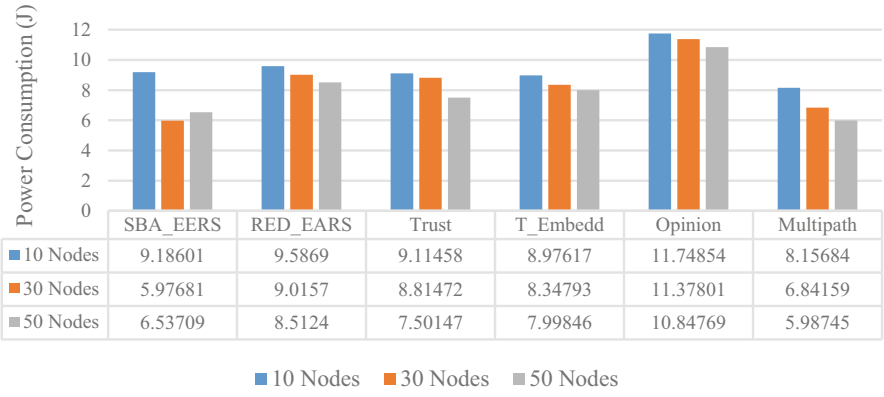
T_Embedd is working on the MAC and network layer, so it uses comparatively little bit energy to take the transmission. Opinion-based trusted routing technique is using more energy comparatively than other techniques because it always depends on their neighbors' opinion, so it will take more energy. Multipath routing technique comparatively uses less amount of energy initially it find the multiple paths so it takes some energy and after that energy level used is reduced.

**Fig. 42.2** Random early detection algorithm

```
Radom Early Detection algorithm [15]
Initialization:
avg =0
count = -1
For each packet that arrives
begin
Calculate the new average queue size avg :
If the queue is non empty
begin
avg = (1-wq) * avg + wq * queue_len
end
else
begin
m = f (current_time – empty_queue_time)
ang = (1 – wq) * m * avg
end
if minth < = avg < maxth
begin
increment count
calculate the probability Pa:
Pb = maxp (avg_minth) / (maxth_minth)
Pa = Pb / (1 – count *Pb)
drop the arriving packet with probability Pa and
then
count = 0
End
End if (maxth < = avg)
begin
drop the arriving packet
count = 0
end
else count = -1
end
```

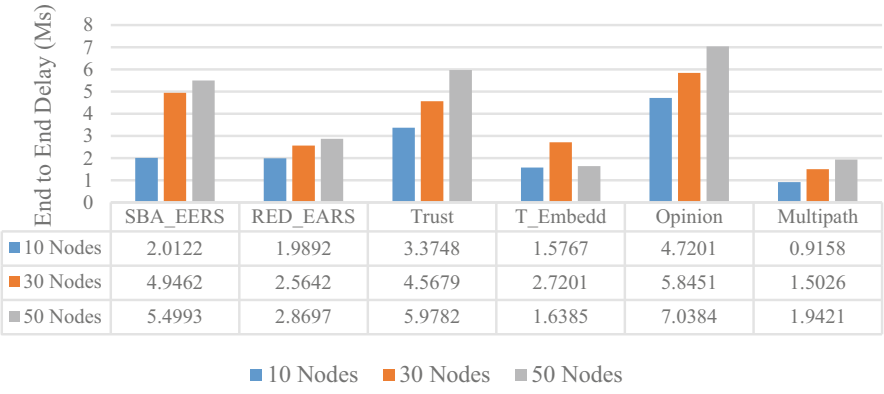
### *42.4.2 End-to-End Delay*

Figure 42.4 shows end-to-end delay with the various trust-based routing techniques SBA_EERS has a little more delay the reason is in auction-based routing technique bidding process takes a little bit of time. Need to overcome this issue, introduced the second technique namely RED_EARS which helps to reduce the delay because the red algorithm modified their nodes queue length here reduce the queuing delay and transmission delay. But the trust- and opinion-based routing techniques have more delay compared to others because trust takes many metrics to find the best node, and the opinion-based routing calculates the neighbors' opinion, so it takes more




| | SBA_EERS | RED_EARS | Trust | T_Embedd | Opinion | Multipath |
|---|---|---|---|---|---|---|
| 10 Nodes | 9.18601 | 9.5869 | 9.11458 | 8.97617 | 11.74854 | 8.15684 |
| 30 Nodes | 5.97681 | 9.0157 | 8.81472 | 8.34793 | 11.37801 | 6.84159 |
| 50 Nodes | 6.53709 | 8.5124 | 7.50147 | 7.99846 | 10.84769 | 5.98745 |

**Fig. 42.3** Energy consumption vs no. of nodes



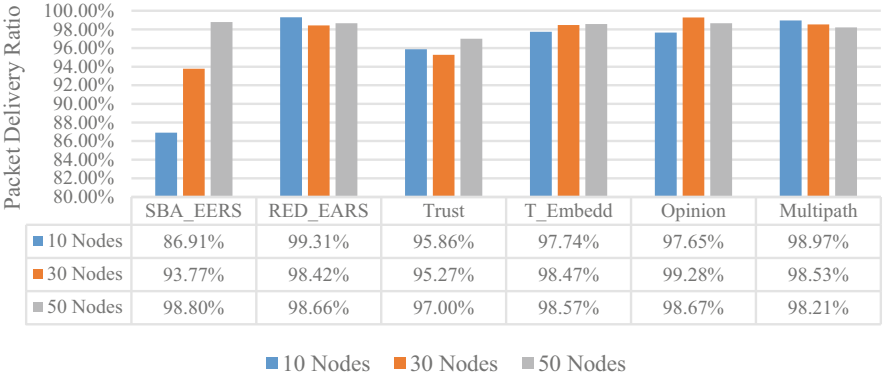

| | SBA_EERS | RED_EARS | Trust | T_Embedd | Opinion | Multipath |
|---|---|---|---|---|---|---|
| 10 Nodes | 2.0122 | 1.9892 | 3.3748 | 1.5767 | 4.7201 | 0.9158 |
| 30 Nodes | 4.9462 | 2.5642 | 4.5679 | 2.7201 | 5.8451 | 1.5026 |
| 50 Nodes | 5.4993 | 2.8697 | 5.9782 | 1.6385 | 7.0384 | 1.9421 |

**Fig. 42.4** End-to-end delay vs no. of nodes

delay. At the same time, T_Embedd and multipath routing techniques are reducing the delay. Trust-embedded routing is basically designed to reduce the delay, and multipath routing initially finds more than one path, so it transmits data in multiple routes. If there are any obstacles in the routing path, it chooses the next path easily.

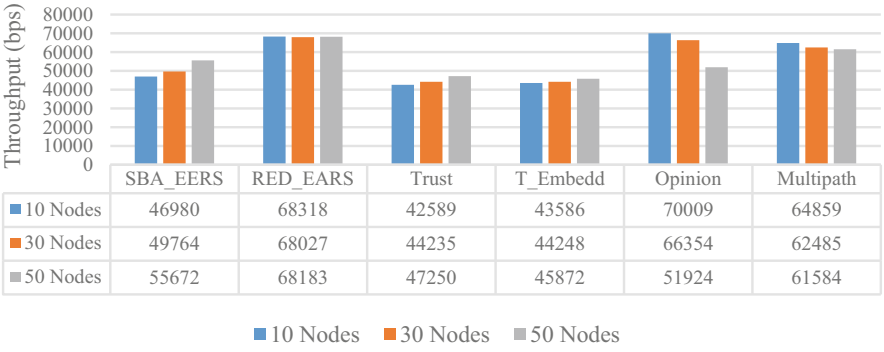
### *42.4.3 Packet Delivery Ratio*

Figure 42.5 shows a packet delivery ratio calculated by a total number of successful packets received divided by the total number of packets sent. Here almost every technique had above 97% of packets delivered but concentrated on 100% of packet delivery ratio




| | SBA_EERS | RED_EARS | Trust | T_Embedd | Opinion | Multipath |
|---|---|---|---|---|---|---|
| 10 Nodes | 86.91% | 99.31% | 95.86% | 97.74% | 97.65% | 98.97% |
| 30 Nodes | 93.77% | 98.42% | 95.27% | 98.47% | 99.28% | 98.53% |
| 50 Nodes | 98.80% | 98.66% | 97.00% | 98.57% | 98.67% | 98.21% |

**Fig. 42.5** Packet delivery ratio vs no. of nodes




| | SBA_EERS | RED_EARS | Trust | T_Embedd | Opinion | Multipath |
|---|---|---|---|---|---|---|
| 10 Nodes | 46980 | 68318 | 42589 | 43586 | 70009 | 64859 |
| 30 Nodes | 49764 | 68027 | 44235 | 44248 | 66354 | 62485 |
| 50 Nodes | 55672 | 68183 | 47250 | 45872 | 51924 | 61584 |

**Fig. 42.6** Throughput vs no. of nodes

### *42.4.4 Throughput*

Figure 42.6 shows the throughput calculated by the total number of successful packets delivered divided by the total time taken. Here SBA_EERS, Trust and T_Embedd routing show similar results. Comparatively, these three techniques are transmitting fewer packets but the RED, Opinion and multipath routing techniques are transmitting the number of packets in a second.

## 42.5 Conclusion

Mobile ad-hoc networks are facing three major problems: energy-efficient, congestion control, and secure routing. In this paper, a sealed-bid auction-based energy-efficient route selection algorithm is proposed. It saved the nodes' energy

and increased the network lifetime. Second algorithm random early detection is an already existing congestion control algorithm. Combined these two algorithms, and use it in the various trust-based techniques for implementation and result extraction.

SBA_EERS gives a better packet delivery ratio, throughput, and energy consumption but increasing the delay. It is the only limitation of this algorithm. RED_EARS is a combination of SBA_EERS and RED. It overcomes the previous issue of delay, but it takes more energy. Trust-based, T_Embedd, and opinion-based routing techniques give a better packet delivery ratio, but these techniques concentrate on other aspects also. Multipath routing gives better energy consumption, packet delivery ratio, throughput and lesser delay and overall it performs well. Here only a basic level of security issue occupied. In the future, the network security could be increased.

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# Chapter 43
# Effect of Sandstorm on Radio Propagation Model of Mars


**Nilofar A. Shekh, Vedvyas Dviwedi, and Jayesh P. Pabari**

## 43.1 Motivation and Introduction

Throughout wireless communication systems, the signal waves travel through a radio channel between the transmitter and receiver, which is the fundamental part of the wireless system. The propagation of wireless signals in any area is affected by a number of factors. It can involve interference with buildings, vegetation, mountains, sand, etc. All of these limitations greatly influence the transmission of data by radio waves. The RF propagation model is represented as a mathematical expression. Its aim is to know propagation patterns at a particular frequency and size and some other conditions. It helps to find out how much will be impacted by the received radio signal. It predicts the loss of path when a radio wave under different constraints is going through a link. For this reason, engineers developed propagation models to predict the signal strength at the receiver. The models for radiofrequency channel propagation are the necessary tool for developing communication systems for wireless applications. The mission for NASA's Mars Exploration contains the use of wireless sensor networks. The wireless sensor network has a short transmission range, less power requirement, low costs, and a relatively short life span. The efficiency of such a wireless network depends primarily on the radiofrequency environment. Analytical models were designed to interpolate attenuation caused by storms of dust. The approach was based on these models of Rayleigh [1–4] or Mie scattering theory [5, 6]. The approximation of Rayleigh is acceptable when

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the particle radius is less than the wavelength. In contrast, the Mie solution has no Rayleigh approximation drawbacks.

## 43.2 Existing Propagation Models for Sandstorm

To achieve the output of a WSN on Mars' surface, many factors impacting the transmission of the radio wave must be taken into account. The main characteristics are cloud formation, snowfall, temperatures, the gaseous structure of the Martian atmosphere, terrains, and dust storm occurrence. Between them, the dust storm function gives the main contributions to the attenuation of the radio wave; however, these contributions differ according to the area of interest and time of year in Mars. This aspect should be taken into account during the space mission planning.

The attenuation of radio waves may result from sand or dust particles via the scattering and absorption of particles. The Rayleigh scattering principle is used when the particle size is less than its wavelength. If the particle is bigger than the wavelength, the Mie scattering principle should be used to measure the effective index refractive [7]. Visibility, v, is determined by the distance at which a mark for terrestrial sand- or dust storms disappears from the background. Normally storm has a visibility of 10 m or less and can reach a height of at least 3.8 m and may reach 1 km or more in height [8, 9]. The average size of dust particles is 10 to 20 μm, with the largest ranging 80–300 μm. In a typical case, the density of the particle, *NT*, is $10^8/m^3$ and mass density of dust, $\rho$, $2.6\times10^6$ g/$m^3$. At S band ($10^8$ cm wavelength), attenuation may be large as 13 dB. The attenuation of X band will exceed 44 dB along the same route (10 GHz) [10]. Therefore, the Earth's dust storm on radio wave transmission has been affected by the sandstorms that create a problem for domestic satellite services in desert areas [1, 3]. The attenuation of the microwave is given in (43.1):

$$A(\lambda) = \frac{189}{\lambda v}\left[\frac{3\varepsilon''}{(\varepsilon'+2)^2+\varepsilon''^2}\right] \tag{43.1}$$

where A (λ) is in decibel per kilometers; visibility, *v*, is in kilometers; r is the radius of particles in meters; and λ is the wavelength in meters.

The first study of the propagation of radio waves was carried out through the Martian sand. The calculation method is for Martian dust storms; the total measured optical depth ($\tau = 6$) is used instead of visibility at 0.67 micron wavelength. The attenuation can be expressed as

$$A(\lambda) = \frac{54.62r\tau}{\lambda}\left[\frac{3\varepsilon''}{(\varepsilon'+2)^2+\varepsilon''^2}\right] \tag{43.2}$$

where τ is the optical density, that is, a cloud opacity measurement. For vertical illumination, $I = I0\ e^{-\tau}$, I is the surface intensity of the signal, while I0 is the

no attenuation intensity [11]. Nevertheless, they did not explain how Mars' dust attenuation and the Earth were significantly different, despite the fact that both the NT and ρ values for storms of dust are identical in Mars and the Earth. If a particle size distribution is available, a different expression form can be used [3]:

$$A(\lambda) = \left[\frac{1.029\ X\ 10^6 \varepsilon''}{\lambda(\varepsilon' + 2)^2 + \varepsilon''^2}\right] \sum_i N_i {r_i}^3 \tag{43.3}$$

where *Ni* is the particle numbers and has radii between *ri* and *ri* + *Δri* per $m^3$. Actually, the term $\sum N\ r^3$gives mass loading of the dust. Using a normalized probability distribution of this formula can be implemented in order to achieve a maximum attenuation effect [10]:

$$A(\lambda) = \left[\frac{3.087\ X\ 10^6 \varepsilon'' N_T}{\lambda(\varepsilon' + 2)^2 + \varepsilon''^2}\right] \int_0^\infty N(r) r^2 dr \tag{43.4}$$

where NT is the density of particles in #/m3 and N (r) is the normalized radii density as shown in Eq. (43.4) and r is the mean radius of a particle to calculate attenuation:

$$A(\lambda) = \left[\frac{1.029\ X\ 10^6 \varepsilon''}{\lambda(\varepsilon' + 2)^2 + \varepsilon''^2}\right] N_T r^3 \tag{43.5}$$

where r is accomplished by integrating all particle sizes into N(r). Parameters of the dust storm have calculated attenuation of the radio wave on both the planets as a reference. We consider that particle size is the key difference in the parameters between Earth and Mars because the measurements of particles are ten times different in size. There is much less mass loading on Mars than on Earth, but the amount of density of dust is one-third of the Earth. Although optical visibility on Mars is not directly measured, we may calculate the parameter using the dust distribution:

$$V = \frac{5.5\ X\ 10^{-4}}{N_T\ r^2} \tag{43.6}$$

Using $N_T\ r^2$ values deduced from [12, 13], We find that Mars is much more visible than the Earth during the storms of dust.

## 43.3 Mars Dust Storm Attenuation

Although the atmosphere of Mars is very thin, the large dust storms can often be produced by Martian winds. This occurs in the late spring and early summer

seasons in the southern hemisphere, as Mars is on its perihelion. Finally, the southern hemisphere is warmed and compared to the northern hemisphere; a large temperature differential is set. It moves from the south to the northern hemisphere with heavy winds and dust. In this case, this process also depends on the wind speed. In any scenario, wind is not included in the earlier model:

$$P_r = \frac{P_t G_t G_r \lambda^2}{16\pi^2} \; |A_{ds}\,(\lambda) + \mathrm{F}\,(v_1)\,\rho_{s1}\Gamma_1\,(\Phi_1)\,\frac{1}{d_1}\exp\,(-jkd_1) + F\,(v_2)\;\rho_{s2}\Gamma_2\,(\Phi_2)\,\frac{1}{d_2}\exp\,(-jkd_2)\;\;(v_3)\,\rho_{s3}\Gamma_3\,(\Phi_3)\,\frac{1}{d_3}\exp\,(-jkd_3) + \ldots . + F\,(v_n)\,\rho_{sn}\Gamma_n\,(\Phi_n)\,\frac{1}{d_n}\exp\,(-jkd_n)\Big|^2 \tag{43.7}$$

where $A_{ds}\,(\lambda) = \frac{(8.232\;X10^6\,).\varepsilon''.w_d.\bar{r}\;N_T}{V.\left[(\varepsilon'+2)^2+\varepsilon''^2\right]}$.

Dust storms mainly happen in Mars' southern hemisphere, but they can cover the entire planet, as well. Since dust particle density $N_T$ is vary (from $N_T = 1\;X\;10^7 m^{-3}$ to $8\;X\;10^7 m^{-3}$). Consider wind speed $w_d$ (from 2 to 28 m/s) and $\varepsilon$' = 4 and $\varepsilon$" = 0.26 and particle density $\bar{r}$ = 1 μm to 20 μm [14].where $F(v_n)$ Fresnel integral is a function of Fresnel diffraction, $\Gamma_n(\Phi_n)$ is a loss of the nth ray reflection with an angle of incidence $\Phi_n$. The delay defines the phase of each ray and is shown by the component exp(−jkdn), Where $d_n$ is the distance traveled by the nth ray and $\rho_{sn}$ is reflection scattering of nth multipath loss factor. It refers to the sum of the reflector distances between the transmitter and the receiver. The angle of incidence is chosen at the Brewster angle, and the position of the reflector is calculated to allow the reflection to reach the receiver for the specified angle of incidence. The permittivity of the soil is determined by the wireless dielectric sensor on Martian surface. Diffraction of the knife-edge obstacle obtained the result in bending of signal and bending of signal due to knife-edge obstacle resulting in greater signal power than rounding [15]. Such obstacles are likely to be considered on Martian's terrain between the transmitter and the receiver. The diffraction gain is represented by the presence of a knife-edge:

$$G_d(db) = 20\;\log\,|\,F(v)\,|$$

The Fresnel integral, F(v), relies on the diffraction parameter v:

$$v = h\sqrt{\frac{2d_1d_2}{\lambda\,(d_1+d_2)}} \tag{43.8}$$

where h is the effective height between them at distance $d_1$ and distance $d_2$, with infinite width, d1 is the transmitter's distance, and d2 is the receiver's distance. The factor of scattering loss ρs is calculated by the Bothias formulation:

$$\rho_s = \exp\left[-8\left(\frac{\pi\sigma_h \cos\Theta_i}{\lambda}\right)^2\right] I_0\left[-8\left(\frac{\pi\sigma_h \cos\Theta_i}{\lambda}\right)^2\right] \tag{43.9}$$

where $\sigma_h$ is standard surface height deviation of the mean surface height and $I_0$ is the first kind of Bessel 0th order function. The areas are usually rough on the surface of Mars, and it may have a variable size terrain that may result in loss of scattering. There are few multipath elements expected since the mission lander will land on a relatively flat or smooth surface where the rover can be easily moved. At frequency of 2.4 GHz, the wavelength of the wireless signal transmission is 12.5 cm, and objects for reflection should be larger. The signal power is provided by the coefficient of reflection Γ below [16]:

$$\mathrm{Pr} = \frac{P_t G_t G_r \lambda^2}{16\pi^2 d^2} .|\ 1 + \Gamma\ \exp(j\Delta)|^2 \tag{43.10}$$

where $\Gamma = \frac{a.\sin\psi - \sqrt{(\varepsilon r - jx) - \cos^2\psi}}{a.\sin\psi + \sqrt{(\varepsilon r - jx) - \cos^2\psi}}$ is the reflection coefficient

$\Delta$ = reflected signal phase shift
$a$ = 1 or correspondingly for horizontal or vertical polarization
$\psi$ = the incidence angle between the transmitter and the reflector
$\varepsilon_r$ = surface relative permittivity

$$\mathrm{x} = \frac{\sigma}{2\pi \mathrm{f} \varepsilon_0}$$

$\sigma$ = conductivity of ground
$f$ = operating frequency
$\varepsilon_0$ = permittivity of free space

In this horizontal interest plane, the power radiated from the omnidirectional antenna and the power obtained from free space are defined by Friis equation under ideal communication conditions:

$$P_r = \frac{P_t G_t G_r \lambda^2}{16\pi^2 d^2} \tag{43.11}$$

Here $P_t$ is the transmitter power and $P_r$ is the receiver power, $G_t$ is the transmitter gain of antenna and $G_r$ is the receiver antenna gain, and λ is the wavelength of operation and d is the transmitter distance. The loss of the free space is a fundamental communication loss on the Martian surface since the atmosphere on the Martian surface is very thin compared with the Earth (Fig. 43.1).

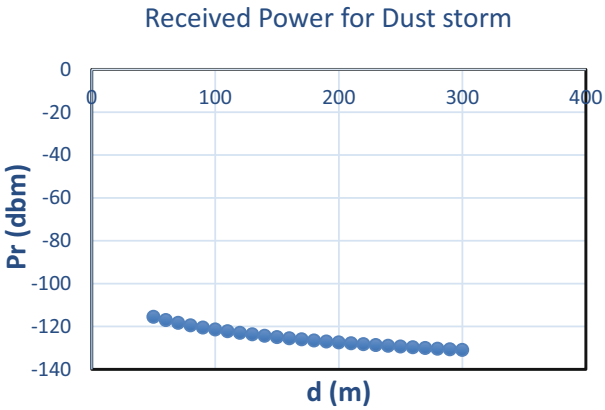
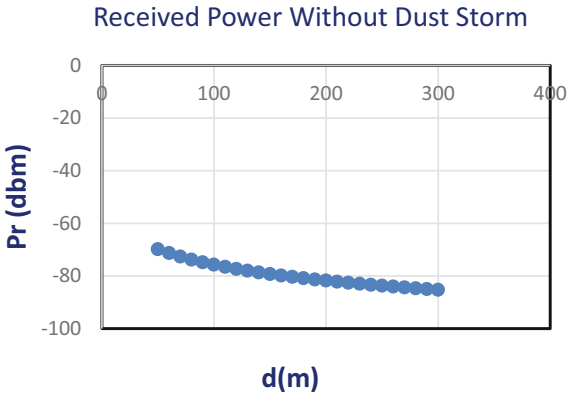



**Fig. 43.1** Distance vs. received power for dust storm propagation model

**Fig. 43.2** Distance vs. received power for channel propagation model without dust storm




## 43.4 Results

Mars wireless sandstorm model is presented with dust storm attenuation. Compare the results to the 0 dbm transmitter power without a dust storm and the dust storm (Fig. 43.2).

## 43.5 Conclusion

Due to the thin atmosphere of Mars, large dust storms can often be caused by Martian winds. In the presence of wind, the sand particles are lifted in the air, and the propagation environment for the radio signal changes. Based on the simulation of the model, there is a measurable impact of the sandstorms on the loss of the

received signal. There are two models which compare the results and observe the major difference in receiving power. The result shows that the received power at the receiver is reduced to around half with sandstorm attenuation. The model is based on the 2.4 GHz ISM band which is one of the most popular WSN bands. A term is added to take into account the absorption of the radio wave that is due to the presence of particles of sand and dust into the propagation of Mars. Furthermore, it is revealed that the wind speed is the most significant factor impacting the level of the additional attenuation.

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# Chapter 44
# Intelligent Infrastructure Support Software Using Singular Spectrum Analysis and Artificial Neural Networks: Applications on Transportation Forecasting

**S. Z. Kolidakis, G. N. Botzoris, V. A. Profillidis, and V. D. Balopoulos**

## 44.1 Introduction

Forecasting transport demand is both a science but also an art. It allows assessing, in real-time, unknown variables of traffic volume with a certain degree of logic and credibility. Time series and econometric methods, despite their apparent complexity, can nevertheless be overly simplistic [1]. In recent years, there is an obvious trend in transportation research to transform from simpler, linear, and low-dimensional into complex, nonlinear, and high-dimensional systems, mainly due to outstanding computational power increase, still not necessarily justified by fundamental or logic research needs [1].

The main research goal was to deliver realistic testimony for the effectiveness of air traffic demand hybrid forecasting methodology that was implemented by an integrated software application that could act as ready-to-use decision support toolbox. The major research challenges the authors investigated were:

- Is a hybrid model competent to generate robust monthly air traffic demand forecasting performance?
- Can this methodology be incorporated as a decision support system in an intelligent transportation systems (ITS) for air traffic volume forecasting real-life problems?

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## 44.2 Literature Overview

Statistical methods are commonly used for long-range forecasting. Successful applications of statistical methods on various scientific topics for the forecast of the future evolution of crucial variables can be found in [2–9].

Hassani [10] applied the SSA methodology for the analysis and forecast of monthly accidental deaths (USA) during the period 1973–1978 and then collated SSA with other methods (such as SARIMA, Holt-Winters algorithm, etc.) for forecasting results. After a brief introduction and the concerning of the basic features of SSA methodology and the differences with other statistical methods, the author described the advantages of decomposing a time series into a set of distinct and interpretable components, such as trend, oscillatory, and structureless (also referred as noise) component. An extended analysis of the mathematical background of the two complementary stages of the SSA methodology (decomposition and reconstruction) was followed by the presentation of the case study (accidental deaths in the USA) and the necessary data set (monthly data between the years 1973 and 1978). During real data application, noteworthy remarks were presented such as rule of thumb for window length selection, separability index of w-correlation, singular values, pairwise scatterplots, and periodogram analysis. Thus, generic stages of SSA were performed, trend and harmonics were identified, the noise was detected, and the forecast was implemented. The comparison of the forecasting ability of the applied methods (SSA, SARIMA, Holt-Winters algorithm, etc.) was based on the statistical criteria of MAE and MRAE, the measures of which proved that SSA ensures more accurate forecasts than the other methods.

Hassani and Thomakos [11] provided the theoretical background, and they examined the various methodological aspects of SSA. They described the analysis of a time series characteristics in order to forecast its future evolution, in the context of economic and financial issues. After presenting a thorough description of SSA, the authors introduced two new SSA approaches, which were based on minimum variance and perturbation theory. Noteworthy was the causality test based on forecasting accuracy, where the history of one variable can advance the forecasting ability of another. Thus, two forecasting methodologies were applied and compared, and if forecast error from the first forecasting methodology was smaller than forecast errors from the second forecast methodology, then it was safe to suggest that there was a causal relationship between two variables. As a non-parametric method for smoothing and trend extraction, SSA provided outcomes that were comparable or better than those obtained by contemporary methodologies. The authors concluded that as a forecasting method SSA was given some promising results; however, SSA has not revealed yet its full dynamics.

Karlaftis and Vlahogianni [12] performed a wide-ranging overview in transportation literature discussing the major comparison between conventional statistical methods and artificial intelligence, reviewing benefits, constraints, and resemblances of each scientific approach.

Raeesi et al. [13] applied feed forward artificial neural networks (FFANN) on traffic volume forecasting. The authors approached time series modeling and forecasting with artificial intelligence techniques on a study case of Monroe – Louisiana, USA. The FFANN architecture performed a nonlinear mapping from past observations to the future values, with a two-layer architecture. Experimental outcomes presented a promising forecasting model, while forthcoming research could focus on FFANN architecture investigation.

Srisaeng et al. [14] focused on forecasting Australia's low-cost passenger demand and revenue passenger kilometers performed, using ANN and conventional econometric models. Passenger demand foresting is crucial for airlines, investors, fleet planning, and airport maintenance. The authors proposed a methodology for passenger forecasting and compared the experimental outcomes with econometric models such as multiple linear regression (MLR). The research presented a thorough literature investigation for both MLR and ANN, where the basic econometric model was fed with six inputs. ANN multilayer perceptron was used, where the first layer had inputs for airfare, GDP, population size, unemployment rate, accommodation, interest rate, jet fuel prices, and four dummies inputs.

Chen et al. [15] compared k-nearest neighbor searching and ANN (k-ANN) for daily electronic toll collection, which took under consideration the external factors such as holidays, weather, free of the highway, etc. Both proposed architectures were analyzed, and the experiment was carried out from February 2011 to August 2015. Inputs were traffic data, day of the week, whether the day is a holiday or not, whether the highway is free or not, weather conditions, wind force, and traffic flow. Results comparison was executed using relative error (RE) and mean absolute percentage error (MAPE). The authors claimed that experimental results proposed k-NN better performance and lower errors than ANN.

Kolidakis and Botzoris [16] assessed the forecasting ability of ANN architecture, using typical statistical criteria as a performance measure. Experimental outcomes identified an ANN architecture with superior forecasting capacity for Sydney airport passenger traffic volume, which accomplished noteworthy and considerable low variation (2.20%) between the actual and the forecasted passenger air traffic volume. The authors advocated that an intelligent transportation system which incorporates the suggested forecasting methodology accelerates promising interventions in air transportation management that would both moderate the economic and environmental effects and enhance operation and maintenance of air transport infrastructure.

## 44.3 Intelligent Infrastructure Support Road Map

The idea of a combined forecasting approach highlighted advantages, while inhibited limitations of hybrid component methodologies were very promising and needed further investigation to insight all necessary methodologies' characteristics that could empower a robust forecasting performance in transportation research.

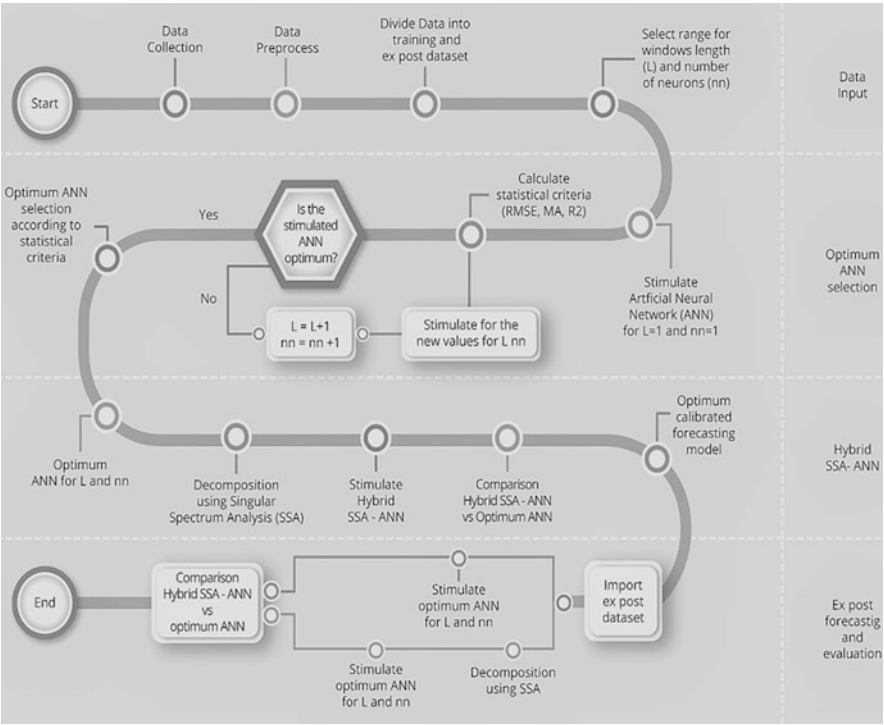


**Fig. 44.1** The road map of the proposed methodology

Artificial intelligence which employed hybrid SSA-ANN was a valuable forecasting methodology for complicated real-life study cases, like traffic volume. It was the prevailing belief that hybrid models presented a superior forecasting capacity related to conventional ANN models [1, 17, 18]. The suggested hybrid methodology relied on the mixture of SSA and ANN, implemented with a ready-to-use "Forecasting Software**-**Beta version" application.

Suggested hybrid SSA-ANN model objective was to improve forecasting capability following steps below [17] (Fig. 44.1):

- Step 1: Data input
- Step 2: Optimum ANN architecture selection
- Step 3: Hybrid SSA-ANN forecasting model implementation
- Step 4: Ex-post forecasting ability evaluation

### 44.3.1 Step 1: Data Input

The first step of the proposed methodology referred to the data input level. It was crucial to obtain a critical mass of traffic volume data in order to investigate the applicability and forecasting ability of the proposed methodology. Data preprocessing was a major task before performing any time series analysis task. The aim of the preliminary data analysis was to attain the "feel" for the data, and a perception of how robust and solid the underlying patterns, such as trend and seasonality, were [19].

### 44.3.2 Step 2: Optimum ANN Architecture Selection

The second step of the proposed methodology referred to data optimum ANN selection level. One major parameter of the proposed methodology was the selection of optimum ANN topology according to forecasting ability performance, based upon statistical criteria. Two factors that defined forecasting model performance were lagged inputs and the number of neurons at hidden layers. These parameters were critical and important because they defined the number of possible topologies to be investigated, in the proposed methodology. In order to evaluate the topology that would present optimum forecasting performance, authors defined a range of numbers for both lagged inputs and the number of neurons, where usually there was a trade-off between the total number of topologies to be investigated and the duration of computational processes.

### 44.3.3 Step 3: Hybrid SSA-ANN Forecasting Model Implementation

The third step of the proposed methodology referred to the hybrid SSA-ANN level. The idea of a combined forecasting approach highlighted advantages, while inhibited limitations of both hybrid component methodologies were very promising and needed further investigation to insight all necessary methodologies' characteristics that could empower a robust forecasting performance in the transportation field.

The main idea of hybrid forecasting models was to combine forecasting methodologies in a way that could enhance forecasting ability against conventional forecasting models. A successful combination of conventional forecasting models into a hybrid forecasting model derived its potential from eliminating the weaknesses of conventional forecasting models and amplifying the advantages of forecasting models separately. In the case of the proposed hybrid SSA-ANN forecasting model, our intention was to exploit the decomposition functionality of SSA methodology and superior nonlinear performance of ANN methodology. The main advantages of

the hybrid model where SSA has the ability to decompose air traffic volume data and ANN ability to deliver promising forecasting performance in complex real-life, real-time air traffic volume forecasting problems.

### *44.3.4 Step 4: Ex-post Forecasting Ability Evaluation*

The fourth step of the proposed methodology referred to data ex-post forecasting and evaluation level [20]. The main reason that ex-post evaluation was engaged to assess the forecasting performance of the proposed model was the requirement to test the generalization ability for an independent dataset that was not involved in the training process [21]. The necessity of ex-post evaluation derived from the fact that in many cases high forecasting performance of ANN was attributed to the embedded ability of ANN to overfit. This property of ANN lied on the fact that during training and validation on historical data, the learning process tried to imitate real values, and ANN converged its behavior very close to real values. Thus, the artificial learning process fails to developed real artificial intelligence (AI) characteristics and was deficient in a mimic performance that cannot be generalized in real-life forecasting problems.

## 44.4 Empirical Study Using Forecasting Software: An Application on Transportation Traffic Volume Forecast

### *44.4.1 Data*

Monthly air traffic volume time series was recorded for the Australia airports of Sydney and Darwin [22] (Figs. 44.2 and 44.3). Sydney international airport is located 8 km (5 mi) south of Sydney city center. It is the primary airport serving Sydney, one of the longest continuously operated commercial airports worldwide and the busiest airport in Australia. It was the 38th busiest airport in the world in 2016. Darwin airport is the busiest airport serving the Northern Territory and the tenth busiest airport in Australia during 2018.

### *44.4.2 Forecasting Software Application*

The authors developed and implemented custom software applications for real-time air traffic volume time series analysis and forecasting, embedding techniques of ANN and SSA. The software application “Forecasting Software-Beta version” was developed upon MathWorks MATLAB. This decision was related, primarily, to prior

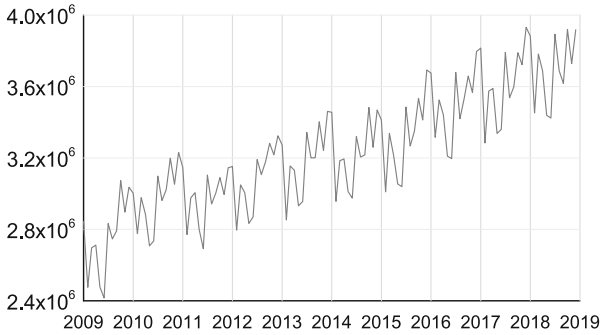


**Fig. 44.2** Sydney airport monthly passengers

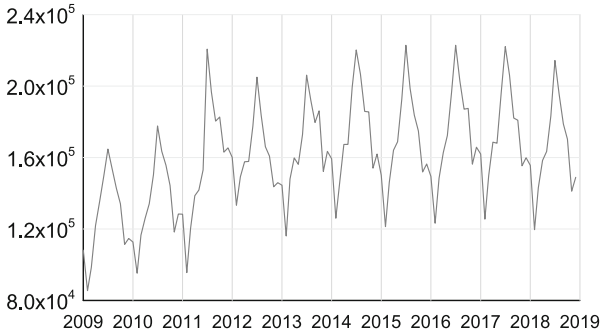


**Fig. 44.3** Darwin airport monthly passengers

programming experience and knowledge of MathWorks MATLAB as well as to all programming benefits and assets of MATLAB such as scalability, interoperability, embedded toolboxes, web applications, and extensive support and knowledge community. "Forecasting Software-Beta version" is a user-friendly custom software (Figs. 44.4 and 44.5), in which all necessary modules and components such as software graphical user interface, functions, statistical measures, forecasting algorithms, and graphical and arithmetical outputs were designed and developed by the authors for scientific and research purposes, not for business exploitation. All figures (except Fig. 44.1) and tables presented in this paper are created and captured from the software "Forecasting Software-Beta version."

Thus, in the specific example, the authors, using "Forecasting Software-Beta version," investigated 24 lagged inputs $\times$ 50 neurons in hidden layer $=$ 1200 different ANN architectures in order to identify the optimum ANN architecture for these ranges of lagged inputs and number of neurons in the hidden layer. For the case study of Sydney airport, optimum architecture achieved with 02 lagged inputs and 17 neurons in the first hidden layer (architecture notated as 02–17), according to Fig. 44.6. For the case study of Darwin airport, optimum architecture achieved with 13 lagged inputs and 16 neurons in the first hidden layer (architecture notated


**Fig. 44.4** "Forecasting Software-Beta version" – Main menu

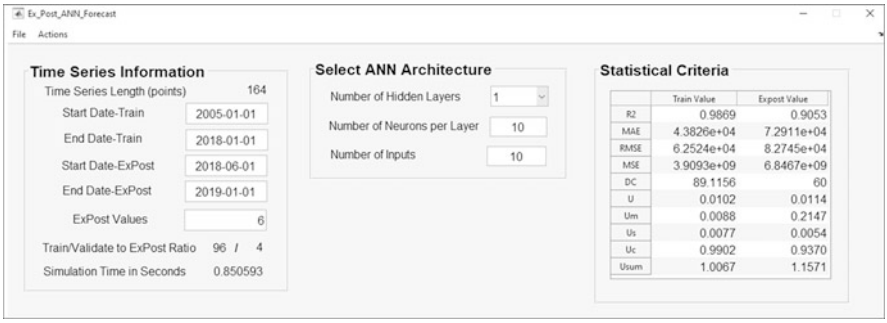


**Fig. 44.5** "Forecasting Software-Beta version" – Ex-post forecasting menu

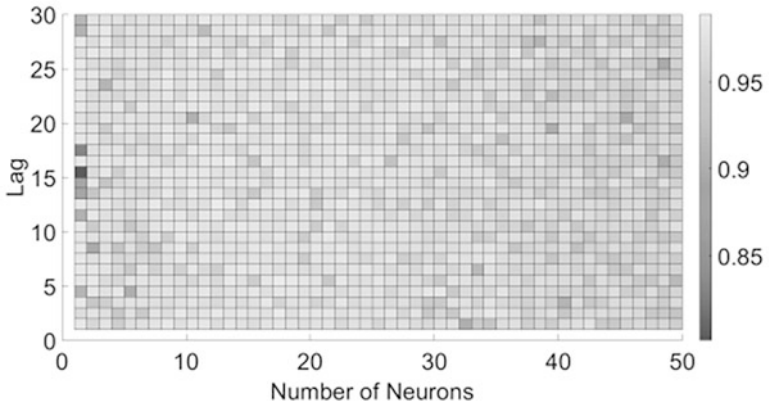


**Fig. 44.6** $R^2$ for one-layer ANN – Sydney

as 13–16), according to Fig. 44.7. Optimum $R^2$ for both airports are presented in Table 44.1.

Simulation of case studies of Sydney and Darwin airport is illustrated in Figs. 44.8 and 44.9, where hybrid SSA-ANN forecasting models achieved to capture

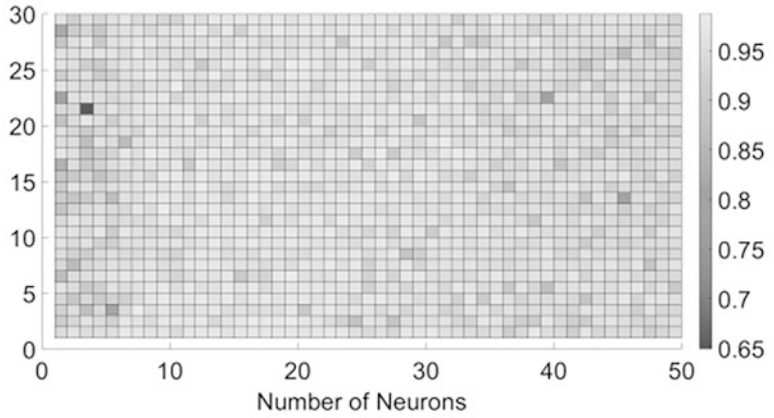


**Fig. 44.7** $R^2$ for one-layer ANN – Darwin

**Table 44.1** Statistical criteria $R^2$ for optimum one-hidden layer ANN architecture

| Airport | ANN architecture | $R^2$ |
|---|---|---|
| Sydney | (02–17) | 0.9885 |
| Darwin | (13–16) | 0.9871 |

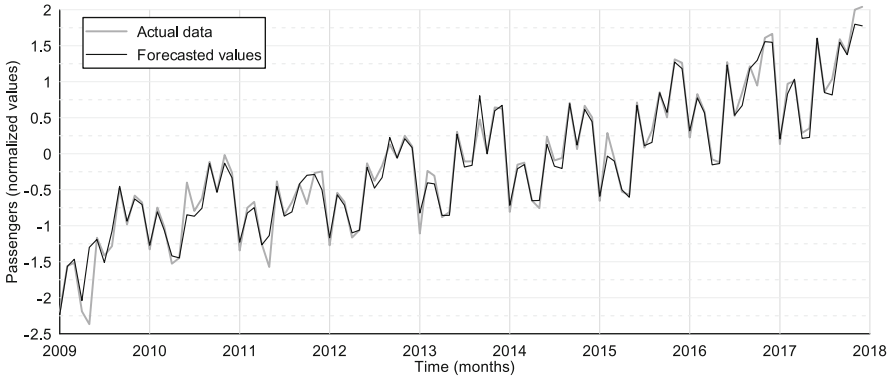


**Fig. 44.8** Hybrid SSA-ANN forecasts – Sydney airport

all the significant characteristics of measured data since it followed both the upward and downward path of the waveform (breakpoints), while it remained close to original time series, maintaining forecasting error in low level [23]. Hybrid SSA-ANN forecasting model results visualization which highlighted the improvement that SSA decomposition conducted to the proposed forecasting model, while numerical analysis (Table 44.2) verified the improvement of the forecasting performance of the proposed hybrid SSA-ANN model.

Hybrid SSA-ANN model results visualization (Figs. 44.10 and 44.11) which highlighted the robust forecasting performance that SSA decomposition conducted

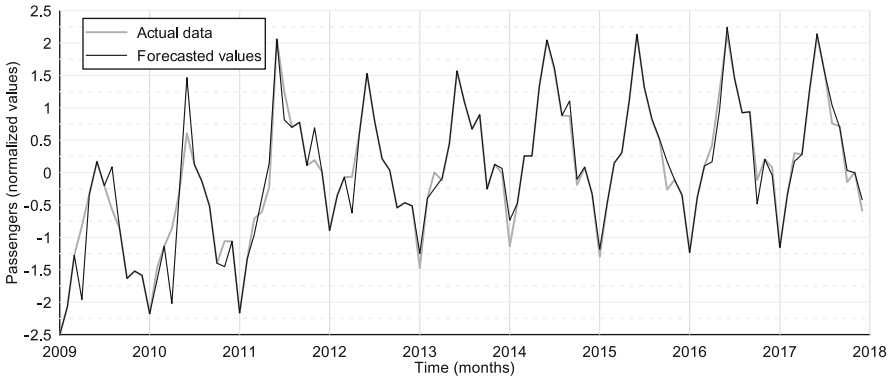


**Fig. 44.9** Hybrid SSA-ANN forecasts – Darwin airport

**Table 44.2** Statistical criteria $R^2$ for the hybrid SSA-ANN forecasting model

| Airport | $R^2$ |
|---|---|
| Sydney | 0.9843 |
| Darwin | 0.9743 |

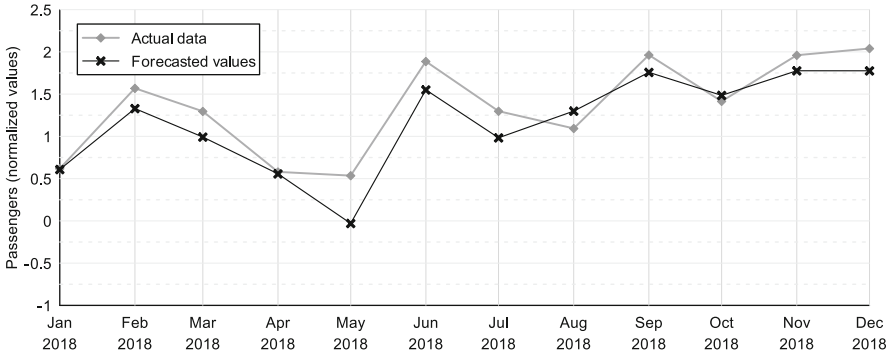


**Fig. 44.10** Ex-post hybrid SSA-ANN forecasting performance – Sydney airport

to the proposed forecasting model, while numerical analysis (Table 44.3) verified the superior forecasting performance of the proposed hybrid SSA-ANN model.

## 44.5 Results and Conclusions

Contemporary time series and econometric forecasting models, despite their apparent simplicity, possess several inherent limitations. One of the major limitations was that when time series and econometric methods dealt with traffic volume forecasting problems, they assumed a linear approach, even though traffic volume time series demonstrated nonlinear characteristics. Additionally, they emphasized

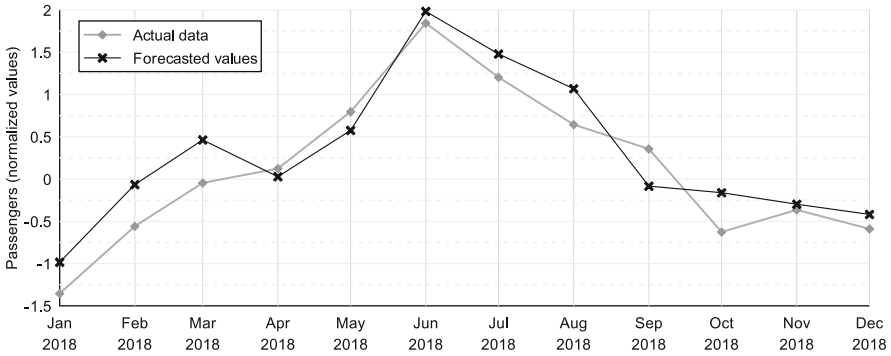


**Fig. 44.11** Ex-post hybrid SSA-ANN forecasting performance – Darwin airport

**Table 44.3** Statistical criteria $R^2$ for the ex-post hybrid SSA-ANN forecasting model

| Airport | $R^2$ |
|---|---|
| Sydney | 0.9325 |
| Darwin | 0.9385 |

on establishing a causal relationship and identifying trend or moving average and independent variables even though the causal relationship introduced unreliability and inaccuracy. Another major constraint of conventional forecasting methods was their deficiency in managing big data from different sources as well as that their econometric relationship and structure remains unchanged, even though traffic volume data were volatile due to human behavior.

The proposed hybrid methodology managed successfully the nonlinear characteristics of traffic volume dataset since ANN performed in both linear and nonlinear models that enabled them to capture in a detailed manner all significant characteristics of underlying real-life mechanisms nonlinearities. Also, robust forecasting ability of proposed methodology derived its potential from ANN's adaptivity in changing characteristics that describe volatile air traffic volume time series. Thus, the authors achieved to develop real-time traffic volume forecasting algorithm that embeds techniques of AI such as ANN and SSA with an improved performance against conventional ANN forecasting performance in all applied case studies.

Real-life applications of ITS require a proactive managing procedure that supports operating, maintenance, and management of transportation systems. A major factor for the implementation of such functionality was the forecast of traffic volume in different time interval horizons in order to identify traffic volume peaks or trends and be able to confront scheduled maintenance operations and encounter extreme incidents or accident situations. Proposed hybrid methodology with the implemented "Forecasting Software-Beta version" encompassed all these utilities and could be very helpful for the improvement of transportation system management. In conclusion, the authors managed to develop a hybrid traffic volume forecasting methodology that, when embedded in a contemporary ITS, could be engaged as a decision support system in ITS and could help the optimization of

operation, management, and maintenance of transportation systems, as well as it could moderate economic and environmental effects of extended transportation infrastructure investments and traffic congestion.

**Conflicts of Interest** The authors declare that there is no conflict of interest regarding the publication of this paper.

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# Chapter 45
# A Novel Modified DC/DC/AC Converter for Maximum Power Point Tracking from Photovoltaic System

**K. Banumalar, R. ThulasiLakshmi, B. V. Manikandan, and K. Chandrasekaran**

## 45.1 Introduction

High gain DC-DC converters are currently an important study area as required to the huge requirement of this knowledge for near requests as renewable energy causes, entrenched structures, transferrable electronic equipment, and constant power supply [1]. To enhance voltage gain and efficiency, various converters are proposed [2–5]. When a greater step-up ratio, the expected output from isolated converters is good [6, 7]. The converters with renewable energy sources have more productivity due to increased costs. In a power transformer, a power conversion system with an output voltage about ten and twenty times that of input voltage corresponding to duty-cycle equal to 0.80. Energy shortage and ecological toxic waste problems have enhanced the use of hygienic energy renewable resources such as wind, fuel cell, and solar power system [8–11].

## 45.2 Proposed System

Solar PV integrated with the grid using full-bridge inverter is given in Fig. 45.1. The solar PV input is given to the modified DC-DC boost converter. Here, the output voltage is improved when the input PV voltage is low, since the name

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J. S. Raj (ed.), *International Conference on Mobile Computing and Sustainable Informatics*, EAI/Springer Innovations in Communication and Computing,
https://doi.org/10.1007/978-3-030-49795-8_45

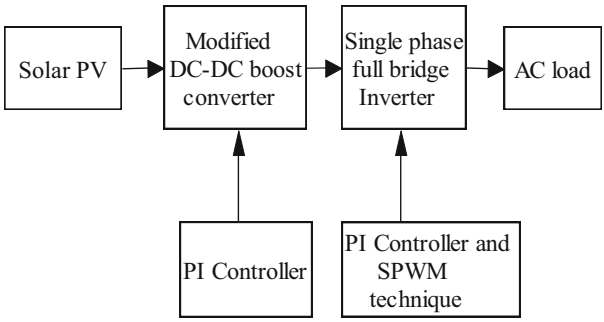


**Fig. 45.1** Block diagram of proposed system

boost converter. Now the input source for the inverter is fed from the proposed converter. The desired switching frequency is achieved by the gate pulse generation in open-loop system. The output of the inverter can be now applied to all single-phase AC load applications. PI controller and SPWM technique used to maintain constant output voltage in closed-loop system. With this excellent control circuit, the satisfactory results of improved efficiency, reduced ripples, and good performance characteristics are obtained more than the expected results. This proposed system can now be applied to any of the AC load applications.

### *45.2.1 Modified DC-DC Boost Converter*

The circuit topology of the proposed system is given in Fig. 45.2. It has a diode, input capacitor, power MOSFET, output capacitor, input side inductor, universal bridge, and resistive load. The input side diode and capacitor used to predict the partial shading effect and to keep the input voltage constant and power MOSFET acts as a switch. Inductor acts as an energy-storing element. The output side capacitance acts as a filter. Converter output is connected as an input source of the inverter. Inverter configuration used here is a universal bridge of MATLAB built-in model. It has two number of bridge arms. The inverter is controlled using SPWM technique [12–15], to maintain required output voltage by varying the modulation index.

The proposed system functions in continuous conduction mode in which current over the inductor never goes to zero, that is, inductor partially discharges before the start of the switching cycle. Figures 45.3 and 45.4 show the modified converter under MOSFET which is ON and OFF state.

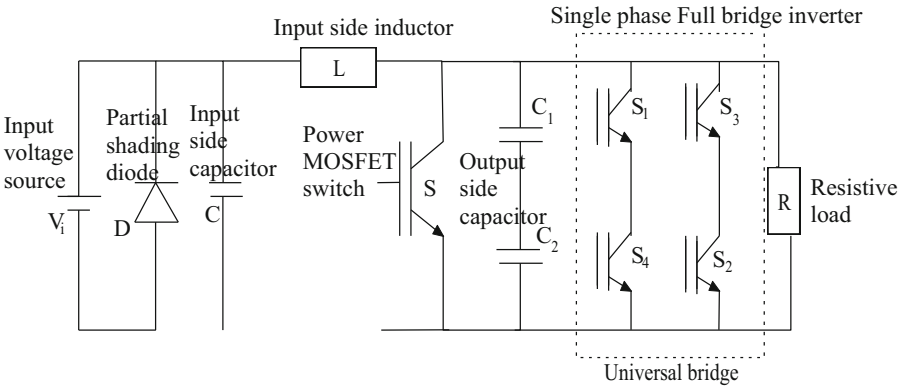


**Fig. 45.2** Modified converter

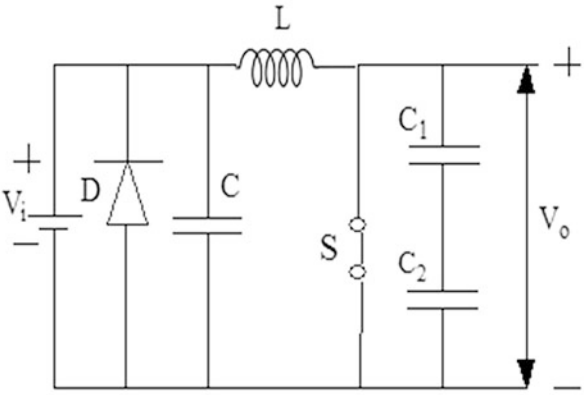


**Fig. 45.3** MOSFET – ON state

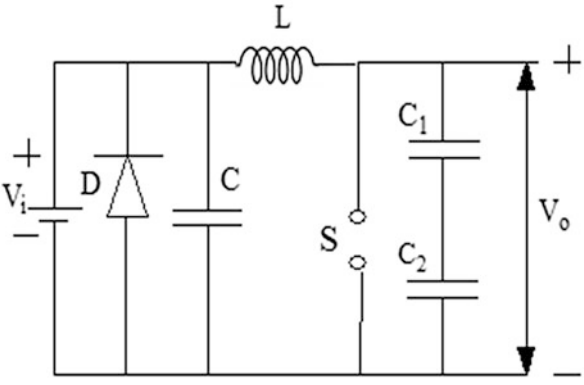


**Fig. 45.4** MOSFET – OFF state

### *45.2.2 Single-Phase Full-Bridge Inverter*

The inverter is used to transfer input DC voltage to output AC voltage. The power IGBT switch that is used here is capable of conducting bidirectional current. Figures 45.5 and 45.6 represent the inverter when the switch $S_1$, $S_2$ is ON and $S_3$, $S_4$ is OFF and vice versa.

## 45.3 Design Equation for Boost Converter

The equations used to calculate output voltage, load inductance, and capacitance are as follows:

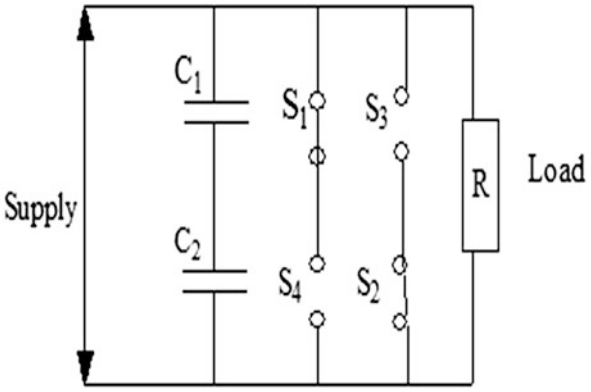


**Fig. 45.5** Inverter switch $S_1$, $S_2$ – ON

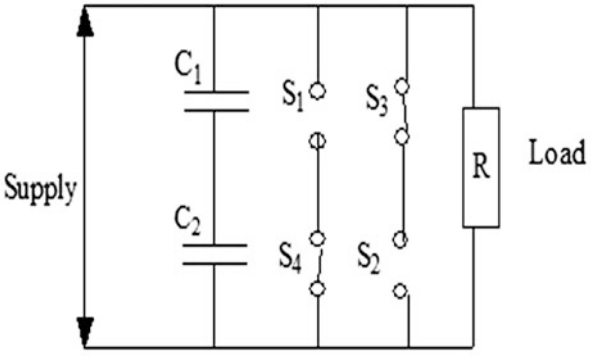


**Fig. 45.6** Inverter switch $S_3$, $S_4$ – ON design equation for boost converter

**Table 45.1** Parameters of modified converter

| Parameters | In open-loop system | With MPPT | With PI controller | Full-bridge inverter |
|---|---|---|---|---|
| Input voltage | 17–22 V | 17–22 V | 17–22 V | 17–22 V |
| Output voltage | 110 V | 110 V | 110 V | 110 V |
| Switching frequency | 5 KHz | 5 KHz | 5 KHz | 5 KHz |
| Inductor | 0.6897 mH | 0.6897 mH | 0.6897 mH | 0.6897 mH |
| Input side capacitor | 20 μF | 20 μF | 20 μF | 20 μF |
| Load side capacitor | 110 μF | 110 μF | 110 μF | 110 μF |
| Resistive load | 90 Ω | 90 Ω | 90 Ω | 90 Ω |

$$\text{Output voltage } V_o = \frac{V_i}{1-\delta} \tag{45.1}$$

$$\text{Gain } \delta = 1 - \frac{V_i}{V_o} \tag{45.2}$$

$$\text{Inductance } L = \frac{V_i D}{\Delta i_L f} \tag{45.3}$$

$$\text{Capacitance } C = \frac{i_c}{\Delta V_c f} \tag{45.4}$$

$$\begin{aligned} \Delta V_c &= 5\% \quad of \quad 110V \\ \Delta I_L &= 1\% \quad of \quad 1.1A \end{aligned} \tag{45.5}$$

Where $V_i$, $V_o$ is the input voltage, and output voltage $D$, $\delta$ is the duty cycle, and gain $I_L$, $V_c$ is the current across inductor and capacitor. According to the design employed and market availability, the parameters used are shown in Table 45.1.

## 45.4 Simulation and Results

### *45.4.1 Boost Converter Including PV in Open-Loop System*

The MATLAB simulation diagram for modified DC-DC boost converter with PV modeling for the open-loop system is shown in Fig. 45.7. The blue color, red color and green color curve represents current-voltage and power-voltage plot of a solar panel for a temperature of 0 & 25, 45degree Celsius are shown in Fig. 45.8.

For the input voltage of 22 V DC, input voltage and current obtained from the solar panel are 19 V DC, 5.5A in open loop. Figures 45.9 and 45.10 represent the input voltage and the current waveform. The gate pulse generated is shown in

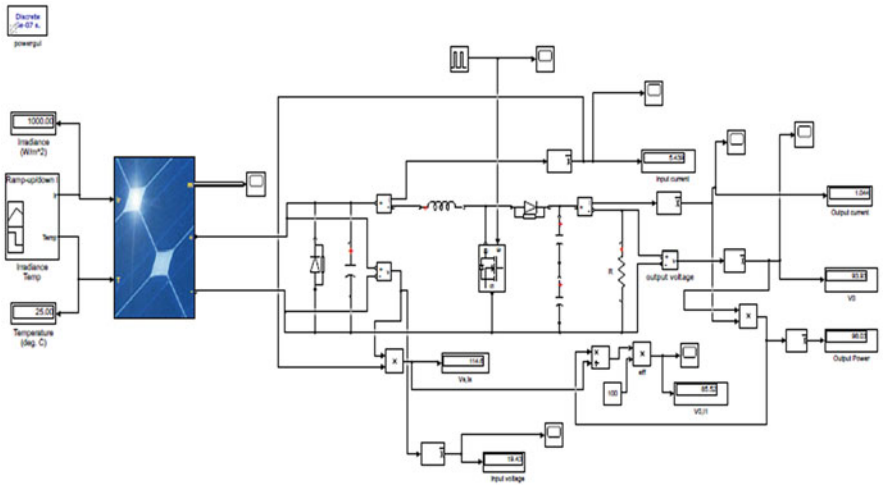

**Fig. 45.7** Boost converter including PV for open-loop system

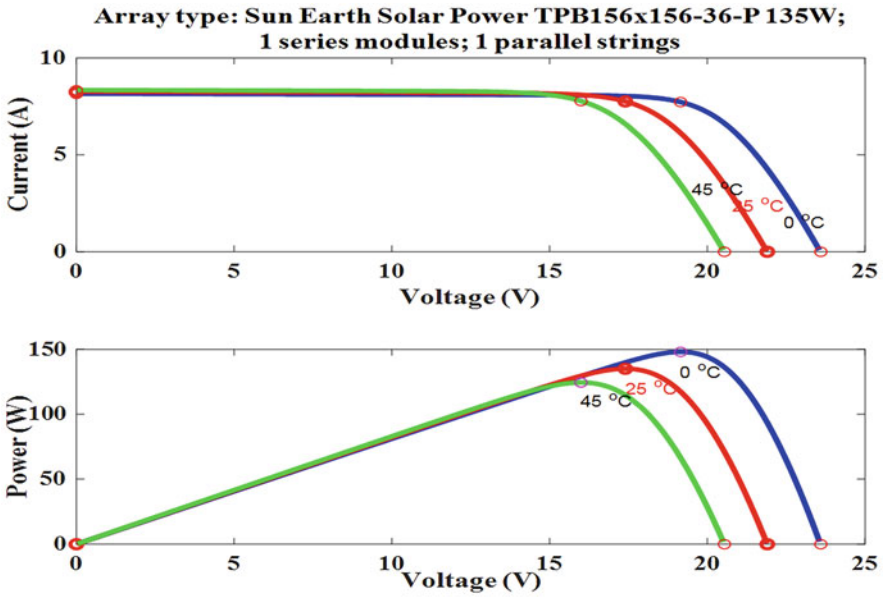


**Fig. 45.8** Characteristics curve of solar

Fig. 45.11 for a modified converter. For input voltage of 22 V DC, output voltage and current obtained are 95 V DC, 1.1A in open loop shown in Figs. 45.12 and 45.13.

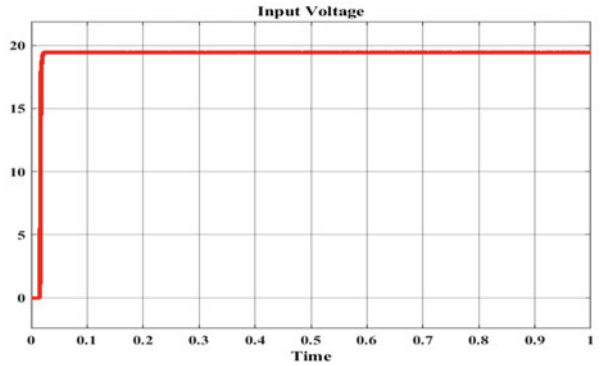


**Fig. 45.9** Input voltage

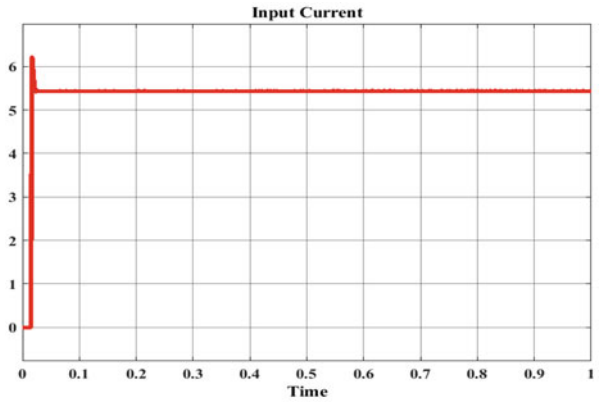


**Fig. 45.10** Input current

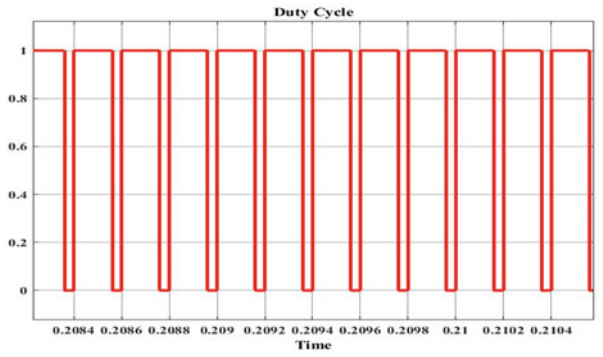


**Fig. 45.11** Gate pulse waveform

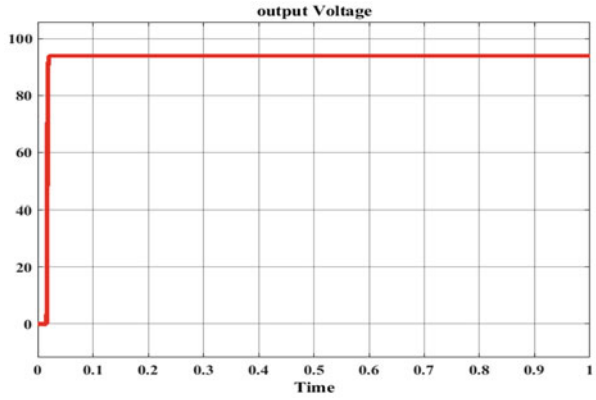


**Fig. 45.12** Output voltage

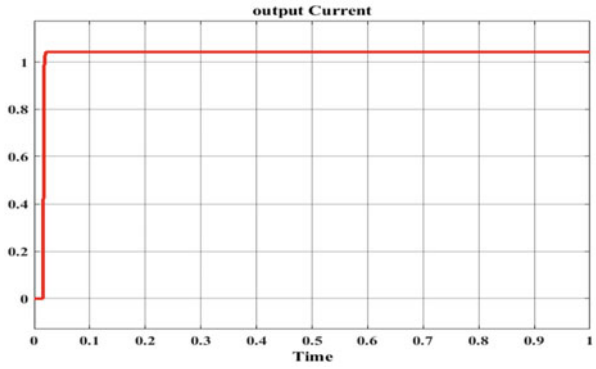


**Fig. 45.13** Output current

### *45.4.2 Boost Converter Including PV with MPPT in Open-Loop System*

The MATLAB simulation diagram for the proposed converter with PV modeling and MPPT is given in Fig. 45.14. For the input voltage of 22 V DC, input current obtained from the solar panel is 6.25A.

Voltage and current input waveform are in Figs. 45.15 and 45.16. The output voltage waveform obtained through simulation in Fig. 45.14 the Matlab-Simulink model boost converter with MPPT. The output voltage and current obtained are 100 V DC, 1.1A as shown in Figs. 45.17 and 45.18.

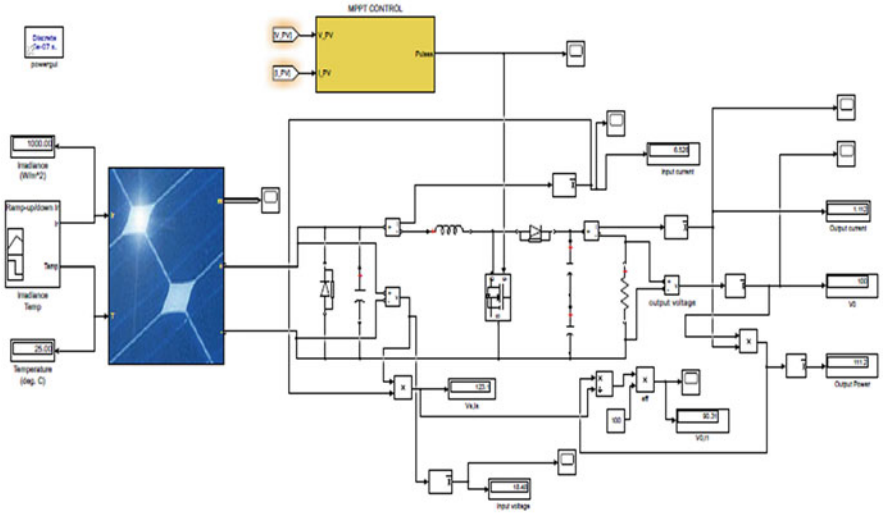


**Fig. 45.14** Boost converter with PV and MPPT in open-loop system

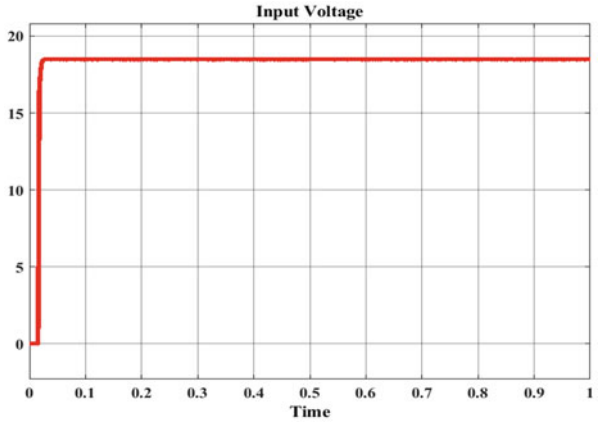


**Fig. 45.15** Input voltage

### *45.4.3 Boost Converter Including PV with PI Controller in Closed-Loop System*

A closed-loop control scheme is one, which utilizes open-loop system as its frontward path, but has one or more feedback loops or paths linking its input and its output. Here the output is feedback to the input through the PI controller given in Fig. 45.19. For the input voltage of 22 V DC, input current obtained from the solar panel is 8.25A in closed loop. The input waveform is in Figs. 45.20 and 45.21. The gating pulse generated through PWM is given in Fig. 45.22. The output waveform

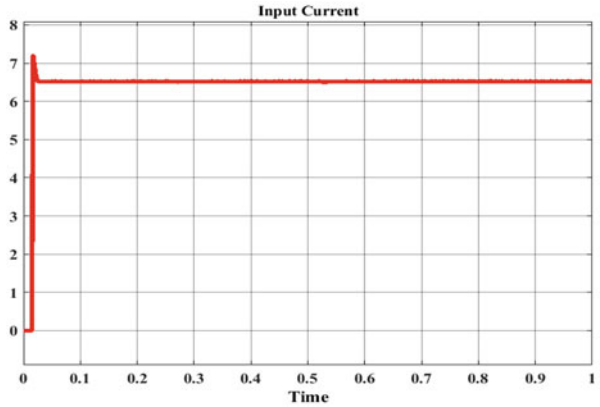


**Fig. 45.16** Input current

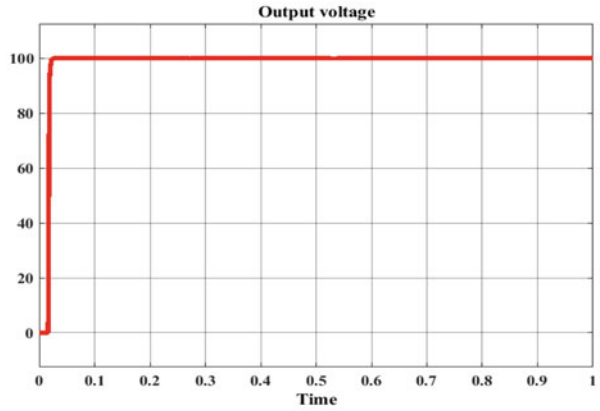


**Fig. 45.17** Output voltage

through simulation in Fig. 45.19 the Matlab-Simulink model boost converter with PI controller. In Fig. 45.19 assuming that the DC output of solar is 22 V DC, the output voltage and current obtained are 109.2 V DC, 1.2A as shown in Figs. 45.23 and 45.24.

### *45.4.4 Boost Converter Including PV with Inverter in Closed-Loop System*

The Boost converter with PV and inverter in the closed-loop system is given in Fig. 45.25. For the input of 100 V DC, input voltage obtained from PV is 100 V, and

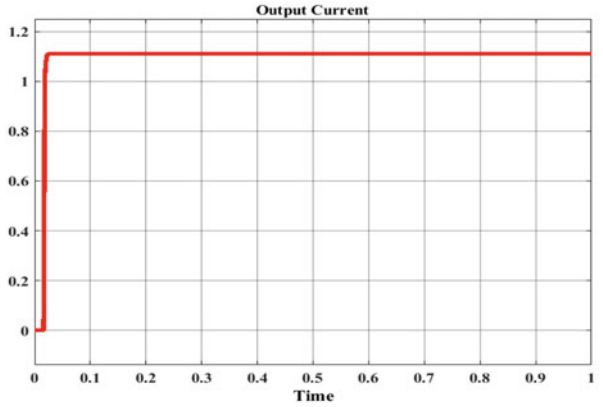


**Fig. 45.18** Output current

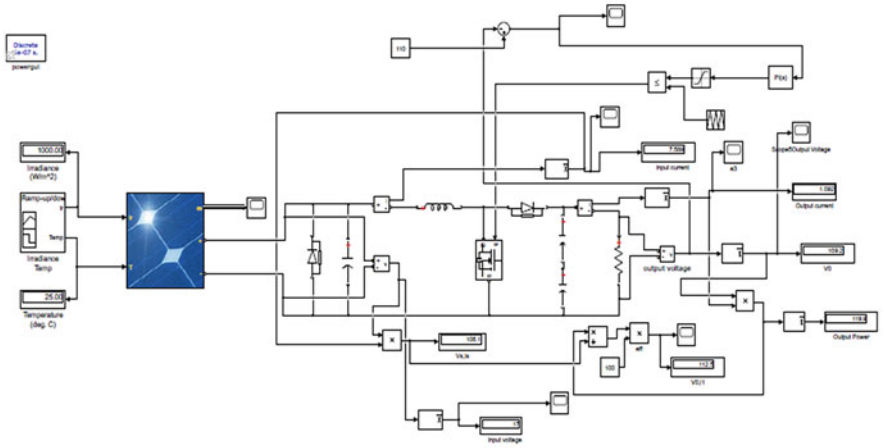

**Fig. 45.19** Boost converter with PI controller

gate pulse generation waveform is in Figs. 45.26 and 45.27. The output voltage and current obtained are 100 V AC, 1.1A as shown in Figs. 45.28 and 45.29.

### *45.4.5 Hardware Implementation of DC-DC Boost Converter in Open Loop*

The experimental verification has been done to evaluate the performance of the converter in open-loop system. The power MOSFET switch is used here. Assuming that, the input voltage given to the proposed inverter is 6.2 V DC and the input

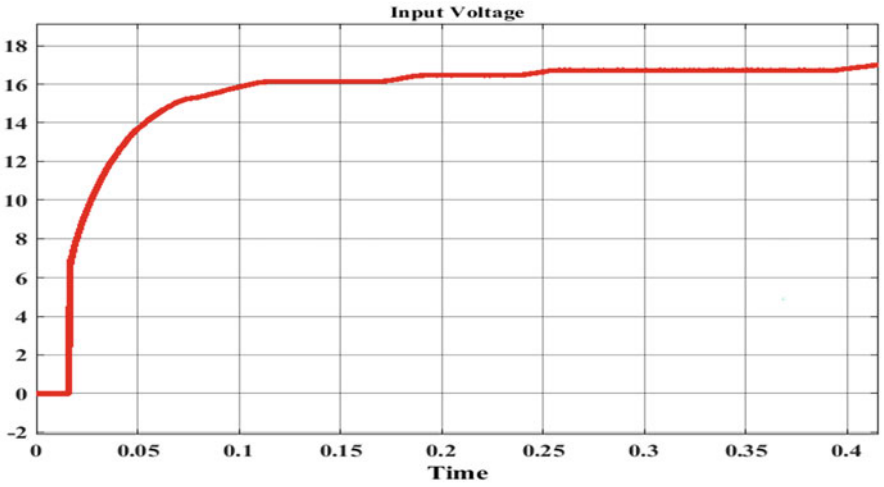


**Fig. 45.20** Input voltage

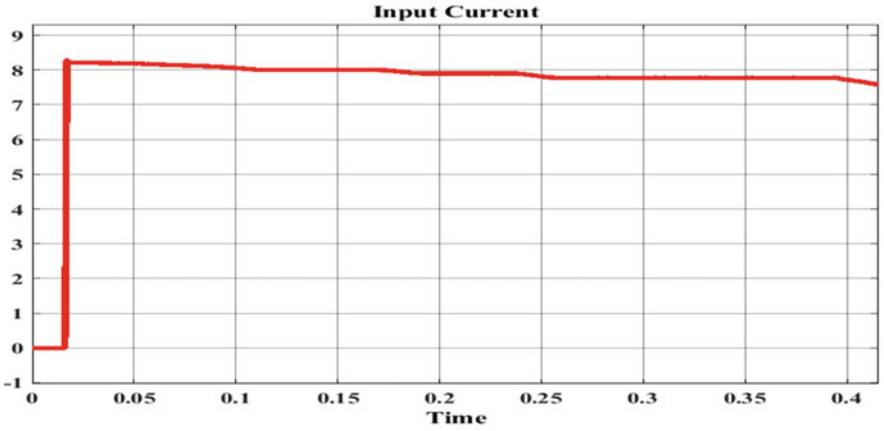


**Fig. 45.21** Input current

current of 2.63A. The output voltage obtained is 18.86 V DC as shown in Fig. 45.30. The simulation and hardware results are verified.

## 45.5 Performance Analysis

This paper has presented a comparison to four different DC-DC converters as shown in Table 45.2, in relation to their voltage, current, power, and efficiency.

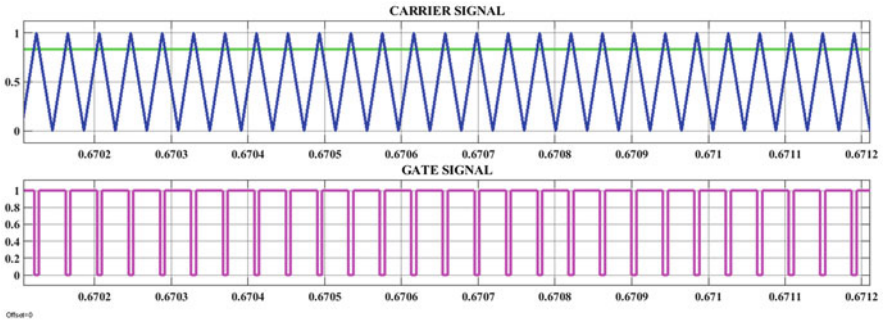


**Fig. 45.22** The pulse generated from PI controller through PWM mode

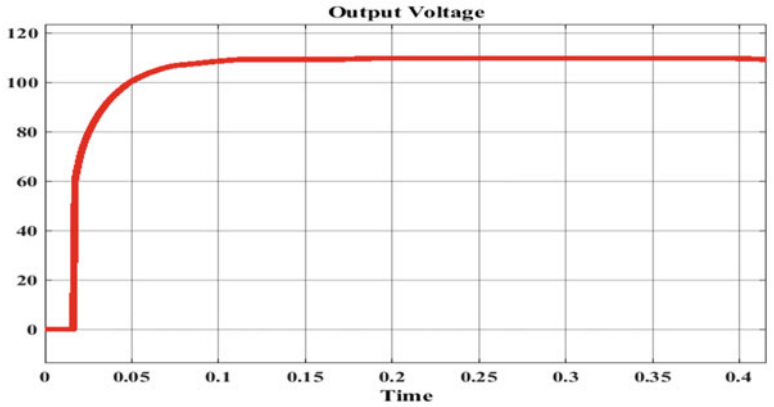


**Fig. 45.23** Output voltage with PI controller

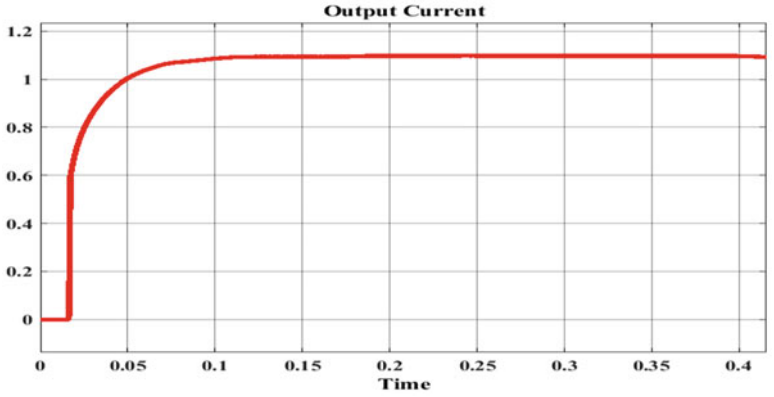


**Fig. 45.24** Output current with PI controller

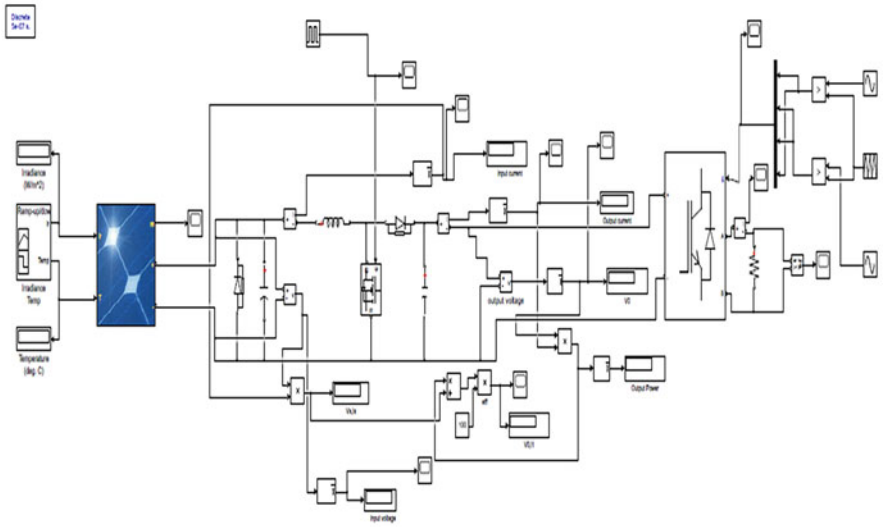

**Fig. 45.25** Boost converter with inverter

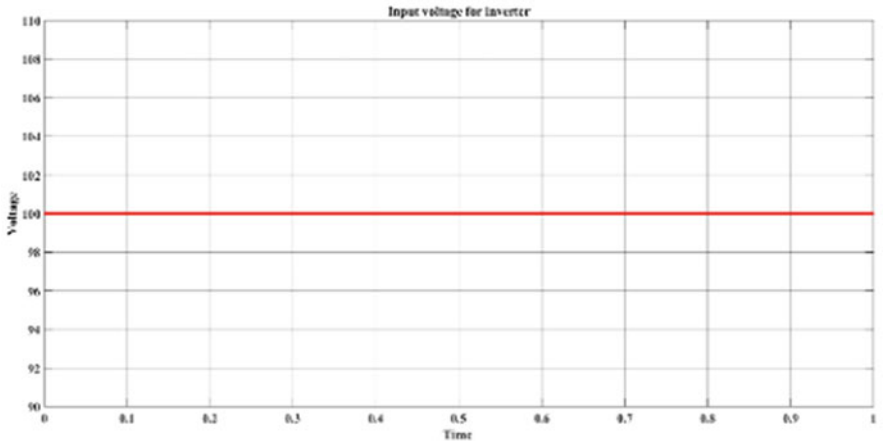


**Fig. 45.26** Input voltage for inverter

The comparison result of DC-DC converter in open loop, with MPPT, with PI controller and full-bridge inverter in Table 45.2 show that, the DC-DC converter with PI controller and full-bridge inverter having higher efficiency and proved that

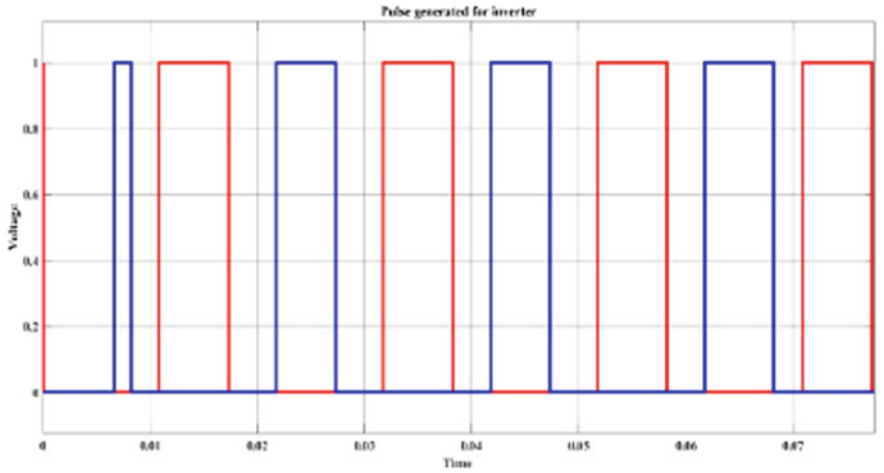


**Fig. 45.27** Pulse generated from inverter

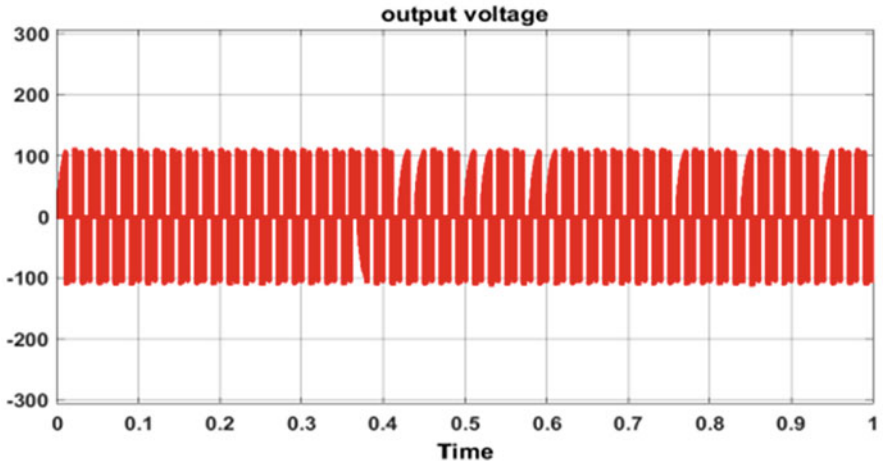


**Fig. 45.28** Output voltage from inverter

it is such a better performance on the output voltage, output current, and efficiency when compared to other modes of operation.

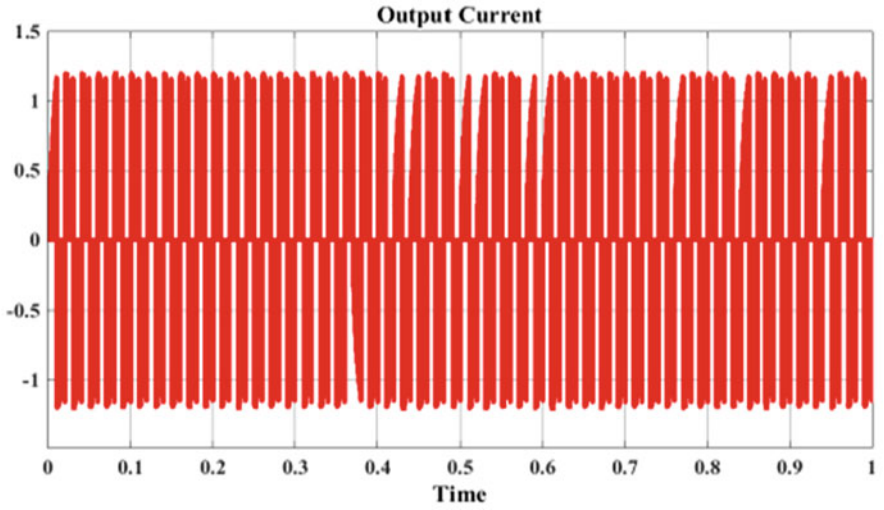


**Fig. 45.29** Output current from inverter

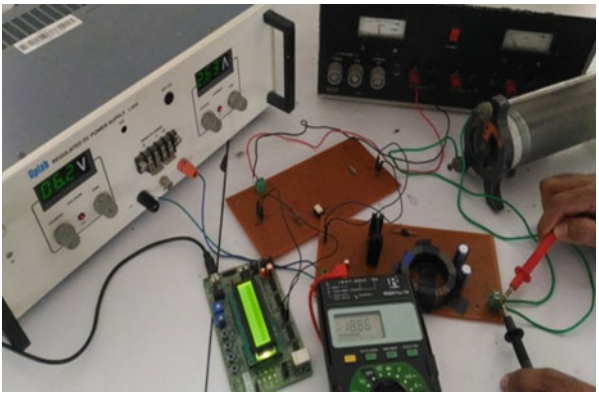

**Fig. 45.30** Voltage measurement – hardware arrangement

**Table 45.2** Comparison of proposed DC-DC boost converters

| Parameters | In open loop | With MPPT | With PI controller | Full-bridge inverter |
|---|---|---|---|---|
| Input voltage | 19.43 V | 18.0 V | 17 V | 100 V |
| Input current | 5.439 A | 6.45 A | 7.9 A | 1.04 A |
| Input power | 114.6 W | 116.1 W | 134.3 W | 95.03 W |
| Output voltage | 93.93 V | 100 V | 109.2 V | 100 V |
| Output current | 1.044 A | 1.1 A | 1.2 A | 0.94 A |
| Output power | 98.03 W | 110 W | 131.04 W | 87.42 W |
| Efficiency | 85.54% | 94.74% | 97.57% | 98% |

## 45.6 Conclusion

In this work, a modified isolated DC-DC boost converter with inverter is presented. It involves a high gain single switch operation, and it is suitable for several renewable applications. Simulation is performed for the proposed system for both open-loop and closed-loop system. The proposed system with converter and inverter is analyzed through simulation, and the results were presented. Hardware realization has also been done for the open loop, and an attempt has also been made for the closed loop incorporating PI controller. The results obtained are quite encouraging. Future work implies the three-phase inverter which can be applied to all AC applications.

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# Chapter 46
# Study on Hybrid Wind-Solar Power Generation System with THD Minimization Using Improved Rider Optimization Algorithm


**S. Ravikumar, H. Vennila, and R. Deepak**

## 46.1 Introduction

Recently, the field of power electronics witnesses a great demand for employing different inverters in different fields. Multilevel inverters (MLI) are generated by overcoming the shortcomings of the traditional inverters. Some of the multilevel inverters are diode-clamped, flying-capacitors, and the H-bridge cascaded (CHB). In the first type of MLI mentioned, only a limited amount of voltage is transferred by the diodes, and hence the stress on other electrical devices gets diminished. Then, in the flying capacitors multilevel inverter, the only limited amount of voltage will be transferred to the device, when the capacitors are in series connection. Further, to bring down the components count in each level, the capacitors and switches together are utilized in the CHB-MLI. Generally, multilevel inverters are being implied in the field of medium and high-power applications as they have embedded a huge number of advantages within themselves like minimized electromagnetic interference (EMI) outputs, reduced harmonic contents, and very low power dissipation on power switches. It can also generate the output voltages with very low distortion, and this is called STATCOM (STATic COMpensator). Apart from this, a practical solution to diminish the harmonics of AC waveforms as well as to enhance the power in the multilevel inverters is by eliminating the harmonic distortions.

In the modern power system, power quality (PQ) is a crucial requirement. With the desire of maintaining the desired operations in the field of power electronics and to maintain the quality of power, it is necessary to measure the THD. In the

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transformers, the eddy current losses are generated by the undesired harmonics, and this may lead to serious consequences in the operating temperature of the transformer. Further, this variation in the temperature may also affect the capacitors by means of heating the dielectric medium. The conductor gets overheated when the harmonics in the current expands, and this, in turn, leads to skin effect. In the case of harmonics in the power supply, improper measurements can be acquired from the meters utilized for utility purposes. Apart from this, harmonics also increases the temperature of the motor windings by means of multiplying the losses in the core of the motor. This also reduces the overall life span of the equipment by slowly overheating them. Hence, there is a necessity to minimize the THD in the multilevel inverters.

The diode-clamped inverter through a most relevant MLI is not utilized in larger extent since the maximum output voltage of the inverter is equal to the half of the input DC voltage and the distortions couldn't be eliminated completely with the PSO and GA that are the genetic algorithm and the particle swarm optimization, respectively. With the flying capacitors multilevel inverter, the in-phase redundancy in switching balances the flying capacitors. Further, reactive as well as active power flow can be curtailed in the flying capacitors multilevel inverter. Apart from this, the switching losses take place due to high-frequency switching during the distortion minimization by GA along with the sinusoidal PWM technique. Further, the employment of bulky transformers is reduced in the cascaded H-bridge multilevel inverter. Each of the individual cells needs a huge set of isolated supply voltages to operate, and THD minimization is a bit difficult. Hence, there is a necessity to develop a novel technique for minimizing THD in multilevel inverters.

## 46.2 Literature Review

In 2017, Hagh et al. [1] proposed a new-PSO algorithm in order to diminish the total THD in the output staircase voltage corresponding to the multilevel inverter. The magnitude of the dc input sources, as well as switching angles, were optimized by PSO by means of an analysis of the staircase output voltage. The seven-level inverter was utilized for validating the effectiveness of the proposed method in terms of THD, output voltage level, and on the count of switching angles.

In 2011, Etesami et al. [2] formulated the imperialist competitive algorithm (ICA) for multilevel inverter's output waveform, with the desire of achieving THD minimization (THDM) strategy. The proposed ICA model was compared with traditional approaches like GA and PSO. The outcomes of the research had exhibited an enhancement in the performance of the model proposed over the prevailing terms of the convergence rate in reaching to the global minimum.

In 2018, Garapati et al. [3] developed a new configuration of switches with the intention of providing five voltage levels as output from the H-bridge multilevel inverter (MLI). In addition, to diminish the percentage of total harmonic distortion

(THD), LS-PD-PWM technique was formulated. Further, with the desire of reducing the THD at the output,

PI and the FLC were utilized to govern the cascaded H-bridge inverter. The proposed THD minimization scheme was implemented in MATLAB/SIMULINK environment.

In 2014, Rao et al. [4] proffered ANFIS in order to abolish the voltage harmonics available in the multilevel inverter. For the actual load voltage as well as the reference voltage, the prediction of the voltage variation of the multilevel inverter was determined, and this was employed to ANFIS for THD reduction.

In 2014, Ajami et al. [5] formulated a THD that is novel to minimize the technique for the MLI-cascaded transformers with the desire of minimizing THD by means of optimizing the transformers' turn ratio as well as the switching angles of the inverter output voltage. Further, to diminish THD and to fundamental components corresponding to the output voltage, the genetic algorithm is utilized. In addition, the nine-level cascaded transformer inverter prototype was utilized with the intention of verifying the feasibility of the proposed approach.

In 2018, Mohapatra et al. [6] introduced a novel differential evolution algorithm (DEA) with the desire of measuring the losses of switches of CHB-multilevel inverter with the help of using insulated-gate bipolar transistor (IGBT) as the switch. The proposed model was efficient in evaluating the conduction and switching loss. Further, the proposed model had minimized THD by optimizing the switching angle as well as the modulation index.

In 2012, Farokhnia et al. [7] proposed a novel-switching strategy with the aim of minimizing the total harmonic distortion (MTHD). The minimization of THD was achieved by modifying DC voltages of capacitors in the corresponding multilevel flexible AC transmission systems. The fundamental components of the system, as well as the THD deduction, were accomplished with the genetic algorithm. The proposed model was verified by constructing a seven-level cascaded inverter-based hardware prototype.

In 2016, Massrur et al. [8] developed selective harmonic elimination named stochastic THD (STHD) strategy on the basis of multilevel flying capacitor inverter (MFCI) in order to diminish the total harmonic distortion (THD). In addition, the evaluation of the switching angle variations as well as the unbalancing of flying capacitor voltages was accomplished by $2\ m + 1$ point estimate strategy. The minimization of THD was done by the cuckoo search algorithm and a self-adaptive mutation tactic.

## 46.3 Problem Statement

From the literature review given in Table 46.1, PSO utilized in [1] overrides the problem of unity as well as optimizes the input dc sources. In contrast to this, the low-order harmonics were not eliminated completely, and this is insufficient in obtaining a unique answer from polynomial equations. In ICA [2], the count of

**Table 46.1** Features and challenges of THD minimization in multilevel inverters

| Author [citation] | Adopted methodology | Features | Challenges |
|---|---|---|---|
| Hagh et al. [1] | PSO | 1. Overrides the problem of unity<br>2. Optimizes input dc sources | 1. Instable in eliminating the low-order harmonics completely<br>2. Unable to obtain a unique answer from<br>3. Polynomial equations |
| Etesami et al. [2] | ICA | 1. The searching process lacked the number of references required for the fitness function<br>2. Reduces the precise line voltage of MLI | 1. Constrained nonlinear problems are not optimized<br>2. High-power loss |
| Garapati et al. [3] | LS-PD-PWM technique | 1. Low-power loss<br>2. The overall cost is minimized | 1. Not applicable for higher output voltage levels |
| Rao et al. [4] | ANFIS | 1. V output, P output, and the power quality are enhanced<br>2. Shows minimum THD for varying loads | 1. Nonlinearity results in poor power quality due to loads found in the system<br>2. Mainly the power quality problems are due to nonlinear loads |
| Ajami et al. [5] | Genetic algorithm | 1. Both isolations of transformers and THD minimization take place | 1. To achieve modulation indices, it is impossible to adjust the turn ratios in the transformers |
| Mohapatra et al. [6] | DEA | 1.Solves the problem of unequal current sharing among the switches | 1. High-power loss |
| Farokhnia et al. [7] | Genetic algorithm | 1. The effective reduction in phase and line voltage THD can be achieved | 1. Low-order harmonics are not omitted completely |
| Massrur et al. [8] | STHD | 1. Considers the effects of the dead time and the unbalancing capacitor v | 1. Low sensitivity<br>2. Inflexible steps of unequal v levels |

the fitness function in the search process is low, and hence global solution can be obtained by eliminating the local solutions. It suffers from the drawbacks of high-power loss, and this method was insufficient in optimizing the nonlinear problems. With LS-PD-PWM technique [2], the overcost of THD minimization is low, and power loss is also low. This model does not suit to higher output voltage levels. The output voltage and output power quality are enhanced with the ANFIS. Apart from this, the power quality is low. Moreover, the problem occurs due to nonlinearity loads connected in the system which causes THD. In the genetic algorithm [5], the isolation of the transformers and THD minimization takes place, and here the tuning of the turn ratios is highly complicated, such that modulation indices couldn't

be achieved for different transformers. The problem of unequal current sharing among switches is rejected by DEA, and it has the drawback of high-power loss. Then, the genetic algorithm employed in [7] minimizes THD in terms of phase and line voltages. But, this model does not reject the low-order harmonics completely. Moreover, with STHD [8], the dead time and the unbalancing capacitor voltages are considered for THD minimization. STHD suffers from high losses. Thus, there is a necessity to have an optimal THD minimization approach in the multilevel inverters.

## 46.4 Methodology

The proposed hybrid power generation system will include the solar as well as wind energy system generating system, converters, and full-bridge inverter. The solar panels will be available for solar power conversion; wind power generation done through the synchronous generator with the permanent magnet has both the full-bridge rectifier and many converters. The energy obtained from both wind and the solar system uses the interphase transformer and converters to get connected with the three-phase full-bridge inverter. Initially, the solar and wind energy system will provide the generated power to the converters for converting AC power to DC. As the main contribution, ***PI controllers proportional and the integral gain parameters will be optimized by the improved rider optimization algorithm (ROA).*** Converters output voltage and the setpoint voltage are given as the input to the ROA. ROA [9] is an algorithm based on the racers who aim to win. THD in the system is reducing using the proportional and the integral gain. The full-bridge inverter will get the control pulses from the sinusoidal pulse width modulation (SPWM) scheme to convert the DC voltage to AC sinusoidal signal. The interphase transformer observes and ensures the voltage variation in the DC voltages at each instant independent operation without any circulating current respectively. Finally, from the transformer, the generated power will be transferred to the load. Figure 46.1 manifests the proposed hybrid power generation system.

## 46.5 Rider Optimization

In ROA there are four sets of riders called bypass riders, follower riders, overtaker riders, and attacker riders. Each rider groups have there on a predefined strategy to follow and to reach the target point. The group 1 riders – bypass riders, can reach the target point with the leading path. The initialization of that group can be represented by the statement equation:

$$Y[t] = \{Y(t)\ \ (i, j)\}, 1 \leq i \leq P; 1 \leq j \leq M \tag{46.1}$$

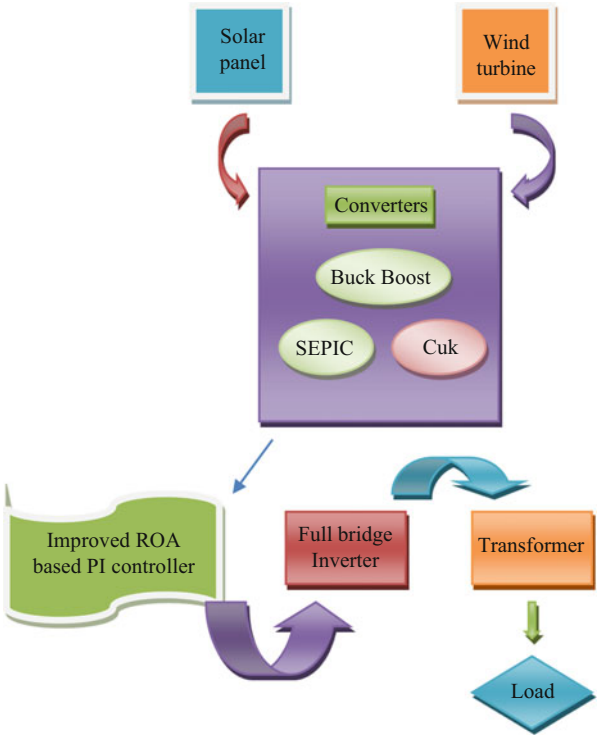


**Fig. 46.1** Proposed hybrid power generation system

P is the rider count, M is the optimization problem dimension, t is time constant and Y[t] is the rider position at instant t, bypass rider is the leading group rider, and the position update is done by the following equation:

$$Y\ [t+1]\ (i,j) = \left[\alpha Y\ (t)\ \ (\varepsilon, j) * \sigma\ \ (j)\right] + \left[Y\ (t)\ \ (\gamma, j)\right] * \gamma\left[1 - (j)\right] \tag{46.2}$$

α is a random variable that is either 0 or 1, η is a random number that is either [1] or [P], and γ is a number ranging from 1 to P. The σ characterized is as [0, 1], size 1 × Q. 2.

The followers are the group of riders; they follow the bypass riders. Therefore the position of the followers is in respect of bypass rider. Follower position update is done by,

$$Y\ F\ \ (t+1)\ \ (i,k) = YN\ \ (N,k) + j\ \cos\left[(S\ (ti)\ , k * YN\ \ (N,k) * d\ (ti)\ , k)\right] \tag{46.3}$$

k selects coordinates, YN is the bypass-rider position, N is bypass-rider index, S ti is the steering angle of the ith rider in the kth coordinate, and dt i is the distance estimated to cover by the ith rider (46.3).

In addition to chasing its own path, the overtaker is collecting the idea for following the bypass rider. The overtaker position depends on the relative success rate, direction indicator, and the coordination selector. The overtaker gathers his information as well as the bypass rider. The overtaker position update is done using the following equation:

$$\text{Yo}\ (t+1)\ (i,k) = \text{Y}\ (t)\ (i,k) + [\text{D I t}\ (i)]\,[\text{YN}\ (N,k)] \tag{46.4}$$

The main advantage of this algorithm is that each rider updates its position by the respective equations by controlling the various rider parameters like brake (N), gear (E), acceleration (e), and the steering angle (S).

**Algorithm**

```
Input: Random position of the rider Yi
Output: Leading rider YN
whilestopping criteria is not satisfied do
Initialize the population
Initialize rider parameters: Steering angle S
Gear E, Acceleration e, and Brake N
Find the success rate rt
While t < Toff
Fori = 1 to P
Update the position of bypass rider using Eq.. (46.1)
Update the position of follower rider using Eq.. (46.2)
Update the position of overtaker rider using Eq.. (46.3)
Update the position of attacker rider using Eq.. (46.4)
Rank the rider based on rt;
Select the rider having maximum rt as the leading rider;
update S,E,e,L:
Return YN;t = t + 1
end for
end while
end
```

## 46.6 Expected Outcome

If the proposed model will be implemented in MATLAB and the experimental analysis will be carried out, an improved result will be here, and the proposed hybrid power generation system will be compared over the existing approaches in terms of THD analysis and controlled output.

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# Chapter 47
# Apple Fruit Quality Identification Using Clustering


**Rahul J. Mhaske, Siddharth B. Dabhade, and Prapti Deshmukh**

## 47.1 Introduction

India is an agricultural nation. Nearly about 60% Indians are directly or indirectly dependent on the business based on agriculture products. It plays a very important role in the Indian economy. Farmers are mostly dependent on the yield of agricultural products; therefore, there is a need to focus on agriculture products which can be of good quality. To scale the economic situation of current poor or low landholder farmers, there is a need to export their products in a demanding market in a good quality [1]. One of the major farm products is fruit. Fruits are very useful to enhance human health. Physicians always suggest good quality fruit to the patients in order to recover from the diseases. Fruits contain different types of vitamins, proteins, etc. which can be helpful to our human body. Hence there is a need to provide good quality fruit in the market. The main reason for eating fruit is to maintain good health. Quality of fruit also considers the storage, transportation, disease, etc. factors [2–5]. Loss of fruit quality in a developing country is approximately 20–40% before the harvest, and also during transportation or storage, some sort of damages have occurred.

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## 47.2 Importance of Quality Fruit

The term quality implies the degree of excellence of a product or its suitability for a particular use. Quality is a term that can show the suitability of the product in an effective manner. A human being can compare N number of parameters to decide the quality of any product or item. The N number of parameters may be appearance, aroma, texture, taste, nutritional, chemical importance, functionality, mechanical,etc. Only humans can decide the quality and instruments that identify the attributes which are decided for the quality measurement [6]. Quality is either depend on the product or consumer requirement [7–9].

## 47.3 Feature Extraction Techniques

Features can be extracted from the image in various ways like statistical features, nonstatistical features, color, texture, etc.

### *47.3.1 Color Feature*

The color image consists of three important colors like red, green, and blue. These colors have different intensity levels. By using this color intensity as features, it is processed, and according to that, results were observed by various researchers. Zou Xiaobo [10] has classified the apple fruit into four grades like reject, class I, class II, and extra. They have developed an organization feature parameter (OFP) method and compared their results with BP-ANN with SVM classification. The mechanism behind the OFP is a genetic algorithm. Overall accuracy is 95% on the fruit surface color. Guo Dong [11] has segmented the image on the basic color with the help of hierarchical prototype learning (HPL). For prototype generation, self-organizing map (SOM) and simulated annealing (SA) were used. Color space is even very useful in the identification of internal structure or defects in pickles using hyperspectral camera [12]. Most of the people were attracted to the fruits because of colors; hence, color is a very important factor while deciding the quality of fruits. Every time only the surface color of the fruit is evaluated for grading the fruit quality [13]. There are plenty of fruits that are available in the market which is red in color like apple, pomegranate, tomato, etc. Audrey Darrigues et al. [14] has developed a tool which can work on phenotype and genotype-based classification of various fruits like potato, cucumber, red plum, muskmelon, carrot, and strawberry. Even they have created the tomato analyzer to find the phenotype. In the computer, vision colors are represented in RGB and HSV color space.

RGB color space has used a combination of red, green, and blue in different ways which can reproduce the colors. Even on the display, it is used as various

combination of the intensity level of each color, the value of intensity color from 0 to 255. By the formation of various additive color intensity, it produces nearly 16,777,216 shades of colors. Most of the old displays were using 16 or 256 colors only with very few memory. HSV color space is an advanced version; it is known by hex-cone color. The working of HSV color space is similar to CMYK or RGB, but there is a slight difference. (H) indicates the hue, i.e., pure color. We have to consider the color wheel which can work upon the pure color value between the 0 and 1, and value is calculated as the corresponding position of wheel in which the fractional values are considered for the representation of color, for example, red color refers 0 value, whereas yellow color uses 1/6 value, and green color uses 1/3 value and so on. Then (S) is a saturation for white color. Representation of pure red color saturation of white color value is 1. (V) is the representation of darkness of the color. The black color is shown 0 value. For the formation of light color, the wheel should be away from the black. Sometimes the value of V is replaced by the brightness, and then this representation is called HSB [15]. H.D. Cheng and other have shown the advantages of color-based segmentation by using various color space like CIE spaces, HIS, YIQ, Munsell, hybrid color space, Nrgb (normalized rgb), etc. with a different type of algorithms [16]. Guy Rosman has shown the color-based image segmentation and processing with various approaches [17]. Current growth stage of blueberry is identified in natural environment using color [18]. Sometimes watershed algorithms are used in combination with color for the segmentation of image for grading the quality of fruits [19]. While deciding the qualities of the fruit by various grading, sometime ripeness of the fruit is also considered for the neural network models used for the recognition of the color [11, 20]. Whenever we are processing the color manually by our necked eyes or through the system on sensors, it is divided into three different approaches based color spacer, i.e., hardware-orientated spaces, human-orientated spaces, and instrumental space. Hardware-orientated space is defined in the properties of the hardware devices used to reproduce the colors. Most of the popular color space comes under this category such as RGB, YIQ, and CMYK. The human-orientated color spaces are based on hue and saturation. HSI, HSL, HSV, and HSB come under this category. Here shade, tone, and tint types of perceptions are as per the ideas of an artistic person. This type of representation of color is not sensitive to small differences of colors which work as a human vision; hence it is not suitable during the processing of production of colors [21]. To get more accurate fine detail information of the colors instead of normal RGB-based camera, multispectral and hyperspectral sensors were used [12, 22].

### *47.3.2 Texture Features*

Texture features give the outlier of the original scene. There is plenty of object recognition system which were developed on the basis of texture-based features. Jun Zhao has developed a system which can work on texture properties of fruits that are on the tree. They have recognized the fruit on the tree with the help of

texture features [23]. S. Arivazhagan et al. [24] have shown the comparative study of various fruits color, and texture features give 86%. Ravikant Sinha has identified the infection with the help of texture features on the basis of the color [25]. Texture features are used to calculate the prediction of the yield of apple fruit [26].

As per the objective or requirement, texture features evaluation categories into three classes [43]—fundamental, empirical, and imitative [7]. For the selection of specific texture of a specific surface, various kinds of statistical methods have been used [2, 27, 28]. To find out the shapes like circle or other types of shapes in texture Hough transformation or Gabor, Tamura texture which features extraction techniques is used [29]. For automatic quality detection texture plays a vital role [30–32]. To detect the quality of fruit through the computer vision, the very first criterion is the identification of texture [33]. The recent development in the domain of fruit quality determination survey indicates the authenticity in the usage of texture features [34, 35].

## 47.4 Classification Techniques

There are various approaches that can be used to classify the object. First approach is statistical in which distance measurement techniques such as template matching, neural network, etc. are used. According to the use of classification, techniques can be categorized into three main broad categories: supervises, unsupervised, and the combination of both approaches. Before actual classification we have to extract the features from feature extraction techniques like partial least squares regression (PLS or PLSR), multivariate linear regression (MLR), principal component regression (PCR), principal component analysis (PCA), and artificial neural networks (ANN) [36]. There is a need to develop a strong feature extraction technique and classification techniques that can classify the data more accurately. K-means, support vector machine, back propagation, RGB to other color conversions, template matching, watershed, Euclidian distance or other distance measurement techniques, etc. are highlighted by the Sandesh Raut and Amit Fulsunge [37]. Apart from other approaches, multilayer perceptron neural networks [2] and fuzzy neural networks can be a good approach for segmentation and analysis of quality identification [38]. Fruit grading can be decided by the classification approach [13], on the basis of multiple features [39].

## 47.5 Experimental Work

### *47.5.1 Proposed Approach*

The following are steps for k-means clustering approach, and it is used for data cluster formation (Figs. 47.1, 47.2, and 47.3).

Step 1 K-means algorithm initializes the process with random centers in data and then tries to attach the nearest points to these centers.

Step 2 Algorithm then shifts the centered group by that means of randomly allocated centers.

Step 3 In the next step, data points are again reassembled to these newly created centers.

Step 4 Steps 2 and 3 are repeated until no member changes in their association/groups.

### *47.5.2 About Our Database*

The local database is collected from the local market fruit suppliers, and images were captured through the smart mobile phone, i.e., Samsung Note 4. Samples' own database is shown in Fig. 47.4.

Own fruit database consists of 220 images, i.e., apple and pomegranate collected from the local market in a camera. Apple images are 59 with 2322*4128. There are some of the variation in image size like 647*483.

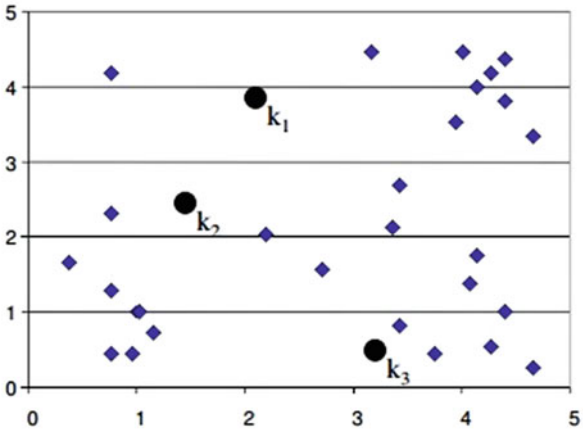



**Fig. 47.1** Random centers in data

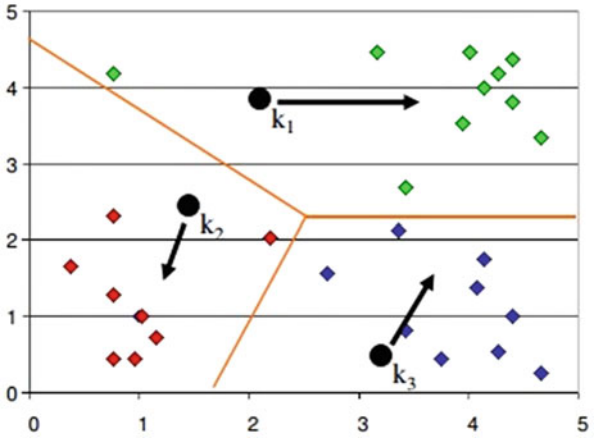



**Fig. 47.2** Create groups

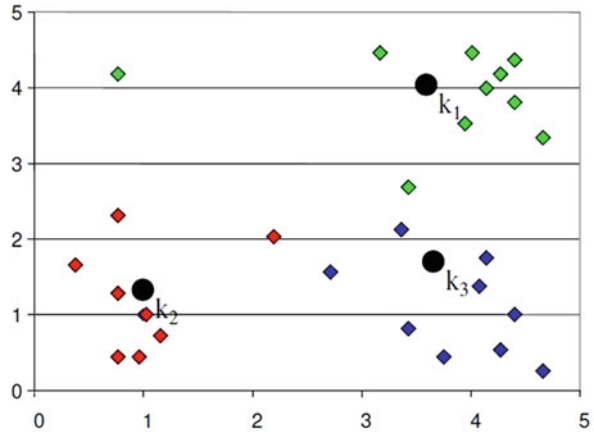



**Fig. 47.3** Newly created centers

### *47.5.3 Computers and Optics in Food Inspection (COFILAB) Database [40, 41]*

For the experiments data set are taken from the Computers and Optics in Food Inspection (COFILAB). COFILAB is located in different laboratories located at Universidade de La Rioja (ULR), Universitat de València (UV), Universitat Politècnica de València (UPV), and the Valencian Institute for Agrarian Research (IVIA), Spain. The image acquisition system was composed of a digital camera (Canon EOS 550D) used to acquire high-quality images with a size of 2592 × 1728 pixels and a resolution of 0.06 mm/pixel. However, the images for download in

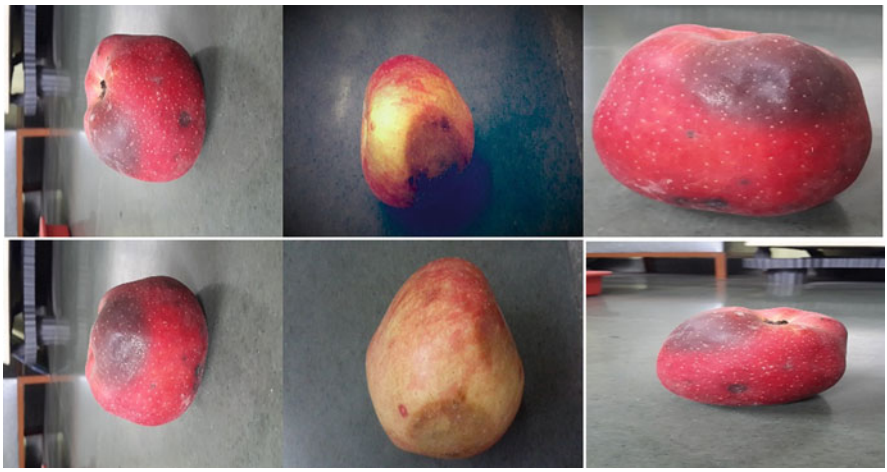


**Fig. 47.4** Own fruit database samples

**Fig. 47.5** Apple 'Royal Gala'

the database have been reduced to a size of 1200 × 800 pixels to reduce storage requirements (Figs. 47.5, 47.6, 47.7, and 47.8).

**Apple 'Royal Gala'** Database of 96 calibrated images of apples 'Royal' (24 apples photographed by four sides).

**Apple 'Golden'** Database of 100 calibrated images of apples 'Golden' (25 apples photographed by four sides).

**Apple 'Royal'** Database of 98 multispectral images of apples 'Royal Gala' (24 apples photographed by four sides in visible and near-infrared).

**Apple 'Golden'** Database of 100 multispectral images of apples Golden (25 apples photographed by four sides in visible and near-infrared).

**Fig. 47.6** Apple 'Golden'

**Fig. 47.7** Apple 'Royal'

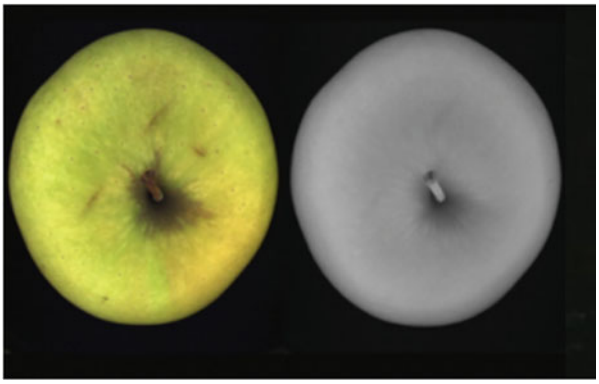


**Fig. 47.8** Apple 'Golden'

## 47.6 Results

For calculation of results, 14 different features were selected like as shown in Tables 47.2, 47.3, and database with their details are given in Table 47.1.

Fruit quality is identified by using k-means clustering. Before processing the K-means cluster, 14 features like contrast, correlation, energy, entropy, homogeneity, IDM, kurtosis, mean, RMS, skewness, smoothness, standard deviation, variance, affected area, etc. are calculated. These extracted features are used to apply on K-means cluster and then calculate the accuracy, and it is found that a minimum 95.16% and maximum 98.38% on both the databases. Most of the research articles do not provide the exact accuracy of their work compared to earlier reported works of other fruits shown in Fig. 47.9 (Table 47.4).

## 47.7 Conclusion

In this research article, fruit quality is identified by using the clustering technique. In the introduction the need for fruit quality in a huge market and current scenario of

**Table 47.1** Fruit database details

| Fruit name | Total images | Image size |
|---|---|---|
| Apple | 41 | 964*1296 |
| Golden apple | 67 | 800*1200 |
| Royal apple | 79 | 800*1200 |
| Royal multispectral | 40 | 964*1296 |
| Local apple | 59 | 2322*4128/647*483 |

**Table 47.2** Samples of features with results

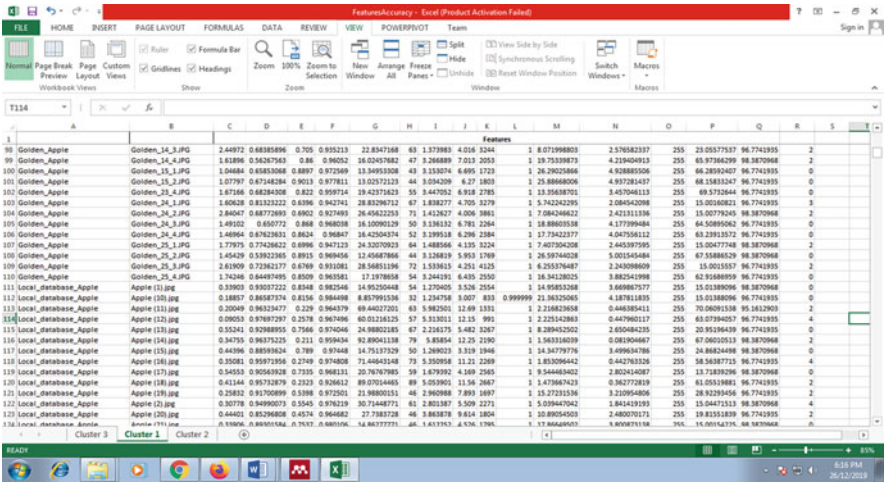
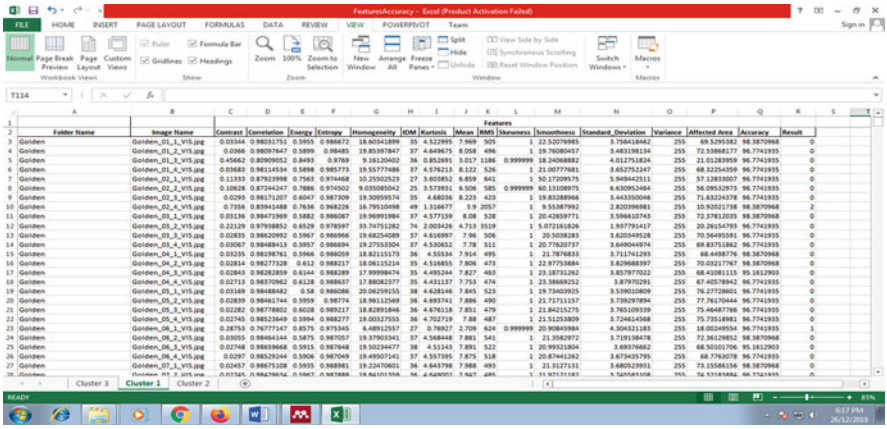


**Table 47.3** Samples of features with results



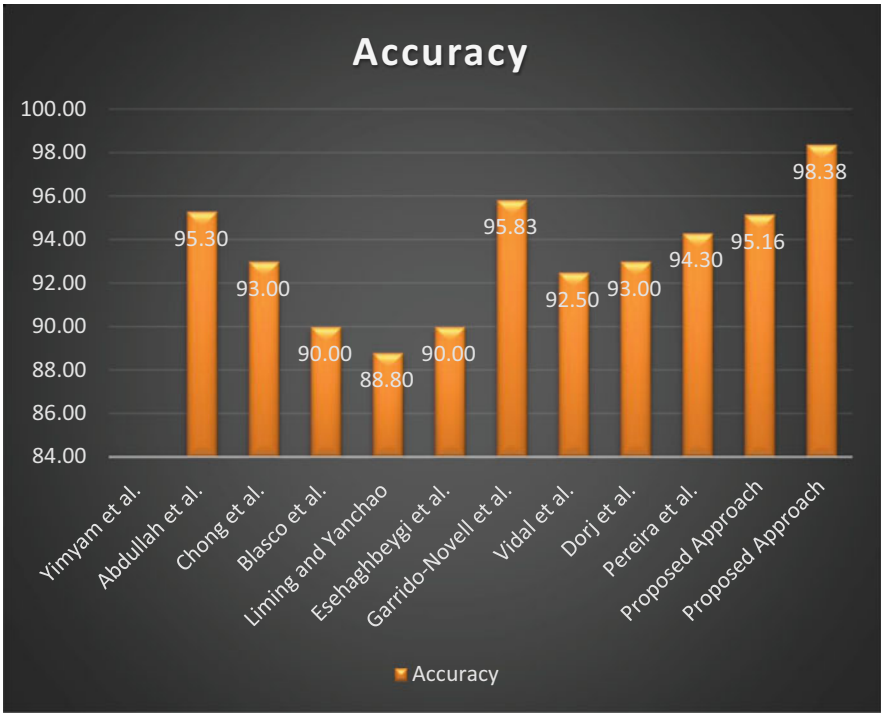



**Fig. 47.9** Comparative results

India has been discussed. The importance of quality and apple fruit is highlighted. Feature extraction approaches used by earlier reported work are mentioned. Our own apple fruit database has been developed and takes the results by comparing it to the standard database. 98.38% is the highest accuracy given by the proposed approach.

**Table 47.4** Comparative results with details [34, 42]

| Year | Author(s) | Types of fruits and vegetables | Parameters | Color space | Accuracy |
|---|---|---|---|---|---|
| 2005 | Yimyam et al. | Mango | Sorting by external quality | HSI | – |
| 2006 | Abdullah et al. | Carambola | Maturity discrimination | HSI | 95.30% |
| 2008 | Chong et al. | – | Color evaluation | HSI | $R2 = 0.93$ |
| 2009 | Blasco et al. | Pomegranate | Grading by color | Grading by color | 90.00% |
| 2010 | Liming and Yanchao | Strawberry | Grading by external quality | CIE lab | 88.80% |
| 2010 | Esehaghbeygi et al. | Peach | Color and size | HSI | 90.00% |
| 2012 | Garrido-Novell et al. | – | Maturity discrimination | RGB | 95.83% |
| 2013 | Vidal et al. | – | Color evaluation | RGB | $R2 = 0.925$ |
| 2017 | Dorj et al. | Citrus | Grading by color | RGB | 93.00% |
| 2018 | Pereira et al. | Papaya | Grading by color | RGB | 94.30% |
| 2019 | Proposed approach | Apple | Color-based segmentation | RGB | 95.16% |
| 2019 | Proposed approach | Apple | Color-based segmentation | RGB | 98.38% |

Comparative analysis has been performed, and it is observed that the given approach delivers better results.

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# Chapter 48
# Data Mining Approach to Job Recommendation Systems


**Tanvi Tayade, Rutuja Akarte, Gayatree Sorte, Rohit Tayade, and Priti Khodke**

## 48.1 Introduction

The rapid growth of the Internet leads to matching the growth of total information available which will raise the need to enlarge the capacity of the client to control all this information. It motivates considerable importance in the field of research and technologies which could be utilized in organizing information overload. The prominent field includes (a) information retrieval and (b) information filtering. Information retrieval is focused to automatically matching the client's data and information filtering used to eliminate redundant information of the user. Recent mechanisms are designed to come across the disadvantages of information overload. The suggested model defines an interesting item for a particular user by availing a lot of information resources which are correlated to user and items.

During the period of 1990s the term recommender system was brought out for the first time in the data system. Numerous experiments are carried out in industry and institutions to create an advancement in recommender systems in past years. The area of interest in the recommender system field remains the same with a considerable reason for its problem-rich research area and its prosperity on practical applications.

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## 48.2 Related Work

Various job recommender systems are present working on different techniques of processing user information. A few recommender systems studied include:

1. Stream analysis using online aptitude test
2. Personality prediction system through CV analysis

This paper proposes a task named stream analysis using online aptitude test to help undergraduates who are seeking after their instructive degrees to pick a stream most appropriate for them, as per their capability. The misguidance of companion weight understudies in large appearance to pick up the course for which their companions have picked. In this manner the understudies who wind up picking a scholastic significance which is contradictory with their interests & energy. To keep away from this quandary, they have proposed this site wherein understudies will have a stage to test their aptitudes in various streams to see where precisely they exceed expectations. Contingent upon their scores in the fitness tests containing inquiries from various streams, the framework proposes the understudy which stream is most appropriate for him/her, as their scores show their degree of intrigue, aptitude, and learning in that specific stream. This site is grown especially to take into account the requirements of the understudies of SSC and HSC and comprises of tests containing inquiries from the relevant subjects and streams [1].

Human resource management is clearly furnished with more open doors by the improvement of the job characteristics model (JCM) which thus depends on the idea of present-day employment plan. Luckily, the improvement in present-day data framework, advanced advancements, and the general access of electronic innovation and web prompted the tendency of the worldwide human resource to board improvement and make the framework more pertinent. Following the pattern, the proposed framework attempts to structure an arrangement to incorporate the job characteristics model into E-HR framework to look for another model of effective activity on human resource management in the Internet age. In this venture, they present a lot of procedures that make the entirety enlistment process increasingly powerful and proficient. They have executed a framework that positions the competitors dependent on weight-age arrangements just as a fitness test. Today there is a developing enthusiasm for the character characteristics of an up-and-comer by the association to all the more likely inspect and comprehend the applicant's reaction to comparative conditions. Along these lines, the framework leads a character forecast test to decide the character attributes of the competitor. At long last, it displays the consequences of the possibility to the selection representative who assesses the top competitors and waitlists the up-and-comer [3].

In this paper, a complete examination of four online occupation recommender frameworks (JRSs) is presented from four unique angles: client profiling, suggestion systems, suggestion yield, and client input. This paper at that point talks about the challenges in structure great JRSs. The major challenge lies in the structure of suggestion methodologies since various occupation candidates may have extraordinary

attributes. To address the previously mentioned test, it has an online JRS, iHR, which gathers clients into various groups and utilizes distinctive suggestion approaches for various clients bunch. Therefore, iHR has the capacity of picking the proper suggestion methodologies as indicated by clients' attributes. Exact results exhibit the adequacy of the proposed framework [4].

This paper proposes an expectation model for worker execution determining that empowers the human asset experts to refocus on human ability criteria and along these lines improve the presentation examination procedure of its human capital [5].

The created framework is a work proposal framework for grounds enrollment [2] which encourages the school situation office to match the organization's profiles and understudy's profiles with higher accuracy and lower cost [6–8]. For profile coordinating, two coordinating strategies are utilized: semantic coordinating, tree-based information coordinating, and question coordinating [10–12]. These strategies are incorporated by portrayals of qualities of understudies and organizations, and after that, the profile closeness degree is gained [13]. In view of profile likeness degree, inclination arrangements of organizations and understudies are created [14, 15]. Likewise, understudies can perform a catchphrase based quest for occupation profiles from different employment enrollment locales (e.g., Naukari.com, indeed.com). Getting information from the online enlistment locales framework uses web creeping. With circle coordinating, coordinating outcomes would be additionally streamlined to provide an increasingly powerful direction to the proposal [9].

## 48.3 The Job Hunt Problem

In this emerging competitive environment, both the industrial recruiters and the candidates undergo a challenge in processing the individual details of the huge number of candidates applying for a particular job opening. This makes the processing to be more time-consuming and complex in nature.

This arises the need to find innovative ways to filter out the qualifiable and talented candidates from a humongous pool of candidates. Manual splitting of these candidates will require more time.

### *48.3.1 Existing System*

To sort out the smart and technically upgraded candidates for further interview processes, most of the companies use a standard aptitude test [SAT], where the overall test score helps the recruiters to filter the candidates who fit exactly to the desired job role. The aptitude tests may sometimes be either technical or nontechnical; it depends mainly on the nature of the job opening posed by the

recruiters. This traditional assessment technique reduces the time consumption and complexity in the interview process.

#### 48.3.1.1 AMCAT

AMCAT is one of the standard aptitude tests adopted by most of the recruiters to deploy the initial screening process. The test mainly focuses on analyzing the candidate in the following aspects, like assessing their speaking skills, semantic knowledge, logical ability, and some technically specific skills required for that particular job role. This greatly assists the employers to determine the suitability of the candidate.

Whereas many other tests assess only the candidates' verbal ability, AMCAT additionally assesses the personality traits and the related technical skills to the posed job requirement. This makes the AMCAT to remain as the globalized entry-level assessment method in any job opening.

### *48.3.2 eLitmus*

eLitmus is an exam through which you get eligibility to apply for different MNCs for specified roles.

It is easy to access to job requirements and more like a job portal.

Once you are done with this exam. You will receive notifications to your mail whenever there are job openings.

Later on, according to the company's specifications, you need to attend for written tests, interviews, etc.

AMCAT is also such a similar exam relating to jobs. You can choose either of them to write [16].

The only difference in AMCAT and eLitmus is that AMCAT provides feedback to the user for future improvements and eLitmus only provides the pH score and according to that pH scores, jobs are recommended.

## 48.4 Generating Employability Through Data Mining on the Candidate's CV

Our project is titled "Generating Employability Through Data Mining on Candidate's CV." In this,

CVs will be taken in a specific format from the user. The skillset will be studied thoroughly and matched with the company requirements. Tests like AMCAT, eLitmus, etc. will be taken to judge different parameters based on that suitable job's requirements, and finally suitable companies will be enlisted to users.

Once the above process gets completed, the candidates will have the results as the list of suitable jobs based on their skillset and an improvement section where they can know on what parameters they have to work on in order to meet the demand of today's recruitment process.

On the other hand, the company recruiters will be having the results as a list of candidates suitable for their jobs with varying requirements. This module will bypass a few stages of the traditional recruitment process which will be beneficial and time-saving for the candidate and company.

## 48.5 Proposed Approach

Our project focuses mainly on the candidate's CV and their skillset. As different candidates have different skillsets and interests, filters will be applied at each level of generated output, and final jobs will be recommended to them.

The panel basically has two modules:

1. Job applicant
2. Recruiter

**Job applicant:** Applicant can be of two types:

- A fresher
- An experienced employee

The panel will have two inputs:

- Candidate's CV in a specific format
- Skillset

The applicant will have to give two types of tests:

- Aptitude test
- Personality test

After successful registration, applicants have to fill a specific CV form and enter their skillset. The applicants will have to solve two types of tests as an aptitude test and personality test where different parameters will be judged.

**Recruiter:** This module has input as company requirements for the jobs.

The company requirements will be matched with the applicant's CV and skillset. Results will be generated using various data mining algorithms and will be shown to both the modules.

After the process completion, the job applicant module will have the output as a list of suitable jobs and improvement section which will show necessary improvements required as per needs by the company.

The recruiter module will have output as a list of eligible candidates for the company.

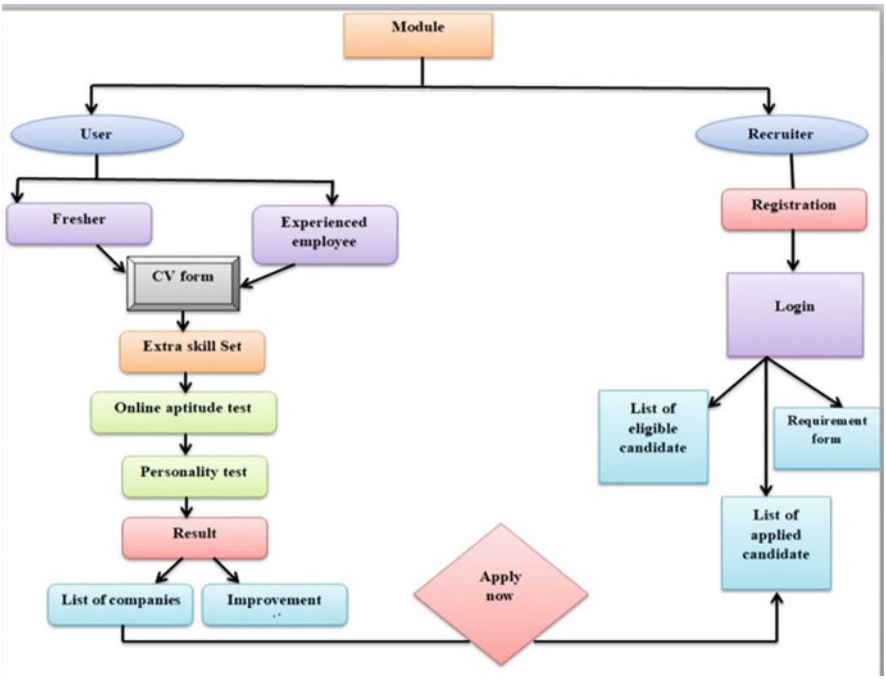


**Fig. 48.1** Flowchart of proposed approach

- For fresher's, aptitude and cognitive tests will be conducted, and possible results will be generated indicating fresher's skills and improvement if needed.
- For employees, filters will be applied at each level like previous job designation, previous salary, expected salary, etc., and companies will be recommended to them.
- Results will be based on:

  1. User's skillsets
  2. Company requirements

Our project also aims at showing improvement to the user if any for getting a suitable job in the company.

The below flowchart depicts the flow of control of the overall process (Fig. 48.1).

## 48.6 Conclusion

According to surveys, employability rates vary by many dynamic factors such as lack of skillsets, lack of prior knowledge of jobs, capital, infrastructure, etc. When provided proper path and guidance, this can be limited. Our project module does the thing of showing the candidate the direction of his/her career-making skills by

analyzing their CVs and additional inputs. Matching of company requirements and candidate skillsets can give better results as far as employability is concerned, and also the improvements are also showed up for obtaining better results.

**Compliance with Ethical Standards** All author states that there is no conflict of interest. We used our own data.

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# Chapter 49
# Deep Residual Learning Approach for Plant Disease Recognition


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## 49.1 Introduction

Agriculture is one of the most significant sources of livelihood which contributes immensely to the world's economy. However, plant diseases caused by different pathogens can curb yield to a great extent. Plants are often affected by a wide range of diseases. Therefore, it is important to combat these diseases at an early stage to boost agricultural production. Infected plants can be identified through various symptoms. However, it is quite challenging for the farmers to pinpoint the disease on their own and take measures accordingly. Symptoms like spots on leaves, discoloration of leaves, malformed stems, fungal infections, presence of pests and so on are common in plants [1]. The basic method of detecting plant diseases is through visual observation by the experts. This method is tedious as well as time-consuming. On the other hand, pathogens nowadays spread globally which can be difficult for experts to identify in a certain area where it did not previously exist [2].

Our aim is to provide farmers an easy solution where they can identify, treat, and prevent plant diseases without the help of experts. We propose an app-based system that will identify whether a plant is diseased and recommend solutions accordingly. Also, the system would provide preventions to overcome any future intervention of pathogens. Through our app, users will upload a picture of the affected area, and the app will recommend preventions and remedies for the diseased plant. Similarly, if a user uploads a picture of a healthy plant, our system will identify the healthy plant and will let the user know that the plant is healthy.

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In this paper, we have proposed the plant leaves disease recognition system from the mobile application using CNN's architectures with fast.ai for four different types of plants. The sections of the paper are organized as follows: Sect. 49.2 discusses the related works regarding the topic; Sect. 49.3 explains the proposed methodology along with implemented models. Section 49.4 presents the experimental setup implemented results of the system, and Sect. 49.5 concludes the aim of research work and further scopes of improvement.

## 49.2 Related Works

Sladojevic S. et al. [2] showed a novel approach of training CNN model with Caffe which is a deep learning framework that was implemented on 13 types of plant diseases. The hypotheses on the built model for separate category testing accomplished precision of 91% to 98%, on average 96.3%.

Sabrol H. et al. [3] presented an approach for identifying diseases of tomato leaves into various classes like septoria spot, tomato late blight, bacterial spot, tomato leaf curl, bacterial canker, and healthy. The authors made a primary dataset containing 383 images captured using a digital camera. Afterward, for image segmentation methodology, Otsu's method was applied, and using the RGB color components, color characteristics were acquired, while shape characteristics were received applying the region props function, as well as texture attributes were accessed from GLCM algorithm. By preparing the decision tree classifier, supervised learning methods were used for classification. Although the precision is high, the decision tree did not set off drawbacks overfitting while it got noisy data, and also the user's influence over the model is substantially smaller.

Naik M. R. et al. [4] included support vector machine, genetic algorithm, and neural networks in their classification model. Their work targeted on speeding up the classification where he included genetic cellular neural network for segmenting the images. Input images were taken by a digital camera on which several feature extraction processes and preprocessing were implemented. Training and testing set were separated where the training set consisted of 5% of the images and the remaining consists of the testing set. Their classification model using SVM achieved an accuracy of 86.77% that was further improvised to 95.74% by using a neural network classifier.

Mohanty S. P. et al. [5] proposed to train CNN models so that a large number of plant variants can be recognized and the presence of any diseases can be identified. They explicitly considered AlexNet and GoogleNet which are two predefined architectures of CNN. They trained the architectures, used transfer learning, and compared the performances of the architectures. Their results are fairly accurate in terms of CNN. However, their method requires several preprocessing of the input images that remain more time-consuming.

## 49.3 Proposed Methodology

### *49.3.1 Dataset*

The dataset is obtained from PlantVillage [6] from which a custom dataset is built that contains almost 7600 images of plant leaves including total 38 categories of apple, blueberry, cherry, corn, grape, orange, peach, pepper bell, potato, raspberry, soybean, squash, strawberry, and tomato.

The dataset has four subcategories of apple (apple scab, black rot, cedar, healthy), two subcategories for cherry (powdery mildew, healthy), four subcategories for corn (Cercospora leaf spot, common rust, northern leaf blight, healthy), four subcategories for grape (esca/black measles, healthy, leaf blight, huanglongbing), two for peach (bacterial spot and healthy), two for pepper bell (bacterial spot and healthy), three subcategories for potato (early blight, healthy, late blight), two for strawberry (healthy and leaf scorch), ten subcategories for tomato (bacterial spot, early blight, healthy, late blight, leaf mold, septoria leaf spot, spider mites, target spot, tomato mosaic virus, tomato yellow leaf curl virus), and one category for orange, raspberry, soybean, and blueberry. Each category contains 200 images. A total of 80% (6080 images) for training and 20% (1520 images) for validation are used for the system (Fig. 49.1).

### *49.3.2 CNN Architecture*

CNN [7–11] is widely used in image classification for obtaining better results than other methodologies. It is called a classifier of the black box and has five major parameters: its structure, kernel, receptive fields, the number of layers, and the number of feature maps of each layer. CNN's groundbreaking layer contains a collection of kernels. Each filter connects the raw pixels of the input image with the dot product between the pixel kernel and the input pixel. That pixel in the input image shows a neuron, with each neuron linked to their neighboring neurons locally in the convolutional layer. This weight sharing system controls the number of free parameters significantly and reduces the complexity and computer training burden of CNNs dramatically. In the *lt*h convolutional layer, the *y*th convolutional filter output is translated to a set of weights that are determined by summing the contributions from neurons in the previous layer:

$$c_j^l = \sum_{i \in M_j} a_i^{l-1} * b_{ij}^l + h_j^l \tag{49.1}$$

If *l* has a network layer, *j* states the core kernel, * is a core operator, $c_j^l$ is an output of the core layer lth neuron, $M_j$ is an input map set in the field (*j-1*)th receptive, al1 I is the input function in $M_j$ lth co-additive layer, $b_{ij}$ is the weight of *j*th co-

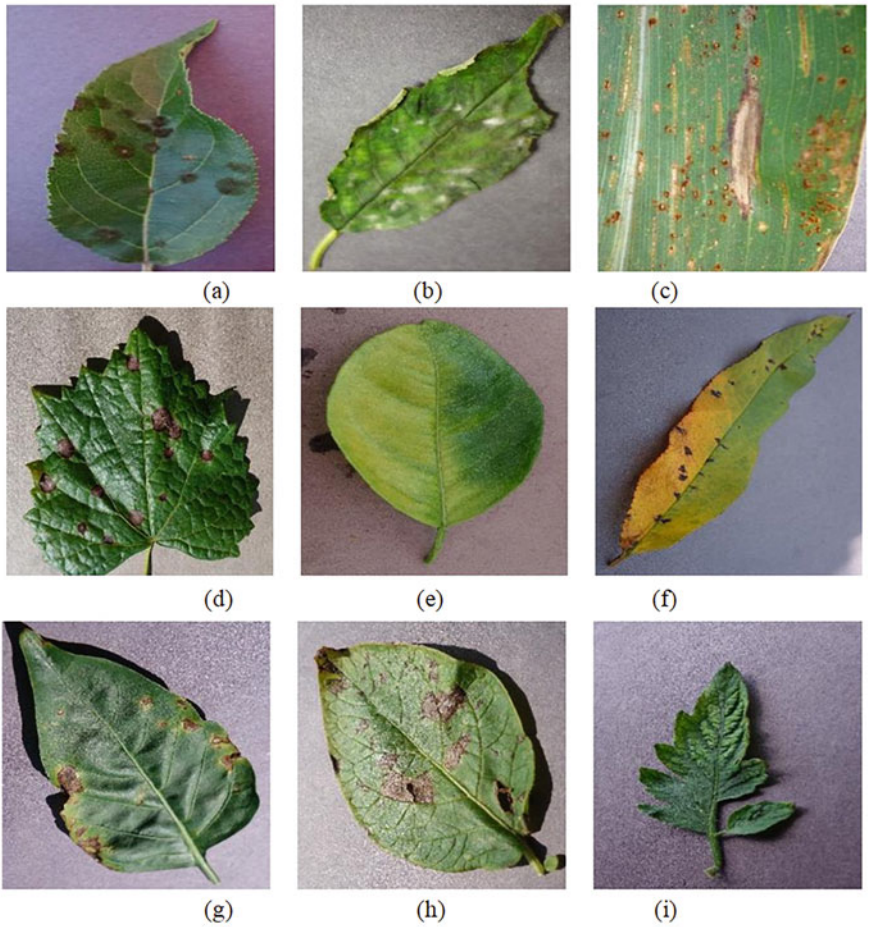


**Fig. 49.1** Data sample of (**a**) apple scab, (**b**) cherry powdery mildew, (**c**) corn northern leaf blight, (**d**) grape black rot, (**e**) orange huanglongbing (citrus greening), (**f**) peach bacterial spot, (**g**) pepper bell bacterial spot, (**h**) potato early blight, (**i**) tomato mosaic virus

additive filter lth, and $h_j^l$ [12] is the input feature of lth co-additive filters, then the convolutional layer applies the nonlinearity of $z_i^l$:

$$a_j^l = f\left(c_j^l\right) \tag{49.2}$$

where f is an activation function. The activation function is used to learn the characteristics of the original picture. Several types of activation functions are available, such as ReLu, logistic-sigmoid, and hyperbolic, where ReLu is widely used in deep learning applications. The definition is as

$$f\left(c_i^l\right) = \max\left(0, c_i^l\right) \tag{49.3}$$

### 49.3.3 ResNet-34

Deep neural networks heavily depend on the data and architecture of the model. The bigger the data and deeper the network of a CNN, the performance of the system is likewise the better. However, the network gets deeper after a depth performance of the system starts degrading. One of the famous reasons is the vanishing gradient problem and that's where residual network (ResNet) outperforms other architectures. This problem is solved in the ResNet architecture as gradients can directly flow from the initial layers to the later layers by skipping layers in between. That is the reason we have applied ResNet-34 [13–15] in our paper. ResNet-34 is a 34 layers deep network consisting of one convolution and pooling step which then followed by the same pattern in four more layers. Each layer is convolved with $3 \times 3$ convolution with a fixed feature map size of 64, 128, 256, and 512, respectively, where the input is bypassed in every two convolutions. And, this model resulted in an accuracy of 97.03% which is comparatively better than the other architectures.

### 49.3.4 Learning Vector Quantization

Learning Vector Quantization, proposed by Kohonen [16], is a neural system that consolidates focused learning with managed learning. It is a ground-breaking and heuristic calculation for taking care of order issues. Because of its basic topology furthermore, versatile model, LVQ [17] has been broadly utilized in numerous applications. It characterizes the given information in a fixed number of classes. In LVQ, the reference vectors comprising of loads are utilized to speak to the classes for learning. The learning depends on the closeness between the info vector and reference vectors. Just one of the yield takes the worth 1 and the others take the esteem 0. The reference vector that gets the worth 1 gives the class of the info vector. LVQ model works as indicated by the "victor takes-all" approach and just the loads of the winning reference vector which is nearest to the info vector are refreshed at each emphasis. The triumphant reference vector is found through computing the Euclidean good ways from the info vector to every one of the reference vectors by (49.4);

$$x = \arg\min_i \{\|a - b_i|\} \tag{49.4}$$

Where $a$ is the input vector and $b_i$ is the reference vector. Reference vectors are refreshed by (49.5) if an arrangement is right, generally refreshed by (49.6):

$$b_i\ (d+1) = b_i(d) + \mathrm{n}\,(\mathrm{t})\ \ (\mathrm{a} - b_i\ (\mathrm{d})) \tag{49.5}$$

$$b_i\ (d+1) = b_i(d) - \mathrm{n}\,(\mathrm{t})\ \ (\mathrm{a} - b_i\ (\mathrm{d})) \tag{49.6}$$

where $\eta \in (0, 1)$. $\eta$ is the learning rate, and this rate is diminished monotonically with time. On the off chance that the reference vector and input vector classes are coordinated, the reference vector is moved toward the input vector. Else, it is moved away from the input vector [18]. An activity of refreshing reference vectors rehashes till the grouping rate is accomplished or the most extreme number of ages is achieved.

### *49.3.5 Mob-IoT*

The system performs the mobile IoT (Mob-IoT) communication protocol to send photo to cloud and retrieve to display result in end-users' interface automatically. Firstly, images can be taken from the device's camera and can be uploaded to Amazon Web Services (AWS) for processing through our proposed android application where it will be processed through our methodology's deep learning model and trained weight. The photo-sending mechanism from phone to cloud is applied by building two objects in Android using Java and AWS SDK [19]. The first object generated on this method takes a string of text, and a file is included in the second object. The first object was then specified in a call to AmazonS3Client.putObject( ), along with the object key and text data, and the PutObjectRequest( ) specifies the bucket name, the file path, object key, content type header, and title metadata of the file which will be uploaded. After being processed in the python script of the deep learning model, the resulting data is stored in AWS DynamoDB [20] with a primary and unique key that is used in retrieval operation. Thus, the user IoT part is performed combining the mechanism of mobile internet and cloud computing.

## 49.4 Result and Analysis

Classification of the leaves has been done using deep residual learning, and for that, we have used the vision module of fast.ai. The images collected from PlantVillage are resized to 224 × 224 resolution, and augmentation of the images was done by random transformations which include flip and rotation. After splitting the dataset into train and validation sets, RGB images were fed into the ResNet-34 model. We trained our model for 15 epochs which resulted in 97.03% accuracy and an error rate of 0.029605.

Based on our experiment, for the 38 categories of images and total 1520 images for validation, we have compared the 3 CNN architectures Inception-ResNet V2 [21], ResNet 34, and Inception V3 [22, 23]. Figure 49.2 shows the accuracy comparison of these three models where Inception V3 achieves 83%, Inception-ResNet V2 achieves 86.54%, and ResNet 34 obtains the best outcome scoring 97.03% accuracy for this multiclass recognition system.

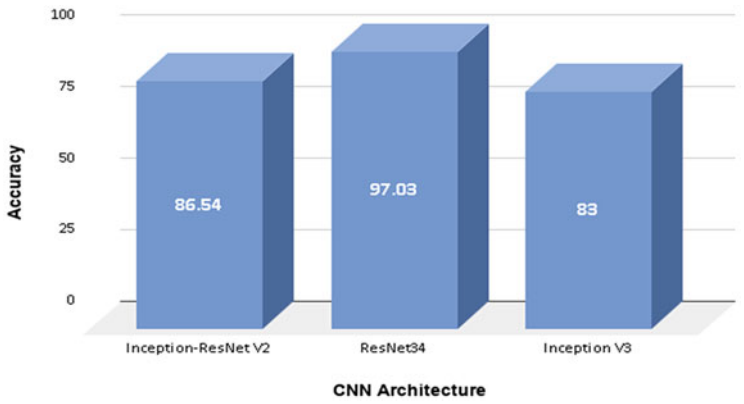


**Fig. 49.2** Accuracy comparison of CNN architectures

Figure 49.3 describes the confusion matrix of identified vs original results of the test dataset of 38 categories. The output is based on ResNet34 which achieved the based accuracy of 97.03%. Here, the confusion matrix visualizes the actual and recognizes comparison of all categories and based on the true-positive and false-positive value; the accuracy of each category is calculated and displayed in the application as a confidence score for the single uploaded image.

Figure 49.4 shows the graphical comparison of training loss (TL), validation loss (VL), and error rate (ER) for 1 to 15 epoch. Along with ResNet 34 architecture of CNN and fast.ai library [13], it began with 3.19 TL, 1.25 VL, and 0.32 ER and researched a constant position, by showing 0.07265 TL, 0.081297 VL, and 0.029605 ER at 15th epoch which represent the strength of the system model architecture (Fig. 49.5).

Finally, an Android application is proposed for end-users to ensure vast usabilities. The application interface contains easy to use modules like photo uploading and processing viewing panel with a confidence level, recognized leaf's disease as well as a primary suggestion of remedies and prevention for early stages.

## 49.5 Conclusion and Future Works

In conclusion, we can say that since plants are the primary source of food, it is important to keep plants pathogen-free. Though predicting diseases through bare eyes and observing the exterior symptoms is a traditional method, it is not very efficient at the same time. For early detection, our approach is going to be much more efficient and feasible for the farmers. The android application will identify diseases in plants like corn, potato, bell pepper, and tomato using deep learning collaborating with IoT architecture from the dataset of leaves from plant village. Implementing ResNet34, Inception-ResNet V2, and Inception V3 with

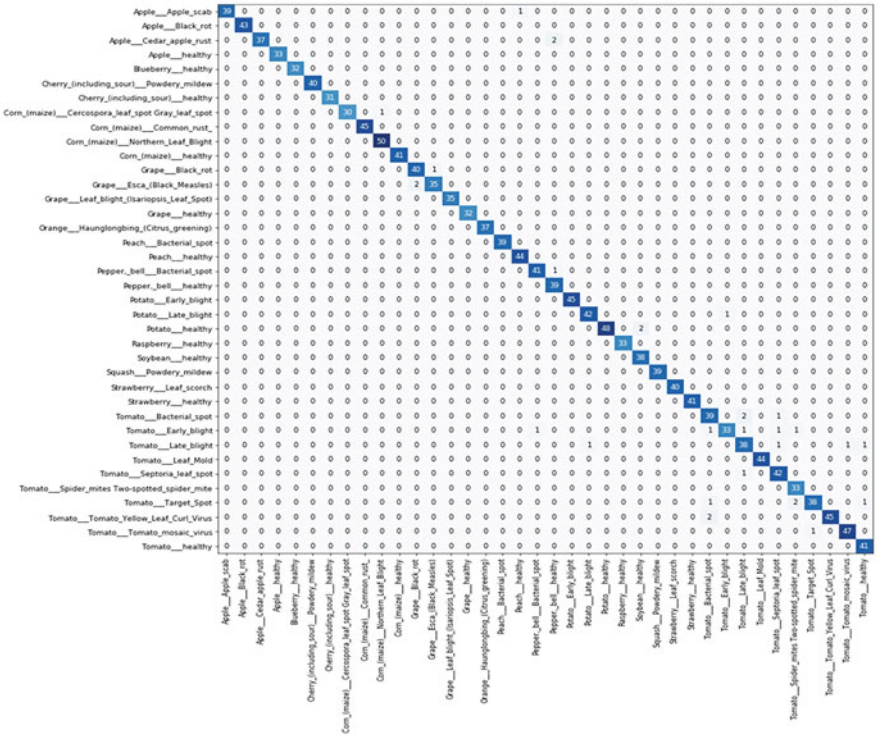


**Fig. 49.3** Confusion matrix

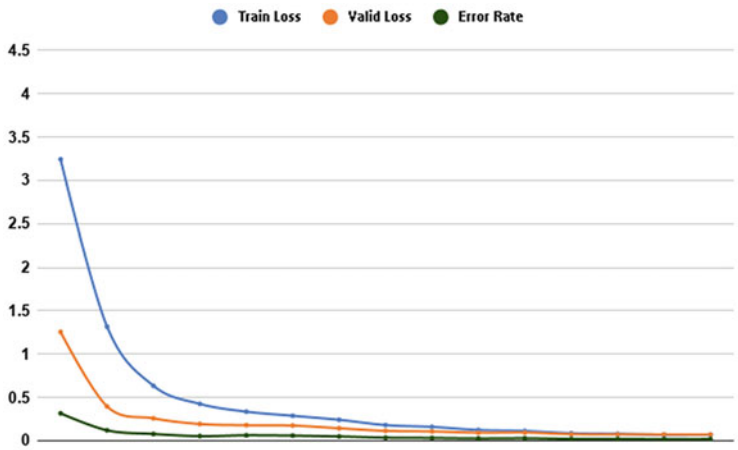


**Fig. 49.4** Performance analysis of each epoch

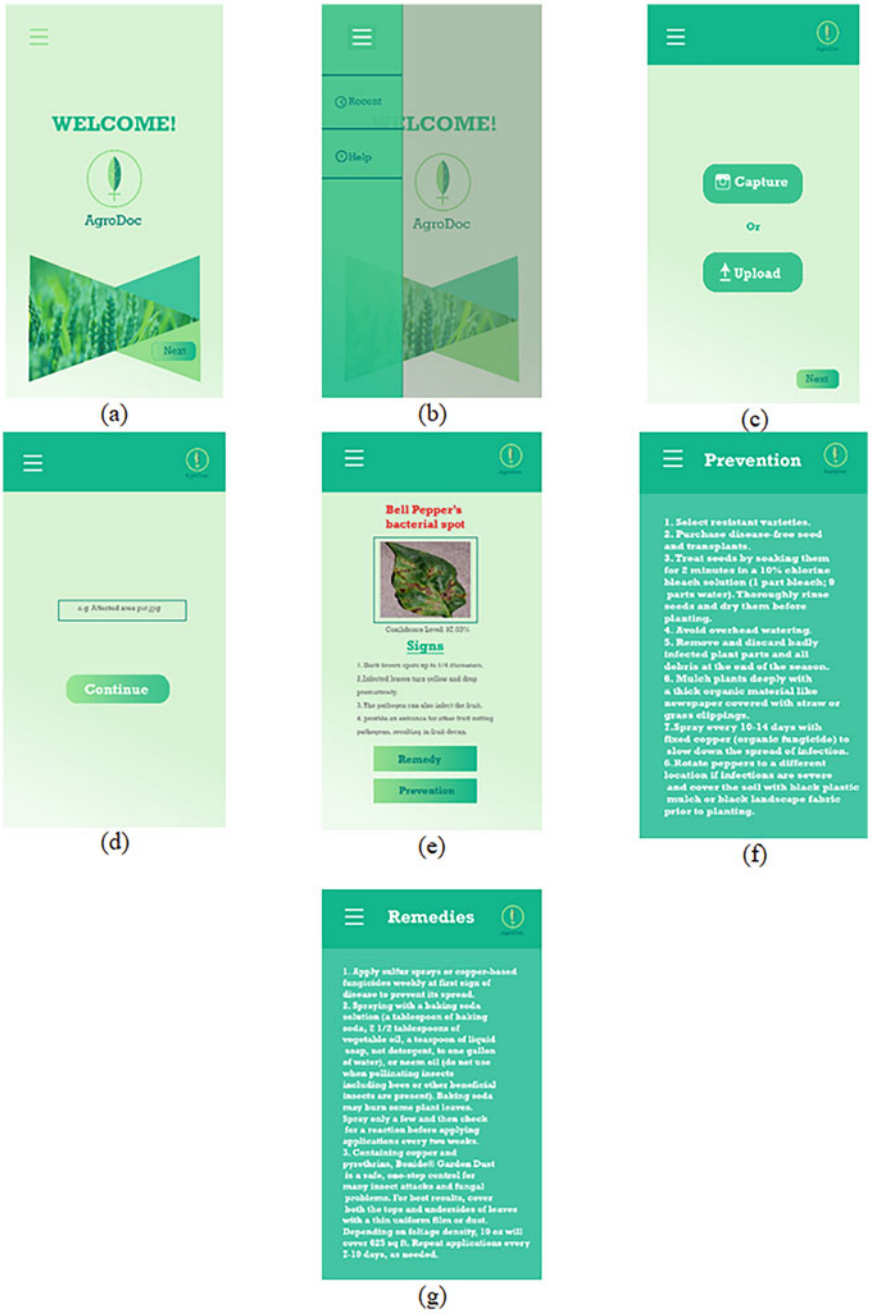


**Fig. 49.5** (**a**–**g**) Android application UI of proposed methodology

fast.ai library on the dataset, an accuracy of 97.03% was achieved which concludes that our approach is more efficient than the existing traditional method. For further improvement and to make global usability, a more categorized dataset is needed to be added with experts' opinions for labeling. A cross-platform software can be made for vast accessibility and easy-to-use process. In the end, by improving the dataset and deep learning model, more accuracy can be gained to prevent diseases of plants.

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# Chapter 50
# Medication Adherence Monitoring with Tracking Automation and Emergency Assistance

**Shadab Ali Shaikh, Obaid Kazi, Mohd Adnan Ansari, and Romaan Shaikh**

## 50.1 Introduction

Adherence consists of two types such as medication adherence (from this patience can take the medicine based on daily basis) and nonadherence (it will be based on the medical situation, and it produce the high cost). The World Health Organization (WHO) provides the solution for cause nonadherence situation in five dimensions (Fig. 50.1).

The MNA to prescribed treatment is thought to cause at least 100,000 preventable deaths and $100 billion in preventable medical costs per year. The reason for nonadherence shows 63% for forgetfulness [1]. A study at Kempegowda Institute of Medical Sciences and Research Center, Bangalore, India, depicts over 21% of MNA problems in hypertensive patients [3]. The technology that could help in improving the MNA-related problem is over 28% combining phone calls (10%), live chat (3%), SMS (9%), and mobile applications (5–8%) [4]. In a survey taken at Boston Consulting Group for about ten thousand patients, the foremost common reported reason for missing medications was forgetfulness (24%), followed by perceived aspect effects (20%), high drug prices (17%), and perception that a prescribed medication would have very little impact on their malady (14%) [2] (Fig. 50.2).

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**Fig. 50.1** Five dimensions of nonadherence. (Source adapted from [2])

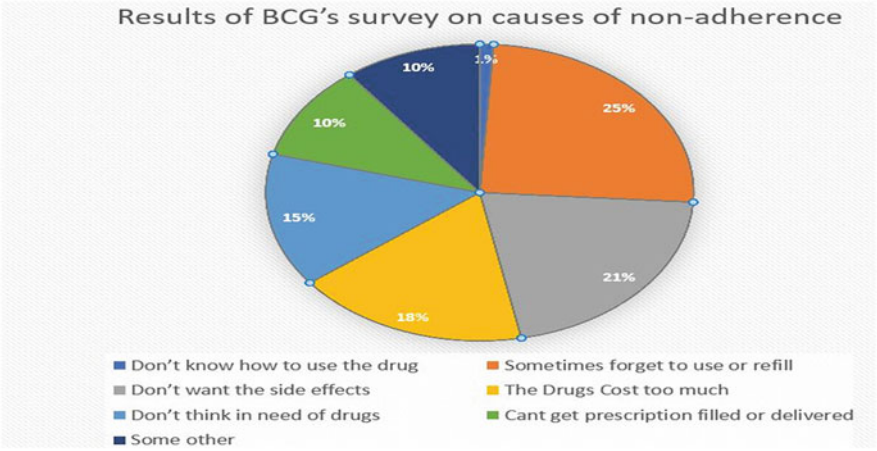


**Fig. 50.2** Results of BCG's survey on causes of nonadherence

## 50.2 Problem Statement

Given a doctor's prescription and/or providing appropriate details regarding medicines, providing with such a platform that can automate the notification process of scheduled medication events reminder through automated calls, maintain a transparency record of events to the respective parental authority and also keeping track of the patient medical history with appropriate analysis and emergency assistance like speed computation, diet recommendation, current location finder, and contacting a doctor.

## 50.3 Proposed System

Our strategy to tackle this MNA-related issue is to develop Web and mobile applications that can be useful for three main roles; those are doctors, patients, and the mentor. As soon as the medication events are available in the system, all of these roles will get proper facilities and notifications in a timely manner. Also, our application would assist emergency assistance facilities with proper scheduling and tracking mechanisms via the Geo-location and Google Cloud Vision APIs.

### *50.3.1 Innovativeness and Usefulness*

- **Medication reminders –** Unlike others, our application also concerns with illiteracy factors and wide open/friendly for such users as well by ensuring reminders through automated dynamic calls, SMS, and system notification with TTS-enabled engine.
- **Medication event scheduling through NLP** – Using our very own deep neural network technologies and Google Cloud Vision API by means of image processing, a user would be able to feed the medicine details just by giving medicine images to our system.
- **Medication events live tracking with effective monitoring** – Users will be able to get daily summary reports with proper analytical mechanisms.
- **Patient's live location tracking and alert with diet recommender** – With the usage of A.I., Geo-location APIs, and deep learning-driven technologies, a user will be able to track patients' speed of traveling, current location, and diet plan and would be able to get an alert notification through system native sensors.
- **Instant messaging with the respective doctor** – After a personal survey was taken by us, a lot of doctors were complaining about their privacy issues that they are reluctant to share their contact info, concerning to that our application would be handy.
- **Gamification-based reward system** – Engaging users, our application will open an opportunity for the end-users to get rewarded.

### *50.3.2 Architectural Framework*

- **Registration and authentication –** A user enrolls in the system via a quick sign up, after profile completion and validity of a genuine user, a user would also get a QR code generated with the username and password enclosed. A user then enters the details, and the passwords are stored in sha256 encrypted hash with 12,000 rounds and 32 salt size ensuring the security aspects. With the help of QR generated or username and password, a user will be able to gain access to the

system. The user roles are divided into three sections, namely, doctors, mentor acting as a guardian for the patient, and the patient who is currently suffering from a disease.

- **Image preprocessing, feature extraction, and manual entry –** For the betterment of the user and due to the advancement in technology, a user need not be made to fill a tedious form; the application provides a take on a snap feature of the medicine and prescription given by authorized doctors. Our system will detect and recognize text to extract necessary medication event details using deep learning custom-build neural network model and A.I. technology-driven Google Cloud Vision. For this, the Pytesseract OCR along with OpenCV library has been used. For a noisy case, the manual entry with gamification UX is also present. The crucial challenge arises over here is to predict the handwriting recognition and that too of professional medical experts. The accuracy of the google cloud vision model is there for the rescue resulting in above 85% accuracy given a noisy environment and a 99% confidence ratio given manageable predefined fonts. The two basic details which are going to target and the system will try to recognize are medicine name and dosage time. The input for this module would be the image samples of the prescription and medicines, and the output will be carried forward by the scheduler.
- **Scheduler –** After the successful medication event details extraction through various mechanisms, the system will take care of scheduling and handle the time management process and will act as a medium for triggering the event. For this either the threading mechanism can be thought of implementation or else the microservices. The input of this module will be the extraction module, and the output of this module will be event tracker and also the notification and alert system. Scheduling a live application considering the stake of patient health is not an easy task, the server will have to take care of the time zones and their medication times and dispatch the request in an efficient manner. For this Django services in collaboration with ajax job-queue scheduler are integrated.
- **Event tracker** – This would be having all the logs of events for the patient medication adherence activity day wise, and accordingly reward mechanism will be determined. This would act as a base for timely report generation of patient activity and can help in the productivity of the sustainable growth of the application. For dumping of such a huge amount of log involves high response time and a highly secure database server, so for that Amazon AWS, DynamoDB will be serving to tackle the response-related aspects.
- **TTS engine and notification system** – With the help of various Geo-location and calling APIs, a user would get dynamic generated calls reminding about the doses that a patient needs to take with custom-made emergency facilities such as speedometer where a patient traveling speed is computed, current location finder, and alerting using native sensors. The automated calling feature is the crux USP of this application considering the short survey taken by us regarding the ratio of smartphone users and old java or Symbian phones. The MNA-related issues drastically hit the senior citizens or the children; most probably they are non-smartphone users so an app-only notification solution is not ideal. Automated

calling functionality increases the target audience, as well as it will become a great cause to serve society. For ensuring such functionality, the Nexmo API will be integrated within the application.

- **Report analysis and diet recommender** – After event tracking module, accordingly the analysis of report will be showcased daily, and also our system will use A.I.-driven deep learning technologies to predict various patterns among infected patients and their behaviors; depending upon the disease, diet plan will be recommended as a suggestion. This would solve the problem for a patient going into the long queues just to get a consultation from the doctor, and the user will also have the sigh of relief for patient health.
- **Instant messaging** – We approached to some of the doctors and prepared a questionnaire regarding the patient, their common behaviors. There was also one of the prime questions asked: What are things that make a bit challenging for a medical professional? The response was the doctors' life is very busy; they can get a call even at midnight, and they have to console the patient. Meanwhile, there is also a concern for a large portion of the doctors, that is, contact sharing. A patient has to contact, but depending upon scenarios, a doctor must also have the right to privacy. While some organization provides basic contact office support, some don't. Concerning the doctors' privacy breaching issues, the doctors will have the facility to directly avail all the notification and reports of the patient. A patient will have direct access to contact doctors for respective situations (Fig. 50.3).

### *50.3.3 Text Detection*

This implies given any image and certain text written residing in these image samples determining the x and y coordinates and predicting as to where the text is present inside that samples. Usually, the very basic step for this is to read the image, resize the image, removal of noises, feature extraction, page segmentation, and finally text segmentation.

The reading of digital image means storing the matrices and computationally processing of such raw bits. After these images are available in matrices to form, it is important to scale the resolution of the image to populate the uniformity and maintain a standard scaling ratio.

There is a certain situation where there is a redundancy in an image; it could be the background, psycho-visual, coding redundancy, etc. Removal of such type of redundancies produces a high compression ratio while keeping the quality of an image. Any unwanted region residing inside an image is considered as noise and removing such pixels will complete the image preprocessing steps.

After the image is preprocessed, relevant features can be extracted from the images. This involves finding such components residing inside that image by

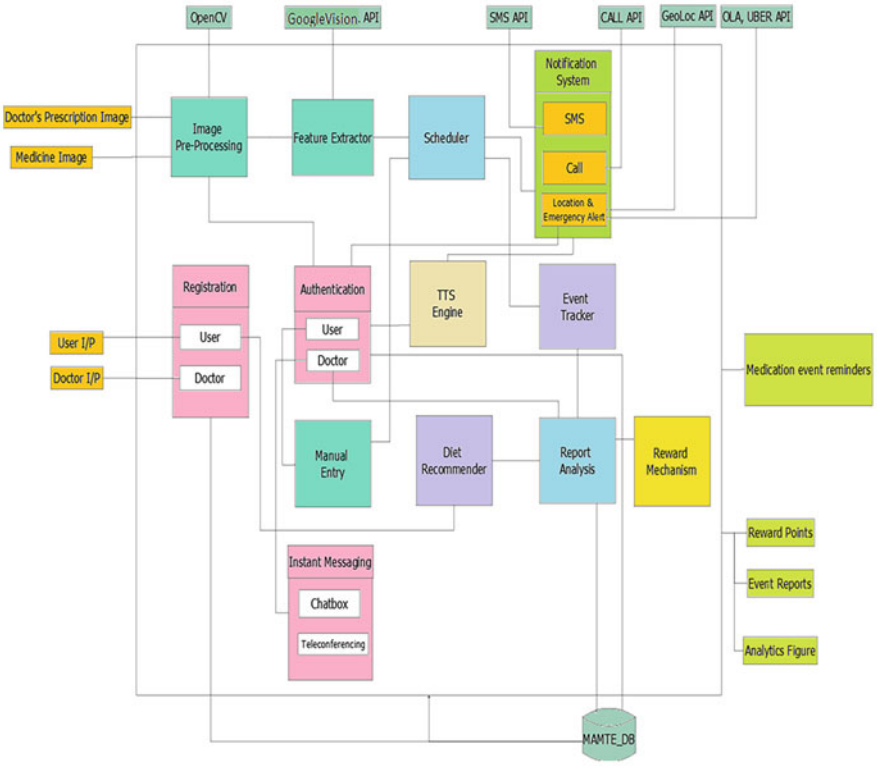


**Fig. 50.3** Overview of MAMTE application

creating an ROI, i.e., region of interest confidence ratio. If a particular pixel lies under that confidence ratio, it would be then forwarded to page segmentation.

After the page is segmented, a particular region-of-interest area will now then be focused and each slice of pages will be cropped. Computationally it helps and drastically improves image processing. Abounding box covering all the words or text inside the image will then be drawn virtually.

The final step encompasses the text segmentation, in which the text will be highlighted and cropped. With this, the text detection procedure will end, but not to forget it has been only detected and not recognized. The text could be in any form may be in the predefined system-generated fonts or personal handwriting. The text recognition classifiers' task is to predict the best matching text of the fed image sample.

### *50.3.4 Text Recognition with Google Cloud Vision API*

The Google Cloud Vision API ensures developers to create visual-based machine learning apps based on OCR. A Naive user who does not have any in depth knowledge in machine learning will be able to use this technology, it uses a model that is trained on a bulk of data consisting of images. Using the Python API library and inbuilt DOCUMENTTEXTDETECTION function, a request is sent. In return, the response is dispatched from the Google server containing AnnotateImageResponse which is in Json format comprising of a list of image annotation results.

## 50.4 Experiments

We created the registration and authentication mechanism and implemented crud operations via the MySQL database, but due to the huge log dumping requirement and MySQL being the constrained structured database, we then used the AWS DynamoDB boto3 sdk. Also, the QR code is generated for the mentor and doctor. We then forwarded with the automated calling approach, via the Nexmo API (Fig. 50.4).

Some of the crucial information which is being stored into the database are medicine name, dosage-taking duration (count in terms of days), dosage-taking

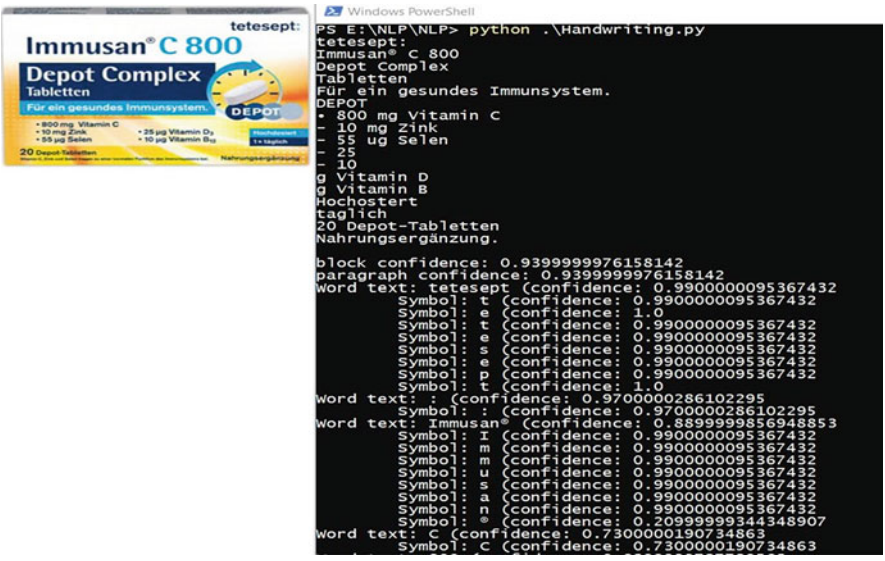


**Fig. 50.4** Immusan C800 medicine image with 100% recognition ratio

frequency (how many for a particular time), dosage count (in a day three times or two times), expiry date (for alerting the user before the expiration of a medicine), medicine type (syrup or tablets), and status of taking medicine (before meal or after meal). The application is able to store and retrieve all the relevant information from the database and make an automated phone call with the desired medicine name at a particular dosage taking the time and predefined text alongside TTS-enabled engine.

After that, we tried to implement text detection and recognition. Initially, our approach has to go with Pytesseract for text recognition and EAST: an efficient and accurate scene text detector for text detection. These technologies were not able to support the outcome of our application. EAST only detected the textual element of the image sample. The bounding box geometry was accurate, but it still failed in some handwriting. Whereas, Pytesseract was only able to detect text which is predefined and not the handwriting.

After that, we proceeded with our research with Amazon AWS Textract and soon found out it is not accurate when it comes to handwriting recognition. Finally, after a lot of research, we introduced a Google Cloud Vision A.I.-based text detector. Not only this is able to detect the text, but it also recognizes it with much efficient accuracy. Our next approach is to build a custom deep learning-based neural network in which the model will be trained for higher precision and exclusively for prescription scanners via the IAM datasets (Fig. 50.5).

We were able to create mobile applications with the help of the Flutter platform. Implementing Geo-location API, the first task was to implement the current location finder of a user and simply display and speak that location with TTS-based mechanism. After that, we proceeded with creating a small module inside the mobile application in which a user will get the detailed timeline of a complete day, what

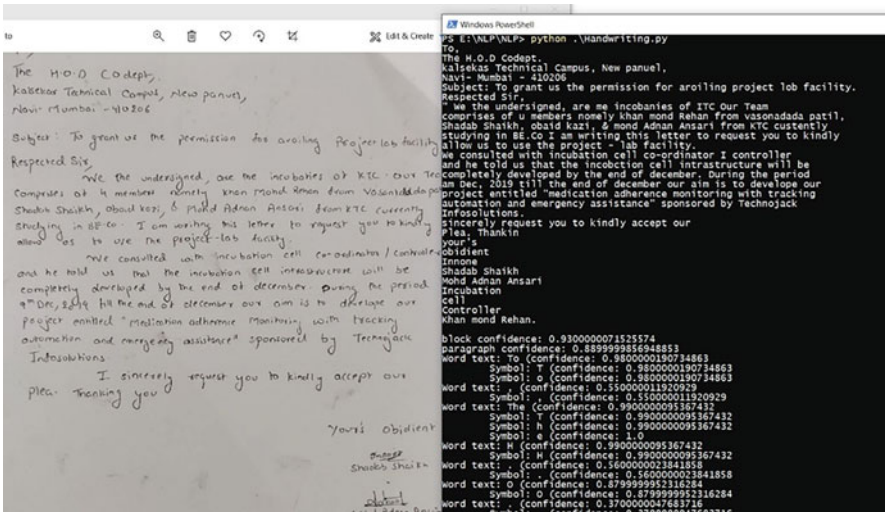


**Fig. 50.5** Personal handwriting recognition of noisy image with 93% block confidence

**Table 50.1** Test result comparison for text recognition APIs. (Source: Adapted from [5])

| Provider | Google Cloud Vision | Microsoft cognitive services | AWS recognition |
|---|---|---|---|
| Correctly predicted (C) | 322 | 142 | 58 |
| Incorrectly predicted (I) | 80 | 76 | 213 |
| No result(N) | 99 | 283 | 230 |
| Precision (C/(C + I)) | 80% | 65% | 21% |
| Recall ((C + I)/total) | 80% | 44% | 54% |


**Fig. 50.6** Example images from a dataset. (Source adapted from [5])

popular landmarks he/she went and where he/she was at a particular time frame in a log of events.

The next approach was to build the speedometer where the user's traveling speed can be computed. In this way, the mentor would get to know whether a patient is driving and whether he/she is driving safely or not.

## 50.5 Results

The following are the image samples with their confidence probability values using the Google Cloud Vision A.I. API for the prediction and recognition of text (Table 50.1).

Quantitative analysis for various text recognition APIs was done on an open dataset. It was used to test the performance in terms of precision and recall. The three APIs for the comparison were Amazon AWS Rekognition, Microsoft cognitive service, and Google Cloud Vision (Fig. 50.6).

Google vision API is dominantly way accurate and efficient than the rest. In both the precision and recall, Google Vision API is a clear winner with an ample margin.

## 50.6 Conclusion and Future Work

Medication adherence monitoring with tracking automation and emergency assistance (MAMTE) is a healthcare-oriented cross-platform digital solution to tackle the medication nonadherence-related issues.

The causes of MNA are huge, its affected people are increasing, and the need of the hour is to have such platforms that could help the patient to take care of their

medication event needs and for parents/mentor track and automate their dear one's daily routine activity.

Our application strives to be the top contender given that latest need of the hour technologies such as deep learning, A.I., and Web-REST API's being present in our system.

The key module are automated dynamic calling reminder of dosage, daily generation of the report, Geo-location operation such as current location finder, speedometer, NLP-based medication details extractor from images, A.I.-driven chatbots, live consultancy from the doctor, QR login, etc.

An automation system can also be integrated wherein if for a given case an accident has occurred, by the use of IoT devices and sensors, timely notification and emergency assistance must be provided to the victim.

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# Chapter 51
# A Discussion on Various Methods in Automatic Abstractive Text Summarization


**Madhuri P. Karnik and D. V. Kodavade**

## 51.1 Introduction

The presentation of content information in short and nonredundant form is termed as summarization which is helpful to catch information on the go for readers. Output types, extractive, and abstractive methods of summarization are broadly responsible for differentiating the techniques to convert the documents to the respective summary. Maintaining the source contents in terms of similar sentences is a process of extractive, whereas changing the sentences but keeping the same information is the main process of abstractive summarization. So far a variety of techniques are available for both the types of summarization. This discussion aims to focus on abstractive summarization and discussion of various methods developed so far by researchers in this field. Dineshnath G et al. [1] have presented a review of distinct techniques with respect to the classification of methods that constitutes traditional, machine learning, and other variety of techniques. With the focus on current technological advancement and performance-oriented methods, in this paper, along with deep learning strategies, various methods are considered while addressing and discussing the techniques in this study. The hypothetical methods require understanding the total evolution in the field which brings the thoughts to fit in that particular class of methods. The methods such as graph-based strategies are in hypothetical methods and require to understand all the available strategies while developing and improving the performance. At the same time, the

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implementation strategy is also required to be considered while developing the hypothetical method which will be required to be evaluated using experimentation. Also, hypothetical processing many times constitutes the limited size of the datasets for training and evaluation purpose. Then again, neural network-based platforms are more flexible and are able to process large size of datasets that show a better evaluation perspective.

The study presented here consists of classified methods with various methods that constitute deep learning-based methods along with other parallel technological advancements with respect to models and development strategy. The intentional and selective consideration of the respective article is having the main objective that, the study will be useful for finalizing the strategy of the model development using a deep learning platform (neural network) for abstractive summarization over other methods. Though a variety of literature is available some of them are considered here with respect to the development era and technological advancement for understanding the change and growth of technology.

## 51.2 Sequence to Sequence Models

There are various challenges while summarizing the long document in a multi-sentence summary form. The main challenge is generating salient information as per the source document in an accurate manner. Out-of-vocabulary words, handling capacity is another challenge. Redundancy occurs in word and sentence level processing. The literature addressed in this type of model focuses on using seq2seq models and few of them have addressed and provided the abovementioned challenges. Rush et al. [2] have shown the use of abstractive summarization using NN language model for decoder with sequence to sequence model as encoder. The model has shown significant improvement in performance over traditional methods. Chopra et al. [3] have given a method using sequence to sequence model of convolutional attention encoder and decoder using RNN. The performance is better and experimented with Gigaword corpus dataset. Nallapati et al. [4] have given a method that consists of keywords capturing based on features. The document structure in a hierarchical format is obtained for attention estimation. The daily mail dataset which consists of data with summaries is used for experimentation and evaluation purposes. M. Ranzato et al. [5] have used a sequence level training technique for abstractive summarization. The REINFORCE algorithm is utilized for training reasons. The Mixed Incremental Cross-Entropy Reinforce (MIXER) method is used by extending REINFORCE algorithm. The generative model obtained by using RNN has the ability to interact with external words. Y. Miao et al. [6] have used forced attention sentence compression model for abstractive summarization. A bidirectional long short-term memory (LSTM)-based autoencoder is used for compression of sentences. A reconstruction model is developed based on a sequence to sequence the compression model for generating meaningful content. The performance is assessed for both extractive and abstractive summarization using

ROUGE score. The experimentation has shown for best suitability of the model for abstractive summarization. W. Zeng et al. [7] have given RNN-based sequences to sequence models for selecting words in a sequential manner while compressing the sentences. The OOV model called Out-of-Vocabulary model and copy mechanism is used for the words which are not in the attached dictionary model. The neural machine translation method for natural language (NLP) processing is used for selecting OOV words while copying them into the summary. The read again model using LSTM is used for corrections in generated compressed sentences and finalizing the proper output content. The results of LSTM read again and GRU read again model are compared from which, LSTM shows better performance. S. Takase et al. [8] have considered the application of abstractive summarization for news headline generation from news information. The abstract meaning representation (AMR) with extension to attention-based summarization (ABS) is used. The AMR graph-based structure is used for generating the encoder model. The LSTM-based AMR model gives better compression capability. The million words pairing is utilized for training in two-phase mode. The resulting accelerated training process in which first ABS training and second AMR training model gives better speed and better performance in terms of ROUGE score estimation when compared to RNN-based encoder models. R. Paulus et al. [9] have given neural intra-attention model with two parts. The intratemporal attention model for input sequence to avoid repetitive encoding and decoding process. Intratemporal attention function to accommodate the increased level information is compared to the sequence previously decoded into the decoder. The input sequence decoder for extracting the unseen uses either a token-generation softmax layer or a pointer system.

## 51.3 Graph to Graph Models

There are a variety of challenges in abstractive summarization. A few of the main difficulties to be focused in this section are the volume of data, data complexity, the interestingness of contents, and change over time. Some of the challenges have addressed by various researchers while considering graph-based neural network models in abstractive summarization and have provided solutions. Here few of the literature are mentioned.

A summarization framework based on a graph called Opinosis is presented by Kavita Ganesan et al. [10], which generates compact abstractive summaries of very redundant opinions. Opinosis utilizes textual graphs to make abstractive summaries. These summaries have a better concurrence with human summaries compared to the benchmark extractive method is shown by assessment results after summarizing user reviews. Opinosis summaries are concise, well-formed, and give essential data. Antonio Maccioni et al. [11] which make use of high-degree nodes to losslessly compress the data. The compressed data is processed utilizing a query-based technique introduced by authors which avoids the requirement of decompressing the data. Authors have implemented this technique as a layer above core graph database

so that the end users get benifitted without requiring modification for pattern matching operations. The procedure lessens the size of the middle outcome sets during query processing and, in this way, improves query execution. I. F. Moawad et al. [12] have presented a novel approach for creating abstractive summary utilizing a rich semantic graph reducing technique where they have created the semantic graph and reduces it to generate the abstractive summary.

Jianwei Niu et al. [13] have presented a chunk graph-based multi-document summarization method. Sentence clustering is done for classifying topic-oriented sentences in groups. The chunk graph strategy is established to get a relation in word structure. The incoming and outgoing paths count is used to select words from the highest incoming and outgoing paths to lowest with end sentence strategy when selected ending word of one of the sentences. Hannu Toivonen et al. [14] have given formulation compress task of weighted graphs as the "simple weighted graph compression problem." The applicability class is even widened with a "generalized weighted graph compression problem." The optimization between longer range connecting nodes along with individual edge weights as a task of generalization. The possible strategies are given to increase the quality and reduce complexity to solve these problems. The problems and algorithms are evaluated experimentally on real networks. Efficient compression and fewer compression errors are seen from the results. Katja Filippova [15] has presented a short and essential summary for a set of related sentences. This is called as multi-sentence compression. They have presented a simple technique that depends on the shortest paths in word graphs. Also without considering syntactic information, reasonable compressions are obtained by them. Atif Khan et al. [16] have presented an improved semantic graph approach for ATS. The semantic graph structure of words is obtained by segmenting the sentence into a set of words and estimating a predicament argument structure. This structure is utilized to evaluate the similarity index for generating semantic graphs and weighted vertices of graphs. The redundancy is removed using a maximal marginal relevance approach. The mean coverage ratio (Pyramid score) is obtained using content units in summary for evaluation of performance along with the ROUGE parameter. Xu Han et al. [17] have proposed a semantic graph model by using FSGM. In FSGM, the sentences are considered as vertices and semantic association as the edges. For calculating similarity of sentences, they have used FrameNet and word embedding techniques.

Qi Song et al. [18] have given graph search method useful for a summarization framework. A hop-based similarity index is estimated to get matching summaries with respect to neighborhood method. With the help of sequential and parallel summarization graphs, a large variety of applicability is possible. A two-approximation algorithm is used for such diversified applications. The resource constraint problem is addressed with a sequential algorithm that finds summaries. Quality improvement is shown with a parallel algorithm. The distributed graph feasibility is possible with the use of the parallel scalable algorithm.

## 51.4 Bag of Words and Its Extensions Alternatives

This section addressed a few methods that make use of the bag of words model using NN-based platform and also its extensions and alternatives developed by various researchers to improve the performance. Quoc Le et al. [19] have proposed an unsupervised algorithm called as Paragraph Vector that learns fixed-length features represented with variable-length parts of texts. A dense vector is used for the prediction of words in the document during summarization. Its development gives the potential of the algorithm to overcome the drawbacks of bag-of-words models. The outcomes show that Paragraph Vectors outperform bag-of-words models along with other methods for text representations. Mani et al. [20] have presented work for multi-document summarization. Here, the reconstruction error in the summary and the documents can be minimized by selecting summary sentences. This method is based on an unsupervised reconstruction framework using a distributed bag-of-words model which is a centroid-based document level reconstruction technique.

The sentence determination and bar search is applied to additionally improve the exhibition of the model. Rossiello et al. [21] proposed a centroid-based method. The word embedding capability in text summarization process is exploited.

## 51.5 Researcher's Perspective Toward the Development of Models

Some papers that provide information about problems in previously developed models and addressing them while providing a solution by the researcher are considered here. Eric Chu et al. [22] addressed abstractive summarization with neural transduction methods. The MeanSum model developed by authors is consisting of two main parts. The first part is autoencoder by using which the summaries are used for the learning stage from a predefined set of summaries. The second part is used to learn the semantic similarities in the original documents and their respective summaries. The LSTM-based strategy for the development of the neural network-based method shows better performance in terms of sentiment analysis of summary, word overlap ratio, negative log-likelihood. The dataset consists of a large number of documents having over 32,000 documents and summaries for the sake of training and evaluation belonging from Yelp challenge dataset. Jiajun Zhang et al. [23] have given a beam search algorithm for developing an encoder using LSTM platform. The historical values and futuristic planned values are produced simultaneously for fine-tuning the training procedure in a bidirectional strategy. The main purpose of the authors is to generate cross-language abstractive summary in German language using English documents as input. The word set from corpus model is used while achieving the meaning linking model during the training phase. The performance is assessed using translation precision estimation along with model size and effectiveness in translation in meaningfulness evaluation. Ritesh et al. [24]

have focused on gender-based word prediction method. The method is useful when there is a need to handle information about objects and generating informative documents about the same which may improve the meaningfulness while narrating the information. The paper is useful to consider while selecting the words relative to some objects in terms of gender considerations while generating a summary. The paper does not focus on summarization but focuses on the use of neural network model development for word type prediction and selection. Yashvardhan Sharma et al. [25] have focused on query processing by asking queries to the user while generating the summary. The estimation of the summary standard is done using facts estimation about the similarity of the two and three word combinational structures. The multiple model structure with the use of LSTM memory models for different tasks is used while developing the entire method of answering system generation. Piotr Janaszkiewicz et al. [26] have given a method for summarizing the story of the document. The storytelling strategy of a particular human being mainly focuses on the perspective of understanding the contents of the source information. Such perspective presenting targets are considered for document datasets while developing the summarization model. The model is developed by authors using taxonomy-based classifier models.

Shengli Song et al. [27] have used fine-grained fragments of sentences that are different than semantic strategy. The hybrid model using LSTM and CNN is developed by authors for obtaining ATSDL. The manual linguistic quality evaluation is used for performance evaluation. Romain Paulus et al. [28] have given a deep reinforcement model in ATS. The main problem of RNN usage is addressed in which repetitive occurrences of words or sentences is seen when long document sizes are taken as input during ATS. The RL called reinforcement learning is derived from teacher-forced learning strategy in which repetition avoidance is achieved. Wei Li [29] have given the significance of semantic method in summarization. The SVM classifier-based strategy utilizes developing a model using co-occurrence semantic relation, verb action semantic relation, and argument semantic relatedness. The phrasing for noun and verb and complete sentence generation provides better meaningfulness in sentence generation. Qian Guo et al. [30] have used multi-head self-attention mechanism model for generating abstractive text summarization. The model has several advantages, for example, sum of weights method for faster processing and maintaining grammatical structures of the sentences.

Aniqa Dilwari et al. [31] have given a summarization of video sequences. The concept is a combination of processing text document information along with its summary document for video data. The method firstly gives a better perspective while evaluating the understanding of information from summarized text. They have proposed a joint end-to-end model, AsoVS for generating natural language description and abstractive text summary for given input video. This strategy provides a better evaluation strategy of the developed model of text summarization. Lijun Wu et al. [32] have addressed the problem of cross-language summarization in which the understanding is in terms of the English language but the quality of meaningful content is degraded in output summary in other languages used as a target. To ascertain the meaningful strategy even in output language, the error

propagation analysis for fine-grained tuning is suggested. The resultant outcome using such a method improves the quality of contents in terms of understandable language when input is English language and output is other than the English language. Li Dong et al. [33] have focused on the development of the NLP model for generating automatic text. The model is composed of a combination of unidirectional, bidirectional, and sequence to sequence text learning strategy. The pretraining process includes three strategy-based training cycles to get a fine-tuned unified language model (UniLM).

Deepak Sahoo et al. [34] have suggested the hybrid method for ATS in which they have used a combination of handcrafted rules that are used for ranking, clustering, fusion, compression, and representation tasks for the text sentences. The strategy is useful for representing and compressing the small parts with respect to classification obtained through the clustering method. Divyanshu Bhartiya et al. [35] have given noun, verb, and adjective identification strategy using a semantic method in which centroid-based sentence segmentation is used. For getting semantic representation of text, they have considered the semantic role labelling and segmentation process to form clusters. The papers addressed in this survey provide sufficient thinking lines to derive the expected steps and modeling strategies while developing the abstractive text summarization method.

## 51.6 Discussion

The abstractive summarization methods based on hypothetical methods show an experimentation scenario with relating the document structures. The dataset consist of such experimentation includes some set of documents belonging to the specific need of summarization. As far as classification of document types is concerned, the size of the dataset considered, during experimentation while evaluating the accuracy and efficiency of the hypothetical models, is considerable. The increment in the size of the dataset does not show impact in terms of significant improvement as feature extraction and processing hypothesis are related to methods developed by the researchers. The automatic improvement in such processing requirements has been geared up with consideration of neural network-based learning and testing strategies. In such scenarios the more the dataset, the better will be the learning and hence well-trained model as an outcome. The well-trained model further shows better performance while testing for abstractive summarization. As a parameter of evaluation, the meaningfulness, language of understanding, compression ratio, and reuse of words in the summary from original documents are various considerations when neural network platform-based methods are better against hypothetical strategies. The methods involving deep learning as a neural network-based method show better capability by using datasets having some predefined inputs and targets. These supervised learning methods require much processing at the time of training and error minimization process, but as and when this processing

is completed, the performance obtained is ultimate against other methods. The evolution in processing complexity reduction techniques and a variety of accuracy and efficiency-enhancing methods show scope for further research to be carried out in abstractive summarization. The deep learning methods which involve CNN, RNN, and LSTM models can further be enhanced with the inclusion of other supportive models of dictionaries and summarization standards defining models. Hence, focusing on neural network-based strategies is the main concern in this discussion. For the sake of understanding the current stage of researches in the abstractive summarization, few papers in this field are addressed here with respect to perspectives of considering the requirements of summary contents while developing the methods.

## 51.7 Conclusion

After the ATS study it is observed that the strategies for its development are available. These may constitute the selection of development platform, the selection of outcome with respect to constraints considered for respective text type, selection of models of language and processing them for generating understandable sentences, the model training and testing methods by means of which fine-tuning can be done, and most important as input to output scenario with respect to document contents and language of output. The perspective method of processing depends on the perspective of target requirements considered by a particular researcher while developing a text processing model. Many times the models are flexible to be trained when chosen with neural network platforms compared to hypothetical development strategies. Also, preprocessing to post-processing which involves handcrafting of rules may also provide improvisation in the resulting summaries which constitute the evaluation parameters such as understandable language, length of sentences, grammatical rules followed for a particular language, the repetitiveness of the words (redundancy), correctness of wording to keep same meaning with respect to input, the constraint-based outcome such as query and then generation, multi-document fusion for generating common content explaining summary, and document to document linkage estimation. On the other side, while selecting the platform of processing and model development, neural network strategies which may constitute the use of encoder-decoder methods such as LSTM, training with error minimization in recurrent methods such as RNN, memory utilization, and optimization, complexity of the model and processing time, interface capability of the model for language-based processing such as natural language processing models are also required to be considered while developing the method. This paper contributes to selecting the literature for studying the development strategies used for automatic abstractive text summarization. The paper is intended to form a thinking strategy while developing any ATS model and not intended to evaluate and discriminate any of the methods. The main purpose is to highlight the researcher's perspective behind the development of ATS models and its scope of evolution while carrying out further research in the same domain.

The paper may provide a respective thinking line to the reader who is interested in the development of models for text-based processing and mainly applicable to text summarization.

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# Chapter 52
# A Survey of Distinctive Prominence of Automatic Text Summarization Techniques Using Natural Language Processing


**Apurva D. Dhawale, Sonali B. Kulkarni, and Vaishali M. Kumbhakarna**

## 52.1 Introduction

NLP provides a subdomain of text summarization, which provides meaningful summarization of large chunks of text. There are two different types of text summarization techniques that includes deep learning-based text summarization technique and NLP-based text summarization technique [6].

When it comes to Natural Language Processing (NLP), the most inquisitive and tough part is automatic text summarization. This process involves a precise and wholistic summary of text from different resources like product titles, e-books, online news, web-hosted data, social media posts, email interactions, and blogs [7].

## 52.2 Literature Review

The study of text summarization started in 1958, which involved keywords, the position of the sentence, and word frequency. Types [1] of automatic text summarization are shown in the table below.

The summarization can be done in two ways: single document and multi-document, and the summarization further separated into two types, namely, extraction and abstract method. In extraction-based summarization, keywords and paragraphs are withdrawn to create summaries. The new text is created in abstractive summarization. There are many text summarization approaches, shown in the following figure (Figs. 52.1, 52.2, and 52.3):

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J. S. Raj (ed.), *International Conference on Mobile Computing and Sustainable Informatics*, EAI/Springer Innovations in Communication and Computing,
https://doi.org/10.1007/978-3-030-49795-8_52

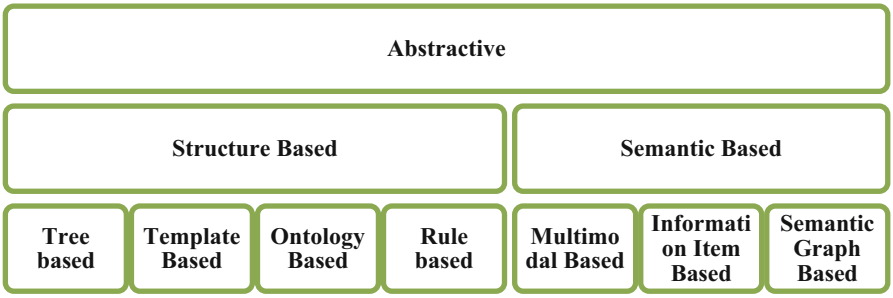


**Fig. 52.1** Abstractive text summarization methods

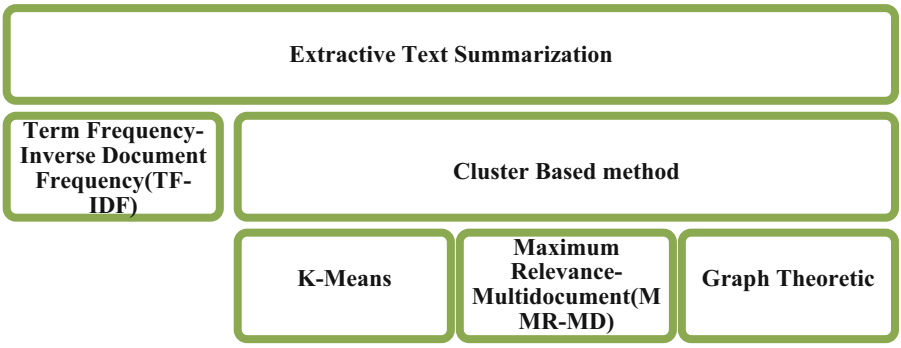


**Fig. 52.2** Extractive text summarization methods

There are different summarization algorithms for autonomous documents summarization. Among these algorithms, Rich Semantic Graph-based, rule-based, tree-based, ontology-based, TFIDF, and cluster-based techniques were shown as more relevant in the previous methods. Based on the survey of various techniques, it is proved that TFISF and graph-based are recognized as the most effective text summarization method for Indian regional languages [2].

The abstractive and extractive summaries can be drawn with many methods; the abstractive methods are shown in Fig. 52.1.

The extractive methods are shown in Fig. 52.2

The different criteria to classify text summarization are: [3]

Content-based summaries are categorized into two types, namely, query-based summaries and genetic summaries.

If the user doesn't have knowledge of the text, the importance of information is at the same level and is termed as genetic summaries.

When the original topic is extracted first then the information extracted is called a query-based summary.

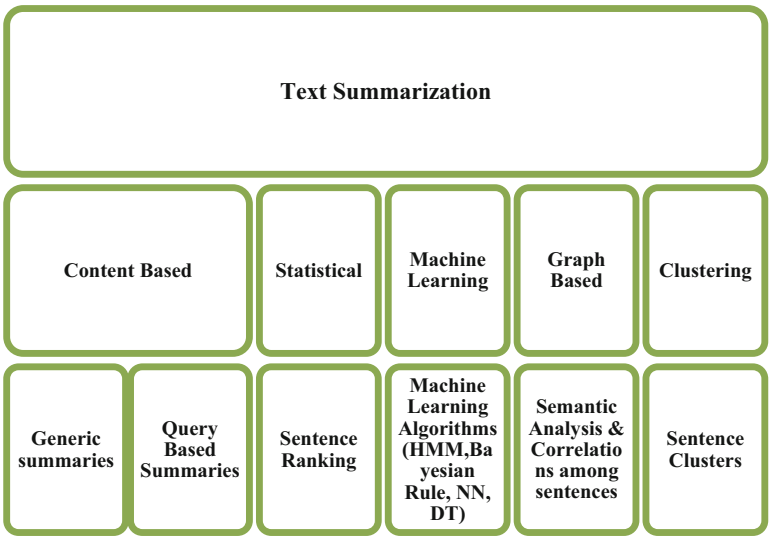


**Fig. 52.3** Text summarization methods

Following are the ways for text summarization:

1. Statistical
2. Graph-based
3. Machine learning approaches

The other approach includes Clustering.

In **statistical** approaches, the sentence ranking technique is used. The significance of sentences is evaluated by using summary statistics; which are identified based on the title, keywords, etc.

**Graph-based or semantic** approaches uses semantic analysis and correlations among sentences.

**Machine learning** approaches use machine learning algorithms for the generation of summaries. The summarization process is dealt with as a classification problem, based on the features, there are two types of classification: summary and non-summary.

The examples of machine learning summarization approaches are:

1. Hidden Markov Models (HMM)
2. Bayesian rule

**Clustering**-based approaches use Clustering algorithms that obtain sentence clusters to extract sentences. Clustering approaches can select and extract related sentences. The advantage of this is it reduces the redundancies [3].

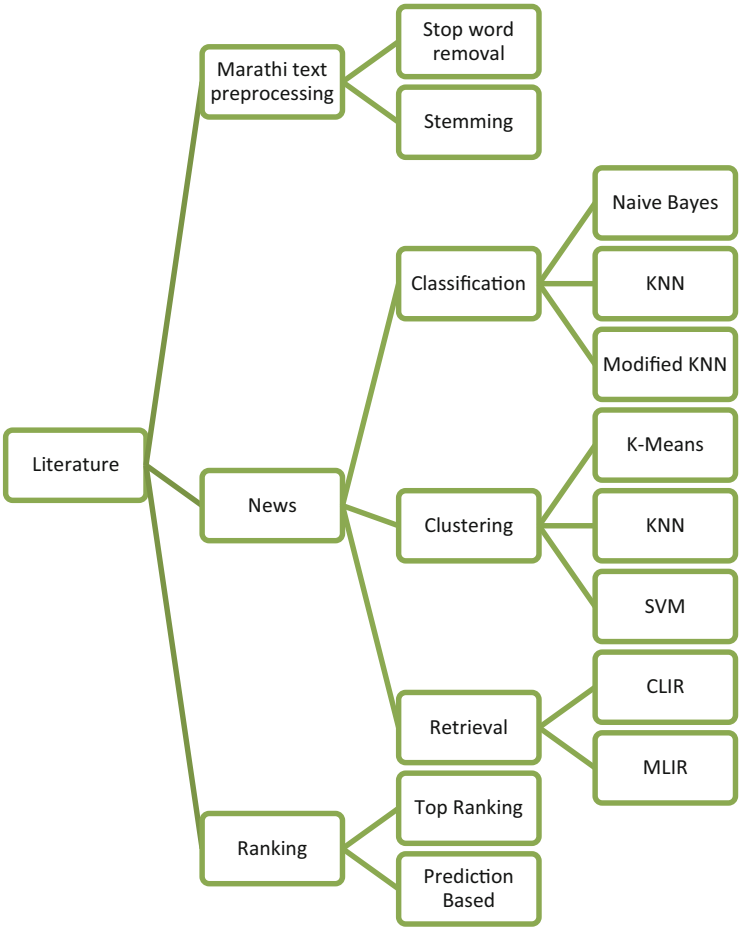


**Fig. 52.4** Topics explored under Marathi text retrieval

There are different kind of autonomous summarization techniques utilized in both foreign and Indian languages that are listed as English, Turkish, Arabic, etc., but for Indian languages, the automatic summarization system is still lacking [4].

In recent years Capacious amount of text documents in multitudinous Indian languages is up for grabs on the Internet. For better management and retrieval of such documents, automatic classification can be helpful [5].

The following figure shows various topics like Marathi text preprocessing, classification, and clustering (Fig. 52.4).

The proposed system in [8] took the input of a set of Marathi documents and uses supervised machine learning methods and ontology-based classification to get the output as classified Marathi documents as per class label. Here, the supervised machine learning methods include Naïve Bayes (NB), modified K-Nearest Neighbor

(MKNN), and support vector machine (SVM) methods which are very much useful for information retrieval system of any language. The classes considered are Festival, Sports, History, Literature, and Tourism, which is again a very important feature that we can classify the document in the abovementioned criteria

The perspective in this paper [9] is about feature-based text summarization. The system utilizes a combination of nine features to achieve feature scores of each sentence, the features are:

1. Similar words among sentences
2. Similar words among paragraph
3. Iterative query score
4. Format-based score
5. Numerical data
6. Cue phrases
7. Term weight
8. Thematic features
9. Title features

The Fuzzy logic is used to score the sentences in the document. This system consists of three phases:

(a) Fuzzifier
(b) Rule base and inference engine
(c) Defuzzifier

To get a precise summary of any document, the user needs to classify the information in the document, and according to the different combinations of features, it is summarized.

Features can be developed based on the perspective levels and divided into five categories such as word, sentence, summary, readability, and source-side features. Evaluation metrics are used to compute the word segmentation by using F score and ROUGE versions [10]. Sentence ranking formula is used to maintain the combination between summarization and information [11]. Word's information can be calculated by using logarithmic equations.

Document summarization technique helps to overcome the obstacle available in the document generation [11–16].

The research work [17–19] takes input sentence from the document, and preprocesses it by separating words, removing stop words, and then the last step is stemming. Merged model graph is used to analyze the summaries in the single paragraph and that is compared with the evaluation summary model [19, 20]. Furthermore, N-gram graph Powered Evaluation via Regression (NPowER) is the most important scheme and that evaluates the machine learning issues and provides the optimal solution for the evaluation strategies [21].

This technique used the two pass algorithm for rhetorical structure theory (RST), and it scores each sentence available in the summary features. This rouge technique will evaluate the summaries of different lengths based on the news editorial professional.

## 52.3 Conclusion

The increasing enormous amount of digital data shows the inevitable role of text summarization in Natural Language Processing. This paper concentrates on different techniques and various work methods applied to different languages. The study can be adapted by the new researchers to get a brief idea about the evolution and comparison of different techniques applied for text summarization. There are various methods like abstractive, extractive, content-based, Fuzzy system, MeMoG, TF, IDF, SVM, KNN, ROUGE, Naïve Bayes, semantic, graph-based, and machine learning. The methods do work with different accuracies for different languages.

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# Chapter 53
# Random Forest Algorithm for Learner's Confusion Detection Using Behavioral Features


**Kavita Kelkar and Jagdish Bakal**

## 53.1 Introduction

The virtual learning system is today's necessity in the educational environment. They are fast, on-demand, cost-effective, anytime, and anywhere systems. The learner can learn at their own pace. The virtual learning systems are expected to be adaptive to individualized learning speed.

In the classroom learning mode, the teacher and learners are facing each other. Learners naturally express their understanding via facial expressions. They may ask doubts or ask to repeat the topic. Thus learners express their confusion in learning to the teacher. Due to direct interaction with learners, the teacher can make appropriate changes in the pace of content delivery. The teacher may take tests to gauge the understanding. The classroom learning is as per schedule and place. Interaction between teacher and student can enhance the learning experience. This form of learning is synchronous and adaptive [6, 10, 20].

In virtual learning mode, contents are displayed to the learners as lessons. Learners are supposed to learn them at the system's pace. Whether the learner is able to adapt to the system's pace and actually learn these lessons is not known by the learning system. There is a need to assess the confusion and understanding of the learner in grasping the contents [11].

Research reports show a link between learner's effect like confusion and understanding [7–8]. When learners are not able to grasp the contents, they experience negative learning affects such as confusion, frustration, and boredom. While after

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grasping the learning lesson properly, learners exhibit happiness and confidence [4, 11]. The research presented in [10] establishes that there is a positive correlation between learning-centered affect like confidence, confusion, and flow to the learning outcome. There is a negative correlation between frustration and boredom to learning outcomes. The better grasping of contents is indicated by the affect of the learner.

Learning is an emotional experience [17]. A learning activity may start with curiosity and excitement. As the learning task increases in difficulty, one may experience confusion, frustration, or anxiety. Learning may be left aside because of negative emotions [3]. If the learning system is able to recognize the emotion of the learner, then the grasping of the contents by the learner and learning outcome can be identified [24]. The virtual learning systems will be able to identify learner's grasping of the lesson in the same way as in classroom learning mode.

To address this problem, we should be able to measure and quantify learning-centered affective state [26]. The virtual learning systems should be able to recognize whether learner has actually grasped the lesson. The system is dynamic as it needs to capture leaner's affect during learning activity. We must be able to identify, quantify, and measure the affect of the learner. The learning systems with knowledge of the learners' affect can dynamically adjust the pace of lesson. This will improve the effectiveness of the learning.

We propose approach for automated detection confusion affective state of the learner in virtual learning system.

The paper is organized as follows. Section 53.2 elaborates related research and existing systems in detecting emotion in virtual learning systems. Section 53.3 describes proposed design of the system and experimental methodology. Section 53.4 presents analysis of data. It elaborates pre-processing of the feature dataset, applicable machine learning algorithms, and experimental results. Section 53.5 presents conclusion and future work.

## 53.2 Existing Systems

The existing virtual learning systems are not able to capture the learning effectiveness in terms of affective state of learner. Many online learning systems gauge the understanding of the learner via question and answers mode. The systems determine the correctness of the answers in a test. Answering the questions correctly is sole criteria of judging the grasp of the contents. As learning is human-centric activity, there are many behavioral clues that are exhibited by the learner [9]. These clues are indicative of the learner affect [1, 2]. Many existing virtual learning systems do not capture such behavioral traits of the learner [4, 13].

There have been virtual learning systems like AutoTutor which capture facial expression of the learner to understand the learner's emotion [16–17]. Explicit usage of webcam is required in this system to record the facial expression while learning [27]. There are other systems which work on physiological sensors to detect the

emotion [8, 19, 25]. They are able to detect affective state of the learner under the specifications of the sensors inbuilt. Due to requirement of additional hardware, the systems are costly and are not easy to implement. The learner is being continuously monitored. The continuous monitoring can be overwhelming to the learner. This can impact the learning effectiveness. Such systems are intrusive and are not easy to implement on large scale [21].

There is a need of adaptive learning system which is non-intrusive, cost-effective, and scalable. There are some systems which capture keystroke and mouse click behavior to predict the emotion [23]. Some systems have been developed to predict the learning affect on the basis of log data analysis for school level subjects [2].

The virtual learning activities can be reading the lesson, solving questions associated with the lesson, using hint of a question, trying different options in a MCQ type test, etc [12, 14]. When these activities are progressing, many learner behavioral patterns can be observed and captured. Behavioral pattern can indicate overall grasp of the lesson as well as the emotional state of the learner [25].

## 53.3 System Design and Methodology

The author's approach for system design, system flow, experiment, and dataset is elaborated in this section.

### *53.3.1 System Design*

The virtual learning and examination system is developed by the author for second year computer engineering students for the course Data structures. The system is designed in two modes: learning mode and examination mode [18]. The system framework is depicted in the Fig. 53.1.

Learners use affective learning system through web interface. Content delivery module delivers the lesson to the learner in learning mode. Examination module generates the test questions for the lesson. The questions are based on cognitive domain of Bloom's taxonomy. The interaction recording module maintains all logs of learner interaction. It records behavioral parameters of interaction. Affective state inference module interprets presence of confusion affective state. Content adaption module adapts lesson delivery to learners' affective state. The database maintains record of contents, questions, and learner interactions.

#### 53.3.1.1 Question Design

The questions are designed according to Bloom's taxonomy cognitive levels. Bloom's taxonomy is a classification used to define and distinguish different levels

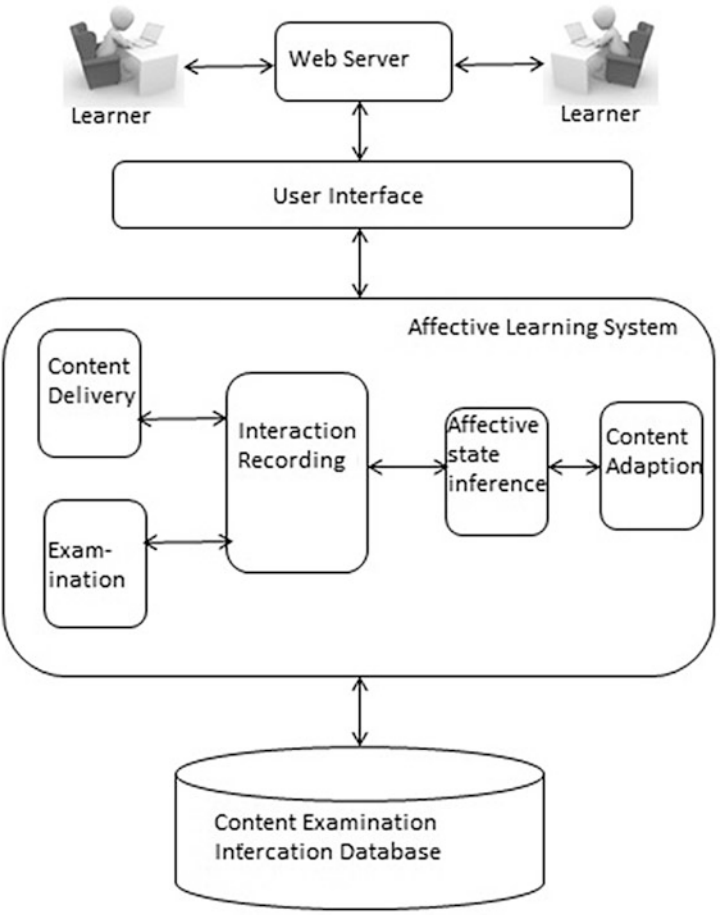


**Fig. 53.1** Affective learning system framework

of human cognition—i.e., thinking, learning, and understanding [22]. There are six levels of cognition in Bloom's taxonomy: knowledge, comprehension, application, analysis, synthesis, and evaluation.

The questions in the test are categorized as easy, medium, and difficult level questions.

Knowledge and comprehension are basics of content understanding. These two cognitive levels indicate knowledge of the content and ability to express the content. Hence these two levels are grouped together as easy level of questions. Application and analysis cognitive levels indicate ability to further processing of the learnt contents to different situations. These two levels are marked as medium level. Synthesis and evaluation cognitive levels are more complex. They show ability to combine different learnt concepts and be able to evaluate the same. Such questions

**Table 53.1** Mapping of Bloom's taxonomy question type with type of questions in test

| Bloom's taxonomy level | Mapping to question types in the MCQ test |
|---|---|
| Level I and II (knowledge, comprehension) | Easy |
| Level III and IV (application, analysis) | Medium |
| Level V and VI (synthesis, evaluation) | Difficult |

are more complex. They indicate thorough grasping of the contents. Hence these two cognitive levels are named as difficult level questions.

The questions are mapped to these three levels as shown in the Table 53.1.

#### 53.3.1.2 System Flow

The learners read the lesson and then attempt the multiple choice questions test on the topic (30 questions). They may choose to read the hint provided at every question before answering. Learners submit the answers to the learning system. The students present self-report about their confusion level during the test. The test score is shown at the end of the test.

#### 53.3.1.3 Affective State

Confusion is defined as lack of understanding and a state of disorder [11]. Learner's typical interactions with the system are indicative confusion [15].

We present the captured interaction parameters and their mapping to the emotion confusion.

### *53.3.2 Behavioral Patterns*

The system captures following behavioral parameters of every learner during the conduction of test. The relation of captured interaction with confusion is explained here.

(i) Time: It captures the time taken to solve each question. Time taken by the student to answer all the questions is an important factor that contributes in determining the extent to which the student has understood the concept. There is an ideal time associated with every question of the test. It is supposed that a student who is confident can appositely complete the test in that period of time. If the student exceeds ideal time for solving the question by 10%, it is indicator of not understanding the topic of that question. This is indication of presence of confusion.

(ii) Difficulty level: There are three difficulty levels associated with the questions, i.e., easy, medium, and difficult level. Each of the level is assigned with weights on the number of correct answers. Difficulty level is a contributing factor for predicting the emotion confusion. Consider the case when question level is easy and student is not able to answer correctly, it definitely indicates the confusion. When a question is of difficult level, and student answers correctly, it is indicative of no confusion.

(iii) The ideal time of the question is dependent on the difficulty level attached with the question. For 30 questions MCQ test, ideal time for medium question is assigned to be 60 seconds, for easy question 30 seconds, and for difficult questions 90 seconds. The ideal times are according to standard associated with MCQ test [28].

(iv) Hints: Hints are supposed to be the coadjutor whenever the student is not able to answer the given question. The system is designed with hints provided for each question. The student may or may not use the hint when answering the question. If student is confident, he most likely will not use the hint. If the student uses the hint, then it is an imperative factor to predict confusion.

(v) The student using the hint for easy question is definitely indicating of presence of confusion about the topic or having not understood the topic. So weight associated with the hint being used for easy question is highest (5). The weight associated with difficult type of question hint is least (2). The weight associated with a medium type of question hint is medium (3).

(vi) The sequence of attempting the questions: As the test is designed of 30 MCQ type questions, the student who is confused may jump over the questions, leave some questions in-between, and may go back to the previous question. This behavioral pattern is also captured by the system as it is indicative of the presence of confusion.

(vii) The test being MCQ type test, the answers are selected as one of the four possible options given per question. A student may click one of the options and may choose other option for the same question again. This behavior is also indicative of presence of confusion. The most confident student will choose the correct option in one go. The system records the clicks per question as indicator of confusion.

(viii) The overall weight of each question when answered correctly is determined from the difficulty level of the question. When an easy question is answered, the weight associated is 2, for medium question is 3, and for difficult level question, it is 5. For questions which are answered wrongly are given the weight of zero.

These behavioral patterns of every learner are captured and are maintained in the back end.

### *53.3.3 Experimentation*

300 undergraduate level engineering learners participated in the experiment. They first followed the reading mode of the system and then participated in the examination mode. They reported their confusion level on a scale of 1 to 10. The system records all answers, the interaction parameters as explained in Sect. 53.3.2.

## 53.4 Analysis of Data

The pre-processing of data and applicable machine learning algorithms is discussed in this section.

### *53.4.1 Pre-processing of Dataset Features*

For analysis of behavioral interaction features of the learner following pre-processing is performed.

(i) Converting difficulty level to numerical values
(ii) Computing the time taken per question (time difference) with respect to ideal time of the question according to difficulty level of that question
(iii) Computing weighted average of the correctly answered questions
(iv) Total time taken to complete the test
(v) Computing the weights associated with the hints
(vi) Number of clicks associated with every question answered
(vii) Determining the recorded sequence of answers if random or in given sequence
(viii) Analyzing confusion level entered by student

The processed interaction features in numeric format are input features for supervised machine learning algorithm. The target variable is the confusion value entered by the learner.

### *53.4.2 Choice of Machine Learning Techniques*

Machine learning techniques enable computers to learn without being explicitly programmed. Supervised learning techniques interpret the learning model from the input data. These techniques are capable of interpreting uncertain objects like emotion and affect.

This research is carried out to investigate an appropriate machine learning technique to model learning affect "confusion." The behavioral interaction features

of the learner are the input features. The target variable is affective state confusion. For our dataset, the two classes are presence of confusion and absence of confusion. The self-report of confusion in the range 1–5 is absence of confusion. The self-report of confusion in the range 6–10 is presence of confusion.

The classification algorithms support vector machines, Naïve Bayes, and random forest algorithm are used for classification and prediction of emotion confusion. The choice of algorithms is based on intrinsic characteristics of the algorithm suitable for affect identification. We validate the results by implementing these algorithms on input dataset. We compare the results in terms of accuracy to choose the best suitable machine learning model.

#### 53.4.2.1 Support Vector Machine

In this algorithm, we plot all dataset items as a point in n-dimensional space (where n is number of input features). The value of each parameter is the value of a particular coordinate. Then, we perform classification by finding the hyper-plane that differentiates the two classes very well.

We have 8 types of behavioral inputs and 16 input features. The problem is 16-dimensional input space.

The support vector machine algorithm works well in high-dimension input space. Hence this algorithm is chosen for confusion detection.

#### 53.4.2.2 Naïve Bayes

Naïve Bayes is a classification technique based on Bayes' theorem. It assumes the independence among predictors. In our case we assume behavioral parameters are independent of each other. The dataset is converted into frequency table. The likelihood table is prepared for each class. Then Naïve Bayes' equation is used to calculate the posterior probability of each class. The class with highest posterior probability is the class associated with the prediction.

For our dataset, the dataset is sufficiently large for determining the likelihood and posterior probabilities. Naïve Bayes algorithm can be implemented as we have two output classes [5].

#### 53.4.2.3 Random Forest

Random forest algorithm is a type of ensemble machine learning algorithm called Bootstrap aggregation. Random forest works well with high-dimension space and can handle categorical features. Because of Bootstrap aggregation or bagging, it creates many random subsamples of the dataset with replacement. It constructs a decision tree for each subsample. The result of each subsample is averaged out to give the final prediction.

From the description of algorithms and the nature of the problem, these algorithms are implemented on the student test dataset. The results are analyzed and discussed in the next section.

### *53.4.3 Experimental Results and Discussion*

The training dataset is sufficiently large. 300 students participated in the experiment of MCQ test conduction (30 questions in each test). This test was conducted 3 times in a semester. There were 70% instances where students were reporting presence of confusion (Class 1: range 6–10). 30% students reported absence of confusion (Class 0: range 1–5). We train the model with ten cross validation technique. In ten cross validation technique, we randomly split entire dataset into tenfold. For each tenfold in the dataset, the model is built on ninefold of the dataset, and model is tested on the tenfold of the dataset. Accuracy is calculated. This process is repeated iteratively till each of tenfold is worked on test dataset. The average accuracy is noted down.

Table 53.2 shows the comparison of the results in terms of accuracy, precision, recall, and f1-score.

The random forest algorithm gives the best classification results with the training accuracy of 99% and test accuracy of 84%. Accuracy is the obvious performance measure. Accuracy is a ratio of correctly predicted observation to the total observations. It is best measure when false-positive and false-negative observations are almost same.

Precision is the ratio of correctly predicted positive observations to the total predicted positive observations. High precision means low false-positive rate. We have got very high precision which is same as accuracy of the random forest algorithm.

Recall is the ratio of correctly predicted positive observations to the all observations in actual class. We have recall of above 90% for training and test dataset.

Support vector machine algorithm shows good training efficiency but has overall less test accuracy. It also suffers when feature dimensions are increased. Naïve Bayes algorithm is far less efficient as compared with random forest algorithm.

Hence Naïve Bayes techniques are not recommended machine learning model for confusion detection. The random forest algorithm also gives us the feature

**Table 53.2** Accuracy of confusion prediction

| Confusion detection | Accuracy | | Precision | | Recall | | F1-score | |
|---|---|---|---|---|---|---|---|---|
| Algorithm | Train | Test | Train | Test | Train | Test | Train | Test |
| Support vector machine | 0.98 | 0.71 | 0.99 | 0.81 | 0.99 | 0.72 | 0.99 | 0.72 |
| Naïve Bayes | 0.30 | 0.33 | 0.17 | 0.20 | 0.31 | 0.33 | 0.17 | 0.20 |
| Random Forest | 0.99 | 0.84 | 0.99 | 0.99 | 0.99 | 0.84 | 0.99 | 0.83 |

**Table 53.3** Feature ranking by random forest algorithm

| Rank | Feature |
|---|---|
| 1 | Time difference (between ideal time and time used to solve) |
| 2 | The weighted score on the basis of difficulty level |
| 3 | Hints used |
| 4 | Difficulty level |
| 5 | Clicks per question |
| 6 | Sequence of questions attempted |

importance of all the features considered for training. It is seen time taken to solve the test is the most important feature in classification as shown in Table 53.3.

So we infer that random forest algorithm is most suitable for implementing the dynamic learner model in virtual learning systems to predict confusion emotion.

## 53.5 Conclusion and Further Work

In this research, we focused on development of a system which captures the behavioral patterns of the learner. These features were learner's interactions with the system while attempting to solve MCQ test after reading activity.

The behavioral patterns are captured in non-intrusive manner. Learner does not face the pressure of being monitored.

The experiment was conducted on undergraduate engineering students. The feature dataset was maintained. Various machine learning classification techniques were implemented. The random forest algorithm produced the best classification result.

We can state that to determine affective learner state confusion, this approach produced promising results. To make the virtual learning systems adaptive to learner's affect, identifying the affect is first step. This research elaborated the approach for identification of confusion state.

The future work includes adapting the system to the identified affective state so that the system can be more effective. When confusion affective state is identified, the system can pose questions of lower difficulty to the learner. Let learner become more confident before posing difficult questions.

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# Chapter 54
# Blockchain-Based Decentralized Cloud Storage


**Dhruv Doshi and Satvik Khara**

## 54.1 Introduction

Today, the requirement of each cloud user is not the same as it used to be earlier; some users need better storage capacity; some need lower storage with better plans; hence the current paper is the complete solution of unique cloud storage which is completely decentralized to provide utmost transparency. The major security problem with the existing system is that it is unidirectional; hence the user can only rent the storage from the big service providers. Instead of that one can develop an ecosystem in which some users could put their unused resources on rent and others could rent them.

Initially, a huge chunk of the amount in buying the resources is not invested to start extreme servers at one point and pile up all the user data in a single space. This would not only reduce the security of the system but also the huge investment upfront, hence to achieve this a better solution based on blockchain Technology along with ERC-20 token based on Ethereum for payment systems is proposed.

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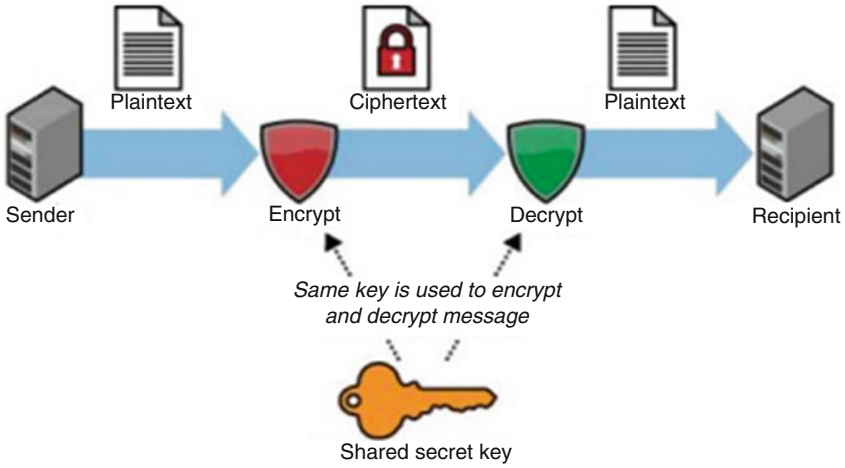


**Fig. 54.1** Centralized approach for the cloud storage

## 54.2 Existing Systems (Centralized Cloud)

### *54.2.1 The Vulnerability of Existing Cloud Systems*

At present, most of the cloud systems which are being used are centralized in which a lot of resources are at a single place on which consumers can rent and save their data on those servers [1]. The problem with it is that it has only one encryption and decryption key as shown below in the figure (Fig.54.1) [2–5].

With the loss of that encryption key, anyone could decrypt the data and access it. Also, the initial head cost for implementing the system is quite high which results in higher rent costs. Still, with these higher rent costs, the utmost security of our data is not guaranteed [7].

### *54.2.2 Proposed Cloud System (Decentralized Approach)*

The distributed peer to peer network is the proposed solution for the problem which is based on the blockchain system which is further elaborated below. An overview of the following figure is taken into consideration which shows how decentralization of cloud would be working on peer networks [8, 9].

The major tasks to be done are encrypting the file, fragmenting it into multiple parts, and maintaining the log file in the form of blockchain to have a record of the system.

This approach enhances the ability to have extremely redundant data bytes which result in enhanced security divisions and contracts which could be developed

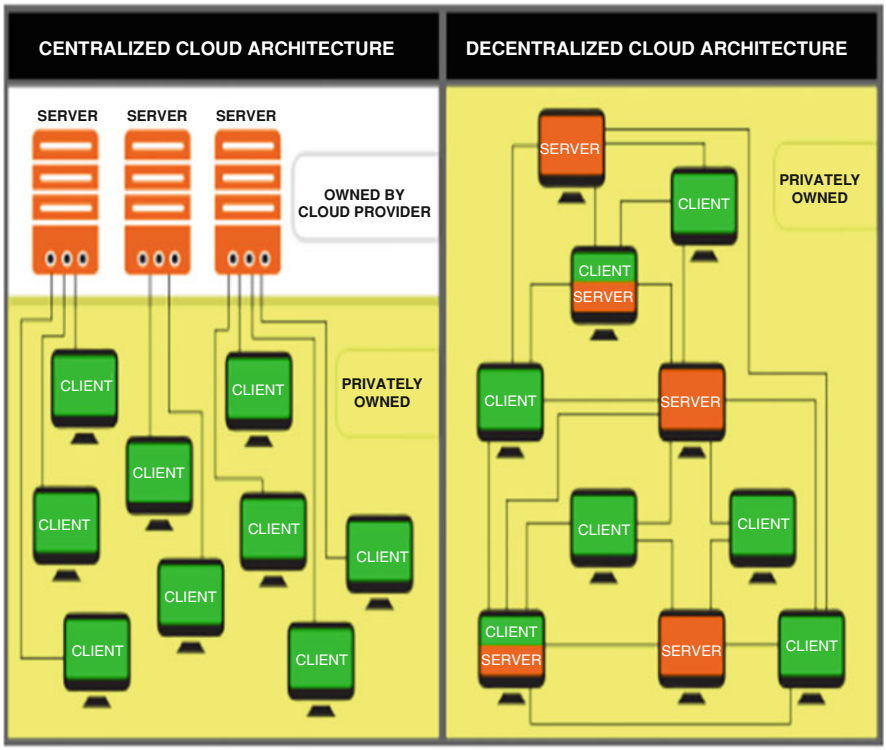


**Fig. 54.2** Centralized approach for the cloud storage

with the help of ERC-20 blockchain contracts based on Ethereum main network (Fig. 54.2).

The redundancy of the saved data regardless of the amount of data saved compensates when there is any sort of failure in the systems.

## 54.3 Implementing Cloud Peers

To implement the system on the decentralized network, there is a need to have data dependencies and complete parity sections for the system in which there is a raid 60 parity system in which each data file could be divided up to 512 distributed peers, and each peer could work as an independent ledger. In case of disk failure from the host, we can retrieve the data with the help of raid systems. This comes up with the complete diversity of the user data for the host systems [6].

They have to set the minimum amount of resources they put on the platform through which we could have a stable system and equation between the host and the consumer. Each host will be directly connected to a special blockchain in which consumers would be a part of and could also have their private blockchain network

with all of the hosts. Their data that is divided in this would lead to better peer to peer transfer of data and better success rate. This would enhance the speed of the transaction of the data in the blockchain systems. For the development of this blockchain, we need to work on the hashing algorithms to make dual passkeys to authenticate the host and consumer. This would lead to no cross-connection and perfect ledger.

## 54.4 Encryption

### *54.4.1 Encryption Overview*

Blockchain is completely about Encryption and Transparency, the biggest benefit is the fastest response time so for this system we need to have dual encryption and decryption system with 4 keys in which we will have one module encryption for our platform to the host platform keys and other set of keys for the user of the system to have his privacy furthermore for the blockchain cryptocurrency which we are going to develop we will be using specially made algorithms which would be based on SHA512 level encoded private keys and public keys, these are the best possible algorithms which would be designed on the top of predefined encryption algorithms in python hashlib libraries and with a bit of modification on those algorithms we can have drastic upstream in performance. For the development of the two-way encryption, MetaMask key method is the best method to have a secret sequence of random words which would be the backup if the private key gets lost. Whole secret key would be saved in different hardware of the users system itself, and at the time of loss, we can generate the system bypass key with the help of the master key software which needs to check all of the combinations possible from the user code of CPU and GPU along with the cryptographic hash code given by the platform. Logically to bypass this algorithm, we have to make a total of 512**512 which is logically infinite, and if we combine the total power of all top 500 supercomputers, still it will take more than 320 million years, so logically we can't get into the blockchain.

### *54.4.2 Encryption Module*

To develop customized algorithms, we need to deal with a lot of complex mathematical solutions. Instead of this we can just deploy our algorithm on top of the SHA512 algorithm which is defined in the hashlib library of python3. We just need to import the sha512 algorithm and update the chip size of the algorithm and along with that, the alphabet consideration to 37 instead of 26 there will be a usage of numbers along with alphabets and the whole system and functions could be inherited as itself. To develop a signature and public key for new users, RSA algorithm is used

which is defined in a crypto package under Public key PKCS1_v1_5 algorithm. It will be used from Crypto package under Signature these algorithms are capable of completely generating 512 string length public key and signatures. The complete algorithm will be working on back end systems with database checking for the database systems we will be using Google Datalabs and BigQuery systems which is one of the fastest for the blockchain systems.

## 54.5 Payment

### *54.5.1 Payment Systems*

Here as the host is letting us use his resources we need to pay them, for that dual-mode payment system would be implemented in which each host is potentially a miner, To run the ecosystem we have created one cryptocurrency DCS Coin [10] this will be deployed individually on another blockchain with the same private and public keys so that both cloud authentication and Cryptocurrency authentication would be same which would make system lot more lightweight. For the development of the complete new coin, we came up with python code on the back end. For another payment gateway we came up with ERC-20 tokens on Ethereum network. These are the mini ethereum coins which are worth the same as ethereum, and we can also trade them for the development of ERC-20 contract [11], Truffle Framework is implemented and on truffle framework, we use Ganache to define some user for the scripting language we came up with Solidity with compiler pragma 0.4.23, executable on a remix engine. For inter-platform transactions, we came up with payment gateways that are in use; we are just taking them as they are. Each time any host mines a coin some defined percentage of that transaction is carried forward to that host blockchain account and now that could be reverted into Ethereum coins. To maintain the flow of the coin in the ecosystem, the major platform can change the rates of the gas price per transaction of the data upload and download. This is how the ecosystem and the market of the coin would be controlled.

### *54.5.2 Payment Module*

It will be defined at the extreme point of Data Transfer while uploading and downloading and prices will differ depending on the availability of maximum bandwidth to upload and download the data instead of putting a barrier on the amount of the data here we just give unlimited storage access to the consumer and let them pay for the faster download and upload speeds technically to put large chunks of data on same peer network they need to have higher bandwidth speeds. The whole payment module system will be dependent on blockchain systems in which the host

has a different contract with the platform and the user will have different contracts with the platform. Just, for example, uploading 1 Tb file on the peer network with the free basic speed of 128Kb/s, users have to wait for 218 years which is logically impossible, for that users have to get into the premium plans and get the higher bandwidths.

## 54.6 Performance Boost

For a system to pile up data in a single centralized server it puts a lot of strain which results in limited bandwidth compare to these multiple ledgers which work as servers with comparatively low resource power works more efficiently and generates more bandwidth capacity for the entire system. For example just think to upload 1 Tb file on the existing cloud storage with 50Mbps speed would take 2 days whereas putting that 1 Tb file divided into 500 pieces and upload it with same 50 Mbps bandwidth would take 5 min and 43 s. This shows the drastic performance boost. We still need to add 1–2 min of performance gap for the allocation of the host and the consumers.

## 54.7 Conclusion

The major problem with an existing cloud service provider is the mediator and centralized system which could be solved by including blockchain and having a peer to peer decentralized systems and implementing specialized cryptocurrency for payments module and specialized algorithms for encryption and decryption of the data and generation of the public and private keys. After the implementation of the complete ecosystem of hosts (miners) and consumers, we can manipulate the cryptocurrency for the flow of coins in the ecosystem.

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# Chapter 55
# A Short Survey: Behavioral Authentication Using Mobile Sensors


**Adnan Bin Amanat Ali, Vasaki Ponnusamy, Anbuselvan Sangodiah, and Kiran Adnan**

## 55.1 Introduction

In this era, smartphones and tablets are highly used as personal devices. And the main issue they are facing is security. Existing authentication methods based on PINs and passwords are not sufficient to ensure security. Due to the inconvenience of typical passwords and patterns, most of the users do not use any PIN, pattern, or password [1]. Even if one applies a complex password, but still it can be attacked by side-channel attacks [2]. There is no 100 percent guarantee about achieving the highest level of performance regarding the identification/verification of a personal identity using these authentication methods [3]. Physiological biometrics (like face recognition, hand geometry, fingerprints, iris, retina, and ear recognition) has its own limitations. The fingerprint recognition system is complex due to the quality of images of finger patterns, but dirt, cuts, wear, and tear can damage the quality of images. In face recognition, light conditions, angles of face rotation, etc. make this process more complex, although physiological authentication systems are more complex, costly, and have many biological challenges [4]. All the abovementioned authentication methods use a single time authentication technique, and there is no check on the authenticity of the user when the session is active. To overcome these problems, researchers are focusing on behavioral biometrics because it is convenient to use and all the required sensors are already present in most of the modern smartphones. The availability of a larger number of sensors is making a rich space to explore the features.

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This paper provides a brief survey of different behavioral authentication methods. Multiple solutions are proposed to use user behavior as a continuous authentication method. But still, this field needs improvement in terms of accuracy, efficiency, and reliability.

## 55.2 Behavioral Biometric Authentication

### *55.2.1 Keystroke Dynamics*

Keystroke dynamics is a process of measuring human typing behavior, extracting behavioral features, and then evaluating the authenticated or unauthenticated user. Keystroke dynamics utilizes the manner and the rhythm of an individual when typing characters on a keyboard [5]. The common features of keystroke dynamics that have been used by different researchers are key hold time, latency, horizontal digraph, vertical digraph, error rate, etc. [6].

Table 55.1 shows the work done for the mobile and computer keystroke dynamics studies

### *55.2.2 Touch Gesture*

Touch gesture is the operation that is performed on the touchscreen, i.e., swipe, tap, double-tap, and pinch. The same gesture for different users gives different feature values. For example for swipe gestures, the swipe speed, swipe length, swipe position, and swipe angle are different in different users due to their hand geometry, e.g., finger size and length [15]. The gesture can be a very useful tool for authentication as the sensors of the mobile phone can uniquely obtain different data as different conditions. Figure 55.1 shows the 3-axis accelerometer and gyroscope reading for data patterns for conditions of change of motion of the user (walking, lying, and moving).

Table 55.2 shows some more works for the use of touch gestures in mobile phone authentication using various approaches.

### *55.2.3 Gait*

Gait recognition is a method that identifies or verifies a person based on his walking pattern. Accelerometer and gyroscope are used to measure the data which is useful in getting behavioral authentication because every person has his own gait data [21].

Table 55.3 shows the use of gait for human authentication

**Table 55.1** Keystroke dynamics (random forest (RF), deep neural network (DNN), neural network (NN), machine learning (ML)

| Ref | Features | Methods | Techniques | Subjects | Results | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | EER | FAR | F RR | Acc |
| [7] | Hold time, digraphs, (press-press, release-press, release-release) duration | Statistical | Mean, standard deviation, feature fusion | 15 | 0.81 | – | – | – |
| [5] | Accelerometer biometrics | ML | DNN | 55 | 2.8 | – | – | – |
| [8] | Digraph, trigraph, accelerometer biometrics | ML | NN | 30 | – | 7.0 | – | 61 |
| [9] | Pressure-based features – finger pressure and area | ML | RF | 42 | 2.3 | – | – | – |
| [10] | Using features like shift and comma | ML | SVM | 34 | 2.94 | – | – | – |
| [11] | Time series features | Statistical | Relative, absolute distance | 95 | – | 1 | 11.5 | – |
| [12] | Dwell time, flight time, caps lock, shift | ML | RF | 50 | – | 1 | 3 | – |
| [13] | Information sets based features based | ML | RF | 42 | 2.5 | 2.7 | 5.4 | 97 |
| [14] | Acc, gyro, and mag | ML | SVM | 99 | 7.16, 10.05, 15.1 | – | – | – |

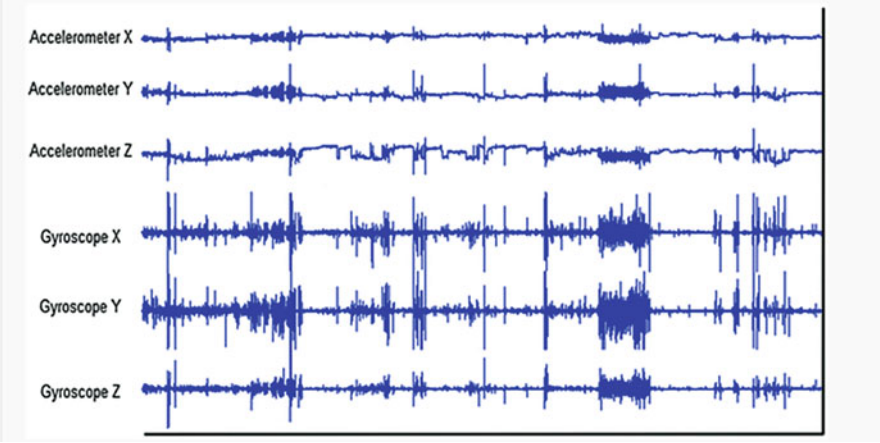


**Fig. 55.1** Accelerometer and gyroscope reading (Source: [15])

### *55.2.4 Voice Recognition and Signature*

Peng [27] developed a voice recognition-based continuous authentication system for wearable glasses. The system is a combination of touch gestures and voice commands. The author developed a user interface called GlassGuard for continuous authentication. For the voice commands, an authentication decision is made for each individual audio file taken from the recorded voice commands. An imposter is detected when the SVM score value is below 80%, otherwise, the user is authenticated. Although voice recognition may sound noninvasive, we have to understand that voice commands may not be practical or available all the time. Unless a combination of voice commands and other features such as keystroke and touch gestures are integrated together. Therefore, a single modality using voice recognition is hard to be achieved, and not much research is available in the literature as well. As opposed to voice recognition, signature detection is another behavior detection mechanism that analyzes the physical activity of signing. There are two ways how signature identification is done: (i) a static method by signing on a piece of paper and (ii) dynamic by signing on a digitizing tablet. As far as the mobile phone is concerned, signature recognition should be more dynamic whereby the signature should be performed on a digitizing tablet and should be real-time.

Table 55.4 shows the use of some more works for voice recognition and signature for human authentication

**Table 55.2** Touch gestures

| Ref | Features | Method | Technique | Subjects | Results | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | EER | FAR | FRR | Acc |
| [16] | Face features and touch duration, direction, length, velocity | ML | Sparse representation, dictionary-based | 140 | 12 | – | – | – |
| [17] | Palm and fingertips features | Not mentioned | Not mentioned | 34 | 7.88 | – | – | 90 |
| [18] | Stroke duration, mean resultant length, average velocity, stroke pressure | Machine learning | k-NN, SVM, RF | 71 | – | – | – | 90 |
| [19] | Tap, swipe forward, swipe two-finger swipe, voice command | Machine learning | SVM | 32 | 4.88 | 0.5 | – | 99 |

**Table 55.3** Gait recognition

| Ref | Features | Methods | Techniques | Subjects | Results | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | EER | FAR | FRR | Acc |
| [22] | Accelerometer and gyro | Machine learning | MP | 51 | 0.13 and 3.12 | – | – | – |
| [21] | Accelerometer | – | – | 35 | 13 | – | – | – |
| [23] | Linear accelerometer and gyro, time | – | – | 10 | 2.40 and 5.50 | – | – | – |
| [24] | Accelerometer | – | – | 10 | – | 1.46 | 6.87 | – |
| [25] | 3d accelerometer and gyro | Machine learning | SVM | 20 | 1.2 | – | – | – |
| [26] | Accelerometer and gyro | Machine learning | MP, k-NN, SVM, NB | 60 | – | – | – | 81 to 97 |

**Table 55.4** Voice recognition and signature

| Ref | Features | Methods | Techniques | Subjects | Results | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | EER | FAR | FRR | Acc |
| [28] | Pen pressure and velocity | Machine learning | NFZ | 100–210 | 4.883.33 | 5.283.36 | 4.483.30 | – |
| [29] | Pen pressure, pen position, Velocity, acceleration | – | MP, BN, k-NN, RT, RF and others | – | – | 3.5 | 0 | |
| [30] | Pen pressure and velocity | Machine learning | NFZ | 40–210 | 11.58 | 12.15 | 11.00 | – |
| [27] | Single-tap, swipe forward, swipe backward, swipe down, two-finger swipe forward, and two-finger swipe backward and voice command | Machine learning | SVM | 32 | 4.88 | 0.5 | – | 99 |
| [31] | 4 statistical features, 13 touch screen features | – | MP | 30 | – | 3.1 | – | – |
| [32] | X and Y pen coordinates and pressure, 23 time functions | Machine learning | Recurrent neural networks (RNNs) | 400 | – | – | – | – |

## 55.3 Challenges

Due to the availability of sensors and advancement in mobile devices with powerful processors, behavioral biometrics is becoming an active and progressive field in mobile devices. However, to build a robust behavioral biometrics-based continuous mobile authentication system, several challenges are being faced. Figure 55.2 outlines these challenges.


**Fig. 55.2** Challenges

### 55.3.1 Usability, Acceptability, and Security

There is a trade-off between usability and security; if the authentication system is very straightforward and user-friendly, then security has to be compromised vice versa; if security is prioritized, then usability will be affected [33–35]. There is a need for such an authentication system that is acceptable to every user to secure the application without affecting the usability.

### 55.3.2 Suitable Feature

To achieve good performance, more suitable features are required [36]. Feature's set should be short, distinct, and easily manipulatable and should be able to distinguish among different users based on their mobile user behavior.

### 55.3.3 No. of Subjects

The more the number of subjects, the accuracy will be more reliable [37]. The number of subjects is small or midsize in the literature. To see the significance of the authentication system, there is a need to evaluate the system with a large number of data.

### 55.3.4 Subject Selection

Subject selection is also a big issue, with respect to age, profession, and technology literacy. Subject selection directly influences the authentication results. Authentication results from technology literate and non-technology literate differ, similarly, for the young and old age group.

### 55.3.5 Training Data

Quantity and quality of training data are different on different interfaces of the applications. Some simple applications that have a specific user behavior usually require less training data, while the applications that don't have specific behavior require more user data, and more powerful machine learning tools are required. Selecting suitable and enough training data and how much data is required to fully train the system is a big issue [37].

### 55.3.6 Training Time

Training time is also a big issue, i.e., how much time is needed to fully train the system. Training time depends on the usage of the mobile. If a person uses his mobile more, training time will be covered early.

### 55.3.7 Implementation

Implementing such an effective and robust continuous identification system is a challenging task. It will take a longer time to implement this system completely [33, 34], because it will need a very intelligent system that should sense in the change of behavior and trained the system accordingly.

### 55.3.8 Changing Physiological Factors

As the user gets familiar with the input methods, his behavioral characteristics change with time. The author in [38] concluded that age affects the performance of the authentication system. So, a system should be built that can adopt changing with respect to physiological and environmental factors. However, some work is done on transfer learning in keystroke dynamics with a little amount of retrained data in different conditions [39]. There is a need to develop a modal that can update the trend of changing behavioral biometrics [28]. There may be a different behavioral or physical condition at the time of enrollment that can affect the authentication process. Therefore transfer learning techniques must be used to cope with the changing behavior problem [34].

### 55.3.9 Speed

Because of the limitations of hardware and memory, mobile devices have to face the issue of speed in the authentication process. The authentication process can take longer time in mobile devices than computers.

### 55.3.10 Accuracy

Getting 100% accuracy is a challenging task for behavior biometrics. Because it is very difficult to find such behavior features that can give very good performance in

identifying the user accurately, a lot of authentication methods have been proposed in the literature, but to evaluate the performance, there is no clear standard [34].

### *55.3.11 Changing Device*

With the change of mobile phone or with improved sensors, the authentication process would also have to be renewed, especially the authentication methods that are based on touch dynamics and gestures. The user of different devices gives inconsistent values of the touch positions and therefore requires normalization unless the data collection is done using devices of the same model, meaning that whenever a person changes the device, the whole system must be retained. That is quite tedious to do so.

## 55.4 Conclusion

Due to the availability of smartphone sensors, behavioral biometrics using mobile sensors have the potential to secure personal data without requiring further hardware. In this paper, different behavioral biometrics techniques used/proposed by different researchers, their advantages and disadvantages, and the possible challenges have been discussed. Most of the work in the literature focuses on keystroke dynamics, touch dynamics, touch gestures, and gait as the most suitable methods of authentication on mobile phones. Although some other methods exist, such as voice recognition and the signature, these methods may not be suitable for continuous authentication. For example, voice commands are available everywhere [27] that can create hindrance in the authentication process. Currently, modern mobile phones are only equipped with a microphone that allows for voice recognition. Unless in the future, with more advancement in technology can introduce methods not only to recognize the person who speaks but also to mimic their intonation, timbre, etc. Signature identification can either be static (paper signing) or dynamic (digital signing). These two mechanisms can be combined with the more traditional method of touch dynamics, keystroke dynamics, touch gestures, and gait to be more authentic.

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# Chapter 56
# Review on Multi-pattern and Multi-polarization Smart Antennas for Aerospace Applications in Wireless Communication


**Giriraj Kumar Prajapati, Santhosh Kumar Allemki, Voladari Praveen Kumar, and S. Manjula**

## 56.1 Introduction

The adjective Smart is implemented in many domain names, regularly to make a product or machine extra appealing. Reconfigurable antennas can either build the abilities of remote incorporated data systems, extend their usefulness, or broaden their transmission capacities, with effective range and power use. Contrasted with the present radio innovation which relies upon contrary correspondence systems with resolute equipment, the innovation of reconfigure capacity will fundamentally diminish the equipment multifaceted nature, the number of segments, and the expense [1]. As portrayed above, reconfigurable antennas warranty to convey a giant crew of advantages in the future age of faraway systems. Cutting edge correspondence structures will depend upon reconfigurable antennas, for example, far off systems in powerful conditions (e.g., satellite/terminal following), versatile shaft filtering (e.g., radar/remote detecting), and MIMO structures (e.g., dynamic administration of station relationship/decent variety/impedance) [2]. Among the diverse range of plans at radio wire level, multi-layout and multi-polarization antennas are integral ones. They can be utilized to improve framework expand and security, fulfill framework prerequisite, preserve away from boisterous condition, and alter to the earth adaptable [3]. The foremost cause is a staged exhibit receiving wire with optical beamforming for the usage of airborne satellite verbal trade. During the flight, this reception apparatus gadget (acts as fixed components) steadily controls its beam toward the geostationary satellite to be gotten. One can likewise

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need to make reference to that the reception equipment adjusts to the electromagnetic environment [4]. In the ongoing years, reconfigurable antennas pulled in increasingly more consideration because of their potentiality in multipattern and multi-polarization. One of the significant applications is in aviation and earthly remote correspondence frameworks [5].

## 56.2 Optical Beamforming

The downlink frequency bands for aeronautical cell satellite TV for PC television for computer offerings (AMSS) in both the Ku-band and the frequencies of the broadcast satellite TV for PC company are:

- Aeronautical earth stations (AES) get band 1: 10.70 – eleven.70 GHz (number one assignment to predictable satellite television for pc TV for workstation transporter).
- Satellite TV: eleven.70–12.50 GHz (number one assignment to communicate satellite backer).
- AES gather band 2: 12.50–12.75 GHz (essential mission to constant satellite TV for PC TV for laptop television for PC carrier). The absolute Ku-band reception apparatus machine includes a radio wire the front-quit and an optical beamforming network (OBFN). The reception equipment factors utilized are stacked fix antennas which can most possibly collect satellite TV for PC TV for PC pointers among 11.7 GHz and 12GHz. The antenna the front-stop consists of the antenna elements and the low-noise amplification and down-conversion chips.

  1. The antenna factors are geared up in 24 tiles of 8 by the ability to use 8 antenna factors.
  2. The low-commotion intensifier (LNA) and down-converter.

The yield of each and every antenna thing is motivated to a low-commotion speaker because of the reality the sign acquired thru nice one antenna detail might be virtually powerless. Before the intensified signal is influenced to the optical shaft-shaping system, its some distance down-changed. Optical ring resonators (ORR) are used as true time delay (TTD) segments. The apex estimation of the put off is then again evaluating to the bandwidth.

## 56.3 The Vibrating Antenna

The adjective case of a Smart Antenna for Aerospace Applications issues a tremendous staged cluster radio wire on a deformable piece of the airplane. The exhibit receiving wire has eight installed fix components in getting mode. It may be

tried that the impacts of misshapen of a cluster radio wire can be stifled with the helpful asset of the methodology of versatile fake beamforming.

### 56.3.1 Effects of Vibration

The impacts of the vibrate arrangement at the radiation example of the cluster antenna are affirmed. The undisturbed exhibit antenna is situated inside the plane $z = 0$. Neither decreasing nor shaft guiding is executed. The patch is displayed with the guide of isotropic radiators.

### 56.3.2 Compensation Techniques for Vibrating Arrays

As of the previous stage might be presumed, that change in the area (in view of out-of-plane disfigurements and vibrations) needs to be redressed. An open door period includes estimating the stage contrasts with a catch to the undisturbed consistent realm of the plate. This sort of fragment adjustment is done to cluster antenna on the vibrating plate.

### 56.3.3 Classification and Technologies of Reconfigurable Antennas

In this article, the reconfigurable antennas (basically these antennas here) are preferred for three requirements: multi-pattern antennas, multi-polarization antennas, and multi-pattern multi-polarization-blended reconfigurable antennas (Fig. 56.1). These antennas are categorized into three large varieties accomplished via altering the bar course, shaft structure, and development,

The shaft heading contains both the omnidirectional and directional bearing. Antennas have the capability of involving omnidirectional and directional radiation

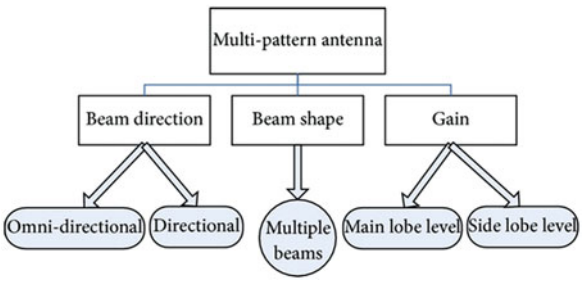


**Fig. 56.1** Categorization of multi-pattern antennas

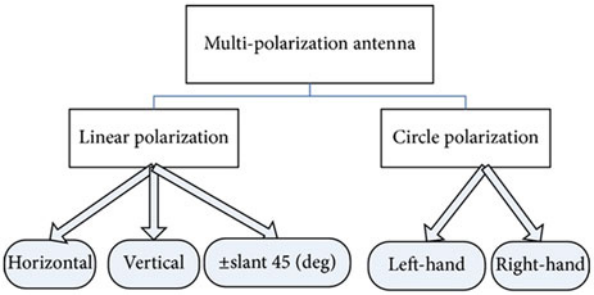


**Fig. 56.2** Categorization of multi-polarization antennas

designs or fluctuate the course starting with one aspect and then onto the subsequent aspect which are acknowledged as the bar-bearing reconfigurable antennas. Bar structure reconfigurable antennas can be finished by varying the volume of bars (different pillars). At last, the addition reconfigurable antennas can be stated by using changing the nation of shaft quintessential flap and facet projection (Fig. 56.2).

The multi-pattern-multi-polarization-blended reconfigurable antennas combine multi-pattern with multi-polarization. So as to perceive assorted reconfigurable antennas, five basic advancements are introduced:

(i) The conventional portions are varactor diodes and more diminutive scale electro mechanical-structure (MEM-S) tunable capacitors/inductors.
(ii) Radio rehash (RF) electrical switch: by controlling the voltage, accomplish the movements to be "on" state or the "off" state.
(iii) Photoconductive switches: enact the semiconductor objects (silicon, gallium arsenide) by controlling the laser light to comprehend the "on" state or the "off" state.
(iv) Exotic material: a static-related electric/appealing field or voltage can change the relative material permittivity/penetrability.
(v) Structural modification: by changing the tallness, grounds, and state of receiving wire, the physical aide can be altered.

## 56.4 Multi-pattern Antennas

The moderate overflowing directional radio wire homogeneously empowers all the bearing. The get-together device, we ought to select the omnidirectional radio wire. After structure, the area heading of getting wire must alternate in the meantime. This kind of antennas apprehends omnidirectional and directional radiation. Radio wire confirmed up in Fig. 56.3 is an integral radiation shape reconfigurable get-together mechanical social issue.

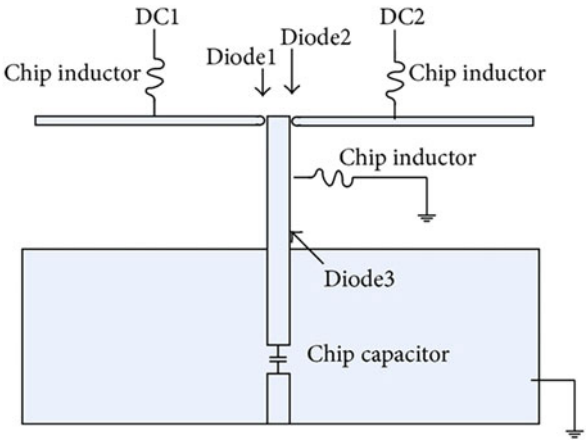


**Fig. 56.3** Radiation pattern reconfigurable antenna

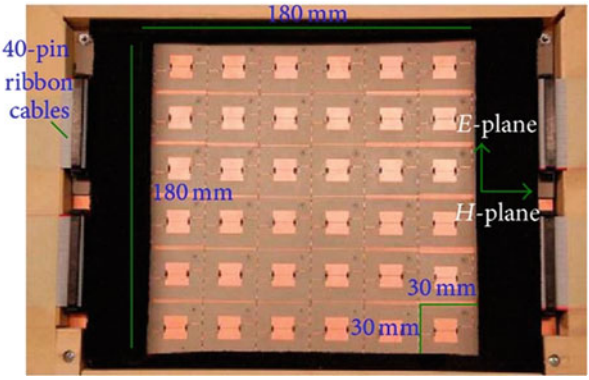


**Fig. 56.4** 6 × 6 planar reconfigurable array

This is a kind of complex radiation shape reconfigurable antennas. The radio wire device is a microstrip composite right-/left-hand (CRLH) insufficient wave receiving wire made up of 25 fell metamaterial unit cells, as confirmed up in Fig. 56.4. The made radio wire confirmed up in Fig 56.4 is a planar 6 × 6 completely reconstructed display working at 5.7 GHz, prepared for working both as a reshaped crew point of convergence and a reconfigurable mirror show. This display can exhibit full 2D shaft shaping with negligible exertion and is certainly now not challenging to make.

The antennas which emanate a variety of pillars in the meantime are called multibeam antennas. Multibeam antennas can jointly transmit motion in specific approaches in the meantime with excessive extend and accomplish the bottom side projection by adjusting the sufficiency and length of the feeds. Shaft that forms reconfigurable antennas are imperative and have been regarded by means of several researchers (Fig. 56.5).

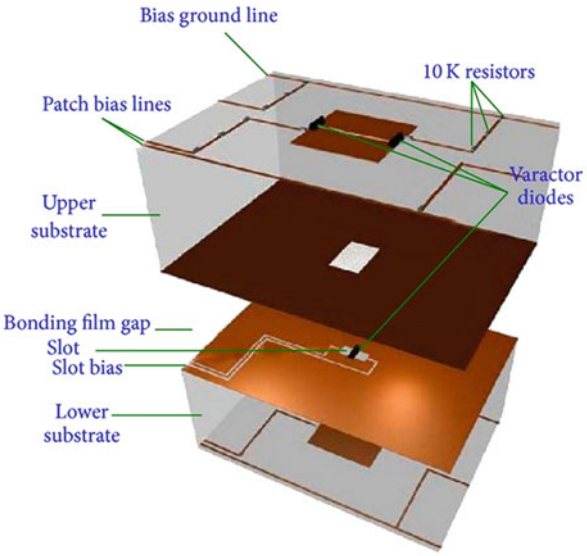


**Fig. 56.5** 6 × 6 planar reconfigurable collection

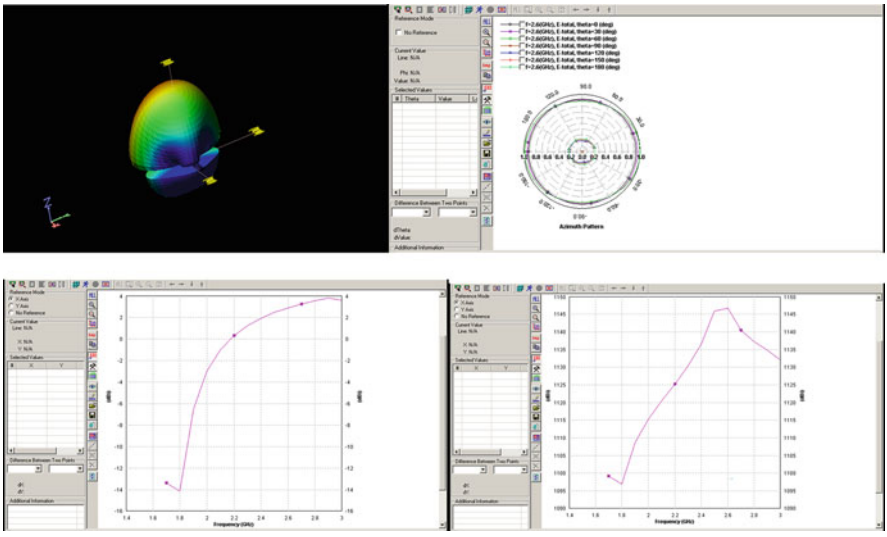

**Fig. 56.6** Outputs of multi-pattern and multi-polarization antennas

The radio wire is made out of a planar exhibit of electrically negligible steel square-molded pixels that are interconnected by using MEMS. By opening or deactivating the interconnecting MEMS switches, the MRA dipole's geometry is modified (Fig. 56.6).

## 56.5 Multi-polarization Antennas

Standing out and set up antennas from single-polarization, the multi-polarization antennas provide focal motives for reducing in basis space, low pairing effect, and low basis price. subordinate upon the structure necessities. The kind of straight polarization is part of even, vertical, and inclination 45° division. The sorts of spherical polarization are perfect hand indirect polarization (RHCP) and left-hand spherical polarization (LHCP). A polarization reconfigurable opening radio wire with unimportant feed is regarded in. Engaged by double constructions for coplanar waveguide, twofold even direct polarizations are invigorated in the opening and restrained through two PIN diodes. The rectangular opening with the portions of $53 \times 50$ mm2 fills in as the radiation gap, scratched in the front element of FR4 ($\varepsilon r = 4.4$, $\tan\delta = 0.01$). Circular Polarization Reconfigurable Antennas. A circularly engaged reconfigurable microstrip pack radio wire with pipe long-established shaft radiation is regarded in the figure. The show radio wire shape contains four L-formed restoration components deliberate in square-ring progress. The radio wire can swap among LHCP and RHCP.

## 56.6 Comparison Between Multi-pattern and Multi-polarization Antennas

The reconfigurable antennas associated with feed be a phase of comprised planar antennas and nonplanar antennas. The planar reconfigurable antennas strengthened with the aid of coaxial or coplanar waveguide are in a customary experience contained microstrip antennas substrate joined waveguide (SIW) antennas and monopole or dipole antennas. The microstrip antennas are generally used in reconfigurable antennas with the upsides of inappropriate size, lightweight, low profile, and simplicity of joining. In any case, confirmed up unmistakably in affiliation with the microstrip-reconfigurable receiving wire, they are constantly difficult to approach and have decreased adaptability. The monopole or dipole antennas have adaptable structure, regardless their popularity is augmentation lower than SIW antennas (Fig. 56.7).

## 56.7 Applications

These antennas have been utilized in both aeronautics and earthly remote correspondence to improve run productivity, for example, remote structures in astonishing conditions, versatile bar checking, and MIMO systems and breaking point darkening in twirling areas at all conceivable recurrent get-togethers of development. In the adaptable shaft inspecting system, the radio wire should normally change its

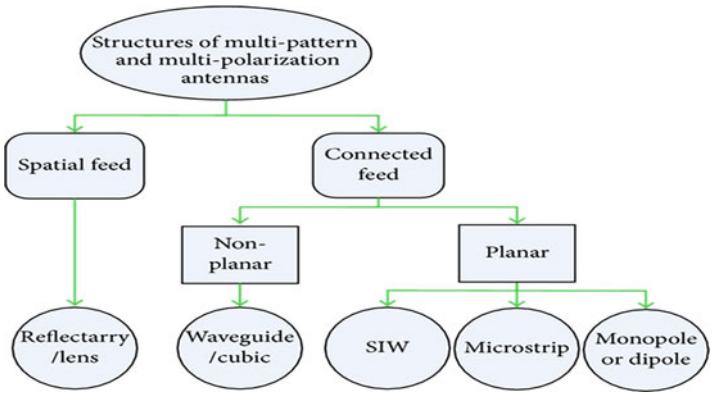


**Fig. 56.7** Various structures of multi-pattern and multi-polarization antennas

radiation column course contrasting with the diverse multiplication circumstances or moving objective, for instance, in the game plan of radar and remote distinguishing. The MIMO structure with reconfigurable antennas can viably administer channel relationships, better than average assortment, and block.

## 56.8 Conclusion

An assessment between a number of these antennas with a range of constructions and working systems is comparatively examined. The reconfigurable antennas can be particularly related to dynamic conditions, adaptable area checking, and MIMO systems. The objective later on work is to fathom the area programmable receiving wire structure to pressure antennas from clear transducers to slicing part wave processors. An astoundingly hypnotizing objective is that we can make area programmable receiving wire structure which acknowledges vague adaptability from different field-programmable contraptions. Field-programmable receiving wire framework, reconfigurable antennas have the ability to recognize adjustments in their RF circumstance and reply in like manner, and what's more, the reconfigurable antennas will acknowledge more and more a primary occupation in air transportation and everyday applications.

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# Chapter 57
# A Review on Advent of IoT, Cloud, and Machine Learning in Agriculture


**Y. Vishwanath, Raje Siddiraju Upendra, and Mohammed Riyaz Ahmed**

## 57.1 Introduction

The agriculture yield must be enhanced by 2050 to meet the demand of the increasing population globally as per the UN report [14]. By this time the population is expected to reach 9.7 billion with 34% growth. Agriculture forms the basis for food security, and hence it is important. Hence, correspondingly the food yield or production must be increased to meet the population demand. It is possible to achieve this by either increasing the agricultural land or increasing the crop yield. But increasing the agriculture land by means of deforestation is not an appropriate solution, so it needs to go by the approach of increasing the crop yield which can be achieved by implementing smart or precision agriculture. In smart/precision agriculture, every parameter is monitored such as soil fertility, moisture content of the soil, light intensity, and balance between demand and supply (usually farmers incur a huge loss because of more produce) which supports productive and profitable agriculture practice. The agriculture practice shall be a profitable venture in support of the technology trio which provides a conducive ambiance that results in healthier growth of agriculture yield. This can be made possible by effectively utilizing current technology trends.

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In India, a majority of the population, i.e., above 55%, is dependent on agriculture as per the recent information. Agriculture is the field that enables the farmers to grow ideal crops in accordance with the environmental balance. In India, wheat and rice are the major grown crops along with sugarcane, potatoes, oil seeds, etc. Farmers also grow non-food items like rubber, cotton, jute, etc. More than 70% of the household in the rural area depends on agriculture. This domain provides employment to more than 60% of the total population and has a contribution to GDP (about 17%) [1]. The current technology trio of IoT, cloud, and machine learning can contribute greatly and effectively to agriculture sector. The technology trends are gradually making their ways in various forms like smart agriculture, smart farming, precision agriculture, etc.

In the present review, paper attempts were made to showcase the advantages and the impacts of current technology trio, that is, IoT, cloud, and machine learning, on optimizing and enhancing the agriculture productivity and also about the contemporary interdisciplinary research in the field of agriculture that uses technology trio.

### *57.1.1 Internet of Things (IoT)*

IoT is a concept of connecting any communicable device to the Internet to share the information and can be perceived as a huge network of various sizes and kinds of devices right from a nanosensor to a space vehicle. All these connected devices collect and share data about its functionality and the ambiance.

In IoT, most of the objects are embedded with sensors that are connected to the platform. These objects collect data from various related objects in a given context and analysis of the relevant data and are applied to solve a particular problem without the need for human-to-human or human-to-computer interaction [15].

Consider a scenario where an agriculture farm is watered every day in the morning at 7 am and then watering is stopped when the moisture level reaches a certain level. This works fine until something goes wrong like there is no water in the tank. If this is IoT enabled, then before 7 am, the water level measuring sensor in the tank provides the water quantity which then triggers the actuators. Now the water must be transported; hence, the system calculates the time to travel and time to fill the tanker and then we finally see that water is available before 7 am and can be utilized.

### *57.1.2 Cloud*

Cloud computing which is simply referred to as “cloud” technology provides an on-demand computing service. The services range from application to storage of data on pay-and-use basis. The three major services provided by the cloud are (1)

software as a service (SaaS), (2) infrastructure as a service (IaaS), and (3) platform as a service (PaaS). There are thousands of sensors available today which primarily work based on an IoT platform to support agriculture practice, each of these sensors generates a huge amount of data that can be considered as agriculture-based *big* data, which can be stored in a cloud for effective and efficient usage.

### *57.1.3 Machine Learning*

Machine learning is about programming the computer to learn from the given input automatically and improve through the experience without being explicitly programmed. It has been evolving consistently and has gained importance because of the ability to predict and also plays a crucial role in decision-making and real-time actions. Machine learning algorithms consume a large voluminous amount of data from which learning happens by considering different entities, drawing relationships, and correlating them. The learning is better when there is large and diverse data integrated from various sources.

## 57.2 Literature Survey

The greenhouse technology has made a greater impact on agriculture worldwide, and the current technology trend of IoT has complemented it and has provided a new paradigm to agriculture practice. A research group has designed greenhouse agriculture with IoT. The main objective of the study is to create an ambiance by monitoring and controlling the essential parameters that are necessary for healthy crop yield. It is a three-layered architecture, which consists of perception, network, and application layer. These layers have wireless sensor nodes, Zigbee and gateway, respectively. The wireless sensors include temperature, pressure, light, humidity, and $CO_2$ measuring devices equipped with CC2530 processing chip. The network layer uses Zigbee that collects the data from the WSN and forwards it to gateways which in turn sends to display devices or to smartphones using GPRS. The paper concludes by sharing the information that they were able to monitor and control the greenhouse more effectively and efficiently [2].

Regarding improving the farm productivity, Jayaraman et al. [3] define smart farming as an application of ICT, IoT, and big data analytics to solve the problems of electronic monitoring of crops and environmental-related properties like humidity, temperature, etc. The Australian multidisciplinary team has introduced an IoT platform SmartFarmNet for smart farm applications and is considered to be the largest system that gives very specific information about crop performance analysis and recommendations. The developed system uses four-layered architecture, and layer 1 provides the information about the feature of deploying any IoT device (sensors, smartphone, etc.) while collecting the primary raw data from sensor nodes

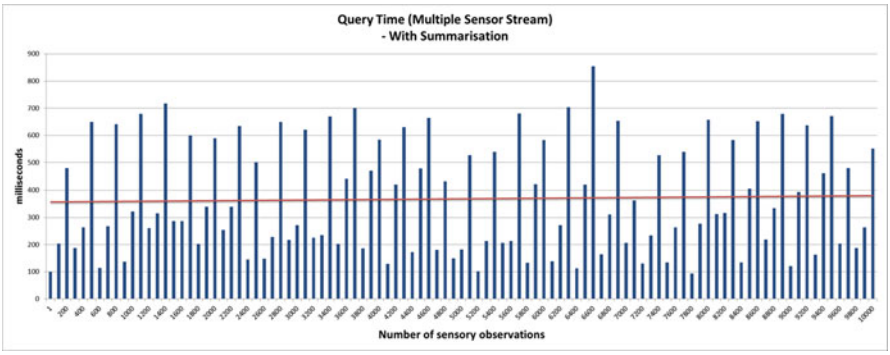


**Fig. 57.1** Query time multiple sensor stream with summarization (Source: [3])

and delivering it to the gateway nodes. In layer 2 the gateways help in processing the data near the source by improving communication bandwidth. The gateway uses Open IoT X-GSN component data ingestion. It then sends the data to layer 3 the cloud storage which can provide a huge amount of data generated through various devices and real-time data analysis is performed. It provides a query access performance latency that has the ability to store high-velocity data and at the same time provide sub-second query response. One such response evaluation has been discussed in Fig. 57.1. Layer 4 is a visualization platform. Hence this framework developed is expected to be flexible in terms of deploying new sensors, fast and high data rate collection of data as well as procession the query and responding and better visualization for decision-making [3].

Cambra et al. [4] demonstrate the potential of IoT and context-based information on precision agriculture. In this background, the research group defines a layered architecture called PLATEM PA that provides service to the farmers through multimedia communication. Layer 1 consists of a WSN node, aerial sensors (drones), and irrigation controllers. Basically, the mesh network of sensors is created using an operating frequency band of 868 MHz LoRa or Sigfox using the drones. Layer 2 is the middleware and is responsible to create the best routes and identify the sensors and also gather data from them and further store it in the database. In layer 3 of the discussed system, the research group adapted SOA architecture in which data from sensors is collected, and it's up to the farmers to get the required information for smart farming based on their needs. Therefore with respect to this, the server is identified with three main functionalities: (1) collecting data from the sensor, (2) applying context-based knowledge using drools governing based on Rete pattern matching algorithm, and (3) producing results in the form of multimedia. This setup was used to experimentally detect the potential fungal attack. Finally, for optimization purpose, the study also tested the bandwidth utilization at various phases as presented in Fig. 57.2 [4].

In a recent study, a research group developed an IoT model blended with machine learning to analyze agriculture data for smart farming. In the developed

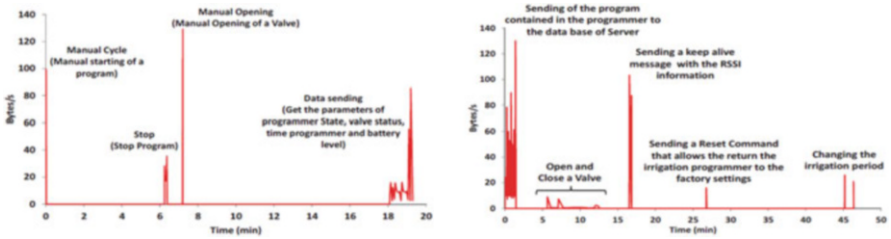


**Fig. 57.2** Bandwidth consumption (Source: [4])

model, the study used the soil moisture sensors to measure the soil humidity and to auto control the functioning of a water sprinkler, solenoid valve to control the flow of water, DHT22 sensor to control the humidity of mushroom farm, and an ultrasonic sensor to control the water level in a chicken farm. A web application is developed to store and maintain the data obtained from these sensors. The stored data is further processed using the data mining approach to define the data format and to cleanse the data to get effective data, and then the study applied the knowledge extraction tools such as classifier, clustering, and association rules (Apriori algorithm) and processed the data effectively to correlate with the input parameters, i.e., temperature, humidity, and moisture. The study also used a linear regression model to assess the relationship between input parameters and output parameters of the lemon and vegetable cultivation agricultural practice. Study claimed that through the data modeling, the knowledge results showed that if the yield of vegetables is high (more than 4 kg/day) and lime cultivation is high (more than 6 kg/day), then the temperature lies between 29 °C and 32 °C, and the humidity will be between 72% and 81% [5]. From this, it is evident that the optimization of the essential factors and conditions of the agricultural practice applying ML and sensor-based IoT plays a pivotal role in reporting the enhanced crop yield.

Araby et al. [6] developed precision-based agriculture smart system based on the integration between IoT and machine learning tool to predict the late blight disease in potatoes and tomatoes in Egypt, where 15% of the crop cultivation is potatoes. The prediction is done before the first occurrence of the disease based on the temperature, humidity, leaf wetness, and soil moisture conditions, and the developed technology will certainly save and reduce the costs of the agriculture practice. The technology utilized shall send the warning message to the farmer during the specific time of infection season. The farmer user interface system helps them to take precautionary measures and apply the protective pesticides in order to save the crop yield and reduce the usage of the needless pesticides. The design aspect of the project implementation has used cloud-based IoT platform architecture, and it has three layers of the system: the perception layer, network, and gateway layer, and application layer. The perception layer consists of air temperature, air moisture, and soil moisture sensors along with Node MicroController Unit (NodeMCU). The perception layer connects to the next layer, the gateway using a protocol called MQTT along with the Wi-Fi module. The gateway layer is implemented using R-Pi

3 microcontroller. The gateway layer ensures that all the captured data from various sensors is relayed to the cloud server for further analysis. The data set is a real data set retrieved from CALC and GDU (growing daily data) data source. SVM (support vector machine) learning algorithm is applied to find the disease severity (DS) based on which the action can be initiated. The application layer consists of a website designed that displays the results of the analysis and also the actual data [6].

In the context of IoT applications in precision agriculture, Grimblatt et al. [7] have intensely looked into effective parameters that are essential and also influence a plant growth such as soil and environment parameters. The soil parameters are moisture, nutrients, pH, temperature, and texture, and the environment parameters are light, temperature, and weather. The study concludes that the IoT can be used effectively in monitoring the agriculture practice, and the prototype designed in the study was still in its progressive development stage; this can be meticulously scaled up to the broader benefit to the farming activity [7].

A four-layer architecture called "my sense environment" was developed by Morais et al. [8] to enhance the crop yield productivity using precision agriculture. The major goal is to provide low-cost data acquisition support, use standardized communication protocols, and also provide better application interface for easy access to the data. Various types of sensors were deployed, and level 2 has gateways to collect data from sensors, level 3 edge computing (fogs) was installed to process the collected data locally, and at level 4, finally, the data is passed on to cloud for applying big data analytics, machine learning, and user interface systems.

The software components include RPi operating system that drives a number of modules that are implemented using python which include (1) database module, (2) real-time alert module, (3) WSN manager, (4) local application, and (5) mySense agent. The database module stores data from every node in the environment in a table created for every device. The Real-Time Alert System (RTAS) module uses database data from all sensors, applies an algebraic expression, and can raise an alarm to find whether there is any possibility of disease because of a change in moisture or air temperature. The WSN manager is dealing with communication and is essential to exchange data between the SPGATE'18 and WSN nodes and basically does the job of pushing WSN nodes data into the local database. The primary aspect of this paper is to provide and ascertain that the data can be collected from different types of sensors and manage this huge data at low cost and use standardized communication protocols [8]. The data comparison in Table 57.1 is collected from Google Scholar papers having maximum citations in this domain and in that particular year.

## 57.3 Conclusion

In smart/precision agriculture, the technology trio of IoT, cloud, and machine learning has been extensively used, and still it is in an infant state. The researchers have developed extensively IoT using various kinds of sensors and communication

**Table 57.1** The technology used in developing precision agriculture over a period of 10 years from 2010 to 2019

| Year | Paper | Sensors | IoT | Cloud | Machine learning | Highlights | Reference |
|---|---|---|---|---|---|---|---|
| 2019 | mySense: A comprehensive data management environment to improve precision agriculture practices | Rain, leaf wetness, sap flow, soil moisture, solar radiation, wind speed, air temperature, and relative humidity | (IEEE 802.15.4/Zigbee, 6LoWPAN, LoRa®, Bluetooth®, IEEE 802.11, GSM/GPRS/3G/4G/5G, Sigfox, LTE) | mySense cloud server | Rule-based | Successful deployment of PA/PV smart monitoring open-source environment | [8] |
| 2018 | Smart IoT Monitoring System for Agriculture with Predictive Analysis | Air, temperature humidity, and soil moisture | Node MicroController Unit (NodeMCU), Wi-Fi module, and MQTT protocol | MQTT broker | SVM | It develops a smart system integrating IoT and machine learning for predicting late blight disease and helps in avoiding and overcoming the disease as well as improving the crop yield | [6] |
| 2017 | An IoT service-oriented system for agriculture monitoring | Temperature, humidity, pH, pressure | 868 MHz IoT mesh network with low energy | Yes | Decision rules | It demonstrates the communication technology and intelligent context-based service with low energy consumption | [4] |
| 2016 | Internet of Things Platform for Smart Farming: Experiences and Lessons Learnt | Any IoT device, JAVA-based semantic sensor stream processor. Arduino and ArduCrop sensor wrappers to interface with IoT devices | 4-layered architecture, OpenIoT | Yes LSM-Light developed using JAVA and Open Virtuoso triple store | No | Provides a flexible environment and high velocity data analysis and better visualization of information that helps in improving crop production | [3] |

(continued)

**Table 57.1** (continued)

| Year | Paper | Sensors | IoT | Cloud | Machine learning | Highlights | Reference |
|---|---|---|---|---|---|---|---|
| 2015 | Intelligent agriculture greenhouse environment monitoring system based on IoT technology | Temperature, moisture, carbon dioxide | WSN with CC2530 chip, modem with Zigbee, GPRS connected to smartphones | No | No | They are able to monitor and control the greenhouse more effectively and efficiently | [2] |
| 2014 | Wireless Sensor Network in Precision Agriculture Application | Temperature, humidity of air, temperature and moisture of soil | WSN with GSM modem | No | Expert system capability | Optimization of water and fertilizer usage using IoT | [9] |
| 2013 | Smart Agriculture Based on Cloud Computing and IoT | Light, temperature, moisture, carbon dioxide, wind pressure | Three layered, i.e., sensing layer, delivery layer, and intelligent control layer. 2G GPRS, 2.5G CDMA | Cloud computing in plant manage-ment | Intelligent irrigation system | Using large amount of data and cloud smart agriculture is realized | [10] |
| 2012 | Application of the Internet of things technology in precision agriculture irrigation systems | Soil temperature, humidity, atmospheric pressure, wind speed | Sensor nodes connected using GPRS with Zigbee wireless communication | No | No | Effective and stable agriculture with efficient water management and precision monitoring | [11] |
| 2011 | The Application of Cloud Computing and the Internet of Things in Agriculture and Forestry | The temperature, humidity of air, temperature and moisture of soil, ambient light, and CO2 | Multihop sensor network with sensor nodes connected through gateway to the communication server | No | DSS | Setting up the IoT and DSS improvement in agriculture produce | [12] |
| 2011 | The Study and Application of the loT Technology | Temperature and humidity sensors | Sensors with MCU (microcontroller unit) communication using Wi-Fi | No | No | Remote control of green house, to monitor and control the ambience | [13] |

protocols to gather data from various plants. The generated raw data can be structured and stored in different forms using edge computing or fog or cloud computing. Finally, an analysis is performed on data collected, and decisions can be taken to improve the crop yield. This approach of increasing the agricultural crop yield can be the solution to meet the food needs of the future population.

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# Chapter 58
# Near Real-Time Mobile Profiling and Modeling of Fine-Scale Environmental Proxies Along Major Road Lines of Nepal

**Nanda B. Adhikari, Sushant Gautam, Alina Devkota, Saloni Shikha, Spandan Pyakurel, and Mandira Pradhananga Adhikari**

## 58.1 Introduction

Climate modification via natural processes or through continual interaction of man-made inventions with the environment is a dynamic progression. Ecosystem diversity on Earth and our own existence are tightly intertwined with the surrounding climate. A variation in climate unquestionably has impacts across the ecological pyramid. Effective profiling of climate change indicators requires markers that are responsive, state-of-the-art, and adaptive to the uncertainties associated with climate change. Nepal being a developing nation is more vulnerable to climate change because it has the lesser capacity to adapt quickly to climate transformation as compared to developed countries [1]. OpenSense [2], a Nano-Tera project, exploits the crowdsourcing technique where users are incentivized to make available data based on physical measurements such as location and pollution through their monitoring assets or personal mobile devices. Also, the dispersion model has been used to compute air pollution map that also helps to assess the quality of the sensor data [3].

The authors deeply acknowledge the University Grants Commission (UGC), Nepal, for providing us with the research grants without which this research would not have been possible and to Ramlaxman Innovations, Lazimpat, Kathmandu, for collaborating with us in collecting the datasets. We are grateful to the Department of Hydrology and Meteorology (DHM), Nepal, and the Department of Environment (DOE), Nepal, for the published historical data.

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As geographic information systems (GIS) and data modeling techniques are becoming popular and are powerful tools in the analysis of environmental proxies, spatial data of environmental variables are highly valued and in need [4]. For a statistical model, estimation models are constructed based on measurements. Spatial interpolation has been in practice using various techniques including Gaussian process regression, also known as kriging [5]. Likewise, land-use information can also be one of the parameters to build up the model [6].

With the advent of remote sensing, low-cost electronics devices are used to collect near real-time data [7] with multiple applications [8]. GPS traces and statistical analysis of in-vehicle GPS trace data have been used for various purposes including incremental map generation [9]. Instead of using stationary sensors, GPS-enabled mobile sensors are in use for an economic way for various road mapping and spatial data collection applications and have proven to have a high potential for real-time GPS trace-embedded remote data collection [10].

## 58.2 Methodology

The first category involves the usage of data gathered from mobile sensors fitted on ground vehicles (see Fig. 58.1), while the second category makes use of data collected from existing fixed weather sites. The data obtained from both categories are used in building prediction models, whereby future climate patterns are generated and the results obtained from the two methods are compared. And, the second part consists of modeling past data and predicting future climate patterns.


**Fig. 58.1** Plot of data points collected along major road lines of Nepal

Recordings of environmental data, calculations, development of scientific methods, and prediction algorithms are all crucial in order to plan/implement adaptation programs in the event of drastic climate change. The rationale behind this project is to come up with a design strategy that provides a researcher with up-to-date and real-time information directly from the field sites, which can be incorporated in the formulation of a climate change model for a given location.

So far, climate change estimation in Nepal has been made on the basis of secondary, i.e., not first hand, derived, i.e., calculated from third-party results, outdated, or macro scale, i.e., very low-resolution data, which are almost insensitive to local-scale activities. Calculations from such sources have provided vague or flat-out misleading results.

### *58.2.1 Time Series Modeling Using Regression*

Regression model is used to analyze the time series of seasonal components [11]. There are possible benefits of using forecasting time series by using the linear methods and multiple input variables. RNN (recurrent neural network) architecture is the network, and it most concentrates on the feed-forward neural networks to sequence and forms the loop based on the information persistence.

The RNN helps to sequence mapping and input and output alignment based on the simulation time.

## 58.3 Results and Discussions

### *58.3.1 Statistical Analysis*

**Environmental anomalies** The data (Kathmandu 2010 to 2019) is the measurements of weather parameters at the stationary station with a sampling rate ranging over 3 h to 8 h over a period of almost 9 years. However, we discuss only the temperature variable in this section. The dataset consists of 15,701 rows and 5 columns, namely, date, time, temperature, pressure, and relative humidity (see Table 58.2). The dataset consists of time series measurement of weather parameters from 2010-01-02 11:45:00 to 2019-12-06 23:45:00. The separate attributes for date and time have been aggregated to form a new attribute date-time to make computations easier (see Table 58.1). Since the data had already been cleaned, no missing values and errors were found. The new columns were generated from date-time (year, quarter, month, day, weekday) to enable for RNN to learn variations properly.

Several statistical tests can be used to quantify whether the data looks as though it was drawn from a Gaussian distribution. D'Agostino's $K^2$ test was used for this purpose. In the SciPy implementation of the test, p value was interpreted as follows: **p** $\leq$ **alpha**: reject $H_0$, not normal. p > alpha: fail to reject $H_0$, normal (Fig. 58.2).

**Table 58.1** Data for the weather (Kathmandu from 2010 to 2019) after removing missing values and aggregation of date and time into a single attribute and generation of new attributes

| | Date-time | Temp. | Year | qrt | mm | dd | wd |
|---|---|---|---|---|---|---|---|
| 15,696 | 2019-12-06 11:45 | 28.4 | 2019 | 4 | 12 | 6 | 1 |
| 15,697 | 2019-12-06 14:45 | 29.8 | 2019 | 4 | 12 | 6 | 1 |
| 15,698 | 2019-12-06 17:45 | 26.6 | 2019 | 4 | 12 | 6 | 1 |
| 15,699 | 2019-12-06 20:45 | 22.4 | 2019 | 4 | 12 | 6 | 1 |
| 15,700 | 2019-12-06 23:45 | 20.3 | 2019 | 4 | 12 | 6 | 1 |

**a**

| | Date | Time | Tmp. | Pres. | Rel. Hum. |
|---|---|---|---|---|---|
| 0 | 19-01-10 | 5:45:00 | 4.0 | 652.1 | 98 |
| 1 | 19-01-10 | 11:45:00 | 16.6 | 652.6 | 58 |
| 2 | 19-01-10 | 23:45:00 | 6.4 | 651.5 | 87 |
| 3 | 20-01-10 | 5:45:00 | 3.3 | 652.7 | 99 |
| 4 | 20-01-10 | 23:45:00 | 6.8 | 653.0 | 100 |

**b**

| | |
|---|---|
| p-value | 0.0418 |
| # Lags Used | 29 |
| # Observations Used | 3022 |
| Critical Value (1%) | -3.4325 |
| Critical Value (5%) | -2.8625 |
| Critical Value (10%) | -2.5673 |

**Fig. 58.2** (**a**) Raw data for the weather (Kathmandu from 2010 to 2019). (**b**) Results of Dickey-Fuller test for temperature

**Table 58.2** Temperature distribution

| | Count | Mean | Std | Min | 25% | 50% | 75% | Max |
|---|---|---|---|---|---|---|---|---|
| Temp. | 15,701 | 18.2 | 6.93 | 0 | 13 | 19.5 | 23.2 | 39 |

The value of alpha was taken to be 0.05, and the result of the statistics test was found as follows: **statistics** $= \mathbf{1000.359}$ and $\mathbf{p} = \mathbf{0.000}$. From the result, we can say that data does not look Gaussian and rejects $H_0$. Kurtosis and skewness were also calculated to determine if the data distribution departs from the normal distribution. The following result was obtained: **kurtosis of the normal distribution**, $\mathbf{-0.671}$, and **skewness of normal distribution**, $\mathbf{-0.335}$.

Since the skewness of our data is less than 1, our data is fairly symmetrical. Temperature is higher in the second and third quarter which is summertime and lower in the first and fourth quarter which is wintertime. Also, the third quarter (July to September) is warmer than the second quarter (April to June), and the first quarter (January to March) is colder than the fourth quarter (October to December).

Various statistical parameters for temperature data are shown in Table 58.2 with mean, standard deviation, minimum value, first quartile, second quartile, third quartile, and maximum temperature to be 18.21 C, 6.93 C, 0 C, 13.00 C, 19.50 C, 23.20 C, and 39.00 C, respectively. The minimum temperature of Kathmandu has not decreased below 0 degrees Celsius and has not increased beyond 39 degrees Celsius from 2010 to 2019 which is not quite accurate. So there must have been some errors in measurement of temperature; most likely the offset had increased in the sensor value measurement. The normal probability plot also shows the data

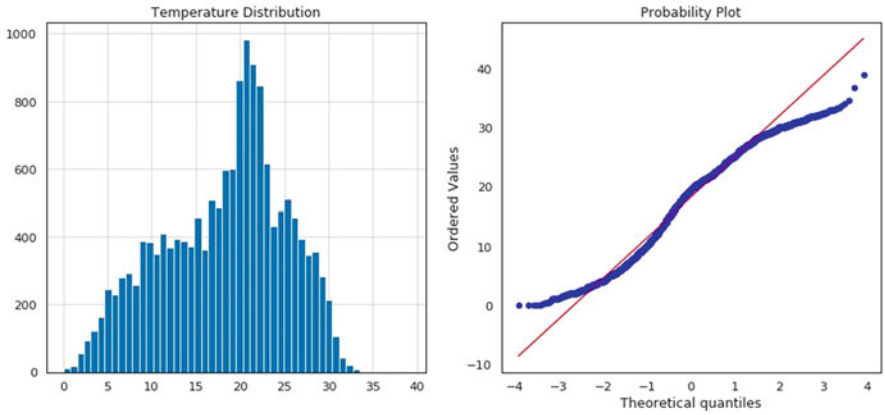



**Fig. 58.3** Normal probability plot for distribution of temperature

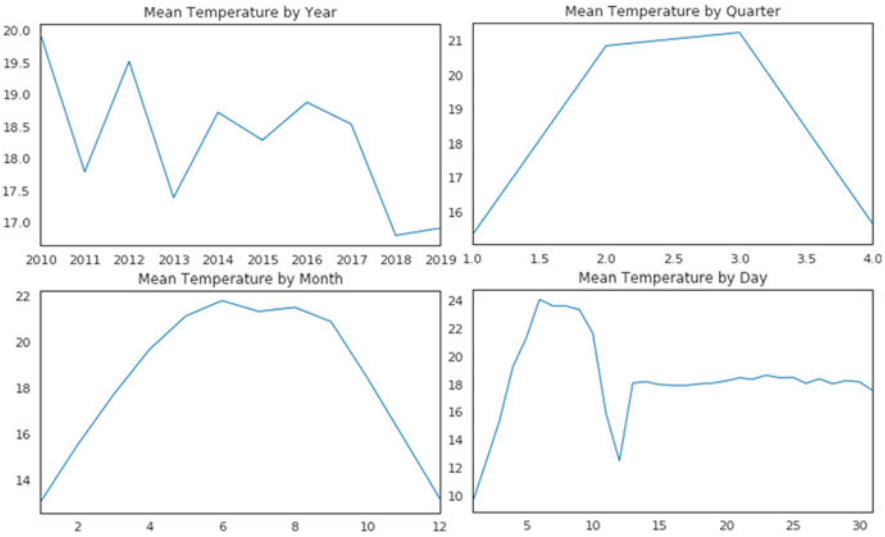



**Fig. 58.4** Mean temperature grouped by year, quarter, month, and day

set is not so far from normally distributed (see Fig. 58.3). In mean temperature resampled over the day, larger fluctuations can be seen with continuous increasing and decreasing pattern throughout the time series. The mean temperature resampled over a week does not have much significance for temperature attribute. The mean temperature resampled over the month as well as the quarter also shows some seasonal trends in temperature throughout the year.

The plot of mean temperature grouped by year, quarter, month, and day (see Fig. 58.4) confirmed our previous discoveries. Temperature falls to its lowest value in Kathmandu in January and reaches the maximum in June. Mean temperature by quarter also confirms previous discovery that the lowest mean temperature occurs in

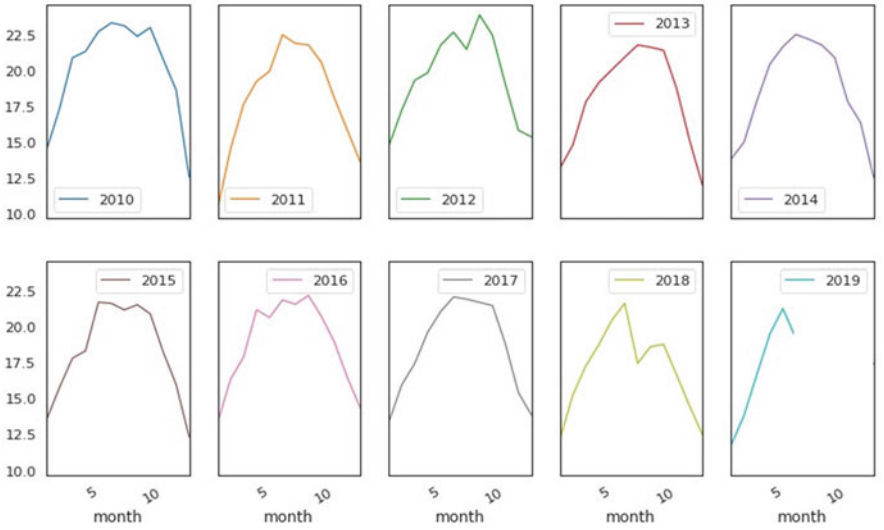



**Fig. 58.5** Temperature by years

| | count | mean | std | min | 25% | 50% | 75% | max |
|---|---|---|---|---|---|---|---|---|
| **CO2** | 87394 | 508.2 | 188.7 | 0 | 419 | 439 | 505 | 7096 |

**Fig. 58.6** CO2 distribution

the first quarter and the highest mean temperature in the third quarter. Figure 58.5 shows temperature by years, where each year shows a similar trend in temperature except for 2019 where complete data has not been collected yet. The Dickey-Fuller test tests the null hypothesis that a unit root is present in an auto-regressive model.

**Pollution proxies** The pollution data (Kathmandu 2018 to 2019) is the measurements of parameters at the stationary stations with a sampling rate of 1 min over a period of almost 1 year. However, we discuss only CO2 variable in this section. The dataset consists of 15,701 rows and 87,394 columns, namely, date, time, PM2.5, CO2, formaldehyde, and VOCs. The dataset consists of time series measurement of weather parameters from 2018-01-12 00:00:00 to 2019-12-05 23:59:00.

The kurtosis of normal distribution was found to be 106.09 and skewness of normal distribution as 6.44. The kurtosis is greater than zero, so the data is heavily tailed. Skewness is also greater than 1, which implies that the data is highly skewed. Various statistical parameters for CO2 data are shown in Fig. 58.6 with mean, standard deviation, minimum value, first quartile, second quartile, third quartile, and maximum CO2 level to be 508.20, 188.72, 0, 419, 439, 505, and 7096, respectively.

The average CO2 level of Kathmandu was found to be 508.27 (see Fig. 58.10) which is way beyond as suggested by WHO level. The normal probability plot also shows the dataset is far from normally distributed. CO2 level is very high during weekdays and attains the lowest value at weekends (Figs. 58.7, 58.8, and 58.9).

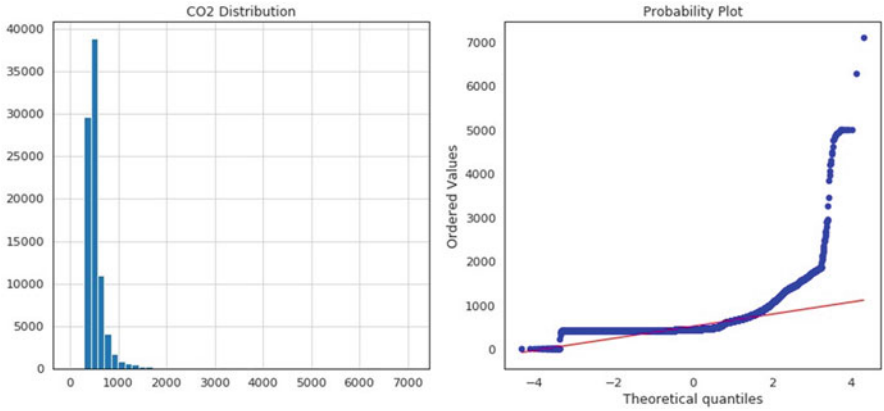



**Fig. 58.7** Normal probability plot for distribution of CO2

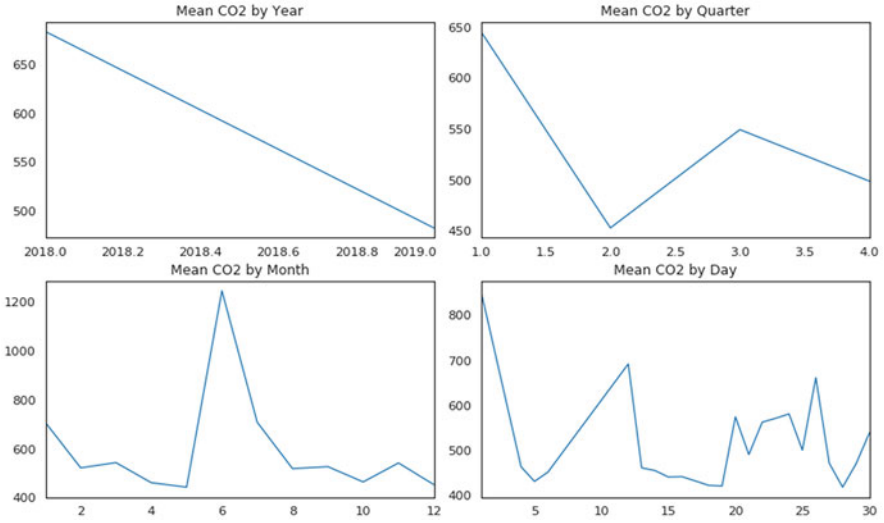
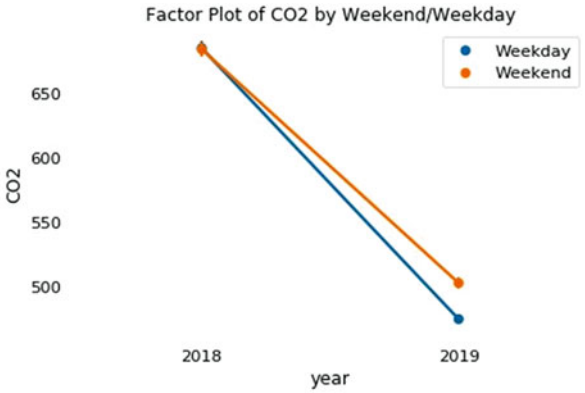



**Fig. 58.8** Mean CO2 level grouped by year, quarter, month, and day

**Fig. 58.9** CO2 emission in weekdays and weekends



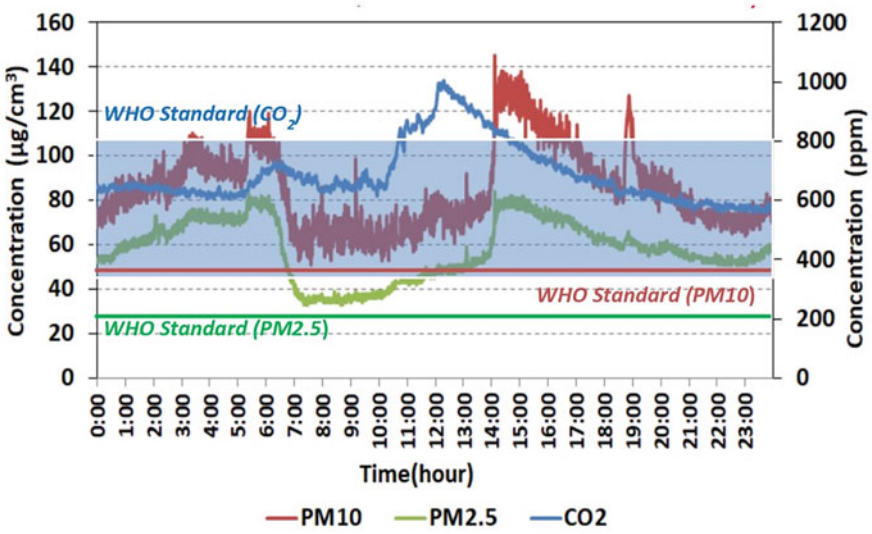



**Fig. 58.10** CO2 emissions measured compared to WHO standard

### *58.3.2 Modeling Using RNN*

Prediction of the average temperature for the next time periods based on the weather conditions and pollution was done using deep learning with the RNN model. The data is converted to an appropriate format and then transformed into a supervised learning problem [12]. Dataset is then split to prepare train and test sets. Mean squared error (MSE) was used for loss function and the efficient Adam version of stochastic gradient descent for optimization. Dropout was used for the second hidden layer to prevent over-fitting. The model was fitted for ten training epochs with a batch size of 256.

### *58.3.3 Modeling Using ARIMA*

The model used is ARIMA (1, 1, 1) × (0, 1, 1, 12). This model is selected based on the minimum value of AIC. A simple way to perform a rolling forecast is to re-create the ARIMA model after a certain number of new observations are received and retraining the model with new observations appended to the previous training set. Forecasting for the next 18 hours was done using a rolling forecast ARIMA model. First, the hourly data of air temperature was converted to 3-hourly data such that each day had 8 data points. ARIMA model was trained to forecast the data of further 6 points. Then the new observations were again provided to re-create the model (Fig. 58.11). The forecast produced by the model, in this case, is shown

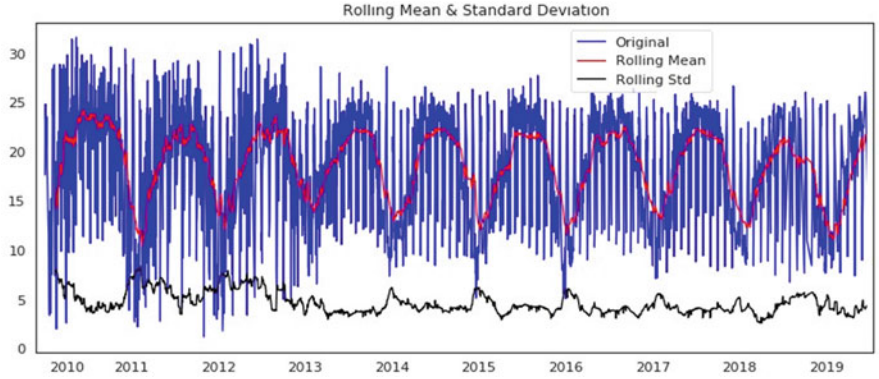



**Fig. 58.11** Rolling mean and standard deviation

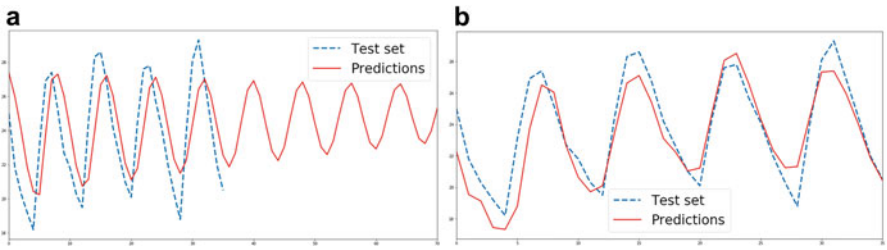



**Fig. 58.12** (**a**) Using the ARIMA model to predict temperature variations. (**b**) Continuous training and prediction of temperature variation. The solid curve using ARIMA

in Fig. 58.12. Similarly, the model was also used to predict future values without training it continuously, and the result of such a model is shown in Fig. 58.12.

Each window contains the predicted output. The same model data points of a single day. The solid curve as shown in Fig. 58.12 is used without continuous output from the real data until training. The previous day and the dashed curve represent the test data.

### *58.3.4 Bagmati River Domain*

Excited by the results over the roads, we also extended the observations to the Bagmati River (see Figs. 58.13 and 58.14). The sensors were installed on a raft boat, and the readings from our sensors were taken along Shankhamul-Sundarighat route on the Bagmati River. Other sensors to measure chemical compositions of the Bagmati River were also used together with our sensors. Subsequent findings and detailed outcomes of the observations have not been included in this paper being beyond the scope. The concentration of CO2 exceeded the standard limit (500 ppm) recommended by the World Health Organization (WHO). The high concentration of

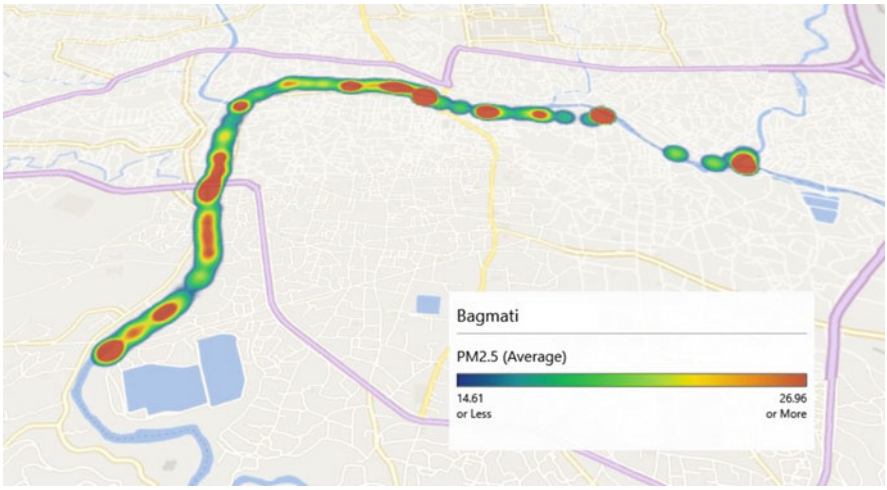



**Fig. 58.13** PM2.5 data collected over Bagmati River along Shankhamul-Sundarighat river corridor

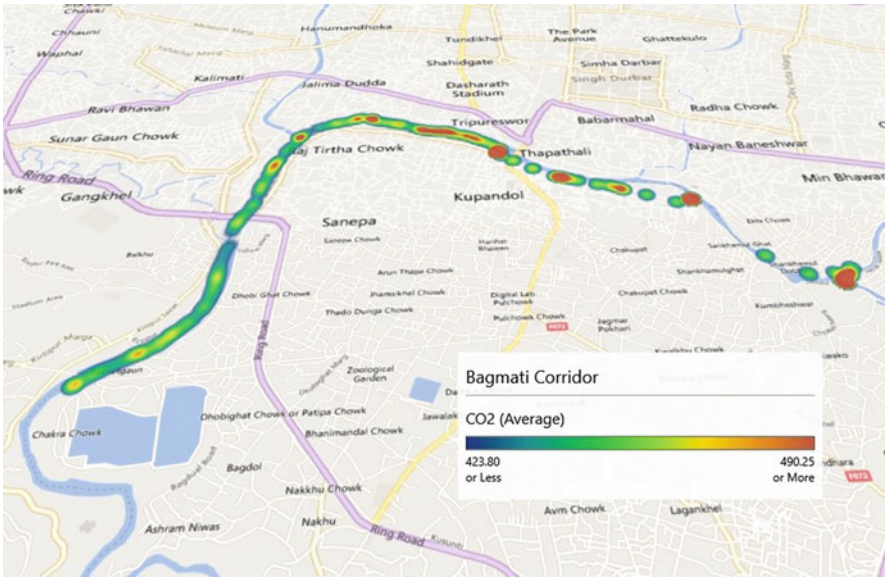



**Fig. 58.14** CO2 Data collected over Bagmati River along Shankhamul-Sundarighat river corridor

CO2 attributes the polluted atmosphere over the Bagmati River. There is a positive correlation between VOC, CO2, and PM2.5 (see Fig. 58.15). These parameters were measured close to the surface of the water; hence, it can be considered that the highly polluted Bagmati River [13] contributes to enhancing the pollutant level in the atmosphere.

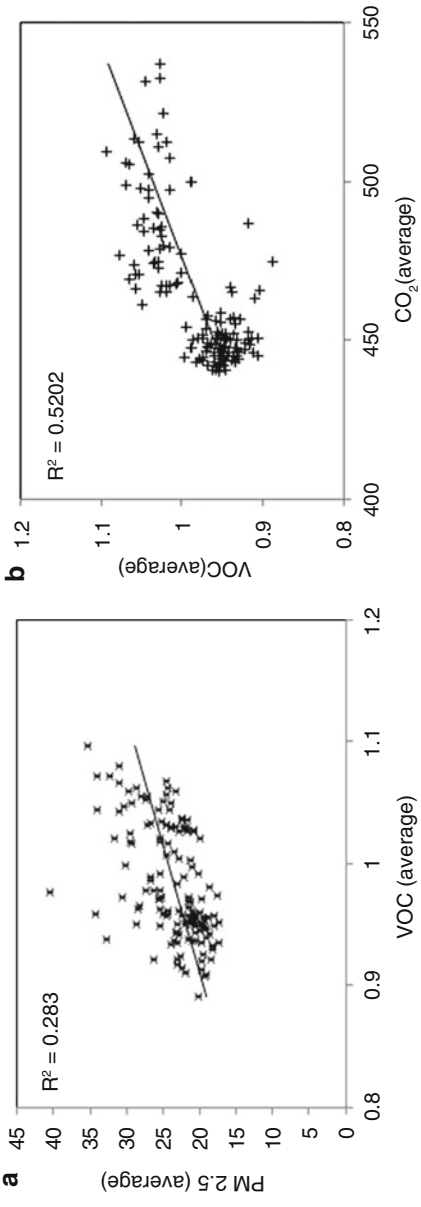



**Fig. 58.15** (**a**) Correlation between VOC and PM2.5 concentrations (1 min average) over Bagmati River (Shankhamul-Sundarighat) segment. (**b**) Correlation between CO2 and VOC concentrations (1 min average) over the Bagmati River (Shankhamul-Sundarighat) segment

## 58.4 Conclusion

The collected preliminary dataset from the area around Kathmandu valley are able to map some interesting features and environmental proxies that are visualized, and the patterns and variations in it are explored using various models such as ARIMA, RNN, etc. The root mean square error (RMSE) of the ARIMA model during the forecasting of the 10-year air temperature data was found to be 1.65 where the temperature ranged from 0 to 39, thus providing

pretty good prediction. For weather data of Kathmandu (2010 to 2019), neural network architecture was studied and implemented for temperature prediction. Among various structures of the network, the best result was obtained for three layers of neural network (first LSTM layer of 15 neurons, second LSTM layer of 14 neurons, and final dense layer of 1 neuron) for which R2 score for train dataset, R2 score for test dataset, and root mean square error were observed to be 0.52, 0.61, and 8.37 C, respectively. RNNs and ARIMA perform well for time series modeling and prediction of environment and pollution proxies. Hybrid approaches combining classical mathematical models and neural networks may also give outstanding results.

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# Chapter 59
# Development of a Risk-Based Information Security Standard for Adaption of Blockchain-Enabled Systems


**Abhishek Biswas, Avhishek Adhikary, Pushan Kumar Dutta, and Arnab Chakroborty**

## 59.1 Introduction

Technology has been interpreted over the past decade as a supporting resource for companies to satisfy their business processes and functions. In reality, the origins of information systems have been functional-based and transaction-oriented devices, but it's become more strategic in direction over the past decades, reflecting the broad and global demands of the enterprise. Technology is a disrupter now, and it has moved from the support part of the business – this is giving birth to innovations by default; with this regard, organizations are embracing the digital era where many functions are being heavily disrupted leading to a new reconfiguration of business models and value generation. In late 2017, the cryptocurrency Bitcoin hits the headlines in a big way. Developing the most effectively implementable risk-based information security standard shall be done with the internationally accepted CIA framework, thereby ensuring the following factors are in place in the system:

- Data **c**onfidentiality
- Data **i**ntegrity
- Data **a**vailability

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Therefore, a proposal is being made for the development of an information security standard, research of which shall follow the following methods:

- Understand the technology and types of blockchain.
- Understand the wide range of sectors blockchain can be implemented.
- Understand the inherent risks in a blockchain-based system.
- Study blockchain's information security risks in detail.
- Understand the capabilities of blockchain.
- Relate the relevant applicable capabilities of a blockchain to mitigate the information security risks.
- Study the impact on and of regulatory bodies throughout the world.
- Study the impact on other conventional financial methodologies that some of the applications of blockchain, e.g., cryptocurrency, may affect – study standard controls to ensure at least the level of security existing methodologies are providing.
- Study the generic risks in a blockchain system in place across different sectors – telecom, finance, international trading, health sciences, logistics, government, etc.
- Build the most effective and implementable risk-based control standard with the internationally accepted CIA framework –
- Data confidentiality, data integrity, and data availability.
- Consideration of other important factors in the information security: the management's responsibility, policy and strategy, and business continuity.

### *59.1.1 Blockchain and DLT*

DLT is a development family that uses a shared database infrastructure to keep parallel (i.e., multiple and identical) copies of an auditable, real-time distributed or unified transaction or data archive. A "blockchain" is a particular type of DLT which is a chain of blocks, connected by cryptographic hashes. A blockchain comprises of two distinct innovations:

- A hash tree, known as a "Merkle stack," which is a stacked data system that combines transaction-level data hash values into one tree. The tree value is stored in the present and the adjacent blocks
- Distributed ledger technology.

### *59.1.2 Categories of Blockchain*

Blockchain can be categorized based on various parameters of privacy.

- **Public blockchains**, such as Bitcoin or Ethereum, enable any user to access and view ledger – with or without the technological ability – create new blocks to the ledger, and validate transactions.
- **Permission blockchains**, as the name suggests, work based on access control technology implemented on the blockchains which limits block addition for external and internal users based on authentication of their true identity.
- **Consortium Blockchain.** A certain type of permission blockchain, used for a consortium of businesses, may develop authorization blockchains by a single party [1].

### *59.1.3 Properties of Public and Permission Blockchain*

**Distributed Ledger** Participants hold on their servers one or more existing versions of the ledger. By having the updated ledger data, these nodes replicate the whole data in a decentralized method. Further, as a result of this, the recovery time is way faster.

**Encryption** Blockchains focus on cryptography that has been implemented at different network points. As a result of this type of encryption, attackers have to change entire the blockchain, i.e., all the nodes in order to compromise the integrity of a blockchain [1].

**Consensus Validation** The rules of a blockchain set protocols to verify the validity of new data blocks before linking them to the ledger. Such laws are known as processes of consensus or methods for the confirmation of consensus. These consensus algorithms are built in the blockchain which determines whether a predetermined number of nodes agree for adding the new node. Post this democratic agreement, the nodes are added [1].

**Initiation Rules, Processes, Membership, Access and Participation Restrictions** In a shared blockchain (more applicable to public chains), any participant in the network can propose new rules which are subject to approval. The owner of the blockchain, administrator, user, or the regulatory agent establishes final methods, i.e., network rules, for the addition of blocks in permission blockchains. The laws of the permission blockchain define users who are entitled to recommend new data blocks addition. Memberships are one of the core factors in the blockchain, and administrators, participants, and owners of a permission blockchain define the rule defining criteria for granting and terminating membership rights. Compartmentalization of data is a concept that can be applied in protecting the chain from intentional modification of data by the members itself [1].

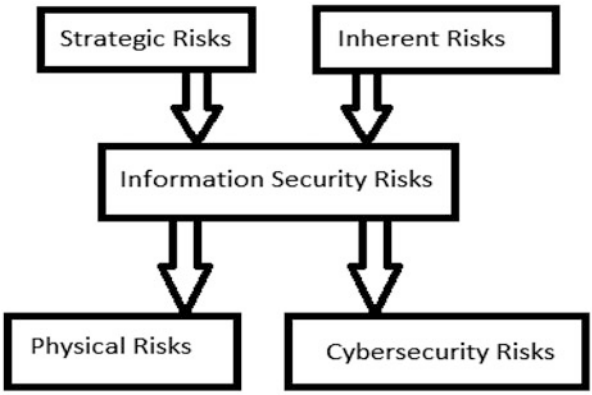


**Fig. 59.1** Risk mapping

### *59.1.4 Risks*

A detailed study should be conducted on the relevant risks a blockchain-based system presents to us, and primarily, the risks can be classified in the following five categories, and then the type of risks can be internally mapped between inherent risks, strategic risks, information security risks, cybersecurity risks (digital security risks), and physical security risks (Fig. 59.1).

## 59.2 Classification Based on Inherent Risks in a Blockchain

**Background** Regardless of the type of blockchain, blockchain carries a huge amount of inherent risks, which comes into play whenever you implement or develop a blockchain. The inherent risk categories may be broadly classified under three categories:

**General risks** Blockchain systems lead organizations to concerns analogous to those involved with current business processes but add complexities that need to be compensated for by agencies. Those rising with these complexities may be referred to as general risks.

**Risks of value transfer** Blockchain enables value transfer from peer to peer without the need for a central intermediary. The capital, identification, or information could be the interest exchanged. Along with the transfer of assets and business processes, risks related to those also get transferred. Like the updated data, every node will inherit a lot of risks that were previously being faced by the central point of transaction [6].

**Risk in the smart contract** As smart contracts are a major application for blockchain, a very inherent risk that comes while digitization of the physical contracts is the mapping of these. One needs to address this risk by establishing absolutely error-free controls for mapping.

A more detailed study on these inherent risks and the corresponding standard along with new controls must be conducted before establishing the controls in the standard. These controls should be absolutely risk-based, as the risk would be the primary focus of the standard.

## 59.3 Classification Based on Strategic Risks in a Blockchain

The major risks that must be studied from a common perspective are detailed below:

**Privacy of Data** Distributed blockchain-based ledger technology decentralizes the data. Although it is encrypted, it is not stored in a single location. The organization has no complete data control [7].

**5G and Cloud Risks** The speed of 5G is much faster than any other commercially available technology, and this indeed increases the chances for compromise. Hence, 5G risks are from both sides – risks from 5G-enabled attack and risk inherited when using 5G [16]. As an addition, blockchain architecture will be mostly based on the cloud. And increasingly, businesses are storing confidential data in the cloud. As per Skyhigh, 21% of the documents of all the types submitted to the cloud-based sharing services have sensitive information [14].

**Artificial Intelligence Risk** Wetware, in addition to the age-old human-trust-game assault, artificial intelligence, and machine learning, has given birth to a new challenge – the Wetware! The term Wetware is used by hackers to describe a hardware, non-firmware, or software approach to pilfer details or, put it another way, people. Of course, the naming comes from the fact that the human body is approximately 60% water. Failure to follow security protocols is the main reason for getting hit by a Wetware. It can be any vulnerability that an employee can give to the organization, e.g., responding to an AI-initiated humanly duplicated phishing mail and AI-triggered social engineering [15].

**Jurisdiction and Regulatory Barriers** It is important to realize that blockchain technology can use worldwide tools. Hence, unlike the businesses on the list, there is no clear jurisdiction. A global single jurisdiction would be very difficult to decide.

## 59.4 Classification Based on Functional Information Security Risks in a Blockchain

Functional information security risks are risks coming from different information security processes, activities, or controls, e.g., key management, secure coding, etc. A detailed study of the functional cybersecurity risks associated with blockchains is discussed below:

**Key management** As the door in one's house, the key is the door to the blockchain application. Key mismanagement gives a threat even to the highest level of a secured blockchain [2].

**Exposure to threats from software coding errors** Like in any other application, insecure coding can welcome risks to the blockchain applications, in addition, other applications that interact with the blockchain system [2].

**Endpoint and external data sources risk** Permissioned chain is only as reliable as the information they absorb. Outside connections incorporate risk into the blockchain infrastructure from a cybersecurity standpoint [2].

**Risks from attacks based on identity** Like in other IT systems, which are not resistant to identity-based attacks, like spoofing, permission blockchains are no different [2].

**Evolving attack vectors** Evolving attack vectors are a huge threat to any new system based on the nascent technology. New threats are giving rise to concern. These new threats indeed give rise to newer vulnerabilities most of the time, e.g., quantum computation-based attacks [2].

**Physical access breach to the data center** The threats related to physical access, though remain same, are lesser in the blockchain systems as they are distributed hold an architecture [2].

## 59.5 Classification Based on Known Cybersecurity Risks in a Blockchain

Common forms of known cyberattacks affecting the blockchain-based systems are studied in detail.

**Malware Risks** Malicious software or "malware" is developed and implemented in a number of ways that can compromise the data, or even harm the information systems in its entirety, of an organization [2].

**Social Engineering** In the business, 77% of security incidents are a result of internal employees, and only 23% are from external threats. The most common form, apart from phishing, to attack an employee is still social engineering.

**Attack on Web Application/Credential Theft** Attacks targeted at web applications are often a first step in the mining of personal data and passwords that hackers use to exploit data on other networks [2].

**DDoS Attacks** A distributed denial-of-service (DDoS) attack is made by sending a continuous sequence of traffic and data to a targeted chain using botnets or other compromised devices to overwhelm the network and temporarily or permanently interrupt system operations [2].

**MITM Attack** A man-in-the-middle (MITM) attack is conducted by agents that are not authorized in the system. These agents may include eavesdropping and placing their device or access method in communications between a user and a trusted party to capture or intercept data [2].

**Attack by a Ransomware** Ransomware come among the top threats now in all the major cyber threat lists. Ransomware attacks attempt to block the access of an organization to its own data if the institution does not make a payment to the hackers [2].

**Theft of Keys** Most of the attacks related to blockchain were intended to steal the cryptographic keys and not necessarily target the blockchain itself. This experience emphasizes the importance of key management at the organization in reducing the potential for lost or damaged keys [2].

**Process-Based Attacks** Blockchain also creates various modes of attack that can be abused by malicious actors. For instance, advanced attackers may attempt to influence any decision-making processes, or a consensus model within the blockchain for addition of new nodes to the chain, change rules or policies, or exploit a managing entity in a manner that is not fraudulent or transparent [2].

## 59.6 Classification Based on Physical Security Risks in a Blockchain

**Background** The physical security risk is maximum in a data center. Therefore, in order to protect the business, sufficient control over physical security risks in a data center must be implemented: capabilities of a permitted blockchain information security consideration. The market participants will identify and understand a range of cybersecurity capabilities, as well as threats and other concerns relevant to this technology.

**Risk Factors** The risk-based standard must use the following capabilities of a blockchain, particularly permission blockchain.

- Administrator risk controls
- Transparency
- Encryption

- Consensus validation mechanism
- Distributed architecture

**Relevant Research for Standard Development** How to help mitigate the risks in a blockchain-based system to the abovementioned capabilities of a blockchain? A risk- and control-based standard may be developed from here.

## 59.7 Standard and Auditing: Auditing Objectives in a Blockchain System – Gaining a Reasonable Assurance from the Standard

**Background** While the traditional approach of auditing is followed over a past period, auditing blockchain should be conducted over a principle of the future period which shall not only ensure that the past period was appropriate but also make it appropriate and effectively risk-free for the future. It is very important to keep the auditing objectives in mind while developing standards. The standard should be practical and easily implementable mitigating all the risks while giving a clear idea for auditing the system against the standard. The auditors look for the complete validations of the following objectives in case of any data security and so will be the case in case of any blockchain-based application [21]. Therefore besides the CIA framework, the capabilities must be used to ensure the following control objectives (refer Table 59.1) for the auditor:

**System Confidence** One area of vulnerability is the digital signatures themselves, because they may be hacked, lost, or stolen. In order to overcome this problem, auditors would need the means to verify their presence by verifying digital signatures and counterparties and providing them with confidence in the functionality, completeness, and accuracy of the entire network.

**Strategies of Audit** Auditing the blockchain will establish the system's confidence. Blockchain has the potential to alter the entire audit nature with new demands for confirmation, reducing the role of the auditor in verifying and validating account transactions. Consensus, key management, automated reviews, management considerations, crypto-asset discovery and verification, algorithm usage, secure code, and

**Table 59.1** Primary control objectives for gaining assurance over functionality of a blockchain system

| Management assertion | Objectives |
|---|---|
| Input accuracy | The input of each transaction and data is accurate |
| Completeness | All transactions are entered |
| Occurrence | Transactions only entered once |
| Transaction accuracy | Processing of transactions is accurate |

network protection are the main assessment scenarios that need to be considered during the audit. It shall be based on the CIA framework [20].

**Consensus Validation Algorithm** In permissioned blockchains, the consensus algorithm is extremely important for the addition of new nodes addition in a blockchain. While the standard should have a particular set of algorithms to be used, a few trusted consensus algorithms are Proof-of-Work, Proof-of-Stake, Delegated Proof-of-Stake, Leased Proof-of-Stake, Proof of Elapsed Time, Practical Byzantine Fault Tolerance, etc. [22]

**Cryptography Hash Auditing** Cryptographic hashes establish the basic connection in a blockchain. Hence, the audit of the cryptographic functions used for hashing should be standard as per NIST or international security standards.

**Crypto-Asset Validation** An auditor should remember that a blockchain system and cryptocurrencies are not the only crypto-assets in the system. A blockchain may have multiple crypto-assets, which need to be validated for assurance.

**Cyber and Software Auditing** Cyber and software auditing can ensure secured and authentic transaction, while real-time systems will identify and examine anomalies and suspicious patterns of transactions as they occur.

**Specialized Automated Controls in Place** Manual verifications over transactions would not be possible over this huge amount of data. A solution to this is automated blockchain audit – and this can be achieved by generic anchoring.

**Generic Anchoring and Risk Minimization** In order to mitigate the risks to transactions, the standard must maximize automated controls for blockchain-based systems. An example of one of these "generic anchoring" principles can be used as one of the required controls in the specification and subject to auditing to achieve fair system assurance. Anchoring and working facts defend against mistakes and attacks of alteration; they do not prevent network maintainers from incorporating contradictory transactions into the blockchain themselves. Logically, audacity attacks can be overcome either by having running audit hubs or by using a decentralized blockchain containing encrypted sensitive data [20]. With anchors, a system can achieve traditional accountability (read, serve audits) by time stamp services. The anchor is a cryptographic hash of the current system state (the latest block header for blockchains), typically distributed using a print media anchoring service (e.g., a newspaper). Anchors are released daily, e.g., every day. A consumer should verify the presence of a connection between the receipt block and any anchored block in an anchor time stamping scheme and ensure that the anchor is present in the traditional media.

## 59.8 The Economic of Blockchain: Financial Considerations

**The Cost Factor** In the development of a standard, it is extremely important to take in the economic factor of blockchains. The two major in-scope costs are described as follows:

- **The expense for verification.** This cost refers to the ability to efficiently check the transaction's features.
- **Networking cost**. Opportunity to bootstrap and run a business without the need for a conventional intermediary.

The accumulated incumbent knowledge and resources create opportunities for new approaches to fundraising startups, protocols for public goods and applications, data ownership and licensing auctions, and credibility systems [5].

## 59.9 Sector-Wise Applicability of Blockchain and Related Risks

While the research primarily shall study the generic risks and control standard approach, but relevant and important additional considerations should also be included after identifying the risks pertaining to particular sectors and existing systems, as discussed below.

**Blockchain and Datacenter** Standard should also study about the effect of blockchain in the data center technology and identify some additional applicable risks in this regard. As far as data center context is concerned, a blockchain's smart contract technology needs to contribute to the automation of "rule-based" service and management tasks such as resource planning, cooling, asset management, and virtualization [19].

**Blockchain and Currency Valuation** For any kind of currency valuation, external real-world data will be required, and oracles are an important factor, and hence, enhanced risks and controls are required to be implemented. Exchange rate fluctuations, including those for cryptocurrencies, produce profits and losses, and these too, in some countries at least, require accounting procedures and tax treatment that could be different [8, 18].

**Blockchain and Citizen Services: Providing Digital Identities** Governments and NGOs can use creating cryptographically secured digital systems with personal identity function to provide a range of public services and prevent the forgery of certificates and identity theft. Governments must research the risks in public services in depth as this opportunity often poses a citizen's single most identify danger [17].

**Blockchain and Healthcare: A Single Truth Source** Blockchain has enormous potential to be implemented privately and safely in the life sciences and healthcare

industry, where data is often stored in silos and data protection is paramount. The wide range of applications covers findings from clinical trials, management of health records, history of vaccination, surveillance of infectious diseases, insurance policies, serialization, and other innovations [13].

**Blockchain and Logistics: Process Automation via Smart Contracts** As far as the oil and energy industry is concerned, Accenture predicted that at least 5% of annual freight spending could be reduced by improving invoice accuracy and reducing overpayments [3, 11]. Additionally, fraud risks must be studied in respect of the standard to follow for the successful implementation of blockchain systems thereby transforming the logistics industry [12].

**Blockchain and the International Market** Detailed research is expected in understanding the critical risks inherited with blockchain technology in order to implement it globally, besides at a cross-border level. According to the Global Blockchain Technology Market Report 2018 – Forecast to 2023 from ResearchAndMarkets.com, the global blockchain market will grow at a compound annual growth rate (CAGR) of 42.8% (2018–2023) which will lead to global revenue of USD 19.9 billion by the end of 2023 [10].

**Blockchain and the Telecom Sector** Traditionally, communications service providers (CSPs) are bound to have the biggest effect of blockchain in their core operating systems and in related services, which will provide opportunities for reduction in cost and increase in revenue through new value propositions through gain in process efficiency and accuracy [4].

**Blockchain and the Public Sector** Simplification of trusted information management could be done by blockchain implementation, which will make it easier for government agencies to manage critical public data, i.e., personal data of the citizens, and maintain the information security side-by-side [9].

**Blockchain and the Financial Sector** Blockchain has the potential to entirely transform the financial services industry in the areas of trade finance, know your customer (KYC), international payments, insurance claims processing, etc. However, further research is required to understand the complete risk scenario for each of the domains in the financial sector [8].

## 59.10 Conclusion

The study of the research towards the development of the information security standard should include the risks that can exist in a blockchain system and corresponding best controls; the regulatory principles across various sectors ensuring protection of critical data, information security, and relevant things; and the internationally accepted frameworks, study towards applicability of the standard per the type and size of the industry, and the ease of implementation. Determination of the risk

factor has always been a subjective thing and a very complex matter with multiple factors being involved. While organizations, including government, are not very open to undertake blockchain as a basic technology for new applications – the most important factor not to consider the technology is not able to identify the risks associated with the technology, from both financial and technical perspective. Hence, the study further opens the door to the development of a standard where controls will be established based on the risks assessed so that organizations may implement the controls in an existing blockchain-based system or consider them while developing a blockchain-based application.

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# Chapter 60
# Rule Learning Algorithm for Detection of Malicious User in Cloud Environment


**Shoeb Ahmad, Yumna Fatma Farooqi, and Anand Rai**

## 60.1 Introduction

Cloud computing is a virtual infrastructure that provides shared communication technology services and information for multiple external users via the Internet. It provides an access to the shared resources on demand. Cloud computing is increasingly becoming a highly demanded service as it provides low-cost services and high computational power. It also increases accessibility and availability. A growth rate of 50% is being experienced by cloud providers. Recently the use of cloud computing has gain momentum in IT area. It delivers wide range of services like storage, computational platform, and computational power. Google, IBM, Salesforce, Microsoft, and Amazon are currently major cloud providers.

Organizations are continually embracing the advantages provided by cloud computing platforms like flexibility and scalability. Security is often considered to be one of their top concerns. Insider threat is becoming a very serious challenge, both to cloud computing and data security in general [1–3]. The insider who is actually malicious can hold details of the major amount of information that are really important. Due to the huge amount of threat that is posed by the insiders, in rapidly growing cloud computing [4] ecosystem, the insider attack researches in the cloud paradigm are gaining importance (Fig. 60.1).

Issues related to security in cloud paradigm: The flexibility ease and power also has lots of security challenges. IT company that does not regularly update their security policy can be vulnerable to security breaches. In cloud computing,

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https://doi.org/10.1007/978-3-030-49795-8_60

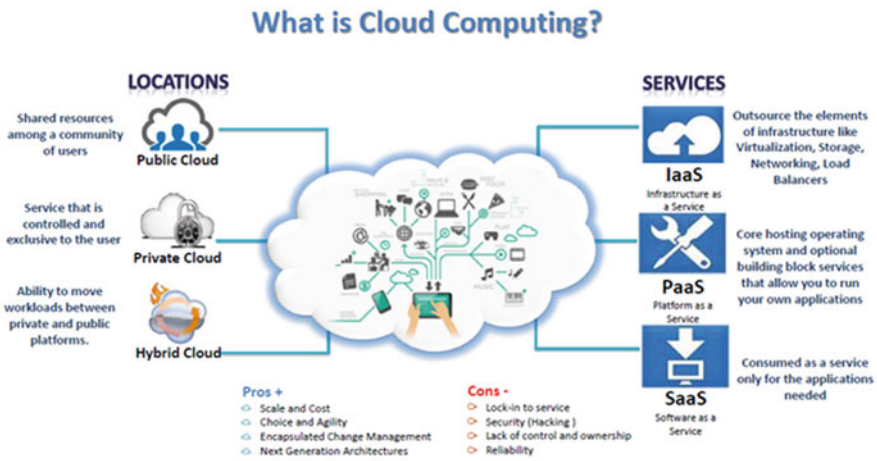


**Fig. 60.1** Cloud computing

customers store their data with cloud provide and this raises many security questions [5].

Security issues in cloud computing could be related to:

- Vulnerabilities associated with technology used. Virtualization and data storage could be most critical security, and an attacker could use them to launch an attack.
- Lack of proper hiring and employee screening practices could also pose serious security threat. If the cloud provider is not performing background check of their employees, they may pose serious insider threat.
- If the cloud provider is not performing customer background check, then any attacker with apocryphal accounts may perform malicious activity without identification.
- Cloud service providers are access through various APIs. If these interfaces are not secure, the security of the cloud could get highly compromised.

Insider threat definition and types: CERT [6] defines the threat inside as "A malicious insider threat to an organization is a current or former employee, contractor, or other business partner who has or had authorized access to an organization's network, system, or data and intentionally exceeded or misused that access in a manner that negatively affected the confidentiality, integrity, or availability of the organization's information or information systems."

Pure insider (employee): A worker has all access rights, and their organization information centers will typically have badges or keys. In reality, the employees might be excellent at rational and organic arrangement of sensitive data because they need the right to access details and the organization cannot forbid the workers during working hours. So, workers are most danger on the point of business executive threats and therefore the business executive threats are presumably by employees

that company solely. As auxiliary privileges of traditional employees, the elevated business executive is associate business executive agency UN.

*Outsider affiliate:* External associations are not a business community and have no legal access to the resources of corporations. A prime example might be insecure wireless network. With none access privileges, the surface assault could access the network. Thus outsiders are to use absolve, and he will do whatever he wishes. It's an understandable downside in firms, and firms ought to awake to such kind of attacks. The businesses thought to upgrade security policies and procedures. These attacks are straightforward to spot or notice [7].

*Why Insider Threat Is Ignored?*

The reason behind the organization ignorance on insider threat is that its detection is difficult. The segment below discusses the reason behind the ignorance of the insider attack.

## 60.2 Literature Review

Eric and Shaw [8] in 2006 said that planning in advance was done for 81% of insider attack and there was nothing common found in demographic profile of attackers. Management perceived 33% of subjects as difficult; other employees viewed 19% as disgruntled. Twenty-seven percent were noticed prior to incident by coworker or supervisor for behavioral concern. They reported that most of the insider threat actions were caused by negative work experience.

As the unauthorized insiders in the cloud gain the complete details of the important information of the cloud, the attacks caused from the insider have become a very important area of research [9].

The CERT [10] Insider Threat Center collected and analyzed over 700 cases of actual insider crimes in 2001. The collected crimes included several types of exploits used by malicious insiders.

The US Secret Service [6] and Carnegie Mellon University in 2005 insider attacks in the banking industry.

IENISA's 2009 study described malicious outsiders as one of the most significant cloud-related threats, a concern that persists, although there is little indication of efforts to resolve based risks [1]. Because of the high level of the insider threats in the rapidly growing cloud computing ecosystem and specially if more of our content is to be placed in the cloud pardigm, it is imperative that the scope, prevention and detection of insider attack in cloud computing we understood [2].

Different techniques have been proposed in several literatures to identity malicious insider [3]. By studying patterns of employees from a series of event, it can be predicted how the behave legitimately. Different pattern matching technique is used in the machine learning techniques. [4].

## 60.3 Proposed Method

*Managing User Identities* This part consists of some nontechnical solutions. Hiring of right employees has to be ensured. Background check of all new employees should be done while hiring. Criminal records, school and medical reports, and credit reports should be checked. The hired employee should be given access to appropriate resources. Privileges and role should be terminated as the employee leaves the organization. It is seen that most of the insider attacks were carried out by disgruntled employees.

*Data Collection Process* The action done by the user should be recorded as raw data.

*Log* To discover each user's pattern, all the events are sent to log files. The log file should be extracted and filtered for creating a user profile. This will lead to identification of interesting patterns that could characterize each user's interaction with the system.

*Pattern Generation* Raw data is created from the log file and to create item set that patterns minimum confidence and minimum support are set as user specified threshold. Every data that meet the specified threshold from sequence of events is added to list; they participate in rule generations.

*User Profile* User profile created after learning algorithm is used for representing user identity in system. The profile is used for differentiating behavior pattern of user within an organization.

*Policy Base* This part manages the part of controls that are nontechnical, for example, strategies and methods that have to be implemented as the specialized controllers are insufficient for relieving the threat of insider.

*Pattern Matching* We employ sequential mining technique to detect pattern of user behavior. Compare the currently generated patterns with those stored in user profile. This comparison checks for the consistent behavior pattern with previous pattern that is stored. If this comparison shows that the behavior patterns are not the same, then the possibility is that the user is a malicious user. To find if user is malicious, the currently generated event sequence from test data is compared with user profile. If the user profile is different from currently generated sequence of events, then the user may be malicious. The user profile was created using the rule learning formula that showed the steps that were involved in developing the user profile (Fig. 60.2).

**Rule Learning Algorithm**

Step 1: Raw data are extracted from the log file.
Step 2: Set data trim verge (minimum support, minimum confidence).
Step 3: Get item sets size.
Step 4: Get maximum level list of sequences.
Step 5: Is generated item sets greater or equal to a threshold?
Step 6: If yes, then add user profile to the sequential rules list and print.
If NO then discard data which is meaningless (Fig. 60.3).

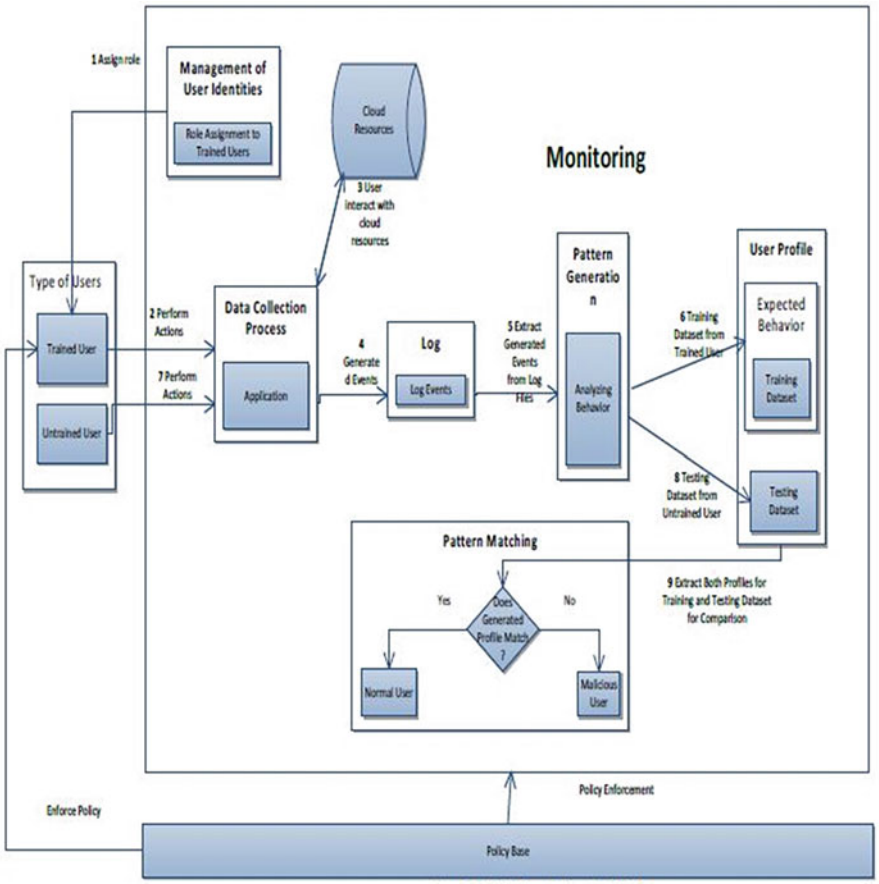


**Fig. 60.2** Insider threat detection model

## 60.4 Result and Implementatıon

*Graphical Representation of Result* To identify true-positive and the false-positive incidents, the user profile was used with the similar sequential rules and included successions of times that were not used as part of the user profile period. Each sequence of occasions in the user profile that cause and fire laws was called true positives, while the others were named false positives. In the wake of getting the quantity of sensitivity, true negative (TN), specificity, false negative (FN), true positive (TP), and false positive (FP) were estimated (Figs. 60.4 and 60.5).

$$\text{Sensitivity} = \text{count of TP}/\text{count of P}$$

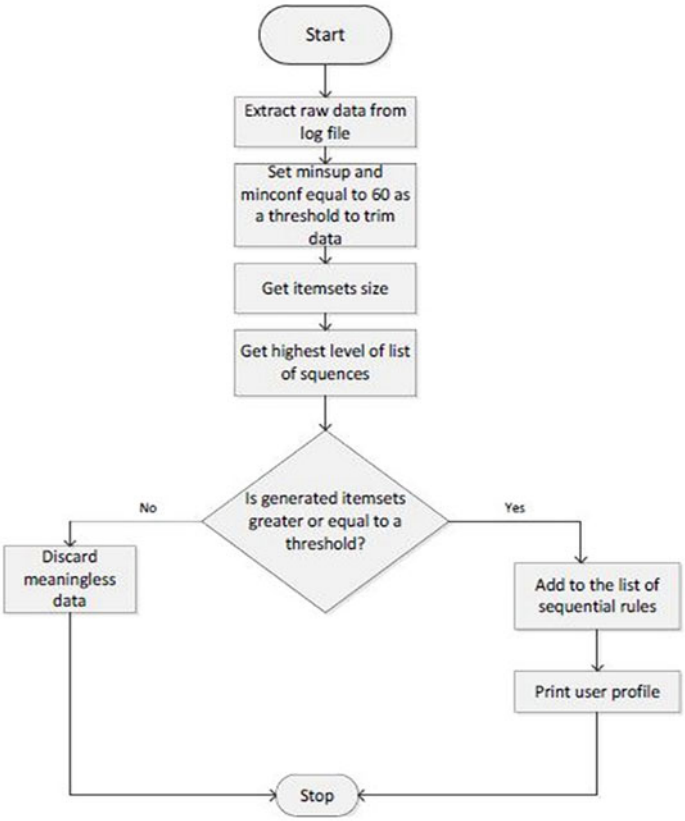


**Fig. 60.3** Rule learning algorithm

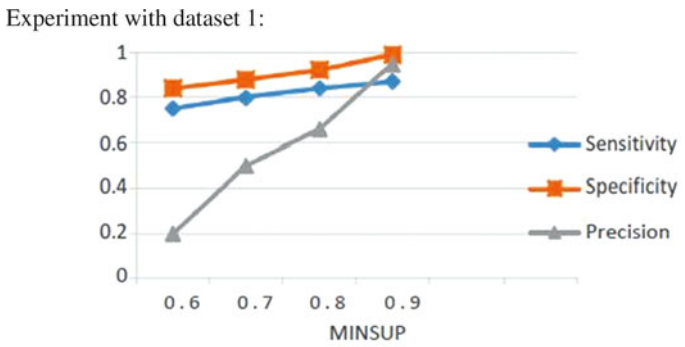


**Fig. 60.4** Sensitivity, specificity, and precision increasing min sup effects

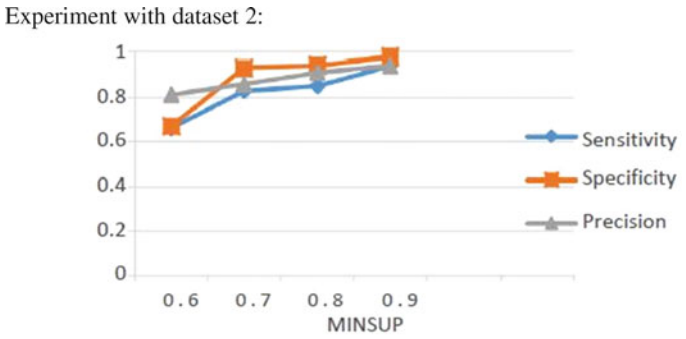


**Fig. 60.5** Sensitivity, specificity, and precision increasing min sup effects

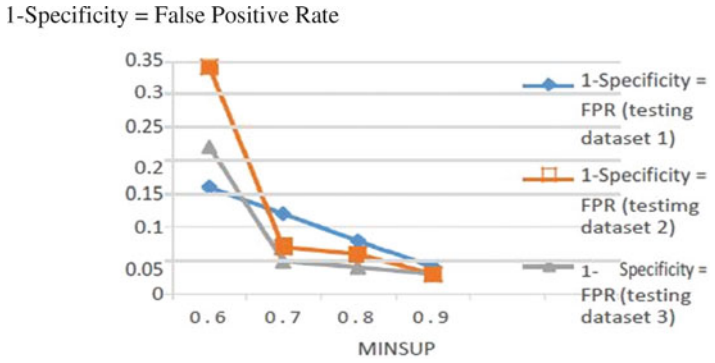


**Fig. 60.6** False-positive rate

where TP is number of positive events that are correctly labelled as positive. P is total size of all events.

$$\text{Specificity} = \text{number of true negative (TN)} / \text{number of negative (N)}$$

where TN is no. of P events that are properly labelled as negative. N total size of all events.

$$\text{Precision} = \text{true positive (TP)} / \text{true positive} + \text{false positive (TP} + \text{FP)}$$

The experiment enhances method to identify the type I error with increased min sup (Figs. 60.6 and 60.7).

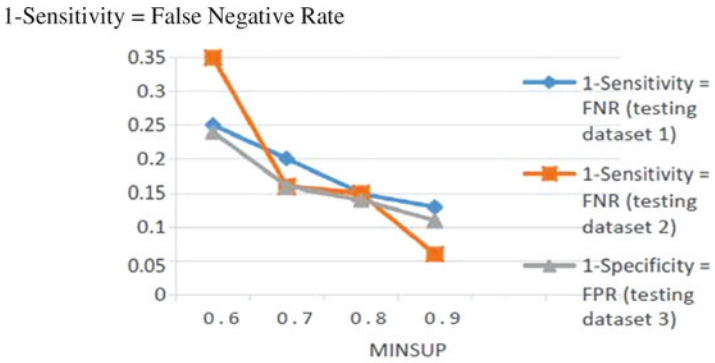


**Fig. 60.7** False-negative rate

## 60.5 Conclusion and Future Work

Cloud computing provides numerous advantages, but the most important issue in cloud computing among researchers is security. In this dissertation we mainly focused on the clouds insider threat-based environment. Detecting malicious insider in cloud-based system is a well-known research problem. It is a progressive as well as a consistent problem. Organizations should be careful while hiring system administrators and be aware of vulnerability of cloud-based system. Even though existing techniques can be effective, future research should focus on identifying indicators of insider threat and addressing openness by utilizing the systems associated with the cloud. To find new strategies that tackle real threats to cloud computing, we recommend that new approaches should be developed based on solid information assurance concepts. The security in cloud computing is far along novel recommendation for the further research, involving the insider attacks related. As previously stated, the manner of the insider is not subjected to alterations, but the vulnerability to the threats increases. Experts concentrate on these new opportunities as regards cloud infrastructure protection and research on avoiding, tracking, and reacting to insider attacks that are associated with the cloud.

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# Chapter 61
# Medical Infrared Image Analysis for Detecting Malignant Regions of the Human Body


**K. Lakshman, Siddharth B. Dabhade, Mrudul Behare, S. N. Deshmukh, and Ranjan Maheshwari**

## 61.1 Introduction

A disease caused by uncontrolled division of cells in the human body is termed as cancer. Nowadays, cancer has spread in large amount in humans. Cancer is a multistage process in which normal cells will transform to abnormal growth and which creates the malignant region along with the tumors. The World Health Organization (WHO) through its cancer research agency keeps record of classification of cancer-causing agents through the International Agency for Research on Cancer (IARC). According to the World Health Organization (WHO) report, cancer is a topmost cause of death all over the world. Cancer patients are increased day by day on the globe. As suggested by scientists, there is a possibility of high death rates which will be 13 million in 2030 due to the different types of cancer. From the year 2008 to 2030, there is a possibility of new cancer disease, and it will be increased more than 80% in poor countries, and the rate will be doubled in rich countries mostly by 40%.

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Apart from genetic factors, the causes of cancer may also include three external agents such as physical, chemical, and biological carcinogens. Ultraviolet and ionizing radiation from various sources are called physical carcinogens. Smoke, tobacco, asbestos, and food and water contamination due to certain chemical components are called chemical carcinogens, and infections from viruses, parasites, or bacteria are biological carcinogens.

## 61.2 Related Work

Thorsten M. Buzug et al.'s [1]. research on early diagnosis of malignant skin cancer. It indicates that 133,000 people worldwide get sick annually due to malign melanoma, with an increasing tendency. To identify the mistrust skin cancer is either malign or benign there is no sufficient and sound noninvasive techniques are not available. To keep safe the life and avoid the miss, i.e., false surgeries they have worked on early stages screening based diagnostic approach to make necessary surgeries. After the screening anomalies on the affected skin area through microscope, they suggested for the patient to proceed with the pragmatic ABCD (asymmetry, border, color, and diameter) approach after 15–20 weeks based on visual diagnostic decision.

Temperature of a malignant tumor is higher than that of normal tissue [2]. To determine the difference between normal image and temperature image is shown. Thermograph has been extensively used as a cancer detection tool but has not been accepted for routine application. Non-neurological vasodilatations adaption of nitric oxide, increase in blood flow and angiogenesis inside the tumor is a regional hyperthermia of a malignant tumor studied by Qi Zhao et al. [2].

Breast cancer patients had abnormal thermograms which related to the growth rate of breast carcinomas.

Noninvasive thermography can denote temperature of body up to 1 mm, and it could not help to find malignancy in deep.

At present, only some clinical data exist to find whether real temperature of the region under the skin correlates with malignancy; in this paper, we have analyzed different parts of the human body with a temperature using thermal camera and compared it with the normal tissue.

To determine the temperature of a malignancy region as low as 0.01 °C. There are 50 patients studied with tumors with the purpose of 1–3 cm below the skin in their head, neck, and hands and also non effected (without any malignancy) of their image were compared.

As per view of Karolj Skala et al. [3], the most general type of thermal imaging includes taking and analyzing only a single thermal image, and it is thus called static thermal imaging. The process of calibration of the system is described, as well as the methods of motion recognition and analysis. Kimio Otsuka et. al. [4], says the body temperature is very essential for finding out the clinical medicine.

Infrared radiation (IR) thermal capacity is common, especially in thermography, since it provides temperature noninvasively and without contact.

## 61.3 Methodology

There are different types of images used to diagnose cancer, such as chest radiography (X-ray), computed tomography (CT), and magnetic resonance imaging (MRI). The computerized cancer diagnosis comprises three primary computational steps.

### *61.3.1 Preprocessing*

Image preprocessing is a tool which uses many preprocessing methods like filtering, normalization, noise removal, etc. It suppresses information that is not related to the specific image processing and enhances some image features important for further processing. The initial level of image preprocessing is image cropping, which means unrelated parts of the image can be detached by the image region of interest (ROI).

### *61.3.2 Feature Extraction*

The term feature can be stated as an "interesting" part of an image. Subsequent to image preprocessing, the features are extracted either at the tissue or cellular level. Quantification and distribution of the cells across the tissue are based on tissue level feature extraction. The properties of individual cells can be extracted based on cellular level feature extraction. There are many feature extraction techniques. In this paper scale-invariant feature transform (SIFT) is used [5].

## 61.4 Different Imaging Techniques

### *61.4.1 X-Ray Imaging*

Mammogram is one of the breast cancer detection technique which can be used X-ray imaging for any specific abnormality hunts by radiologist expert. Biopsy and anxiety for the patient are involved due to human factor error. To overcome this problem, use computer-aided detection (CAD) system to reduce the human factor involvement and to help the radiologist find out the mammograms automatically.

### *61.4.2 MRI (Magnetic Resonance Imaging)*

MRI imaging is one of the methods for detecting the normal cell; it may affect the normal human body. MRI is an advanced technology which gives rich information about human self tissue anatomy. There are different techniques to detect the cancer cell using MRI:

1. Dynamic contrast-enhanced MRI
2. Proton magnet resonance spectroscopy

Drawbacks of MRI and ultrasonic are:

(a) Its high cost
(b) Low throughput
(c) Low sensitivity

Because of the drawbacks of the MRI system, this system is rarely used for the detection of the breast cancer. Due to this, many techniques/methods came out to detect breast cancer such as elastography, tomosynthesis, dedicated computer tomography (CT), positron emission tomography (PET), photoacoustic imaging, and optical imaging.

For detecting and clinical management of breast cancer, the dynamic contrast-enhanced method is used. Nowadays breast cancer is the major health disorder. It can cause death when it is not treated. According to statistics published in November 2019, cancer cases increased by 300% in 1 year. The total number of people visiting 2017 and 2018 from 3.5 crore to 6.5 crore increasing incidence of the disease to rapidly changing the lifestyles.

### *61.4.3 Thermal Imaging*

Nowadays thermal imaging technique is used in different medical operations to detect cancer. It is used particularly in the assessment of human cell. This gives an advanced advantage than infrared imaging. Thermal imaging is used to detect different body temperatures of the human cell. According to this, we are getting the information of the abnormal cell. If temperature changes, according to this, we get the abnormal growth of the human body (Fig. 61.1).

## 61.5 Infrared-Thermography for Objective Pain Assessment

According to Czaplik et al. [7], in biomedical engineering, a number of research are carried out to find malignancy in clinical medicine. Anesthesia, particularly,

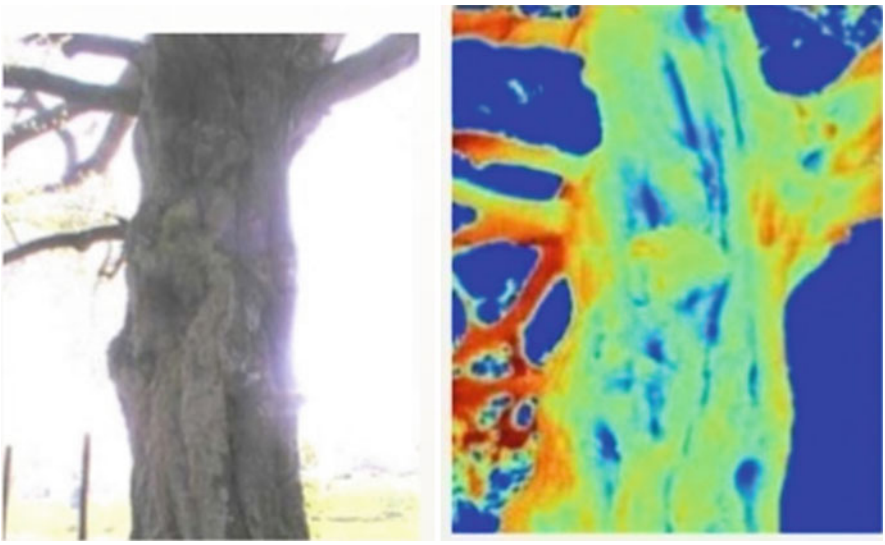

**Fig. 61.1** Thermal image of tree showing tree health

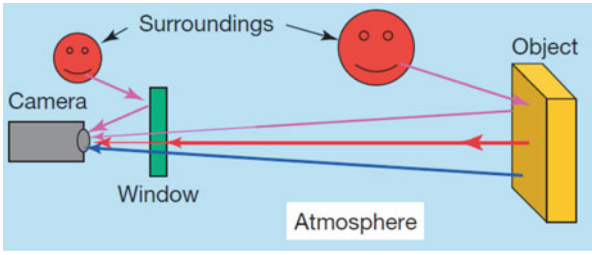


**Fig. 61.2** Thermal image processing

has become easier to administer and safer because of new monitoring devices and further techniques.

Figure 61.2 shows that the thermal image processing and the results depend on the numerical rating scale (NRS), and it ranges from 0 to 10. By using NRS, sensitivity can be detected. If it ranges above 0.75, then it helps to detect the level of pain (Figs. 61.3, 61.4, and 61.5 and Table 61.1).

Thermal symmetry breast is established based on the two different breasts of the patient [9, 10].

## 61.6 Malignant Analysis

Abnormal growth of any cell is nothing but cancer. This abnormal growth of the cancer cell can affect any part/location of the body. This different location is called malignant region. Using thermal imaging technique, cancer cells can be detected.

**Fig. 61.3** Thermal image of PCB [4]


**Fig. 61.4** Thermal image of palm [5]

Malignant regions help to detect the cancer cells present within the body. The early detection of malignant region helps in saving the life of an individual. To obtain thermal images, a thermal camera is used which can detect temperature variations in the body, as low as 0.1°C. The thermal cameras can be used to capture the skin temperature in different states such as biophysiological and emotion specific system [11].

Selvarasu [12, 13] and proposed an automated asymmetry analysis technique for abnormality detection from breast thermographs. Through the canny filtering and segmentation technique, malignancy can be detected. It involves the steps provided in Fig. (61.6).

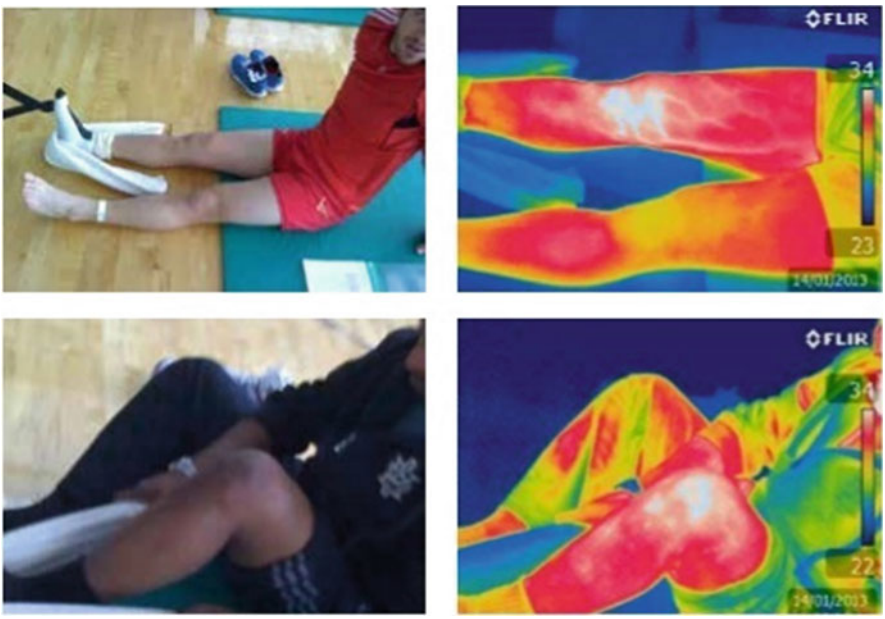


**Fig. 61.5** Thermal image providing inflammation of knee [7]

**Table 61.1** Skin temperature measurements

| Region of interest | Normal | Rheumatoid arthritis |
|---|---|---|
| Metacarpals | 32.68 ± 0.52 | *35.28 ± 0.83 |
| Palm | 34.43 ± 0.23 | *35.39 ± 0.71 (P < 0.001) |

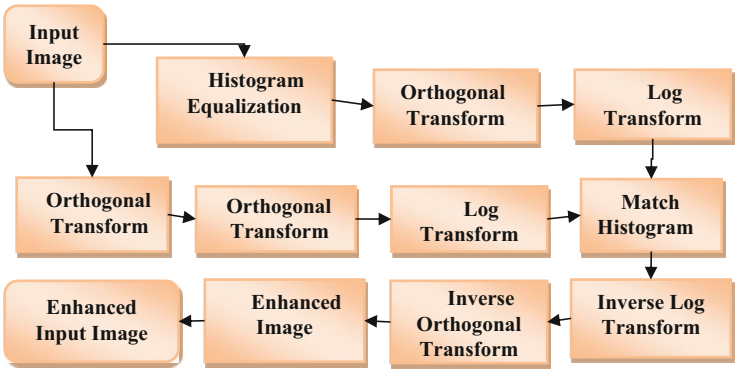


**Fig. 61.6** Abnormality detection, flow diagram of various images, and abnormality identification including malignancy, infection, gangrene, and ischemia

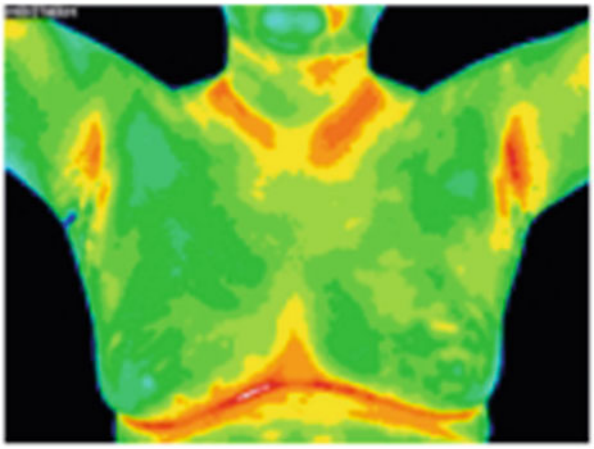

**Fig. 61.7** Normal thermograph [5]

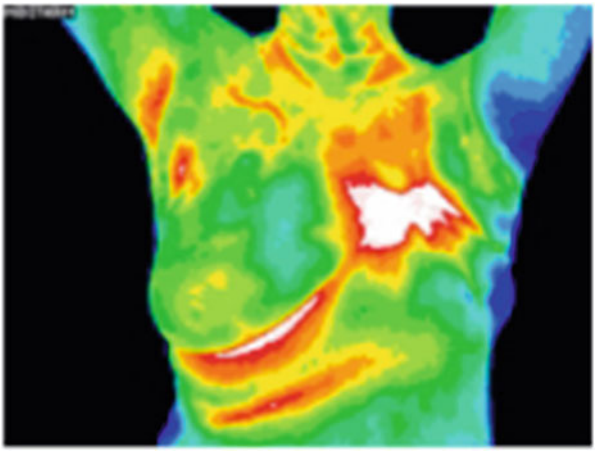

**Fig. 61.8** Abnormal thermograph [9]

### *61.6.1 Breast Thermograph*

Abnormality detection through thermograph depends on the two dimensional values x and y, and it represents the spatial coordinates. Here, g(x, y) represents the vivacity at the pixel. It shows that thermographs are pseudo-color thermographs in which both the colored red and white intensities equal up to the high temperature region and hence shows the presence of the abnormality. It is initiated accordingly thermograph of a regular person is symmetric and there is no unexpected variation in temperature (Figs. 61.7 and 61.8).

According to Nhan and Brian R et al. [14], the asymmetry is measured in terms of skewness, kurtosis, and absolute difference in mean and variance between both halves. This is to establish that there is an important difference in kurtosis and complete difference in mean in both the normal and abnormal thermographs.

## 61.7 Conclusion

We did a literature survey on almost 30 papers and found different techniques to find the cancer cell/abnormal growth cell in the human body. With respect to this, the thermal image processing is an emerging technique to find out the cancer cell in the human body. Thermal infrared imaging embraces the possibility of a great advantage within several areas of recent clinical medicine and imaging modality in noninvasive structure. In order to get good results, we are planning to get real-time images of cancer patients and processes.

**Compliance with Ethical Standards**

All author states that there is no conflict of interest.

Humans/animals are not involved in this work.

We used our own data.

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# Chapter 62
# Firewall for Intranet Security


**Premchand Ambhore and Archana Wankhade**

## 62.1 Introduction

In today's world, the most important factor is security issue with the Internet spread all over the world. To maintain the security in the Internet world, most important issue and it does not like the other forms of security. Each computer security has two different faces like a coin; one face leads the threat, and another one leads the security cost.

Computer security helps to obtain more security for information, and it provides the complete security for data transmission. Security should be maintained in each layer and maintain the defense of the same height. The success key of information security is achievable through firewall technologies.

## 62.2 Firewall

Firewall helps to prevent the malicious software from spreading by using the wall made of fire-retardant material and reduces the slowdown process. Firewall configures as both hardware and software devices and provides the high security level for computer network with different levels of trust. The following strategies are used in firewall (Fig. 62.1).

1. Data communication via firewall is the most secure.
2. It permits high traffic with authorization.

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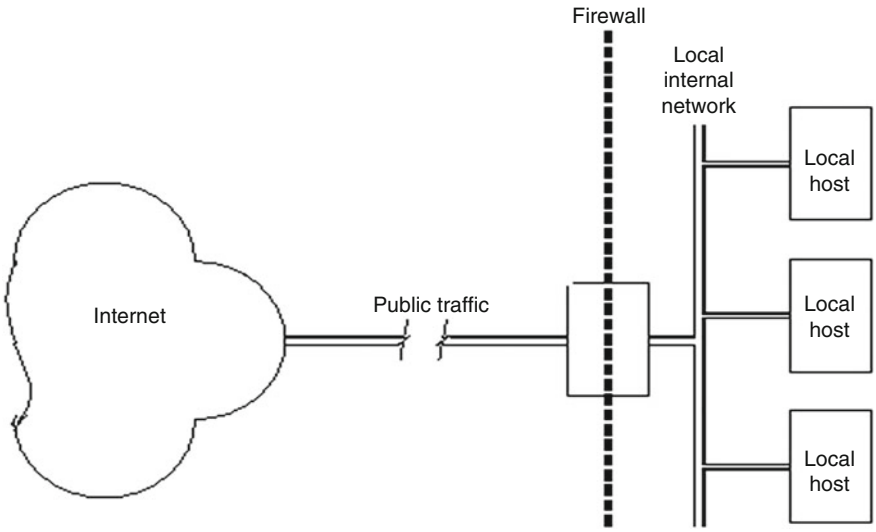


**Fig. 62.1** Concept of a firewall

3. It withstands attacks.
4. Prevents unauthorized access from a system [1, 2].

## 62.3 Data Mining

*Data mining* is often described as finding hidden information in a database. The terms Knowledge Discovery in Databases (KDD) and data mining are often used interchangeably. Data mining uses the database in a traditional ways like questions, data, input, and output.

### *62.3.1 Data Mining Applications*

Data mining has a wide variety of applications which include:

Finance: It stores the information which contains the account details and credit worth.

Marketing: It has the consumer behavior-based algorithms and determination of market strategies.

Manufacturing: It involves optimization of all resources like machines, man power, and materials.
Health care: Health-care applications include discovering patterns in radiological images [3, p.37].

### 62.3.2 Data Mining Algorithms

The data mining algorithms can be classified under three broad categories – classification, clustering, and association rules. The candidate data mining algorithms under each of these categories which can be applied in firewalls are enumerated here. The techniques under classification include the following: statistical-based algorithms, distance-based algorithms, decision tree-based algorithms, neural network-based algorithms, genetic algorithms, rule-based algorithms, hierarchical algorithms, and partition algorithms [4].

**Why Use Data Mining Techniques in a Firewall?**
Managing firewall is a very difficult approach and a time-consuming process. This one helps to validate the firewall rules and optimize the network administrators by using the policy management system [5].

**Modules of the System** This system of building the firewall is divided into following modules: management module, graphical user interface module, and working module [6, p.20, 7, p.49] (Fig. 62.2).

(i) Packet filtering module
(ii) Information scanning (content filtering)
(iii) Protocol filtering (port scanning)

### 62.3.3 Graphical User Interface Module

This module deals with the ***front-end functionality*** of the firewall. As the firewall is intended for use by an average user, the user interface should be very convenient and lucid for use. Mainly the GUI offers two kinds of functions: ***policy editing*** – log viewing consists of viewing all the records of incoming and outgoing traffic to and

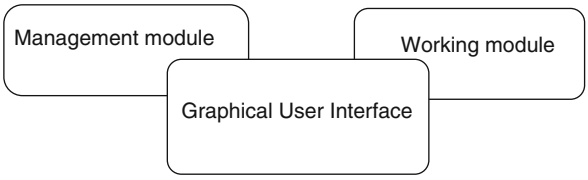


**Fig. 62.2** Conceptual representation of various modules

from the network interface. It also consists of rules to manage the log policy, e.g., days to keep log in database, etc. ***Status viewing*** – status viewer shows the current status of the network packets that are accepted or rejected based on the policy rules [8].

### *62.3.4 Management Module*

Management module is used to monitor and control the working module and GUI module. Management module manages the firewall database which includes the security policy, rule base, users, resources, and so on. The management module stores these databases as well as logs generated by the working module [9, p.23].

### *62.3.5 Working Module*

This part of the firewall is the most important. It consists of all core functionality of the firewall. The real use of data mining algorithms will be in this module. Working module works with following two kinds of functions: packet filtering module and protocol filtering (port blocking) [10, 11] (Fig. 62.3).

The following table (Table 62.1) shows the functions of each submodule and the required data mining algorithm for that module.

Explanation of the above figure shows the proposed model for implementing the firewall. The user or the administrator will put some rules to filter the packets at the network interface (Fig. 62.4). These static rules govern the functionality of the firewall. Now based on the current incoming and outgoing networking traffic and

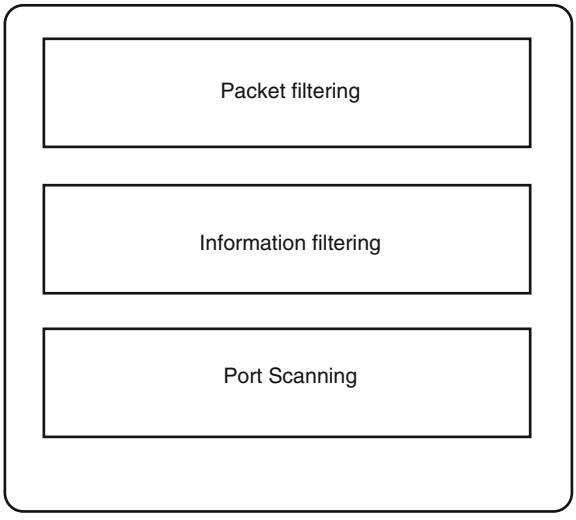


**Fig. 62.3** Working module

**Table 62.1** Functions of data mining algorithm

| Submodule | What it does | Which data mining technique to use |
|---|---|---|
| Packet filtering | Rejects data packets from unauthorized hosts rejecting connection attempts to unauthorized services by extracting the packet headers and deciding their fate based upon a set of rules | Apriori algorithm |
| Port blocking | Checks for ***active connections*** and also for backdoor ***intrusion*** which may be malign for the system | Gap analysis clustering |

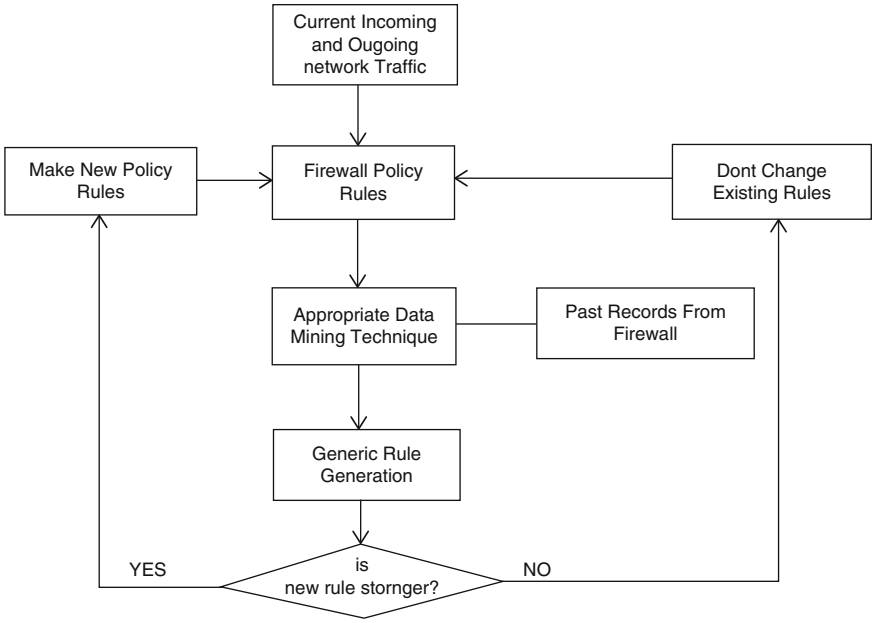


**Fig. 62.4** Proposed model of implementation of firewall using data mining technique

existing policy rules, each and every transaction, i.e., the log, is recorded in the log file with the result of action on the packet. Taking this logged data as the source, we apply the appropriate data mining technique. This helps in creating new set of policy rules. These rules are subtly different from the original ones given by the end user. One of the two things can happen here. In either the mining algorithm can make the original rule stronger, or it can narrow down its effects to being negligible. We check if the new rule is stronger than the original rule. If it is, we update the current rule; otherwise, we keep the same set of rules. The process continues in the same fashion. The important thing to mention here is that this flowchart represents the ideal way of dealing with the packet filtering only. In actual implementation there are other filtration techniques that we need to consider. Also, unlike packet filtering, the rest of the features do not require data mining primarily [12, 13].

## 62.4 Scope and Future Work

This software is intended for home users for whom the Internet is an easy access to obtain a large amount of information but are generally unaware of the network attack. If they are somewhat aware, they do not know much about how to prevent it. However in big networks, there are those network administrators who know how to prevent it by using commercially available firewalls which are quite expensive and out of the reach of general user. Moreover they are designed keeping in mind that the user is an expert in networking, thus laying very less importance on user interface. Our software is designed keeping in mind a novice user. We have laid a great deal of emphasis on a sound user interface so that a general user should learn how to use and control this firewall in simple and easy steps without compromising functionality and flexibility of the software. After a careful consideration of all the algorithms [14], we have selected two algorithms for use in firewalls – the apriori algorithm and the gap analysis clustering algorithm. Both these algorithms have their own advantages and drawbacks. The prime motive of our system is to bring together the merits of all types of *firewalls using the best data mining techniques.* This study leads us to grasping the basics of firewall. This is helpful in developing the best of its breed firewall. The comparative study of various data mining algorithms is mentioned. The apriori algorithm is discussed in detail, as part of implementation of firewall, along with example, for implementation of packet filtering. Similarly the gap analysis clustering algorithm is studied in enough depth that is suitable for implementing port scanning technique [15, 16].

## 62.5 Conclusion

Thus, using the best techniques from both the domains, firewall and data mining, their fusion is expected to be a reliable, safe, and user-friendly firewall system. The system is also expected to evolve with time because of the use of genetic algorithm. Hence its functionality and reliability will be greater than that of a conventional firewall.

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# Chapter 63
# Drowsiness Detection System Using Raspberry Pi and OpenCV


**Md. Farukh Hashmi, N. Kusuma Priya, S. Surya Reddy, G. Vakula, and D. Usha**

## 63.1 Introduction

In the recent years, there has been a tremendous development in the field of computer vision. Computer vision [1] is a scientific field that helps the computers to understand high-level information from digital images and videos [2]. It includes the methods of acquiring, processing, and analyzing the high-level information in order to produce symbolic information. Artificial intelligence is a co-domain of computer vision which is helpful in pattern recognition and learning techniques. Computer vision has various applications in the fields of medical sciences, industries, and military. Autonomous vehicles are the newer application areas which use computer vision. Drowsiness detection [3] has become an important application in the development of intelligent vehicles. Due to drowsiness of the driver road accidents are caused and they account to 20% of all the accidents occur in a year. The National Highway Traffic Safety Administration has given a report which include 1,600 deaths, 80,000 injuries. Humans can easily recognize the faces because our brain consists of specialized nerve cells which respond differently to the different features of the face. But this cannot happen with the computers as they don't have brains. So, the computers are trained using some algorithms in such a way that they analyze and recognize the faces without the intervention of humans. Among all these algorithms the most commonly used face recognition algorithm [4] is based on the key facial structures of the face. This algorithm marks the positions of facial features [5] like the ears, eyes, nose, and mouth and helps in the construction of feature vector which gives details about the distance between those points and

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also the angle between them. The algorithm is further proceeded by calculating the Euclidean distances between them. Among all the face recognition algorithms [6], the most popular face recognition algorithms are Eigenfaces, Fisherfaces, and Local Binary Pattern histograms [7]. The Local Binary Patterns Histogram is implemented in the user authentication procedure and is shortly known as LBPH Face Recognizer Algorithm. To detect the drowsiness [8] of the driver, various technologies are in usage. Some of them are steering pattern monitoring which primarily makes use of input from steering system which is powered electrically, vehicle position in lane monitoring which makes use of lane monitoring camera, and driver face monitoring [9] which takes the help of computer vision to detect the driver's face with the help of external USB camera or a built-in camera. Body sensors are used to detect the activity of the body parts in physiological measurement systems [10].

## 63.2 Related Work

As discussed in the previous session, some of the important face recognition algorithms are Eigen faces, Fisher faces, and Local Binary Patterns Histogram [11]. The Eigen Faces algorithm has 96% recognition rate. The Local Binary Patterns Histogram (LBPH) has a better recognition rate compared to that of Eigen faces and Fisher faces. The Local Binary Patterns structures an image by comparing each pixel with its neighborhood, i.e., it takes a pixel as center and thresholds its neighbors compared to the center and then it denotes one if the intensity of its neighbor is less than the center; otherwise, it is zero. So there will be 28 combinations since there are 8 neighbors for a particular pixel. These combinations are called Local Binary Patterns and are referred to as LBP codes. There are several other approaches for drowsiness detection [12] of drivers. Behavior of drivers steering, analysis of driver, etc. are considered as the factors for acquiring the parameters for driver drowsiness detection [13], e.g., yawning detection, eye tracking, electrocardiogram (ECG), and blinking of eyes [14]. In the beginning era of advanced driver assistance systems, the study of yawning detection and ECG has become more popular. Electrocardiogram (ECG) [15] includes the development of low-cost sensor which is considered as a factor for determining the drowsiness detection of the driver. The ECG signal obtained is transferred to the PCB in which the processing of the signal takes place with the HRV (heart rate variability) [16] data which results in better results. Here, ECG [17] is combined with the facial recognition-based drowsiness detection to obtain the more accurate recognition rate. In yawning detection [18] the position of lower lip is observed to obtain the drowsiness state during yawning. Haar Cascades classifier is used to detect the portion of facial features. During yawning, the position of upper lip is fixed, and only the lower lip is moved and based on the movement of the lower jaw. In addition to this, the movement of eyelids is also observed to avoid false detection. This technique speeds up the process of drowsiness detection as it

avoids the false detection. The results obtained using this technique proved that the performance of drowsiness detection has increased up to 80% even under varying lighting conditions [10].

## 63.3 Methods and Materials

In this section the hardware setup used and the description of various hardware components are discussed. The major components discussed are Raspberry Pi 3 and USB camera.

### *63.3.1 Raspberry Pi Architecture*

This work makes use of Raspberry Pi 3 which is a single board computer which consists of an ARM Cortex-M0 microprocessor. This is the most commonly used single board computing system. Raspberry Pi 3 is compatible with various Linux operating systems [19]. Raspbian OS is the popular operating system in real-time applications. Raspberry Pi 3 consists of an Ethernet port, a USB-A port, and a 3.5 mm headphone jack. It also has a memory card, through which Raspbian OS is installed on to the system. This board has 40 GPIO pins, modulation pins, SPI (Serial Peripheral Interface) pins, I2C pins, serial pins, and 5 V,3.3 V pins. It also has additional features like Wi-Fi and Bluetooth sacks which are useful in connecting to the IOT platform [20]. This board can be interfaced with USB camera which is used in capturing the facial data which is further used in required applications. The architecture of Raspberry Pi 3 board is shown in Fig. 63.1.

**Fig. 63.1** Raspberry Pi 3 board


**Fig. 63.2** USB Camera

### *63.3.2 USB Camera*

Raspberry Pi is compatible with USB camera which is used in capturing the live images and video streams [20]. This USB camera supports picture formats like JPEG, GIF, PNG, BMP, etc. It also has an advantage of getting the mirror of an image or flipped version of it. Two types of camera modules can be interfaced with Raspberry Pi 3. They are Camera Module v1 and Camera Module v2 with resolutions 2592*1944 pixels and 3280*2464 pixels, respectively. USB Camera Module is shown in Fig. 63.2.

## 63.4 Proposed Methodology

In this section the hardware methodology and the description of various steps used for implementation of software methodology are discussed.

### *63.4.1 Hardware Platform*

The block diagram shown below Fig. 63.3 describes the functionality of drowsiness detection. USB Camera Module is used to capture the livestream data, and this data is sent to Raspberry Pi 3 module on which computations are done, and based on the results acquired from the Pi board, if the driver is drowsy, a trigger is given to the alarm which is used to alert the driver.

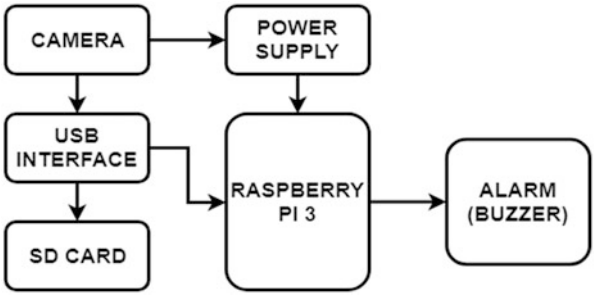


**Fig. 63.3** Block diagram of drowsiness detection system

### *63.4.2 Software Platform*

The software setup in this context includes three phases. The first step includes the recognition of face and extracting the face features, followed by eye detection, and then drowsiness detection of the driver. The flowchart for the drowsiness detection is as follows. In this system, the camera module continuously captures the livestream data once the device is turned on. The data is then sent to the Raspberry Pi board and is then processed to obtain the desired parameters. If the obtained value is less than the threshold value, an alarm alerts the driver. Proposed process flow of drowsiness detection system is shown in Fig. 63.4.

#### 63.4.2.1 Face Recognition

In facial recognition, the main objective is to extract the facial features using common facial structure prediction methods. It involves two major steps. The first is to recognize the face of the driver from the image captured using the USB camera and locate the key facial structures like the eyes, eyebrows, ears, mouth, etc. This recognition is done using the Haar Cascades data set so that the image captured is compared with this data set. The localization of image is represented in the form of 2D coordinates as shown in the below Fig. 63.5.

#### 63.4.2.2 Eye Detection

After extracting the features of the face using face detection techniques, the main objective is to identify the eye regions. Each eye is visualized as six points in the 2D coordinate system. Of those points, two points are at leftmost and rightmost corners of the eye and the remaining four along the edges of the eye, i.e., two along the top edge and other two along the bottom edge.

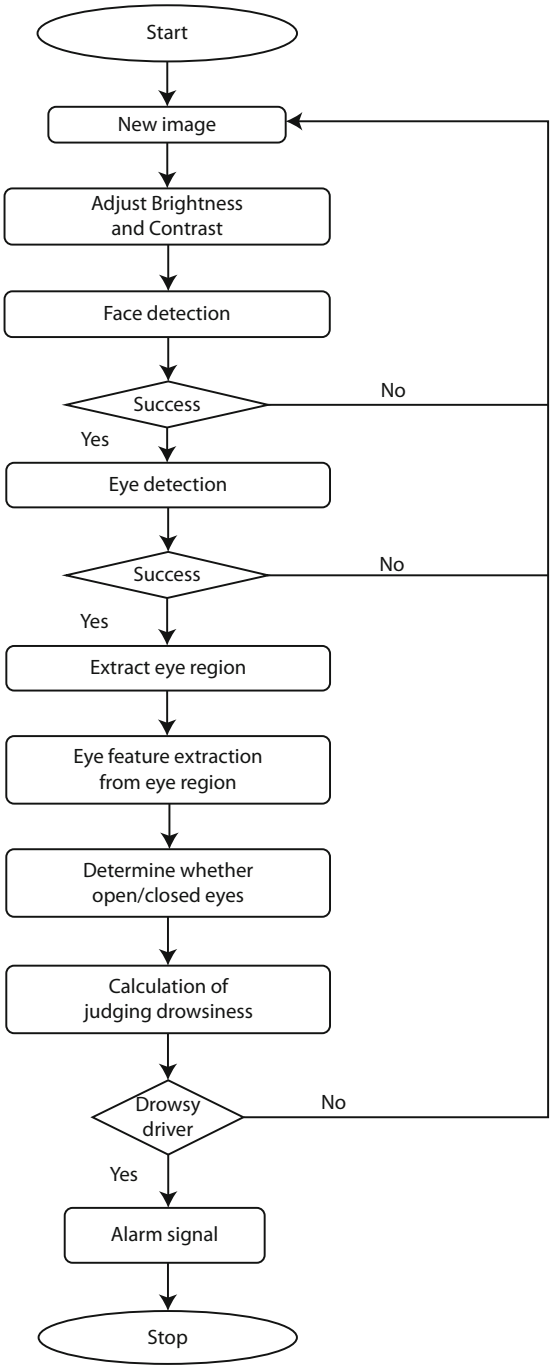


**Fig. 63.4** Proposed process flow of drowsiness detection system

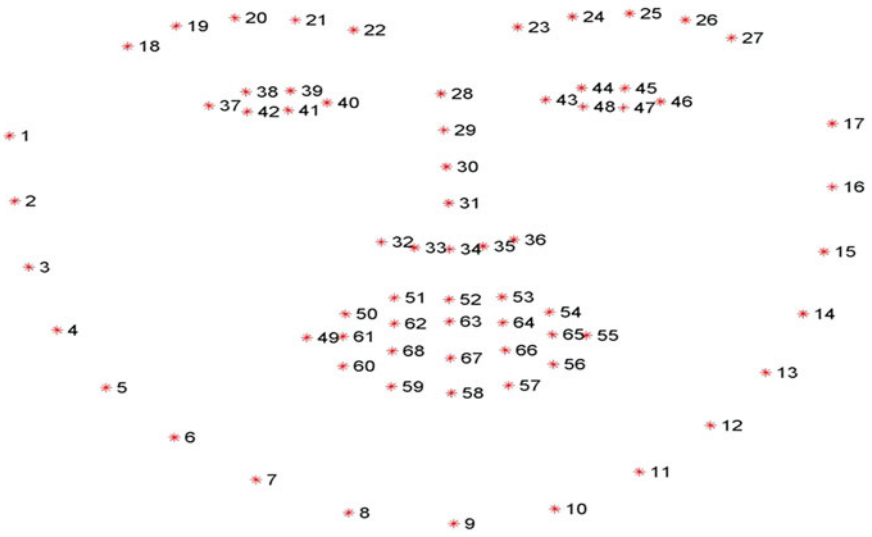


**Fig. 63.5** Extraction of face features

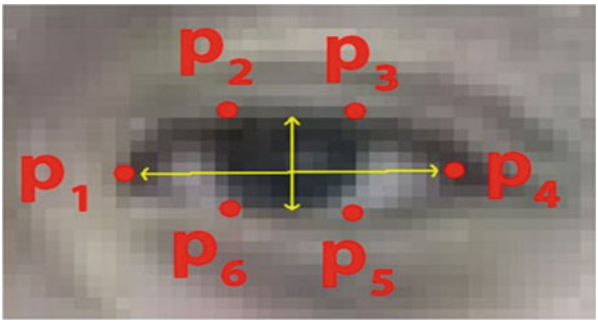


**Fig. 63.6** Eye aspect ratio

The width and height of these coordinates are related using an equation which is known as eye aspect ratio (EAR). The eye aspect ratio is given as follows:

$$\mathrm{EAR} = \frac{\| p2 - p6 \| + \| p3 - p5 \|}{2 \| p1 - p4 \|} \tag{63.1}$$

where p1, p2, . . . , p6 are 2D facial coordinates. In the equation showed, the numerator indicates the spatial distance calculated between the vertical eye positions, and the denominator indicates the spatial distance between the horizontal eye positions. The EAR is constant when the eye is open, and this ratio falls to zero rapidly when the eye is detected as closed. Eye aspect ratio calculation is shown in Fig. 63.6.

#### 63.4.2.3 Drowsiness Detection

After getting the eye aspect ratio, the next step involves the drowsiness detection of the driver. In this, a threshold value of EAR is fixed so that the calculated EAR value is compared with that of the threshold value. If the obtained value falls below the threshold, a trigger is sent to the driver which is used to alert the driver.

## 63.5 Results and Discussion

Deploying the code and software setup in the Raspberry Pi board, the camera starts to capture the livestream data of the driver continuously. If the driver falls asleep, the EAR ratio falls below the threshold, and a trigger is given to the driver. The results using OpenCV is shown as follows. The results includes two states. One showing the drowsiness state of the driver and the other showing the state where the count is constant. Results showing the drowsiness of the driver and initial state of the driver are shown in Figs. 63.7 and 63.8.


**Fig. 63.7** Results showing the drowsiness of the driver. (We used own author's photo)

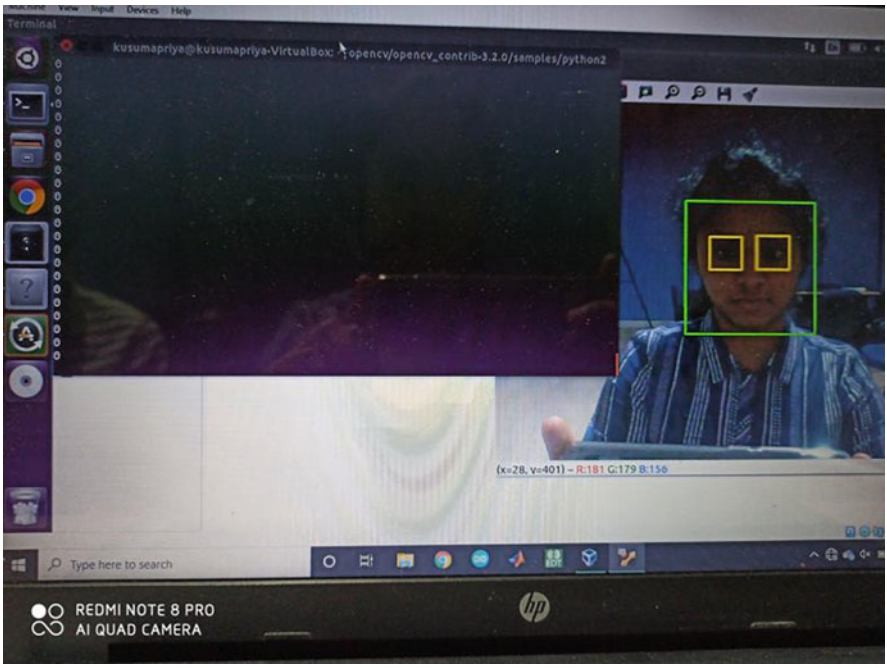


**Fig. 63.8** Results showing initial state of the driver. (We used own author's photo)

In Fig. 63.7, the driver is sleepy for a longer duration. The count gets gradually increased when the driver's eyes is recognized to be sleepy. If the count value exceeds the threshold value, an alert signal is sent to the driver. If the driver is awake before the threshold is reached, then the count resets to zero and starts counting again if the driver is sleepy.

In Fig. 63.8, the eye portion is recognized using Haar Cascades and is monitored continuously. The status of eye opening is related to a counter. The count value is constant and is zero if the driver is not sleepy. This is the initial state where the driver is alert and not sleepy.

## 63.6 Conclusion and Future Scope

The system proposed in this paper was able to recognize the drowsy state of the driver and able to alert the driver. Face detection was done in real time by capturing the live status of the driver and was able to compare with the trained data set. This system is used to obtain the required parameters which were used in obtaining the results. A threshold value which is already set is used to compare the drowsiness detected duration. When the person is sleepy for a considerable amount of time, the

system detects it as a drowsy state and alerts the driver. Thus the system proposed is helpful to assist the driver and is considered as one of the advanced driving assistance systems. An automated break system can be developed using machine learning (ML), in which a timer is initiated as soon as the alert signal starts. If the driver is not awake even after the timer expires, then the automatic brake system comes into play in order to stop the vehicle.

**Compliance with Ethical Standards**
All author states that there is no conflict of interest.
We used our own data.
In results we used author's photo.

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# Chapter 64
# BanglaMusicMooD: A Music Mood Classifier from Bangla Music Lyrics

**Nazia Parvin Urmi, Nasir Uddin Ahmed, Md. Habibur Rahman Sifat, Salekul Islam, and Abu Shafin Mohammad Mahdee Jameel**

## 64.1 Introduction

In our leisure and recreation time, we usually do some activities such as reading books, listening to music, and playing. Among these activities, listening to music is one of the popular ones that have an amplifying effect on social consistency, the emotional state of mind, and mood of the listeners [1]. Among music lovers, music classification and recommendation model has obtained large popularity.

The power of music to influence mood and create scenes, routines, and occasions is widely recognized and this is reflected in a strand of social theory that portrays music as an influence on character, social structure, and action [2]. Music is an important art that is very soothing and relaxing which can make our bad days better. The more we will be able to examine what we want in music, the more music will be appealing to us. Around 68 percent of people who have aged between 18 and 34 years old announce that they listen and enjoy music every day.

In our approach, we created our own Bangla song dataset for filtering and music mood prediction of listeners that can be associated with happy or sad emotions. Our main focus is to create a system that can be able to predict song mood that will be applied to the song database to select music by its lyrics analysis.

The ensemble technique can be said as a hybrid approach. Multiple classifiers can be used. The ensemble technique is divided into two types. One is called "Bagging," and the other one is called "Boosting." Bagging is helpful in the way to reduce variance. In bagging, samples are drawn with replacement. Advantage of bagging is that we don't suffer from random errors that classifier is bound to make. In bagging

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each tree is independent of each other because they consider different subset of features and samples. As bagging reduces variance, it helps to avoid overfitting. We have used bagging with support vector machine (SVM). SVM gives high accuracy. It also works well in case the dataset is not linearly separable. Another key point is SVM can help to avoid overfitting by regularization of parameter.

Term frequency-inverse document frequency (TF-IDF) was used for feature extraction. TF counts the occurrence of a term within a document. IDF finds out the importance of a term. TF-IDF becomes large when there is a large count of a term in a document and the low number of documents with a term in them. TF-IDF becomes smaller if the term appears in many documents in the corpus.

In Sect. 64.2, we provide our project-related work information. In Sect. 64.3 methods that we are using in our project. The process and results we obtained in our project are discussed in Sect. 64.4. In Sect. 64.5, we summarize our whole works and also provided future works of our project.

## 64.2 Literature Review

In this section, we will discuss some related works on music classification, also some recent literature review about mood prediction in text [3]; very little has been done so far to address the classification of lyrics according to their mood.

### *64.2.1 Music Classification*

Widowati et al. [4] classified the music into moods like happy, peaceful, angry, and sad. They performed this classification with 200 track database for training and 50 for testing. Kashyap et al. [5], in their paper, worked on text mining. They used naive Bayes for strong independent assumptions to divide the model. They also focused on parts of speech, so that word can be easily tokenized. In previous, the majority of work related with music mood have done by categorical (happy, sad) models of emotions [6]. In [7, 8], they classified music mood through audio lyrics.

### *64.2.2 Mood Prediction*

Widowati et al. [4] used some music features like pitch, pulse clarity, tempo, key, and scale. To classify, convolutional neural network (CNN) is used in this paper. For this, the accuracy they have got is 82 percent. Kashyap et al. [5] took motivation from mood detection challenges. The features they focused on are mood perception, mood cataloging, and acoustic cues. Acoustic cues [9] made their work significant. They followed the divide and conquer approach to break a model into multiple

ones. By gathering the information, they trained the model. They divided their dataset based on models in the categories like stop words, sad words, angry words, aggressive words, average words, happy words, etc. It is like a bunch of trees. So feature mapping becomes easier [10]. In this paper [6], they predict the mood of a song based on song lyrics. Happy or sad mood can be detected by high precision based on the text lyrics features [11].

### *64.2.3 Bangla Mood Processing*

Bangla's mood processing depends on word embedding [12]. A single Bangla word can occur in a sad song or a happy song. The divide and conquer approach can be followed. At the same time, the probabilistic approach applied to find the best match. Mood processing by using Bangla song lyrics dataset is not enriching.

## 64.3 Proposed Methodology

### *64.3.1 Method Overview*

Figure 64.1 shows a complete overview of our project. At first, we created a corpus that contains Bangla song lyrics. Corpus [13] mainly appears in natural language processing (NLP) area. In the next step, we sampled and labeled the corpus, which means we have preprocessed the data. The next staff is feature extraction. Feature's extraction is mainly the transformation of raw data into features, which can be used as the input of a learning algorithm. In this project, we used the term frequency-inverse document frequency (TF-IDF) for feature extraction and then divided the data into training and validation set. In the next stage, we have applied an ensemble learning technique [14]. More clearly we have applied a bagging algorithm. Ensemble technique is the process of combing different classification techniques to build a powerful composite model from the data. Bagging combines different classifiers into a single prediction model. We have used a bagging classifier with a support vector machine (SVM) model.

### *64.3.2 Our Dataset*

For classifying lyrics mood, we did not find a suitable dataset. So, we have built our dataset. In our dataset we have two attributes; they are lyrics and mood, following that we have 40 objects. In the train set, we have 32 objects, and in the test set, we have 8 objects.

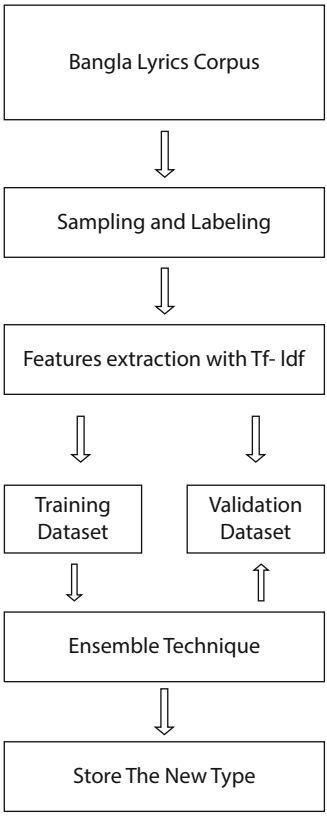



**Fig. 64.1** Flowchart of the proposed method

### *64.3.3 Feature Used*

TF-IDF: term frequency-inverse document frequency (TF-IDF) is used to know how important a word is to a corpus. It is mainly used for feature extraction. Term-frequency (TF) finds how often a word appears within a document. Inverse document frequency (IDF) down scales words that appear a lot across documents. From the lyrics, tokenization has to be performed. For tokenization, the lyrics were converted into vectors. The vectors could have different n-gram sequences. A Porter-Stemmer-Tokenizer hybrid to splits sentences into words (tokens) and applies the Porter stemming algorithm to each of the obtained tokens [15]. Tokens that are only consisting of punctuation characters are removed as well. Only tokens that consist of more than one letter are being kept. Binarization is used to transform both the discrete attributes and continuous attributes into binary attributes. For counting the number of times, each word occurs in each lyrics term frequency (tf) which has been used.

$$t\ f\ \ id\ f\ \ (t;d) = t\ f\ \ (t;d)\ \ id\ f\ \ (t) \tag{64.1}$$

The equation was used to calculate term frequency depending on normalized term frequency. Term document frequency is used as a form of inverse document frequency.

$$idf(t) = \log\left(\frac{(1+nd)}{1+df(t;d)}\right) + 1 \tag{64.2}$$

"nd" is the total number of lyrics. In the lyrics corpus, the columns correspond to terms, and rows correspond to documents in the collection. The value of "nd" increases proportionally with the number of times along with the word appears as a document.

Tokenization: From the lyrics corpus, it is important to extract desired content. For breaking lyrics into tokens, we have used porter tokenizer. After tokenizing the lyrics, the texts were kept into a vocabulary. Stop words from the corpus were removed.

### *64.3.4 Procedure*

Figure 64.2 shows the workflow of our work. The training examples are indicating the lyrics' corpus. The corpus is divided into small bags which contains Bangla lyrics randomly from the lyrics corpus. The bags are being used as the input of the learning algorithm. Here we have applied support vector machine (SVM) as the learning algorithm. In the bagging procedure by support vector machine (SVM), we need to fix the "n estimators." The term "n estimators" indicates the number of trees we want to build before taking the maximum voting or averages of predictions. We have used the value of "n estimators" equal to 10, which means it would build ten classifier models. Then the algorithm would take combined voting. And thus it will give the prediction.

### *64.3.5 Model Used*

Support vector machine (SVM): In the project to build classifier, we have used support vector machine (SVM) as the model Fig. 64.3. It is a supervised learning technique. The support vector machine tries to find the optimal separating hyperplane; as a result, the margin of the training data can be maximized.

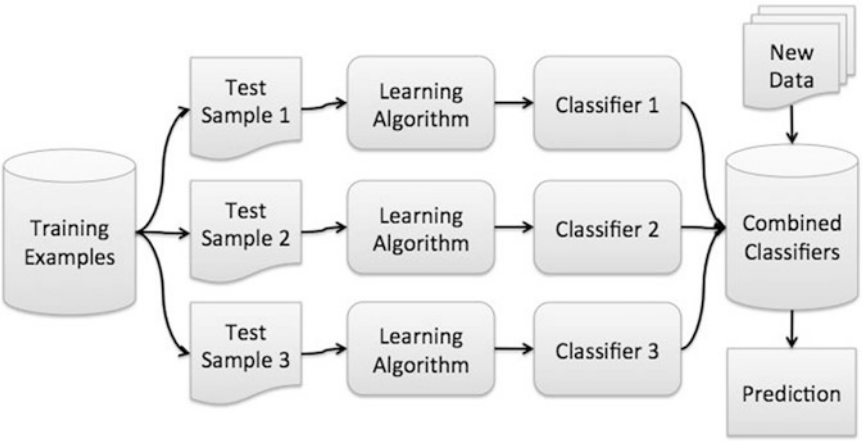
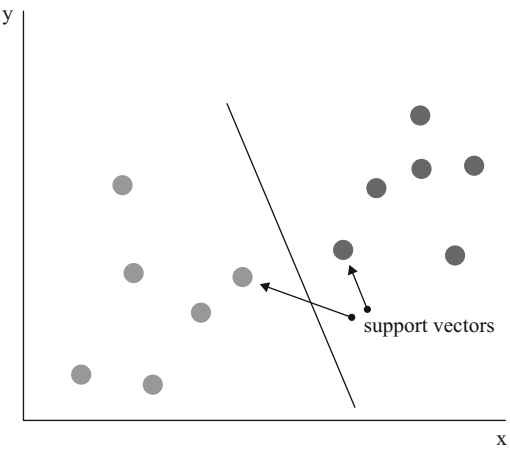



**Fig. 64.2** Workflow of the Bagging Technique

**Fig. 64.3** Support vector machine diagram




## 64.4 Result and Experiment

By using precision, recall, and f1 score, we have evaluated the performance of our model. The formulas of the following terms as follows:

$$F1 = 2\frac{precision\ recall}{precision + recall} \tag{64.3}$$

where

$$precision = \frac{T\ P}{TP + FP} \tag{64.4}$$

**Table 64.1** Results of training and test accuracy

| | |
|---|---|
| Training Accuracy | 0.9375 |
| Test Accuracy | 0.875 |

**Table 64.2** Model evaluation

| | Precision | Recall | F1-score | Support |
|---|---|---|---|---|
| Happy | 0.50 | 0.33 | 0.40 | 3 |
| Sad | 0.67 | 0.80 | 0.73 | 5 |
| Accuracy | – | – | 0.62 | 8 |
| Macro avg | 0.58 | 0.57 | 0.56 | 8 |
| Weighted avg | 0.60 | 0.62 | 0.60 | 8 |


**Fig. 64.4** Happy word cloud visualizations of the most frequent words

and

$$recall = \frac{T\ P}{TP + FN} \tag{64.5}$$

TP = number of true positives, FP = number of false negatives, and FN = number of false negatives

Table 64.1 shows the test and training accuracy of the model. Table 64.2 shows the evaluation result. Macro average (macro avg) takes the average of the precision and recall of the system on different sets, calculating metrics for each label, and find their unweighted mean. This does not take label imbalance into account. The weighted average (weighted avg) calculates metrics for each label and finds their average weighted by the number of true instances for each label. Figure 64.4 shows the word cloud for happy class and Fig. 64.5 shows the word cloud for sad class.

**Fig. 64.5** Sad word cloud visualizations of the most frequent words

## 64.5 Conclusion

We have tried to develop a classifier to detect the mood of the Bangla song. Due to the scarcity of the Bangla-labeled lyrics dataset, we have created a dataset for the project. We have used Bagging with support vector machine (SVM). We tried to show the fruitfulness of Bangla song mood prediction by using lyrics. For feature extraction, we have used term frequency-inverse document frequency (TF-IDF). Stop word removal was also in the act. However, we have created low-dimensional dataset containing lyrics and moods as features. In the future, we want to enlarge the dataset, and we want to apply the neural network to increase the performance.

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# Chapter 65
# Novel Approach of Automation to Risk Management: The Reduction in Human Errors


**Abhishek Biswas and Pushan Kumar Dutta**

## 65.1 Introduction

Ever imagined even a paperweight is automation? It automates the manual task of forcefully holding the paper to keep it stable. And it makes no error, because it has been designed in a simple yet effective shape and size to keep the paper stable. A human hand, otherwise, would have gone tired and released it for moments that would lead to mishandling of the paper. This simple example shows how humans are prone to errors in tasks but machines are not – they do not judge, do not react, and, of course, do not get tired. They'll not function inappropriately until and unless they are made erroneously. Hence, the application of any kind of automation, if made appropriately, will perform much more perfectly than a human being doing the same task.

But the problem is everything cannot be automated. We need to understand the scope of automation in our tasks. And this study is exactly this – understand your opportunities for automation for improving your process. And we have studied and experienced the same in risk management and associated domains, which is applicable for any industry. While a lot of technologies are out there, a proper bridging-the-gap item is required everywhere which will let the business stakeholders know about the technical scope. We shall study the scope in the following domains of risk management:

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- Risk assessment
- Risk treatment planning
- Controls implementation
- Controls testing
- Emerging technology threat control

The computer-aided audit is an older tool that primarily deals with data assurance, which is a practice in assurance/auditing/accounting where the data, typically (but not limited to) in the order of thousand rows, is analyzed for finding the reconciliation gaps. A general ledger vs. trial balance analysis, which may have thousands of rows, is a common example of assurance over the data of the entity. But in today's world, the risk management and corresponding accounting that need to be done are much more than rule-based analysis. We shall study the markets for state-of-the-art audit automation tools:

- Artificial Intelligence
- Robotic Process Automation
- Blockchain

It should be noted that process automation ultimately reduces the audit cost by leaps and bounds. That shall also be discussed. Besides, we shall also study the economics of risk management, including computer-aided auditing. The cost reduction factor is a main player in the industry. Ultimately, to the C-suite, the cost is one of the major factors. The other point of study would be sustainability. Anything impractical and resulting in short-term profits cannot be recommended for implementation in mid-to-large organizations. Hence, those kinds of automation have been eliminated purposefully.

Section 65.2 discusses about the opportunities of automation in risk management, Sect. 65.3 discusses the role of the state-of-the-art technologies in the automation of risk management, and Sect. 65.4 discusses the economics of risk from the management and financial perspective. The study ends with a conclusion in Sect. 65.5.

## 65.2 Risk Management Automation Sectors

We shall study the automation opportunities that are available in the entire extended risk management cycle – risk assessment, risk treatment planning, controls implementation, and controls testing. The ideas for automation are mainly studied based on tasks that are mostly repetitive in nature. However, we shall discuss areas where tasks not so repetitive in nature are also discussed. Additionally, the great help automation can do in controlling the emerging threat is also studied.

### *65.2.1 Risk Assessment Activity Automation*

**Background and Human Workflow** Risk assessment is the base of risk management and auditing. Risk assessment refers to understanding the risks to an organization. This is a broad term referring to a wide range of activities in order to analyze the risks, which is extremely critical to the success of the organization. There is a core risk assessment task followed by a risk treatment plan.

Risk assessment in an organization is carried out by either internal employees, internal auditors, and external consultants or in a combination of the mentioned. However, the ultimate responsibility of the approach and success of the risk assessment is with the management of the organization.

**Importance** As mentioned earlier, risk assessment is the base of extended risk management. Imagine we have two gates at your house. The threat to the first gate is thieves. But for some reason, we fail to identify this threat for the first gate and, instead, determine that the second gate has a threat from thieves. Hence, we put up a lock at that second gate to cover up the vulnerability of the gate being open. Our mistaken is we have left the actual gate open because we failed to identify the risk caused by the threat. Improper or inadequate risk assessment may lead to a total failure of the business. If we don't know where to use the necessary things, we'll end up having great losses of reputation, technology, sanctions, and finance.

**Calculation** Risk Assessment is a majorly of two types:

- Asset-based – based on risks of all the assets
- Scenario-based – based on risks of all business scenarios of failure

Although there may be other logical ways of analyzing your risks, let us take an example of a very basic asset-based risk assessment. We calculate the threat to an asset here. But every asset may not be of equal importance to the organization. Compromising an asset's confidentiality, integrity, or availability may not affect the organization in equal ways. Hence, we rate each asset by an "asset value," based on 1–5. There is a rating given to the asset of getting exposed to external threats. Measurement of the same is done generally by the following:

- Threat value = threat − probability * threat − impact
- Vulnerability value = Measurement of weakness in the asset, i.e., vulnerabilities existing from which the asset may get exposed to the threat
- Risk rating = Asset value threat value + vulnerability value

Refer to Table 65.1 for a sample risk assessment calculation.

**Opportunity for Automation** The scope of automation in risk assessment lies end-to-end. The following programs may be written:

- Automatic addition of threats and vulnerabilities: Each asset has multiple threats if the addition is being in odd in one place.

**Table 65.1** Typical asset-based risk assessment

| Asset | Asset value | Threat value | Vulnerability value | Risk rating |
|---|---|---|---|---|
| Linux server 1 at datacenter | 4 | 5 | 3 | 12 |
| Source code repository | 5 | 3 | 1 | 9 |
| CCTV | 3 | 2 | 5 | 10 |
| Data management system | 2 | 4 | 4 | 10 |
| Real-time AI tool | 5 | 3 | 4 | 12 |

- For an organization with 200 assets, it takes approximately 20 working days to complete the risk assessment exercise to completely identify the assets, C-I-A value, its' threats, and the vulnerabilities that may exist against those threats.
- With the program automating the threat-vulnerability task, the only manual task in the process would be adding the type of asset.
- Threats and vulnerabilities depend on the asset category (e.g., application, server, data, hardcopy, etc.) and location (e.g., outside, office premises, datacenter, secured cabinets, etc.)
- The automation increases the efficiency of the process, besides accuracy.

### *65.2.2 Risk Treatment Activity Automation*

**Background** According to the definition by the European Union Agency for Cybersecurity, Risk treatment is the method by which risk mitigation interventions are identified and implemented. The outcome post the exercise is a plan where risk treatment measures can include risk prevention, optimization, transfer, or retention [1].

**The Human Workflow** Post the assessment of the risks, we populate the "inherent risks." The next task is to identify the existing controls over these risks. After combining the existing risks with the existing controls against them, we find the current or actual risks. If the actual risks are not acceptable, we then prepare the risk-mitigating plans for them. This is called the risk treatment plan.

**Opportunity for Automation** Like risk assessment, the scope of automation in risk treatment lies end-to-end. If a look is taken at ISO Standard versions or the internationally accredited SOX law, amendments are hardly made over a range of 6 years. For example, Sarbanes-Oxley, which is named after bill sponsors US Senator Paul Sarbanes and US Representative Michael G. Oxley, came into effect on 2002 primarily for the protection of investors' interests. It got a few amendments. Again, for ISO 27001, the latest versions have a gap of 8 years (2005 and 2013). Hence, it is understandable that the standard controls hardly change over a mid-range time, for which it may be extremely sustainable to use a set of controls against the existing threats. The addition of any new controls may be added to

an automated risk assessment-cum-treatment system. Therefore, it can have the following functions:

- Select the asset and asset category.
- The systems give the latest threats and vulnerabilities.
- Latest threats and vulnerabilities can be added manually.
- Controls will come from the standard/laws based on the risk identified.
- Risks will be automatically mapped to the controls.

The end result is the automation of the entire risk treatment plan, and there won't exist any manual task in this, except for review and enhancement. This ensures that at least the risk and compliance requirements will be fulfilled.

The next part of the task lies with the management to implement the controls.

### *65.2.3 Controls Implementation and Testing*

**Background** Controls refer to the risk-mitigating activities or measures, which the organization needs to undertake in its regular operations to run the business smoothly, thereby protecting it from internal and external threats. In a layman terminology, controls are a cover-up for the vulnerabilities that may exist inherently and strategically in any business. While controls implementation is the responsibility of the business to run a risk-free environment, controls testing which is a part of the audit process is also crucial to the business from many aspects. Audit is important for continuous improvement of the organization as well as to maintain find the gaps in the risks identified, controls designed, controls implemented, and controls functioning effectively.

Controls are a combination of people, process, and technology which are critical in a business process. Based on the level where the controls operate, there are the following types of controls:

- Entity level controls
- Transaction level controls

Based on the time (i.e., after which process it is taking place and not frequency) of operation in a business process, the controls are divided into the following:

- **Preventive controls:** Preventive controls are enforced to that risk may be prevented and before the fault has occurred. For example, changes must be approved before being migrated into the production server.
- **Detective controls:** Detective is applied in the middle of risk in order to restrict the full implication of the risk. It detects the fault in the process and provides a path to correct the same, e.g., review of user's roles or exception reports.

- **Reactive controls:** Reactive controls are applicable to the end of the lifecycle of the risk, i.e., after the effect of the risk has been realized. These controls try to lower the severity of the impact of the risk, e.g., cyber insurance [2].

**Opportunity for Automation** With the impact of automation, the idea is to convert most of the detective level controls to preventive controls, without human intervention.

A risk model fed into any system will give all the exceptions in the transactions or system configurations. This eliminates the necessity of most of the manual controls, IT-dependent controls, and IT general controls auditing. As auditing is critical, but after all a support to the central business in any organization, the idea of audit automation is well accepted everywhere. Till now, there are computer-aided auditing tools, which can consider only specific kinds of inputs, and mostly they are related to data analysis of general ledger, accounts, and transactions gave in DataTables format, and hence, extensive use of ETL (extraction, transformation, and loading) tools was required. But when the RPA tools came into force since the mid-2000s, the appropriate actions must be taken in order to eliminate human repetitions now, in 2020.

**Automating a Process Directly Affects the Controls Testing Cost**
As mentioned earlier in the introduction, automating a process ultimately reduces the corresponding audit cost by leaps and bounds. By auditing standards of the American Institute of Certified Public Accountants (AICPA), inspecting of a single transaction is enough for an end-to-end automated control. As an addition, a one-time configuration review of such a control is mandated to gain assurance over the accuracy of the transaction. But for manual controls, 10% of all the transactions (5 < =10% of transactions <=25) is considered to be the global standard for external audits.

The logic behind this is a machine (software, hardware) will perform numerous times the same way it performs even a single time. A machine cannot make a mistake, unless and until you make a mistake in building it. So, it is fine to test the configuration and one end-to-end transaction, i.e., control activity, for the testing. However, manual control is done manually by the people of the organization. They may use some tools, but the task is manual (e.g., checking, approving, reviewing, etc.). A human is bound to make a mistake(s). We can consider the following three things:

- Law of averages
  "The law of averages is the commonly held belief that a particular outcome or event will over certain periods of time occur at a frequency that is similar to its probability" [3].
- Murphy's law
  "Things will go wrong in any given situation if you give them a chance." Or "Whatever can go wrong, will go wrong" [4].
- Sociology researches

> Researches find that there is a positive and significant correlation between repetition and human error among workers. Repetition can cause workers to feel tired and indirectly cause them to lose their concentration while performing the same movements over a long period of time. In the end, this will most likely lead to the prevalence of human error [5].

From the law of averages, it can be ascertained that a human being will make a mistake after some time – one cannot be perfect 100% of the time. Even if the law of averages fails, Murphy's law indicates that if something has a chance to go wrong by even a very small percentage, it will go wrong sometime. And human repetitive tasks are endless. Multiple sociology researchers have discovered that repetitions cause errors in any transaction, be it a paper-based task or a hard work like that in the manufacturing industry.

Hence, it is clearly determined why human beings are prone to errors, and automation not only reduces the time in business but saves a human being from frustrations of repetition as well.

It is well established that the entire risk management cycle has the opportunity to be automated. Once the repetitions are automated, humans involved in the risk management sector can solely focus on the strategic side of it and involve themselves in enhancements of the process. In other words, operations of the risk management will be taken care of the automation program, while professionals will only do the "intelligence" part.

### *65.2.4 Emerging Technology Threat Control*

The emerging technologies threat control is one of the top concern areas for management all over the world. The sole reason is that the technologies are "emerging" and people hardly have the entire knowledge of the technologies – leave the threats from the same.

Nevertheless, the technologies using Artificial Intelligence contain and transfer one of the major risks. They can learn what a human can do. And that's exactly where the security concern is. Social engineering is quite an old concept now. AI-triggered social engineering is a new threat, where millions of people can be fooled by a web BOT, at a single time.

The management and decision-makers of IT strategists must closely examine the new technologies while, or before, they incorporate into the regular operations of their businesses or clients and understand the broader information security implications of a possible compromise. At the beginning, policymakers should explore the significant number of components that can somehow minimize the threats the emerging technologies inherently carry. Minimizing the exposure to these threats will ultimately mitigate the risks. For instance, using guidance agnostic adaptive data loss prevention strategies ensure that information is not compromised in the network via vulnerabilities of Internet of Things, whereas email and web security

applications of the next generation will definitely strengthen protections against data-borne attacks. The rising technologies will offer untold new opportunities to all the stakeholders. However, the point to remember is everything is not a bed of roses – opportunities will come only along with unforeseen threats. Therefore, a complete and accurate strategy for risk evaluation (if possible, by quantification) will be needed to protect both the internal and external stakeholders [6].

To prevent the level of threat, human training and awareness are not enough – even at the mass level. Because as has been stating multiple times, humans will do errors. In that context, we shall say:

Leave a machine to fight a machine.

## 65.3 State-of-the-Art Technologies in Automation

### *65.3.1 Artificial Intelligence*

**Background and Opportunities** The first Artificial Intelligence Program came into existence in 1955. The Logic Theorist, designed by Newell and Simon in 1955, may be considered the first AI program. Artificial Intelligence (AI) is the branch of technology, and more specifically computer science, in which a machine learns the intelligence of a human being from a set of inputs and performs the tasks, i.e., desired outputs, with various levels of accuracy. Probably the biggest thing to happen in the twenty-first century is AI. It is an extremely broad term that incorporates various branches like machine learning, deep learning, natural language processing, data science, robotics, and other fields. For risk management, although this is not the complete list, the following AI uses-cases are one of the most important ones:

- Policy review by text summarization.
- Policy generation by story generation of natural language processing.
- Policy transformation by natural language transformation.
- Automating threat feeding to threat intelligence in cybersecurity.
- Identifying of grey areas in financial ledgers.
- Identifying of patterns in fraud.
- Fake email detection.
- Autocorrect ion of firewall rules based on threat intelligence feeds.
- Auto incident management – automatic prioritization of incident/issues.
- Auto-addition of threat intelligence feeds in threat-vulnerability mapping list.
- Automatic suggestion of possible causes for a cyberattack.
- Automatic flowchart creation from business process text document.
- AI can be used extensively in financial corporation's risk management as it provides banks, nonbanking financial organizations, insurances, and credit unions with solutions to identify potential risks and fraud based on historical data [7].

- Risk management modeling by back-testing and model validation [7].
- Automated stress testing [7].

**The AI Market** The global Artificial Intelligence market will capture $94.01 billion by 2027, growing at a CAGR of 40.39% during the forecast period 2019–2027. It is so extensively used that recently in 2017 and 2018, biggest tech companies are providing AI as a service. Examples include the launch of "Google Cloud AutoML" and "Amazon AI" in 2017 and 2018, respectively.

### *65.3.2 Robotic Process Automation (RPA)*

**Background and Opportunities** Robotic Process Automation or RPA is nothing but a software robot. Meaning, it is a tool that articulates human behavior in a system. It automates a business process, which is manual and repetitive in nature. However, RPA has the power to integrate Artificial Intelligence and extensive data analytics and interact with the system exactly as a human does. In risk management, it has the power to entirely automate the controls testing, where a human performs a lot of repetitive tasks and plays with Word documents, spreadsheets, PDFs and images. Robotic Process Automation initially came into existence in the 1990s, several start-ups were formed in the 2000s, but it took the mid of the second decade of the twenty-first century to know that RPA can help the business. Fast identification of opportunities could have saved a lot of money and added greater value to the organizations. Organizations are building teams slowly, but a complete roadmap is yet to come. The following are important, but not all opportunities that RPA has the opportunity to take over:

- Automated mailing
- Automated reporting of various activities in all the stages of Risk management
- Scheduled running of various audit processes
- Specific template preparation and template population of
- Testing of various parameters of auditing from image/Word/PDF evidence and populating the template in spreadsheets form
- Testing of various parameters of auditing from image/Word/PDF evidence and populating the template in Word document form
- PDF markups based on various given conditions
- Faster audit reporting: Automated reporting to the management about the pending documents at a regular interval by regular comparison between the required list and uploaded list of evidence
- Data analysis

**RPA Market** As improving core business with RPA enables an organization to streamline IT and business operations, RPA growth has seen a tremendous positive trend. Per Grand View Research's "Robotic Process Automation (RPA) Market Size, Share & Trends Analysis Report," the global RPA market was valued at $

597.5 Mn as of 2018. It is expected to register a compound annual growth rate (CAGR) of 31.1% over the forecast period of 2019–2025 [8]. Global support centers of various businesses which are typically set up in countries with a lower labor cost in order to support the main business with lower input costs. They have a huge possibility for automation. RPA is so disrupting that the biggest of the technology giants are bringing in their products in this segment. Microsoft decided to enter the market with its new products, which experts think may be a strong contender for the top-3. SAP has acquired RPA vendor Contextor recently as well [9]. However, the RPA service category is much more than the product category indicating the gap between product and the end users. As of 2020, the top three players for RPA are UiPath, Blue Prism, and Automation Anywhere. However, UiPath and NTT-AT have registered an insane 629.5% and 480.9% growth respectively in their 2018 revenue. All of them are RPA product companies and provide only specific functional support [10].

## 65.4 Blockchain

**Background and Opportunities** In simple terms, blockchain is a chain of blocks where the data of each participating member has stored over the chains and a distributed technology is maintained. The advantage is that no data can be altered in the blockchain – altering a single block without altering previous blocks of the chain is impossible. The reason being that each block contains a cryptographic hash of the previous block, a timestamp, and transaction data. By design, a blockchain is resistant to modification of the data [11]. Hence, blockchain has gained popularity over the years but not at the globally huge level until the last 5 years. Financial and tech firms invested an estimated $1.4 billion dollars in blockchain in 2016 with an increase to $2.1 billion dollars in 2018. With the rise of various blockchain-based applications, automation is required to gain assurance over the systems and business processes. As smart contracts and cryptocurrency become more and more useful at the organization level, managing their risk is becoming a primary concern. Some of the use-cases of blockchain are described below:

- Automating of authentication mechanisms is the main benefit from blockchain.
- Establishing an appropriate generic anchoring methodology in blockchain helps to establish proper authentication mechanisms in the blockchain.
- Testing solely the configuration of the generic anchoring can sustainably assure the blockchain's functions automatically.
- The use of blockchain in regular authentication mechanisms can lower down the cost and time of risk management, besides lowering risks.
- The use of blockchain is smart contracts which will eliminate the tasks of repetitive auditing for each of the contract papers.

- Building secured healthcare, automated logistic mechanisms, financial systems, and others which can significantly lower the process costs and the corresponding risk management.

**The Economics of Blockchain: Financial Considerations** In the development of a suitable roadmap of using blockchain for more automation, it is extremely important to take in the economic factor of blockchains. The two major costs are described as follows:

- The expense for verification: This cost refers to the ability to efficiently check the transaction's features.
- Networking cost: Opportunity to bootstrap and run a business without the need for a conventional intermediary.

Paired with a native token, a blockchain allows a decentralized network of economic agents to decide on the true state of shared data at regular intervals. This decentralized data can reflect shares of money, intellectual property, securities, information, or any other types of contracts and digital assets, making blockchain a general-purpose technology that can be used to transfer limited, digital property rights and create new types of digital platforms. Marks coming out as a result of this are characterized by competitive pressures, lower entry, and, of course, innovation barriers. However, they have a lower risk of privacy and censorship and encourage participants within the same community to invest in supporting and running shared infrastructure without allocating market power to a platform operator. The accumulated incumbent knowledge and resources create opportunities for new approaches to fundraising start-ups, protocols for public goods and applications, data ownership and licensing auctions, and credibility systems [12].

## 65.5 Economics of Risk

**The Market** When we say about the technicalities of risk management, it is also important to know why it should get a place for priority in this ever-changing world. While Source Global Research (UK) estimated the global risk consulting market to be valued a huge $80 Ban by the end of 2020, the current market has already crossed $70 Bn. There has been a growth of $30 Ban in the past 5 – credits for which is given to the current economic and political landscapes.

With new regulations coming regularly, increasing cyber threats, disputes over international trade, and the uncertainty of Brexit, organizations are continuously seeking the appropriate expertise and guidance for understanding the risk landscape in order to protect themselves from potential damage which may lead to a financial and reputational loss [13].

**Management Concerns and Innovations** PwC's annual CEO survey revealed that the top threats concerning them are overregulation, political tension, skill and manpower retention, threats from cybersecurity, and global as well as regional

conflict of trade interests. Additionally, the conflict between the USA and Iran has given rise to a potential war condition, and the corresponding sanctions create possibilities of new threats.

A rapidly growing part of risk management is harnessing innovation and developing the use of technology. While Robotic Process Automation, cloud technologies, Artificial Intelligence, blockchain, data science, and Internet of Things offer operational advancements, greater accuracy, cost-cutting, and efficiencies, they are bound to escalate the information security risks while creating disruption. With a projected $15 Ban market, cybersecurity is the biggest risk management service [13].

### *65.5.1 Risk Economics*

Risk has been a key factor in business for a long. This is a field where finance, economics, legal, and engineers work hand in hand to run an organization. According to the "Global Risk Management Survey," tenth edition by Deloitte, although many companies seek to improve their risk management activities around the world, this survey reveals that leaders concentrate on the regulatory implications of current global trends and question what is to come next. The survey was done on the financial sector only and was focused on the risk management positions to understand the best scenario. The conclusions are based on responses from 77 financial institutions from around the globe, including various financial services industries, reflecting an aggregate asset amount of $13.6 trillion [14].

To see the future, over 78% of financial institutions responded that "Enhancing information systems and technology infrastructure" is going to be the priority for the organization in risk management. 70% responded that "Attracting and retaining risk management professionals with required skills" are their priority; 61% responded that "Identifying and managing new and emerging risks is their top priority" [14].

Automation is a one-stop solution to all these priorities. Enhancing technology directly relates to automation; the need for attracting professionals will now require a lesser cost. The best people can be hired now with bigger packages since the basic tasks of risk management will be taken care of by the automation programs and BOTs. On average, the average no. of risk management professionals in an internal audit or cybersecurity department in a firm can be brought down from 5 to 2 (considering the firm size is 10,000 people). Identifying and managing risks would be easier, as you already have the existing risks in your program. Also, the program will help you identify the new risks as well.

It can be stated that automation has the potential to drive the priorities of the organization heavily and proper opportunity areas should be identified to gain the maximum benefit. Besides these, the key stakeholder in the risk business is the consulting firms who serve almost all the fields of risk management starting from risk assessment to auditing. Technology firms would also benefit from the

development of applications that will, ultimately, provide automation. Further research is expected to get the exact value of the market.

### *65.5.2 Risk Financing*

At a certain stage, it becomes infeasible to take more risk control measures. For instance, a company owner is forced to use the hazardous chemicals but has taken necessary safety precautions within the business in compliance with regulatory requirements and methodologies; nothing can really be done to avoid risk other than closing down the business. Risk funding is, therefore, a suitable risk management instrument. It can be a reserved capital taken away from the budget or, if possible, buying insurance to help the company recover from a potential loss [15].

## 65.6 Conclusion

The study leads to an extraordinary conclusion that using state-of-the-art technologies in traditional business tasks, almost 60% of the overall tasks and 75% of the repetitive tasks can be automated at present. Risk management is a great place to focus, as the area has got a lot of repetitive tasks. But the focus should be more on generating collaborative efforts from government, academics, and the private sector. The collaboration of traditional technologies with emerging technologies gives the maximum benefit. Starting with a few pilot projects in any of the sectors is recommended. Usage of RPA, Artificial Intelligence, blockchain, and IoT should be promoted in all the fields, even on a testing basis to assess the issues and prepare for the best. In order to get the fruit of automation technologies, employees should also upskill themselves to be updated. However, mass-scale upskilling might be a loss of revenue at the moment, and the responsibility of targeted upskilling ideally is a vision of the management. It is determined that suitable arrangements for automation have a very bright prospect where the people are bound to think for innovations instead of repetitiveness – not only in risk management but in all the business processes.

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# Chapter 66
# Imputing Block of Missing Data Using Deep Autoencoder


**Shyam Krishna Khadka and Subarna Shakya**

## 66.1 Introduction

The problem of missing data exists almost everywhere like in the field of biology, medicine, wireless sensor networks, and recommendation systems. The sources of the missing day may be different such as equipment malfunctions, refusal of respondents to answer certain questions, node failures, environmental conditions, etc. depending on the application fields.

Imputation is a statistical term that denotes the procedure of finding values for missing data items. Some of the common naive approaches of imputation are ignoring missing values, mean/median substitution, hot/cold deck, regression, and interpolation. All of these methods are not perfectly able to extract the complex structure and interrelationship among variables of the data. On the other hand, neural network or particularly deep autoencoders are very good in finding the complex structure and correlation in the data. Further in most of the literature, the missing value patterns are explained as falling into these categories: missing completely at random (MCAR), missing at random (MAR), and not missing at random (NMAR) [1].

But there exist other types of missing values also which are not mentioned in most of the existing literature: block of missing values. For example in wireless sensor data, a sensor node is unable to measure its readings for a certain interval of time. The missing pattern is shown in Fig. 66.1 where there is a large dataset of n dimensions, and values m. Here large dataset of n dimensions, and values m. For some portion of the dataset, $d_3$ to $d_n$ variables values are missing, while for other

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https://doi.org/10.1007/978-3-030-49795-8_66

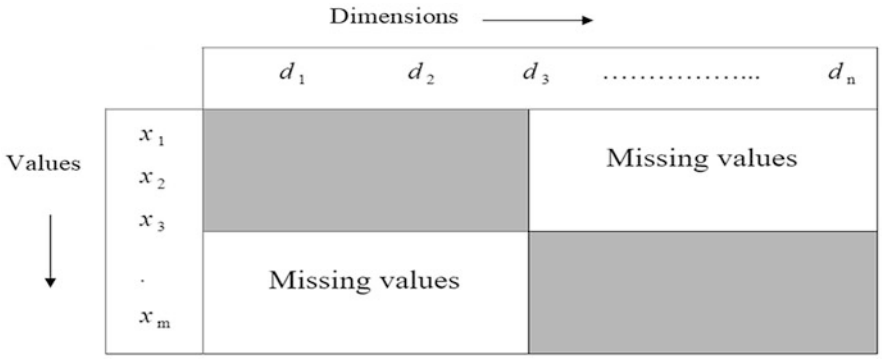


**Fig. 66.1** Missing data pattern

dataset $d_1$ to $d_3$ variables are missing. This paper focuses on solving such a problem of a block of missing value by using the deep autoencoder model.

## 66.2 Related Work

The papers [2, 3] propose imputation methods based on the k-nearest neighbor algorithm. The first paper has shown that their method outperforms the internal methods used by C4.5 and CN2 to treat missing data [2]. However, the main drawback of KNN-based approach is it searches through all the data set to look for the most similar instances. It can be computationally expensive for large datasets. The paper [4] has also used KNN-based algorithm for the imputation of DNA microarrays data. The performance is compared using the RMSE method with the row average method.

Six different imputation algorithms are compared in paper [5] using RMSE as evaluation criteria. The number of samples compared in this paper is very less (maximum100). In this paper, a neural network-based imputation method that can work even for a large number of samples is proposed.

Wong in his paper suggests the imputation using a sparse autoencoder where sparsity constraint is used on the hidden layer of the autoencoder to know about the interesting structure in the data [5]. The proposed model in this paper gets rid of computing sparsity constraints in a neural network. The paper [6] combines a deep learning approach followed by a swarm intelligence approach for imputation where deep learning is used for feature extraction and as a part of the objective function to be optimized by swarm intelligence. Unsupervised backpropagation technique is used which may be viewed as a non-linear generalization of matrix factorization in paper [7]. It assumes that there are complete data in some rows and can't solve the problem when there is not any complete data row. The paper [8] proposes a tracking-removed autoencoder where the input structure of the traditionally hidden

neurons is redesigned in a dynamic way. It imputes the randomly missing data only. In paper [9], the autoencoder is trained with the data having no missing values for missing values prediction. The paper [10] proposes a theoretical model for missing data imputation where probability density function is used for neuron's response in the first hidden layer.

The paper [11] uses matrix factorization (MF) technique that competed in the Netflix competition. But this method is not suitable for the data exhibiting non-linearity.

## 66.3 Methodology

### *66.3.1 Deep Autoencoder*

A deep neural network (DNN) consists of multiple hidden layers in between input and output layers. DNNs can model complex non-linear relationships among data [12]. An autoencoder is a neural network model that learns to give exact output $x'$ as that of input $x$. In this paper, deep autoencoder, consisting of multiple hidden layers, is used. The interesting structure about the data can be found in deep autoencoder by placing constraints on the network [13]. Here in this paper, the constraint is placed by placing less number of neurons in hidden layers (Fig. 66.2).

For imputation purposes, the general deep autoencoder model is modified. The forward process is the same as other neural networks. But caution is made during a backward propagation step. During backpropagation, only the outputs of non-missing values are used for gradient calculation. The missing input values are neglected. Some of the concepts are similar to the dropout [14] concept introduced

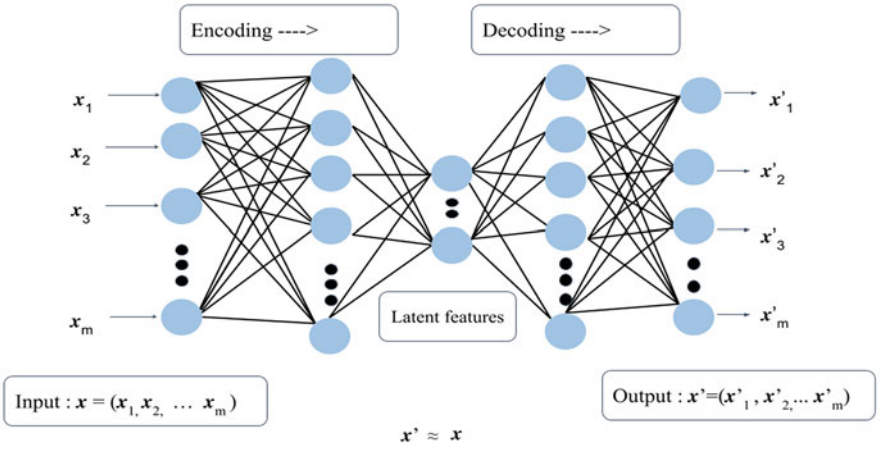


**Fig. 66.2** Deep autoencoder

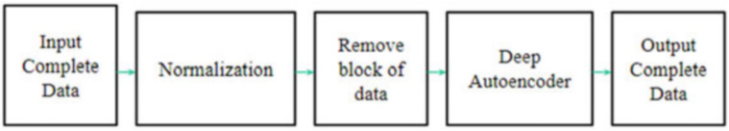


**Fig. 66.3** System block diagram

by N. Srivastava, G. Hinton, and his team. Here, the connections between neurons are manually dropout to reduce overfitting. In this paper, the contribution of missing value inputs is made to be zero during backpropagation. The system block diagram is shown in Fig. 66.3:

### *66.3.2 Algorithm*

**Algorithm** : Deep autoencoder training method for missing data imputation, with $m$ number of samples

1: **for** number of training iterations **do**
2: **for** each input $x$ with incomplete data **do**
3: Feed-forward pass to compute activations at all hidden layers, then at the output layer to obtain an output $x'$
4: Measure the deviation of the input $x'$ from input $x$ as loss function
5: Back propagate this loss function value to update weights such that only the output of non missing values is taken into consideration
6: So the loss function to be optimized is

$$loss = \frac{1}{m}\sum_{i=1}^{m}\sum_{j=1}^{n}(x_j^{(i)} - x_j'^{(i)})k_j^{(i)}(x_j^{(i)} - x_j'^{(i)})$$

7: **end for**
8: **end for**
9: **result** = Final layer output

The various parameters of the loss function mentioned in above equation are as below:

$m$ : Number of input samples
$n$ : Number of variables
$x$ : Input missing data, matrix of size $m \times n$
$x^{'}$ : output of autoencoder
$k$ : indicator matrix.
$k_i$ = 1 if $x_i$ = 1 i.e no missing value
$k_i$ = 0 if $x_i$ = 0 i.e missing value

## 66.4 Result and Discussion

### *66.4.1 Dataset: Synthetic Dataset Generated by Multivariate Gaussian Distribution*

The algorithm used for generating multivariate Gaussian distribution is based on the book [15]. In the multivariate Gaussian distribution dataset of 20,000 samples, 6 variables were generated. It was then normalized within the range of 0 to 1, before feeding into neural network.

The various experiments, with different block of missing values, carried for this samples using learning rate 0.00005, minibatch size: 1000, activation function sigmoid are shown in Table 66.1:

### *66.4.2 Dataset: Abalone Dataset*

The abalone data, which is available at UCI machine learning repository [15], consists of the physical measurements of abalones, which are large, edible sea snails. It contains nominal, continuous, and integer data types. This dataset contains nine attributes about the fish which are sex, length, diameter, height, whole weight, shucked weight, viscera weight, shell weight, and rings. Here, the abalone dataset without attributes sex and rings (having nominal and integer attributes) is taken. Then shell weight variable is manually removed to perform imputation. The number of samples used in this dataset was 4177. It was then normalized within the range of 0 to 1, before feeding into neural network. The various experiments, with different block of missing values, carried for this samples using learning rate 0.00005, minibatch size: 200, activation function sigmoid are shown in Table 66.2:

**Table 66.1** Different block of missing values and corresponding loss function values for multivariate Gaussian samples

| Variables missing | Network size | Epochs | Loss |
|---|---|---|---|
| Variable 6 for first half, variable l for another block | [18, 2, 18] | 10,000 | 0.0002875 |
| Variable 6 for first half, variable 1 for another block | [18, 2, 18] | 20,000 | **0.000124** |
| Variable 5, 6 for first half, variable 1, 2 for another block | [18, 2, 18] | 20,000 | **0.0001718** |
| Variable 5, 6, 4 for first half, variable 1, 2, 3 for another block | [18, 2, 18] | 20,000 | **0.0000607** |

**Table 66.2** Different block of missing values and corresponding loss function values for abalone dataset

| Variables missing | Network size | Epochs | Loss |
|---|---|---|---|
| Variable 7 for first half, variable l for another block | [21, 3, 21] | 20,000 | **0.00002977** |

### 66.4.3 Dataset: Wireless Sensor Nodes Dataset

The dataset taken was FORTH-TRACE Dataset version 1.0, available in https://github.com/karayan/FORTH_ which was created in the paper [16] related with feature selection for human activity recognition. The data was collected from 5 Shimmer sensor nodes placed in different body parts (left/right wrist, torso, right thigh, left ankle) of the 15 participants. Then the participants were told to perform a series of 16 activities.

The captured signals are the following: 3-axis accelerometer, 3-axis gyroscope, and 3-axis magnetometer.

Out of the 12 columns of csv file of the FORTH-TRACE Dataset version 1.0, 9 columns were chosen which are accelerometer x, accelerometer y, accelerometer z, gyroscope x, gyroscope y, gyroscope z, magnetometer x, magnetometer y, and magnetometer z.

The experiment was conducted taking into consideration of measurement of only one participant: part0. So, five csv files that correspond to five different devices were chosen: part0dev1.csv, part0dev2.csv, part0dev3.csv, part0dev4.csv, and part0dev5.csv. The measurements were taken from time 1800 to 1,001,800 ms, for all the five devices (five files) in the interval of 100 ms. Here, only accelerometer readings (x, y, z) are taken into consideration. Then there exists a complete dataset. Now in order to make missing values, device 1 was assumed to be down for certain time block and device 5 for another time block. This results in missing values for accelerometer reading (x, y, z) for device 5 for certain time (first half of dataset) and accelerometer readings (x, y, z) for device 1 for another half. After this, data is normalized in the range of 0 to 1, before feeding to neural network.

The missing pattern looks like shown in Fig. 66.4. Here, only the first participant (part0) and accelerometer readings are taken under consideration.

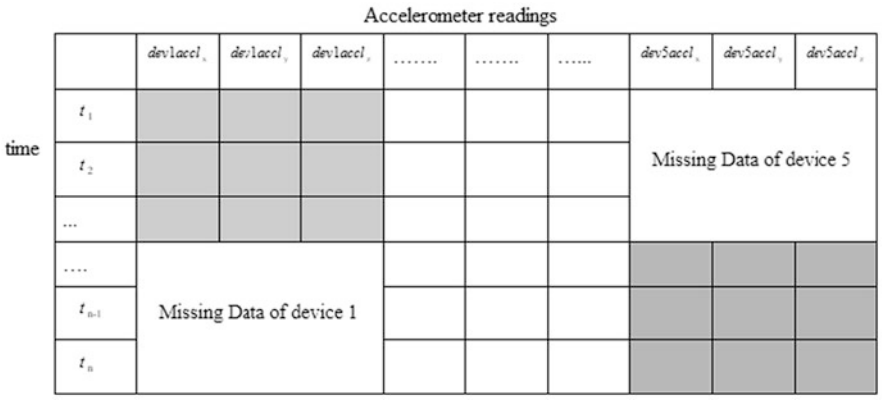


**Fig. 66.4** Missing value pattern for wireless sensor nodes

## 66.5 Performance Comparison

### *66.5.1 Mean Imputation*

Here, the missing value of a variable is imputed by the mean of the same variable in other available data rows. For example, if variable 6 is missing for first block of data, then it is replaced with mean value of remaining complete data. But this method is very sensitive in case of presence of outliers in data.

### *66.5.2 KNN-Based Imputation*

In this method, imputation is performed by finding the "k" closest neighbors to the observation with missing data and then imputing them based on the non-missing values in the neighbors. Here "k" refers to the number of neighbors to look for. Using weighted mean seems to be used most commonly. For similarity measure, Euclidean distance is used. Euclidean distance is often somehow sensitive to outliers. The implementation is based on the paper [4].

### *66.5.3 Result Analysis of Multivariate Gaussian Distribution Samples*

It is seen that up to 33% of missing data; imputation performed by the developed deep autoencoder model is better than mean imputation method. Here the value of "k" used for KNN is 3 which is the optimal value obtained after several experiments. If there is around 50% and more missing data, none of the method autoencoder (AE) and KNN are able to achieve better result. In that case, mean imputation performs the best. In fact, 50% missing is very big value. Here, none of the existing imputation algorithms work. So the mean imputation is the last option for it (Table 66.3).

**Table 66.3** Performance comparison of deep autoencoder model and mean imputation using RMSE for multivariate Gaussian distribution samples

| Variables missing | Data missing | RMSE autoencoder (AE) | RMSE mean | RMSE KNN | Best? |
|---|---|---|---|---|---|
| 2 variables missing | 16.67% | **0.0240247** | 0.0556529 | 0.2912425 | AE |
| 4 variables missing | 33.33% | **0.0239566** | 0.0268617 | 0.0278027 | AE |
| 6 variables missing | 50% | 0.1946794 | **0.0347063** | 0.5260027 | Mean |

**Table 66.4** Performance comparison of deep autoencoder model with mean imputation and KNN-based imputation using RMSE for abalone dataset

| Variables missing | Data missing | RMSE autoencoder (AE) | RMSE mean | RMSE KNN | Best? |
|---|---|---|---|---|---|
| 2 variables missing | 14.29% | **0.00808092** | 0.0458544 | 0.0098570 | AE |
| 4 variables missing | 28.58% | 0.0211232 | 0.0412985 | **0.0095294** | KNN |

**Table 66.5** Performance comparison of deep autoencoder model with mean imputation and KNN-based imputation using RMSE for wireless sensor nodes dataset

| Variables missing | Data missing | RMSE autoencoder (AE) | RMSE mean | RMSE KNN | Best? |
|---|---|---|---|---|---|
| 6 variables missing | 20% | 0.04537 | **0.0502190** | 0.1225202 | Mean |

### *66.5.4 Result Analysis of Abalone Dataset*

The number of data samples present in abalone dataset is 4177. The Table 66.4 below shows the comparative results.

Here number of neighbors "k" used is 100 which is the optimal value chosen after running several experiments varying its values of k from 1 to 200. It is interesting to see that RMSE value for KNN and AE is nearly equal. But for 4 variables missing case, KNN is the best method. The reason of this is because of the less number of data samples; deep autoencoder may not be performing better in case of large portion of data missing.

### *66.5.5 Result Analysis of Wireless Sensor Nodes Dataset*

The number of data samples present in wireless dataset is 9982. The Table 66.5 below shows the comparative results. The optimal value of "k" for KNN algorithms found is 1000.

It is seen that the mean imputation performed better. The reason that deep autoencoder performed not well in this case might be because of the less number of samples. Another reason might be because of weak correlation among variables, which can be visualized from the scatter plot diagram shown in Fig. 66.8.

### *66.5.6 Visualizing Imputation Result Using Scatter Plot Diagrams*

The scatter plot of imputed variables (x-axis) vs original non-missing data (y-axis) is drawn to verify the result. The scatter plot diagram of original and imputed data samples for the case where 2 variables are missing is shown below (Figs. 66.5, 66.6, and 66.7).

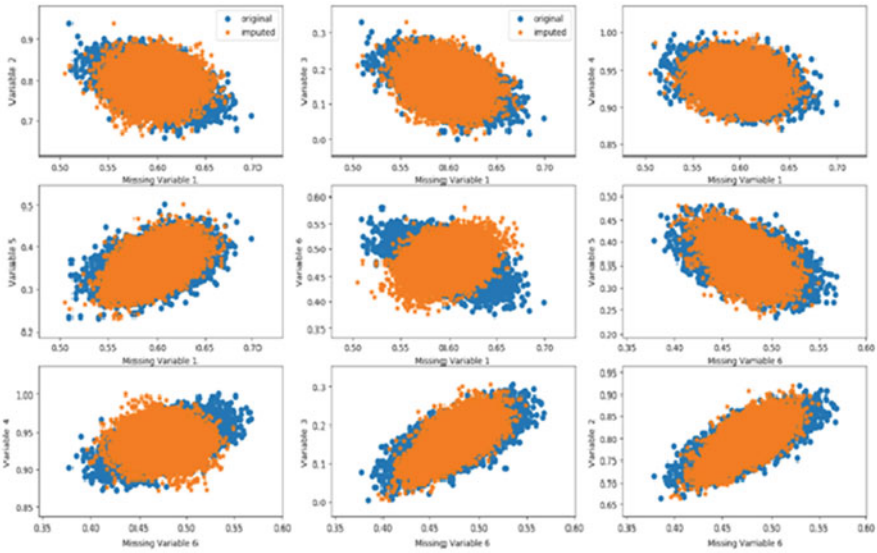


**Fig. 66.5** Scatter plot for deep autoencoder-based imputation method (2 variables missing) for multivariate Gaussian samples

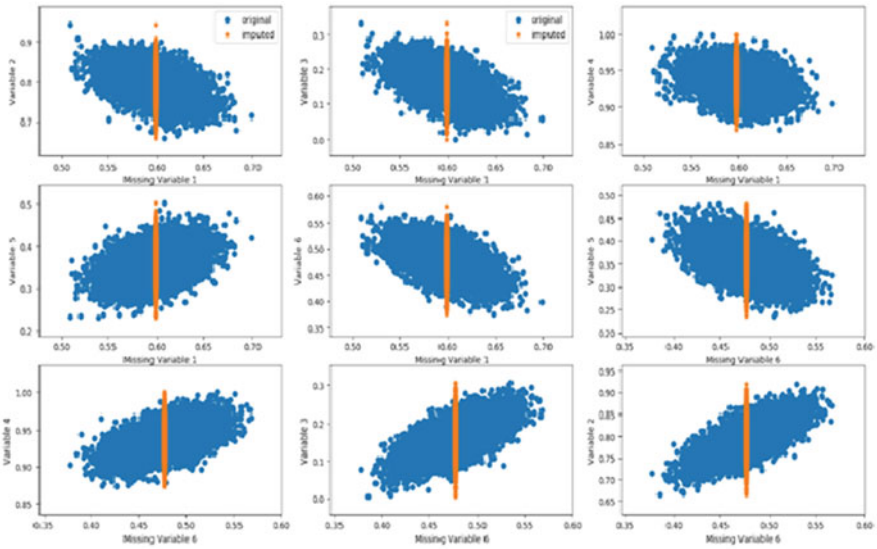


**Fig. 66.6** Scatter plot for mean imputation method (2 variables missing) for multivariate Gaussian samples

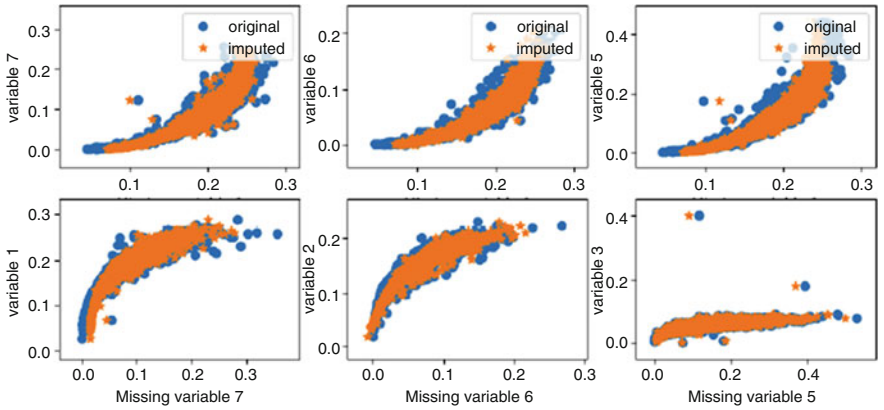


**Fig. 66.7** Scatter plot for deep autoencoder-based imputation method (2 variables missing) for abalone dataset

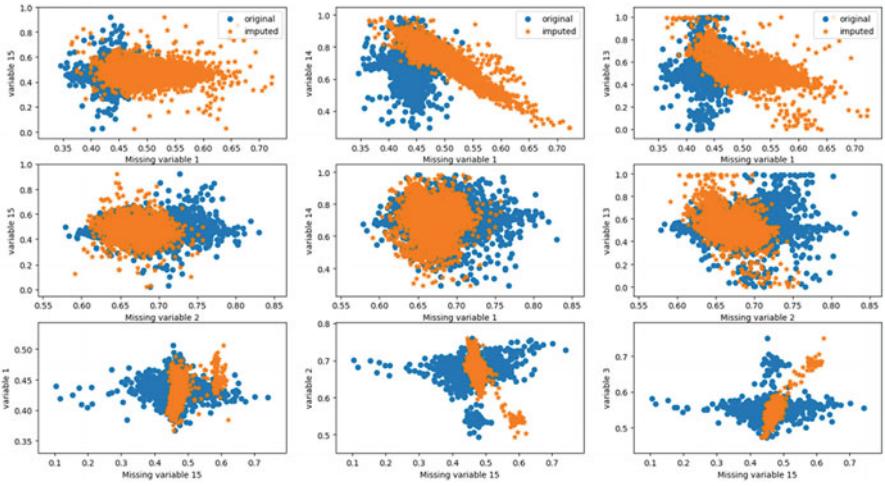


**Fig. 66.8** Scatter plot for deep autoencoder-based imputation for wireless sensor nodes dataset (6 variables missing)

## 66.6 Conclusion

This paper introduced a novel approach of imputing missing data using deep autoencoder. Here the autoencoder is able to learn even without complete data. The deep autoencoder architecture is designed in a way that initially the input data is taken into higher dimensional subspace. Then it is compressed into lower dimensional subspace. This process is reverse backed in decoding layer of the model. Accordingly, the number of neurons in first hidden layer is almost thrice the size of input variables which is reduced by almost half the size of input

variable in second hidden layer. The same number of neurons architecture is reverse backed in decoding layer. Here, the contribution of missing data is ignored during backpropagation.

Using RMSE as evaluation criteria, it is found that the developed deep autoencoder model is pretty much able to learn the structure of input data. Its performance is better specifically for the dataset having strong correlation among variables and having large number of samples. This can be justified as the imputation result is better for multivariate Gaussian distribution samples than abalone and wireless sensor datasets. The distribution of imputed data is qualitatively closer to the input complete data as seen from scatter plot diagrams.

**Compliance with Ethical Standards**
All author states that there is no conflict of interest.
We used our own data.

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# Chapter 67
# Big Data Analytics: Tools, Challenges, and Scope in Data-Driven Computing


**C. Vijesh Joe, Jennifer S. Raj, and S. Smys**

## 67.1 Introduction

Every day the data produced around the world make the digital world to stun. Researchers say around 2.5 quintillion bytes of data have generated per day. In 2020, it is estimated that 17 Mb data will be generated per second around the world. Every object is digitalized in this digital era. Because of this problem, our storage devices are making alarming. Data servers, servers, and data centers are looking for a new aspect to find a solution to this problem nearby.

Each data generated from each source is valuable information to someone. Along with the Internet of Things, cloud computing, big data, etc. make much more complex to the current situation. Even if we find a solution to the storage, then processing of those data becomes our next problem. Our traditional architectural mechanism won't suit for the current situation. For example, if we give 1000 files of data which sizes various from 1 to 5 MB with a cumulative of around 3 GB will take a processing time of 10 min. At the same time if we give a single file of size 3 GB, processor feels the difficulty to process it and takes around 15–20 min for processing. So, here the big data problem arises.

Similarly, we are facing challenges in developing efficient algorithms, tool, and architectures which suit for modern days. Researchers still facing problems in providing security issues, Data Duplication problems, storages even visualizing

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the processed data. Data analytics plays a vital role in this century by converting logs into money. They will analyze the logs of individual users and based on that, they will develop their marketing strategy. It is known as Business Intelligence or Business Analytics. Many companies are investing in data analytics firms and hiring a large number of data analysts and data scientists to process them. Also, clients are expecting live data analysis. The data should be analyzed before storing it into the database then after querying the database after storing it into them. In this paper, we will discuss in detail more about data science in the aspects of data generation to visualization, their challengers, and the new technologies emerging based on data analytics.

The organization of the paper is given below.

- Section 67.2 – Computer Science vs Data Science
- Section 67.3 – Stages in Big Data Analytics
- Section 67.4 – Challenges in Data Science
- Section 67.5 – Tools in Big Data Analytics
- Section 67.6 – Researches in Big Data Analytics
- Section 67.7 – Future Work

## 67.2 Computer Science vs Data Science

Computer science is the traditional way of studying the process of how the computer works like storing data, networking, design, hardware, and similar technological aspects. One who masters in them is termed as computer engineers in general. But data science is completely different. In data science people will only study or work with the data. As we know the data can be mainly classified into three types like structured, semi-structured, and unstructured data. A lot of work can be done over these types of data to extract valuable information from them [1]. Similarly, data mining, storing, conversion, fusing, and cleansing like many operations can be done. These work processes are studied though data science, and people working over it are termed as a data analyst or data scientist. Like computer science, data science has its own programming, scripting, database, and networking tools. The major reason for this is the large size of the data which are generated nowadays in this digital era as big data. Comparatively more researchers are going in the data science area to provide better efficiency in data storing and processing in upcoming days. Computer science mainly focuses on technological growth, whereas data science mainly focuses on managing the data. The main problem where users face in computer science is speed and performance. But in data science, users mainly face the problem in data redundancy and file size.

## 67.3 Stages in Big Data Analytics

In big data analytics, the data are processed through various stages. From the source point where data is generated and to interpretation state where the user can make a decision based on the information which is obtained from the data [2]. Let us see in detail, about these various stages.

67.3.1 Data Acquisition
67.3.2 Data Extraction
67.3.3 Data Collation
67.3.4 Data Structuring
67.3.5 Data Visualization
67.3.6 Data Interpretation

The flow chart mentioned below, in Fig. 67.1, clearly states the various level of data flow from source to the user.

### *67.3.1 Data Acquisition*

The process starts with collecting or acquiring the data from different sources. Due to the recent growth in technologies, the growth of data is exponentially increasing. Most of the peoples are using smart devices like Smart Phone, Smart TV, PDA devices, etc. After merging with the Internet of Things (IoT), almost all devices are now generating the data. Most of these details in the data are in an unstructural or semi-structural format. But we can't ignore them. Each data gives some valuable information to someone. These structural data can be directly obtained through any form of databases like cloud databases. So, the acquisition of different sources is first a tremendous process for the user.

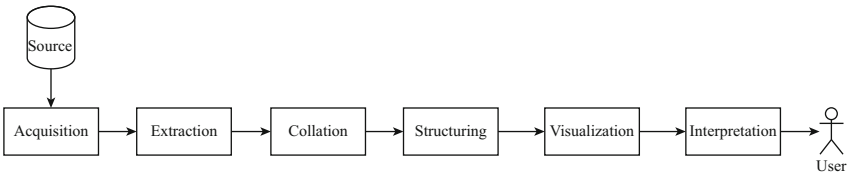


**Fig. 67.1** Various level of stages in data processing

### 67.3.2 Data Extraction

After acquiring the data, the main challenges of extracting the valuable source from it begin. All the data generated from various sources will not provide 100% values. So, the extraction process depends on the user. What should be extracted should be predefined by the user. If data is in structural form, it's easy to query and get the data. If the data is in semi-structural or unstructural means either we have to preprocess the data by converting it into the structural form or we have to use any NoSQL databases and should be extracted directly. Since the last decade, all the data will be processed after storing in some sort of databases, but nowadays live streaming data analysis techniques are used which help the user to extract the data before it reaching or getting stored in the databases. Various classification, various clustering algorithms, and, for model building, various classifiers are used.

### 67.3.3 Data Collation

Data collation is very important in order to trust or validate the data which we have extracted. We can't decide the accuracy of the data which we have obtained from a single source. Because there may be technical fault, data loss, and interpretation problems, anything can happen. So always it's preferable to collect the data from various source points, and processing them under the same platform will give reliable results. For example, we can't predict the weather of a location just by getting the temperature or humidity of that place. We should compare with previous weather reports over that place for that season, satellite images, neighborhood weather conditions, humidity, temperature, and the moisture of the place under continuous observation. On analyzing all the details from various sources, we can predict the result with better accuracy.

### 67.3.4 Data Structuring

Data structuring provides the extracted and collated details into a specific shape by organizing them in a structural format. So, the user can easily query the database based on their requirement. Even nowadays NoSQL databases are used. In there, data are not in structural format, but the querying tool provides the user to process the unstructural data by extracting the information precisely. But in a tradition, we have organized the data into the database by defining the schema and extract the information by querying the database.

### *67.3.5 Data Visualization*

In general, when the user queries the data, it will represent in the console or with a command line interface with no proper dimensions. So it's hard for the user to analyze it. Data visualization techniques help the user to view the output in a multi-dimensional view. With the help of graphical user interface (GUI), the output can be visualized in front of the user. Even some visualization tools are made with interactive screens. So even a non-technical person can able to query the system. It helps the user to eradicate the time by restructuring the details again.

### *67.3.6 Data Interpretation*

The final stage is data interpretation, where all the data which we acquired, extracted, collated, structured, and visualized will provide the information to the user in an analytical way. The user can decide whether he can conclude based on the report or he can predict the future scope using the report.

## 67.4 Challenges in Data Science

In data science lots of challenges are faced today. It is due to the rapid growth of technology in this area. There is no stability. Researchers and programmers are developing new languages and databases frequently and providing the customers as an open-source so that it can be customized to multi-level users [3]. Some of the challenges frequently faced are in security of data, storage issues of large size data, extracting valuable information from the stored data, and visualizing the extracted data.

### *67.4.1 Security*

Security for the data is a big concern for lots of years. We are unable to ensure complete security of any data in computer science or in data science. The major reason for this is hackers are evolved with their own technology and attack users with various types of attacks. In data science a huge volume of data is processed in various states like mining, correlating, structuring, and visualizing [4]. So preventing the information in the data during all the processes carried out before visualizing is practically not feasible. Data science doesn't have any specific security mechanism or algorithm. They follow the usual networking and data mining security process like encryption, hashing, authentication, and authorization. Providing live

data security for streaming data is a nightmare for security providers. Still, they are lacking it. Researchers are working on providing exclusive security for big data by developing new data policies and prevention mechanisms.

### *67.4.2 Storage*

Even technology was grown providing the storage need is not satisfied. From data centers to our mobile storage, we are facing the storage problem. It is due to the sudden rise of data production through IoT and the size of those big data. Whether the data is any kind of format providing them in a space in the database is a big problem. Because processing unstructured or semi-structured data into structured data costs more space. We are deleting the archives in order to maintain the rhythm. It is not a good sign because maintaining those logs in data can give vital information for decades [5]. Even if we dump all the data into the server without organizing properly may cause input and output speed problem for the machine which ends in data loss, data corruption, and data redundancy. Nowadays we are using SSD instead of HDD to avoid the latency delay. But storage space is not satisfied. Developers provide a new solution by overcoming from our traditional data storage and processing mechanism to a new level. Some of them are like maintaining data in the Hadoop environment where map-reduce maintaining the compression process and store large size data into a storage medium as, many clusters. It is a distributed storage mechanism that gives temporary relief for storage issues. Because we can handle semi-structured and unstructured data using its own query language, new frameworks are suggested frequently to overcome this issue. But none of them provide long-term solutions till now.

### *67.4.3 Data Duplication*

Data duplication is a new challenge in this digital era. Until millennium no one seriously cares about this data duplication or data replication. But now everyone is thinking about these issues almost every day. Even in our PDAs or mobile, no one likes the same data in multiple copies because it will kill our storage unnecessarily. Nowadays, due to the lack in these storage facilities because of the rapid growth of data, all are looking seriously into this problem. Most of the data deduplication techniques involves in metadata identification only, which identifies around 25%–50% of replicated data [6]. Even sometimes it mistakenly identifies the genuine file due to mismatched attributes. So the hash level mechanism is done in servers in data centers, which will give a temporary solution for low accuracy.

### *67.4.4 Extracting Information*

Extracting valuable information from the data is a big challenge. Because we all know that each data has some value and whether it is useful or not is dependent upon the user. But in Big data, the file size varies from Gb to Pb. Those large-sized data are not even in structural format [7]. So we have to process the data and convert them into a structural format, and we have to retrieve the data from it. As we said it is not possible in a single step. The problem starts from acquiring of data from source to cleaning, converting, processing, extracting, and finally visualizing in user required format. Lots of tools and a conditional environment are required to make it out.

### *67.4.5 Visualization*

After processing the junk data into valuable information using the analytics tools, plotting or giving the extracted information in an interactive way with graphical representation is very important. Our final stage of implementation of the tediously processed work responds to how it represents the common man with no technical knowledge. Normally graphs and charts are used for summary [8]. But using data analytics interactive behavior is introduced, so that we can query and process the given data for our own requirement basis. Visualization is a challenging process because each user came to access the data in different mindsets, so that the machine should be in an adaptive state to process their request. For that machine learning and Artificial Intelligence, techniques play a major role in it. More than in traditional 2D or 3D view, users are expecting to view the information extracted from the data from a multi-dimensional view for better clarity. So, it is a big challenge to develop information in these adaptive types of models in visualization.

## 67.5 Tools in Big Data Analytics

Moving from the traditional computer science mechanism, data science has its own specific tools to handle big data, even providing the storage space in an efficient manner by utilizing each bit in the cluster. Moreover, for analyzing and processing, we are having a huge number of tools [9]. Some of the tools used in various kind of process, and their corresponding application names are mentioned below in Table 67.1.

**Table 67.1** Tools used in data analytics for big data

| Process | Applications | | | |
|---|---|---|---|---|
| **Data analysis** | R | Python | SAS | Stringer |
| **Data migration/integration** | Sqoop | Flume | Chukva | Storm |
| **Structured data processing** | Hbase | | | |
| **Unstructured data processing** | Pig | Hive | | |
| **Distributed data processing** | Map reduce | Yarn | Spark | |
| **Distributed storage** | HDFS | | | |
| **Storage** | Couch Db | Hbase | Cassandra | MongoDB |
| **Statistics** | SAS | SPSS | R | |
| **Visualization** | Tableau | QlikView | Domo | Microstrategy |
| **Data management** | Oozie | Flume | Logstash | |
| **Machine learning/data intelligence** | Mahout | Drill | Weka | |
| **Data streaming** | Storm | Samza | | |
| **Interaction execution development** | Hcatalog | Lucene | Hama | Thrift |
| **Data serialization** | Avro | Thrift | | |
| **Data monitoring** | Zookeeper | Ambari | | |
| **Graph processing** | Giraph | | | |
| **AI** | H2O | Splunk | | |
| **SQL query engine** | Impala | Presto | Drill | Phoenix |
| **Indexing search** | SolR | Elastic | Kibana | |
| **Messaging service** | Kafka | | | |

## 67.6 Researches in Big Data Analytics

### *67.6.1 With IoT*

Nowadays, all the things and gadgets are connected to the Internet which provides the base concept of the Internet of Things. Due to this emerging concept, the data generated from all the things are numerous bytes. Every second they will provide the information to the concern. So, researchers are converting all things based on IoT [10]. For example, basic home utilities like fan, light, pipe nozzles, doorknob, etc., are converted. Just imagine each second it is sending the information to the user through some app which is linked through some network.

### *67.6.2 With Cloud Computing*

To overcome the storage and computing crisis, cloud computing will provide better solutions to a certain limit. This reduces the local storage problem also. And it will provide the data in a centralized server and users from various points which can access them [11]. They provide various services like Software as a Service (SaaS),

Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). And they have various deployment models like public cloud, private cloud, and hybrid cloud. Using them we can make the data analytics in a more comfortable way.

### *67.6.3 With Agriculture and BioScience*

Agriculture and health science or BioScience is the important key domain world which is looking into. Genetically modified crops and fertilizers are imported in order to improve the yield [12]. Lots of research work is going on improving crop health in various climatic conditions. Also, it should have the resistance to survive over the crop attacks. Similarly, in BioScience, improving the health condition of human life is very important. Identifying the newly forming diseases and providing a medical solution with introducing new medicines are challenging [13]. Lots of data are analyzed to give a better solution.

### *67.6.4 With Artificial Intelligence*

Machine learning gives the key concept of Artificial Intelligence. Once, the information are extracted from the data, they are made into various model building depending upon the users need. In model building, many numbers of data are given for training [14], so that the classifier can easily understand and distinguish the difference between each data. The more we give as training data are the accuracy of the data will get improvised. The more we give as training data, the accuracy of the data will get improvised, which can be checked using testing data samples. Our model will be well trained with Artificial Intelligence, and it will carry the work in an unsupervised working area. Many algorithms are available for these machine learning concepts.

### *67.6.5 With Business Analytics*

In this digital era, everything is commercialized. Companies are interested to know about each customer to improve their sales and increase their profit by increasing production. Lots of analytics companies are evolved in analyzing human behavior [15]. They will analyze each log and turn them into a profitable one. This concept is known as Business Analytics. More companies are investing lots of money in these analytics. So analyzing these data in various aspects is very hard. Data analyst and data scientist are assigned to get better results.

## 67.7 Future Work

Still providing efficient security for big data is a nightmare for researchers. Also, data analytics lay the path to Business Intelligence. So, making efficient algorithms and techniques will surely give a new revolution to technology. Almost we have discussed the growth of data, to the stages which undergo various levels to extract vital information. The problems in each stage still exist. No high level adopted techniques are used to handle it. Still, we are using the traditional way to handle them, which may not suit for long term. Because we all know that, these IoT, cloud computing, and neural networking are generating rapid data. We are still looking for a storage crisis only. If we look into the analytics side, lots of work are to be done. Clients are looking for live video data streaming analysis, before the data is stored in the storage medium.

**Compliance with Ethical Standards**
All author states that there is no conflict of interest.
We used our own data.

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# Chapter 68
# Survey on the Security Threats in IoT System


**S. Shinly Swarna Sugi and S. Raja Ratna**

## 68.1 Introduction

The Internet of Things (IoT) is an ever expanding network of entities ranging from sensors to supercomputers that share data in a continuous manner. The IoT environment constitutes billions of devices with differing capabilities and functionalities communicating in a common medium. Various challenges like interoperability, scalability, security, and software complexity arises during the deployment of the technology. The security aspect of IoT has gained prominence due to the widespread deployment in critical applications like smart healthcare and industrial automation. There are multiple points of vulnerability which pose a greater risk to the IoT environment.

The organization of the paper is given below:

- Section 68.2 – IoT Architecture
- Section 68.3 – Classification of Attacks on IoT System
- Section 68.4 – Security Measures at IoT Layers
- Section 68.5 – Conclusion

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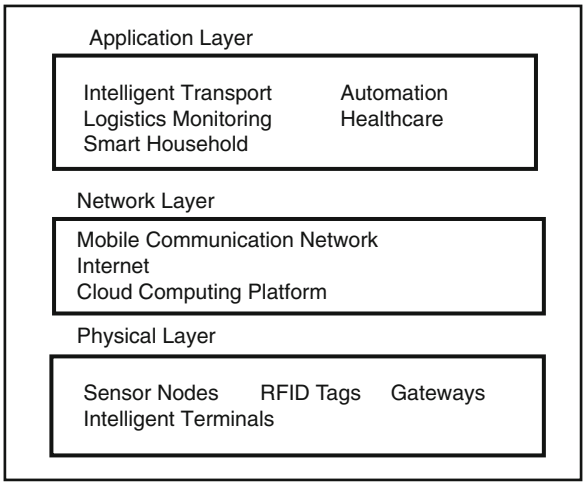


**Fig. 68.1** Architecture of IoT

## 68.2 IOT.Architecture

The IoT mainly operates on three layers: perception, network, and application [1]. Each layer is characterized by its distinct functionality and the devices associated with it. Hence the security specifications and concerns in each layer differ widely (Fig. 68.1).

### *68.2.1 Perception Layer*

The prime function of this layer is data acquisition from the ecosystem or environment. The perception layer is a physical layer consisting of hardware elements in different forms. This layer senses the environment through the usage of sensors and actuators. The data thus collected is transmitted to the next layer (network layer). The collaboration of the nodes is also handled by this layer for short-range networks [1].

### *68.2.2 Network Layer*

The network layer of IoT performs the function of transferring the information from physical objects or sensors to different IoT hubs and devices over the Internet. This layer encompasses the routing devices, gateways, and the technologies like WiFi, ZigBee, 5G, etc. The data aggregation and routing occurs through secure channels

using a communication system based on different technologies. The data is passed on to the next layer after information processing and filtering [1].

### *68.2.3 Application Layer*

The application layer is implementation-specific suited to the demands of the varying IoT applications, such as smart city, smart healthcare, smart grid, etc. The application layer manages the service and the business model of the IoT application [2].

## 68.3 Classification of Attacks on IOT System

The IoT environment is prone to major security vulnerabilities compared to conventional Internet owing to the heterogeneous and openness of the deployed IoT devices. The ubiquitous nature of the network all adds up to the security issues. The security attacks on IoT are broadly classified into four categories, namely, physical, software, network, and encryption [3]. These attacks take multiple forms with its risk level ranging from low to critical. Each category of attack is associated with different layer of the IoT system.

The types of attacks and the mode in which it is carried out with its outcome are discussed briefly in Tables 68.1, 68.2, 68.3, and 68.4.

**Table 68.1** Mode of physical attack

| Type | Mode of attack | Threat |
|---|---|---|
| Node tampering | Attacker physically alters node | Steals sensitive information [4] |
| RF interference on RFIDs | Noise signals are sent along with radio frequency signals | Denial of service attack [5] |
| Node jamming in WSNs | Wireless communication is interrupted with the usage of jammer | Denial of service attack |
| Malicious node injection | Malicious node is physically injected between legitimate nodes | Modifies the data. Legitimate nodes are misjudged as malicious nodes. |
| Physical damage | Intentional physical harm of hardware utility of IoT system | Denial of service attack |
| Malicious code injection | Introducing malicious code in one or more nodes of the system | Attaining control of part/entire IoT system |
| Sleep deprivation attack | Consuming excess power through incessant message routing | Shutting down of legitimate nodes [6] |
| Social engineering | Manipulating users for monetary/influential gain | Stealing sensitive information of users |

**Table 68.2** Mode of network attack

| Type | Mode of attack | Threat |
|---|---|---|
| Traffic analysis | Analysis of traffic because of weak cryptographic methods, intercepting and examining messages | Obtaining network information |
| RFID spoofing | Spoofs RFID signals and acts as transmitting from a genuine source | Propagating misleading information and tags forgery |
| RFID cloning | Copying data from existing RFID tag to another RFID tag without copying the original id of the RFID tag | Illegal data modification and compromising the cloned node |
| RFID unauthorized access | Gaining illegal access by eavesdropping and traffic analysis | Altering message and data theft |
| Sinkhole attack: | Attracting traffic by sending bogus routing information from malicious node to other nodes | Dropping data packets and illegal data modification |
| Man in the middle attacks | Intercepting sensitive information by eavesdropping | Data theft and loss in privacy |
| Denial of service | Flooding the network with tremendous traffic | Intended users are withheld from availing the service |
| Sybil attack | Impersonation of multiple genuine node by malicious node | Illegal data modification, packet dropping, propagation of false data |

**Table 68.3** Mode of software attack

| Type | Mode of attack | Threat |
|---|---|---|
| Phishing attacks | Adopting fake websites and spoofing emails to gain sensitive credentials of users like password | Privacy and confidentiality is compromised |
| Malicious scripts | Introducing malicious scripts along with authentic scripts for illegal entry into the system | Illegal data access, control of entire or part of the system |
| Virus, worms | Spyware files are introduced into the system from downloadable files | Information leakage, access denial, and insecure system |
| Denial of service | Service is brought down intentionally caused by flooding of requests, power outage, etc. | Service is denied to rightful user culminating in personal, financial milieu to the attacker |

**Table 68.4** Mode of encryption attack

| Type | Mode of attack | Threat |
|---|---|---|
| Side-channel attacks | Exploiting the side channel attributes such as power, time required for execution of operation, fault frequency | Discovering the exponents and factors in the encryption algorithm, difficult to detect [7] |
| Cryptanalysis attacks | Obtaining the encryption key by accessing the cipher text or plaintext | Stealing sensitive information and proliferation of misused data [23] |

### *68.3.1 Physical Attacks*

The physical attacks mainly target the perception layer and are carried out, while the attacker is in close proximity to the entity.

### *68.3.2 Network Attacks*

The network attacks typically seize advantage of the security vulnerabilities in the network layer.

### *68.3.3 Software Attacks*

The software attacks on the application layer. The end-to-end encryption and point-to-point encryption mechanism are affected by the encryption attacks.

### *68.3.4 Encryption Attacks*

An encryption attack is the process of attacking the security of a cryptographic system by finding a weak spot in a code, cipher, and cryptographic protocol. This attack also called as cryptographic attack or cryptanalysis.

## 68.4 Security Measures at IoT Layers

Existing security solutions of Internet do not necessarily match with the security issues faced by the IoT system. This mismatch arises due to various reasons: power-constrained devices, heterogeneity of IoT entities, billion points of vulnerability, and

the openness of the communication in the IoT architecture. Protecting the data and privacy is key aspects for maintaining trust and confidentiality. Hence, the existing security solutions and mechanisms need to be extended or altered to countermeasure the security treats of the IoT systems. The existing security solutions in the layers of the IoT architecture are discussed in this section.

### *68.4.1 Security at IoT Perception Layer*

The perception layer encompasses the perception node and the perception network. The perception node can be sensors, controllers, actuators, etc. The perception network comprises of technologies like ZigBee, RFID, NFC, etc.

The authors in [8] address the eavesdropping and tag spoofing using OTP mechanism in which the password is dynamic in nature. The aforementioned mechanism aids in the prevention of threats like tag cloning and eavesdropping. Another effective method to counteract tag cloning is proposed in [9] by detecting the attack by differentiating the clone tags from the authentic tag using synchronized secrets method. Privacy and the data are protected by adopting the trusted service manager which acts as a secure bridge for the entities. This method also makes use of less resources resulting in a smaller overhead.

In [10], a public key infrastructure (PKI)-like protocol is implemented in which many nodes connected to each other, and they make a network in the form of a tree. The root node acts like a base station in the tree. This also employs RSA encryption mechanism. Another protocol proposed for authenticating valid entity is OAuth (open authorization) [11] in which a client can directly or indirectly receive authorization grant from authorization server.

### *68.4.2 Security at IoT Network Layer*

To overcome the security vulnerabilities arising out of heterogeneity issues, SDN [12] is introduced. The SDN works in conjunction with the IoT to create a single architecture consisting of IoT agent, IoT controller, and SDN controller. This method is found to be cost-effective and provides security to the network layer, preventing the entry of potential hackers [13].

The authors [14] proposed a hierarchical scheme where the network is divided into clusters with cluster head which is chosen by the base station. Cluster level intrusion detection (CLID) along with network level intrusion detection (NLID) ensures a trustable climate in the network. Malicious nodes are suspended from participating in the activities in network.

Another method to detect the misbehaving nodes in the network is provided in [15]. In case of malicious behavior of a node, the trust manager raises the ALARM message and broadcasts the address of the misbehaving node within its range. In

[16] privacy is governed by the service provider of preference of the client at the same time providing security.

### *68.4.3 Security at IoT Application Layer*

Two tiers of access control, namely, physical and logical, are awarded based on the topography [17]. The framework of virtual identity (VID) is put forward to protect the privacy of the user from potential attackers. A third party is involved in granting accessibility based on the consent of the user. VID provides secure and authorized access [18]. OpenHab is an open source platform of IoT. It acts as a bridge and watchdog at the same time. The devices and entities with similar capabilities and resources are supported after registration [19]. The main constraint in this platform is the limited support for minimizing the mismatch of devices, and it is not user-friendly. The client system for establishing communication with the server whose primary objective is to allow authenticated access of user's location is presented in [20].

## 68.5 Conclusion

In this survey, we have studied the existing classification of attacks on the IoT environment. The measures in place to battle the security threats are also presented. More detailed studies need to be undertaken to gain a deeper insight of the problem areas and proposing a novel technique for boosting security.

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# Chapter 69
# A Survey on Classification and Prediction of Glaucoma and AMD Based on OCT and Fundus Images


**Raksha Bharuka, Diksha Mhatre, Neha Patil, Sahil Chitnis, and Madhuri Karnik**

## 69.1 Introduction

Age-related eye illnesses are hard to fix if not identified early, and they lead to perpetual harm to the eye or complete visual impairment. It has been surveyed universally that at least 2.2 billion individuals have a visual deficiency, out of which 1 billion individuals have a debilitating eye that could have been prevented [1]. Out of these 6.9 million people are influenced by GL [1]. Likewise, AMD influences 17 million individuals worldwide [2]. This number is most likely to reach 196 million by 2020 and increment to 288 million by 2040 [2].

GL is an illness that harms the patient eye's optic nerve. It, for the most part, happens when the fluid develops in the front part of the patient's eye; the extra fluid builds up the pressure in the eye of the patient and thus harms the optic nerve. In the macula, the internal retina is generally influenced by glaucomatous damage, and estimations of the macular fiber layer of the retinal nerve (RNFL), the layer of ganglion-cell and inward layer of plexiform, produce a glaucoma-separating ability [3].

AMD is an issue related to the retina. It occurs when a part of the retina (macula) is impaired. With AMD loss of focal vision happens which impairs the capacity to see fine details in the event of something is close or far. One of the most widely recognized premature signs of AMD is drusen – minor yellow spots beneath the retina – or pigment clumping [4].

Fundus imaging involves photographing the back of an eye (medical term fundus). Fundus imaging uses specialized fundus cameras which includes an

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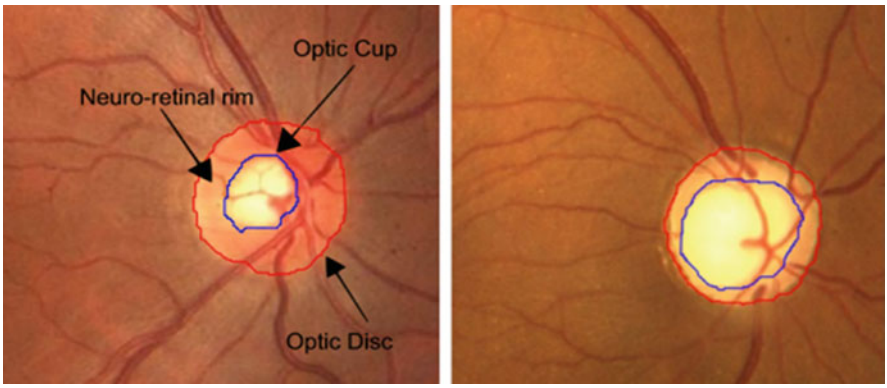


**Fig. 69.1** FI showing normal eye and glaucomatous eye [2]

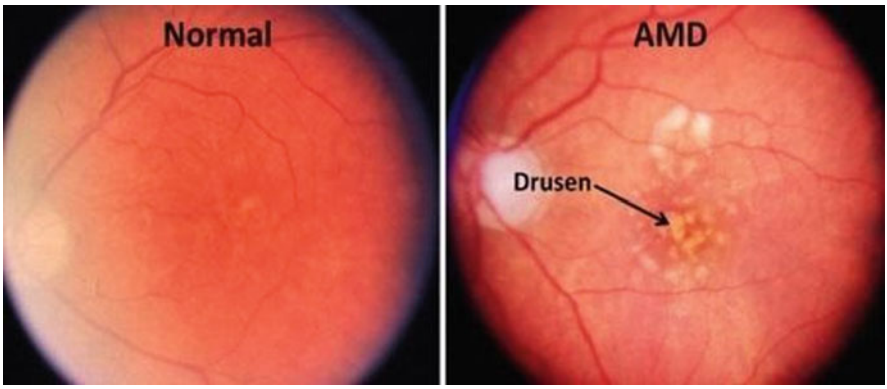


**Fig. 69.2** FI showing normal eye and AMD-affected eye [2]

elaborate microscope connected to a camera enabled by flash. The image captured in the FI of glaucomatous eye and AMD-affected eye is depicted in Figs. 69.1 [5] and Fig. 69.2 [6], respectively.

OCT is a nonintrusive imaging test. OCT utilizes light waves to take cross-area photos of the retina. With OCT, the ophthalmologist can view every one of the retina's particular layers. This enables the ophthalmologist to guide and quantify its thickness. Image captured in the OCT scan of AMD-affected eye glaucomatous eye is depicted in Fig. 69.3 [7] and Fig. 69.4 [8], respectively.

## 69.2 The Criteria for Consideration and Elimination

The survey has tried considering all the related works based on five categories: (i) GL detection based on FI; (ii) GL detection based on OCT scans; (iii) AMD

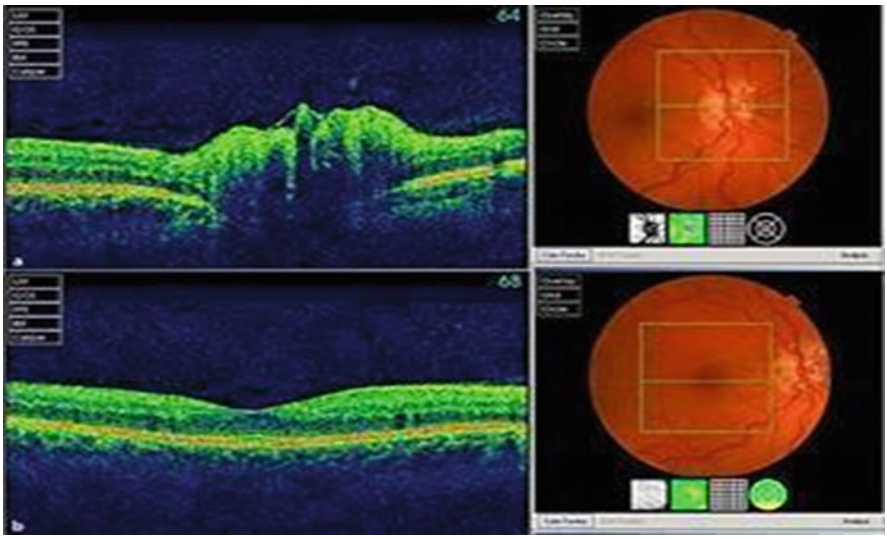

**Fig. 69.3** OCT scan showing (**a**) AMD-affected eye [1] and (**b**) normal eye [2]

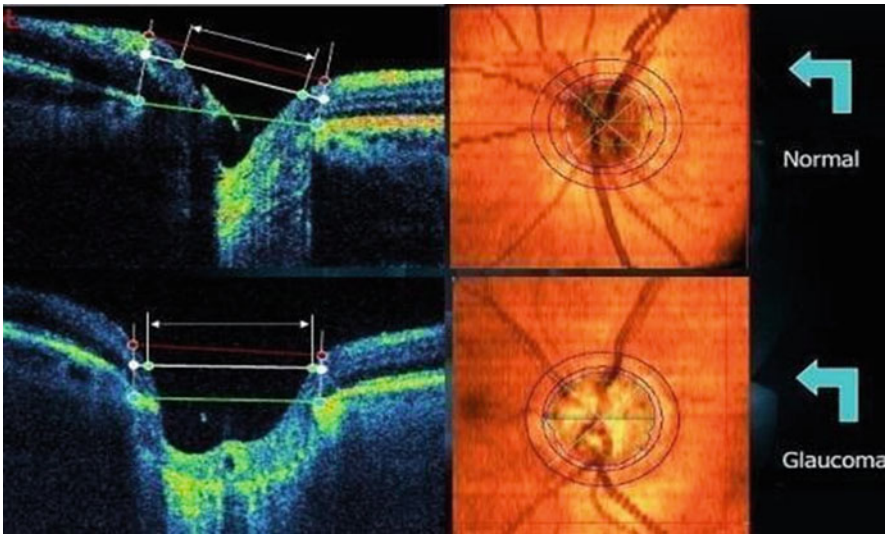


**Fig. 69.4** OCT scan showing normal eye and glaucomatous eye [4]

detection based on FI; (iv) AMD detection based on OCT scans; and (v) image segmentation of GL or AMD. Sub-inclusion categories are (1) original work and (2) authored in English. The following contemplates were avoided: (1) surveys; (2) nonhuman investigations; (3) non-English language ponders; (4) scans other than

shading FI and OCT picture; (5) reports that didn't highlight hearty validation; and (6) examinations other than GL and AMD.

## 69.3 Literature Survey

### *69.3.1 Glaucoma*

#### 69.3.1.1 Models Based on Fundus Images

In the study conducted by Andres et al. [9], it utilizes five publicly accessible datasets – ACRIMA, HRF, Drishti-GS1, RIM-ONE, and sjchoi86HRF. Overall 788 pictures were glaucomatous and 919 pictures were of normal patients. For fine-tuning the procedure, they cropped the FI surrounding the optic disc(OD) of the eyes utilizing the bounding box which was one third of the span or the radius of OD. For cropping, a basic convolutional neural network (CNN) was employed to locate the most plausible pixels in the region of the OD, which were then sorted out using a threshold. Then they utilized five different architectures (Xception, VGG16, ResNet50, InceptionV3, and VGG19), the authors changed the last completely associated tier of every CNN with the fully connected dual nodes to every two classes of one GL followed by a softmax classifier that is healthy. To acquire the best execution, a couple of tests changing the number of adjusted layers and the number of epochs was performed and furthermore assessed the exhibition of CNN using the K-fold Cross-Validation. Likewise, to improve the robustness and anticipate overfitting, pictures were extended by horizontal and vertical flipping, rotations that are random and range-zooming somewhere in the range of 0 and 0.2, additionally resizing the photos of regular size of the CNN design. Accordingly, an avg. area under the curve (AUC) of 0.9605 with a 95% confidence interim of 95.92% to 97.07%, an avg. specificity (sp.) of 85.80% and an avg. sensitivity (sen.) of 93.46% received subsequent to using the Xception architecture, altogether enhancing the presentation of other top tier works.

In [10], the author Q. Abbas has extracted regions that are of interest with radius 150 and size 301 $\times$ 301 pixels. He implemented CNN to extract the invariable characteristics through multilayer. The architecture with the deep-belief paradigm was utilized to choose highly effective characteristics depending on the dataset used in training. Finally, opinion was to execute using the linear classifier-softmax to classify the GL and non-GL FI retinal layer. The system was trained on 1200 images in total from four datasets – DRIONS-DB, sjchoi86-HRF, HRF-dataset, and PRV-Glaucoma. On avg., the sen. equal to 84.51%, the sp. equal to 98.02%, the accuracy (acc.) equal to 99.01%, and a precision (PRC) equal to 84.02% were attained.

In [11], Andres Diaz et al. proposed an algorithm that utilizes anatomical qualities to recognize a fundus that is glaucomatous or normal. Anatomical features incorporate situations cups and the vessels of optic nerve. The algorithm was assessed on two datasets one got from 12 de Octubre Hospital (Madrid) 53 pictures

(23 ordinary and 30 glaucomatous pictures) of 768 × 576 pixels and other, DRIVE, is an open dataset which has 40 pictures of 565 × 584 pixels. Firstly, the color FI is resized and the ROI is localized. It uses several color spaces and then performs cup segmentation in three steps as inpainting, stochastic watershed segmentation, and then cup adjustment to improve the performance. The proposed strategy for cup segmentation is then used to quantify attributes, for example, for example, the ratio of cup -to- disk (CDR) area CDR and ISNT-rule, which are useful in the GL diagnosis. Accordingly, a sp. of 0.81 and sen. of 0.87 were acquired utilizing Luv color space.

In [12], Arunava Chakravarty et al. have tried to put forth a method where they combine features that are image-based and the ones based on segmentation (OD or optic cup (OC)) for a semi-supervised environment that is centered with the co-training to overcome labeled data's insufficiency. They have worked on a total of 1799 images among which training was done on 717 unlabeled and 386 labeled images. Testing was done on a private test dataset of 696 photos and the DRISHTI-GS1 dataset. The classification is based on the optic CDR and ISNT rule. The images were resized and that of the left eye were vertically flipped. Nonlinear SVM with radial basis function (RBF) kernels was employed except for the prior fusion schemes for achieving the efficiency that are optimal utilizing SVM that is linear. As a result, acc. of 73.28% for the private test dataset with the area under curve 0.79 and an acc. of 76.77% for the DRISHTI-GS1 test dataset with AUC 0.78.

In [13], Xiangyu C et al. suggest a deep learning framework that comprises six layers among which four are convolutional layers and two are fully connected layers, which deduce a hierarchical depiction of photos to classify between non-glaucomatous and glaucomatous patterns for the diagnostic decisions. Furthermore, to reduce overfitting, overlapping pooling layers and response normalization layers are used and to further improve the performance data augmentation and dropout strategies are employed. The output from the last two fully connected layers are supplied with the softmax classifier to predict the GL. Datasets used are ORIGA (482 normal, 168 glaucomatous) and SCES (1676 FI, 46 glaucomatous) dataset. The AUC values obtained for the ORIGA dataset is 0.831 and for SCES dataset is 0.887.

In [14] J Cheng et al. suggest a technique for OC and OD segmentation using superpixel classification for GL screening. The proposed method of segmentation has been evaluated on a dataset of over 650 pictures with OC and OD boundaries which are manually marked. This system achieves AUC of 0.800 and 0.82 in 2 datasets. This system uses a superpixel classification algorithm called the SLIC(Simple Linear Iterative Clustering) and SVM(Support vector machine) as a classifier. The feature extraction for OD segmentation was done by using a contrast-enhanced histogram using 5 channels, center-surround statistics. The feature extraction for OC segmentation was carried out using the bounding box of the disc, histogram feature is deduced similar to the OD segmentation, but the red channel histogram is not utilized. After the cup and disc were obtained, their ratio was carried out. Here, LIBSVM with linear kernel is utilized rather than a nonlinear RBF kernel.

In [15] Fengshou Yin et al. have suggested the procedures that rely on the SM (statistical model) for the segmenting the OC and the OD form color FI. Their proposed method combines channel subscriptions that are best for OD segmentation and the knowledge-based Circular Hough Transform. Their system was examined on 325 photographs, and the disc segmentation dice-coefficients average was initialized as the 0.922 and 0.82 for segmenting cups. This method also has 101 CDR error that are mean obsolete. With the help of an active shape model, 24 landmark points were chosen. To elude the local minima/maxima problem, the model located centers of OD as well as roughly calculates the dimension of the OD in each image. To quantify the performance of the algorithm, the procedures utilized the Hausdorff distance and the dice metric relative area difference. Hence to assess the proffered architectures efficiency, a level set dependent on the OD segmentation technique and clustering following the Fuzzy c means was utilized to compare, and proposed system was found far less susceptible to leakage than the level-set approach.

#### 69.3.1.2 Models Based on OCT Images

In [16], a technique for detecting GL utilizing CDR from spectral domain OCT (SD-OCT) images is created by authors Tehmina Khalil et al. In this framework, CDR has been determined for the interior coat of the retina using SD-OCT pictures and the process of Cup-Diameter-Calculation, starting from layer of the ILM – inner limiting membrane – we extract a cup outline. At first, the input SD-OCT picture has been preprocessed. The values of the CDR were extracted from the diameter of the cup and the disc. At last, according to the CDR *value*, outcomes have been examined. In this framework, the computed pictures green channel is utilized for deriving layers such as the ILM and RPE. The dataset used comprised 50 SD-OCT and 50 FI. The acc. obtained was 94%.

In [17], A. Rajan et al. have built up a strategy for detecting GL prior to the wavelet domain using OCT images. An SVM classifier is utilized for diagnosis that is automated. This proffered methodology adequately sorts out the GL and non-GL picture with a PRC of 90.75%. This model depends on three modules that incorporate, pre-preparing, extracting of features, and selection of features, and finally the categorization stage. This framework utilizes the Haar wavelet for decomposition. The t-test utilizes the criteria of class separability for determining the features. This technique utilizes 200 OCT pictures.

In [18], Menglin Wu et al. have proposed a framework in which automatic segmentation of OD is carried out using SD-OCT images, and CDRs are quantified by neural canal opening with the patch searching (NCO) identification. The proposed algorithm uses a two-step procedure; it first recognizes the NCO and approximately finds the projection pictures-Coarse disc margin utilizing the fitting of hull, followed by the most likely patch with the NCO in its center and is found by a patch searching method which uses a probabilistic SVM classifier to refine the segmentation result. The dataset comprised of 42 SD-OCT images. The framework has accomplished

high segmentation exactness and a low cup-to-disc proportion assessment error which is 2.216 ± 1.406 pixels (0.067 ± 0.042 mm) and 0.045 ± 0.033.

In [19], T. R. Ganesh Babu et al. have advanced a strategy to automatically detect GL with the help of OCT image. The steps involved in the method recognize the retinal vitreal boundary, choroid extraction, and the edges of the retinal choroid boundary. Then they calculated cup and disc proportion and the last advance was to characterize the picture dependent on the obtained proportion. For this reason, Haar wavelet transforms and multilevel thresholding was utilized. Bezier curve fitting is applied in order to smoothen the retinal vitreal and retinal choroidal boundaries. A sum of 125 OCT pictures was gotten, and their CDR is determined. This created algorithm has delivered 92% achievement rate.

### *69.3.2 Age-Related Macular Degeneration (AMD)*

#### 69.3.2.1 Models Based on Fundus Images

In [20], Joel E. W. Koh et al. proposed a method for automatically detecting AMD using FI. In this work, "speeded up robust features (SURF) and pyramid histogram of oriented gradients (PHOG)" strategies are applied to the FIs to extract valuable data for classification. Then synthetic sampling that is adaptive (AdaSyns) is applied to adjust the quantity of highlights in the two (ordinary and unusual) classes. Then they coalesced the features obtained from the PHOG and SURF using CCA – analysis of canonical correlation. The PSO strategy is utilized to choose the ideal arrangement of characteristics to be sustained in classifier used for the purpose of classification. The acc. obtained was 96.21%, sen. of 95.00%, and sp. of 97.42%.

In [21], P. Burlina et al. used image features computed from pretrained deep neural networks for AMD detection and predicting its severity. Tests were conducted on 5600 pictures. Deep CNN is used for classification in detection. OverFeat (OF) features are used to solve the issue of feature selection. The resulting feature vector is utilized as input to a linear SVM classifier. They have a grid pattern in the image. They concentrated on a set of two-class problems where they tested early stage vs. intermediate or intermediate/advanced stages. The acc. obtained is between 92% and 95%.

In [22], Jen Hong Tana et al. have utilized a technique for identifying AMD early using a DCNN. Fourteen-layer DCNN is used to classify FIs into non-AMD or AMD classes. The submitted model has four max pooling layers, seven convolution layers, and three completely associated layers. The fully connected layer utilized a softmax activation function for the output layer to foresee the input FIs into normal or AMD classes. Dataset utilized in this work contains 1110 AMD pictures. Accuracies for the blindfold and tenfold cross approval is 91.17% and 95.45% individually.

In [23], Philippe M. Burlina et al. have built up a technique for automatic detection of AMD using DCNN. They utilized the ARES dataset which contains

130,000 color FIs. The authors used DCNN-A and DCNN-U methods for the preprocessing of input FIs. These methods detect the retina's outermost margins and resize the image according to the expected input size of the model used. The model used for classification is the AlexNet DCNN model. This model classifies the images into two categories: (1) no AMD and (2) latest AMD. The acc. ranged between 88.4% and 91.6%.

#### 69.3.2.2 Models Based on OCT Images

In [24], a clinical application architecture AI method to provide a solution to image interpretation is developed by the authors Jeffrey D. F. et al. The system works in the following manner: Digital OCT scan Segmentation Network Tissue-Segmentation Mapà Classification Network Referral Suggestion. The framework uses the patient's FI and medical history to come to a conclusion. It is divided into four clinical referral suggestions – urgent, routine, observation, and semi-urgent – only. The image undergoes five segmentation processes and five classifications to determine the result. There are 2 separate test datasets consisting 1113 clinical OCT scans in total. Deep learning was also implemented to evaluate segmentation. The author has used a two-tier architecture. The error rate achieved was 5.5%. In this, two machine types are made one and had a 46.6% error rate which they improved in type 2 and reduced it to 5.5%. The authors have tried to create a framework that matches decision-making as close to that in clinics.

The authors of [25] publication, Sajib Saha et al. proposed a strategy for identifying and characterizing AMD utilizing convolution neural systems. Automated recognition and classification of intraretinal hyperreflective foci (IHRF), hyporeflective drusen foci (hRF), and subretinal drusen deposits (SDD) from OCT B-scans was done in the system using a dataset comprising of 19,584 OCT B-scans. Just those pictures were chosen where the grader had certainty of over 90% or increasingly about that picture being an AMD present picture. The data was divided into 9:1 parts for training and testing the model. Information growth was implemented on it like rotation, shearing, scaling, and flipping of image after the split to increase diseased image by 10–15 times. Deep learning was used to employ a machine to learn to extract features from the scans to detect the early biomarkers hinting the presence of AMD. They have used ImageNet44 to initialize the network parameters. Before giving the picture to the CNN for pathology location and characterization, a pre-division is performed of the retinal layers utilizing ReLayNet. The PRC got 87% for distinguishing the nearness of early AMD. SDD can be related to an exactness of 80% ~ 86%. PRC for recognizing the nearness of IHRF and hRF was 89% and 88%, separately.

In [26], Oscar Perdomo et al. have presented a model with a feed backstage based on deep learning for automatic classifications of three retinal ailments through B-scans. In totality 3 databases are utilized comprising of 459 scans in all. The datasets were arbitrarily separated into three autonomous parts: training, validation, and testing. OCT-NET model is utilized for an order of explicit retinal illnesses.

The authors used customized CNNs for classification. It contains ten convolutional layers, four max pooling layers, two completely associated layers, and one dropout layer. This strategy comprises of six phases. First, the system gets the crude pictures as info. Second, the system comprises pre-handling of pictures to resize them. In the third stage, highlight extraction is performed, and in stage four, infections are characterized. In the fifth stage, class activation map is utilized to feature the applicable zones for order. In sixth stage assessment is done based on the given data to approve the got outcomes. The exactness is 93% and AUC is 0.99.

In [27], Md Akter H et al. presented a new model of classification to automate recognizing people with diabetic macular edema (DME) or AMD. The authors utilized SD-OCT images where there are ten features in the retina that show considerable changes if the disease is present in the eye. Dataset utilized is gotten from four distinct sources. They applied diverse algorithms of machine learning such as decision tree (DT), SVM, and random forest (RF) in which RF showed highest acc. The classification method depends on retinal highlights like drusen and hyper-intelligent intraretinal spots. In RF algorithm, two highlights of the framework are the automatic classification of images and automatic feature extraction. In the proposed strategy, features are extracted from images once segmentation is done. After the feature extraction system is trained and patients are classified. The AUC value is 0.99 for both datasets with a standard deviation of 0.001. acc. is more than 96%.

In the paper [28] Reza R et al. have used "multi-scale convolutional mixture of expert ensemble" models to detect AMD; it subsumes a CNN for quick learning of images. They have utilized 2 diverse datasets of 148 and 45 OCT images, respectively. The data preprocessing algorithm on various steps is performed including normalization, retinal flattening, image cropping, ROI selection, VOI generation, multi-scale decomposition. This system consists of two main steps which include data preprocessing and a classification step.

In [29], Paolo Fraccaro et al. compared the predictive work of "white-box" and "black-box" techniques. These techniques were investigated for deriving an automated AMD diagnosis system. Data from sound patients and patients determined to have AMD or other retinal infections were considered for testing. The images used were OCT images. Clinical signs associated with AMD included soft drusen, RPE, depigmentation area, macula thickness, macular scar, and subretinal fibrosis. DT and logistic regression are white-box techniques. SVM, RF, and AdaBoost are black-box techniques. The authors performed a systematic t-test to collate the performance of white-box and black-box methods in terms of AUC. The mean performance of AdaBoost, RF, and logistic regression is 0.92 and of DT and SVM is 0.90. As per the outcomes acquired, "white-box" technique is preferable.

## 69.4 Conclusion

This paper presents a survey based on the different ML techniques developed and research done for the area of detection of GL as well as disease associated with the AMD with OCT scans and FIs. It also gives a brief overview of image processing techniques that can be used for better feature extraction by deep learning or machine learning algorithms. These technologies can provide an efficient analysis of the disease where ophthalmologist to patient ratio is biased. By observing the above research papers, there is a scope for building an application by combining the fundus and OCT images for identification of a particular disease or multiple diseases at a time.

**Compliance with Ethical Standards**

All author states that there is no conflict of interest.

We used our own data.

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# Chapter 70
# GSM Broadband Coverage Analysis Under Rainy Environments

**Rabin Kasula and N. B. Adhikari**

## 70.1 Introduction

The attenuation due to rainfall in mobile communication frequencies shall not be neglected as path attenuation significantly increases on heavy rainfall [3]. This is the major objective of this research, to find accurate relation between the rainfall rate R (mm/h) and the specific path attenuation due to rainfall k (dB/km) for 900 MHz (2G), 1800 MHz (4G) and other 5G and WiMAX frequency bands [1]. The relation between k and R is defined by ITU (International Telecommunication Union) ITU-R P.838-2 [2] shown in Eq. (70.1).

$$k = \alpha R^{\beta} \tag{70.1}$$

where $\alpha$ and $\beta$ are coefficients that depend on the signal frequency, type of polarization and DSD (drop size distribution) of rainfall. Further, theoretically, the relationship can be derived using Eqs. (70.2) to (70.9).

The drop size distribution defined by Marshall and Palmer [4] is given by Eq. (70.2).

$$\mathrm{N}(\mathrm{D}) = \mathrm{N}_0 \mathrm{e}^{-\lambda \mathrm{D}} \tag{70.2}$$

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where N(D) is number of concentration ($m^{-3}$) of drops of diameter, D in mm, $N_0$ is the value for N at a diameter of zero (fixed value of 8000 $mm^{-1}$ $m^{-3}$) and λ (in $mm^{-1}$) is the parameter related to the median drop diameter of the size spectrum defined by Eq. (70.3).

$$\lambda = 4.1R^{-0.21} \; or \; \lambda = 3.67/D_0 \tag{70.3}$$

where $D_0$ is the median drop size diameter denoting the drop size for which half the liquid water volume of the drops is contained in smaller and half contained in drops larger than this diameter.

Since the values of k and R significantly depend on the velocity and DSD of rainfall, the following expression is used for evaluating values of k and R theoretically by simulation [5].

$$k = \frac{1}{\ln 10}\int_0^\infty \sigma_E\,(\lambda, D)\,N(D)dD \tag{70.4}$$

where D denotes the equivolumetric spherical drop diameter [mm] and $\sigma_e$(D) denotes the extinction cross-section [$cm^2$] due to a drop of diameter D, and N denotes the DSD: N(D)dD [$m^{-3}$] is the number of drops, in the diameter interval [D, D + dD], per unit volume and $a$ is wavelength of the used frequency.

According to Mie scattering/absorption theory [6], the scattering, extinction and absorption cross-sections in terms of expansion coefficients $a_n$ and $b_n$ can be expressed as shown in Eqs. (70.5), (70.6) and (70.7), respectively.

$$\sigma_s = \left(2\pi r^2\right)/\rho^2 \sum\nolimits_{n=1}^{\infty} (2n+1)\left(|a_n|^2 + |b_n|^2\right) \tag{70.5}$$

$$\sigma_e = \left(2\pi r^2\right)/\rho^2 \sum\nolimits_{n=1}^{\infty} (2n+1)\left[-\mathrm{Re}\,(a_n + b_n)\right] \tag{70.6}$$

$$\sigma a = \sigma e - \sigma s \tag{70.7}$$

where $\sigma_e$ is extinction cross-section, $\sigma_a$ is absorption, $\sigma_s$ is scattering, r is drop radius and $\rho = 2\pi r/a$; $a$ is wavelength of the frequency used. The coefficients $a_n$ and $b_n$ are called expansion coefficients and represent the magnetic electric multipoles of order n, respectively. Here, the extinction cross-section is defined as the sum of scattering and absorption cross-sections.

Similarly, the rainfall intensity [7], R [mm/h], can be expressed as a function of the DSD, given by Eq. (70.8).

$$R = 6\pi 10^{-4}\int_0^\infty D^3 v(D)N(D)dD \tag{70.8}$$

where $v(D)$ [m/s] denotes the terminal fall velocity of a raindrop of diameter D.

$$v = \begin{cases} 0, & D \leq 0.03 \text{ mm} \\ 4.323\ (D - 0.03), & 0.03 < D \leq 0.6 \text{ mm} \\ 9.65 - e^{-0.6D}, & D > 0.6 \text{ mm} \end{cases} \tag{70.9}$$

Because the integrands of Eqs. (70.4) and (70.8) are similar at frequencies used for mobile communications, k and R are almost linearly related (i.e. they are directly proportional). Generally, $\beta$ can be approximated to unity (1.00) [8]. Therefore, Eq. (70.1) simplifies to Eq. (70.10).

$$k = \alpha R \tag{70.10}$$

As the frequency bands proposed for 5G network are very high, the effect of rainfall will be higher.

### *70.1.1 Methodology*

The research includes two approaches for finding the specific path attenuation due to rainfall. The complete system diagram is shown in Fig. 70.1.

**Simulation Based** The algorithm and code based on the theoretical expressions from Eqs. (70.2) to (70.9) are used for calculation of k-R relationship in simulation. Equation (70.2) gives the drop size distribution function with drop diameter that ranges from 0.35 to 5.2 mm based on the light, moderate and heavy rain. The drop size distribution (DSD) data was collected from the real field disdrometer measurement of one of the places of India which is almost similar in geography of the region chosen for this research.

Mie scattering is considered for the extinction cross-section calculation which depends on the drop radius, r, and normalized radius, $\rho$, as expressed in Eqs. (70.6) and (70.7). The simulation is carried out to calculate extinction cross-sections, $\sigma_e$, with the consideration of refractive index of water in temperature of 10 degree Celsius.

With the simulated values of $\sigma_e$ and collected value of DSD, the value of specific attenuation $k$ is evaluated by simulating Eq. (70.4). Also, with the consideration of falling velocity, $v$ ranging from 1.4 to 10 m/s [9], the value of R is calculated for same DSD values as used for calculation of $k$. The simulation is carried out for 2G, 3G, 4G, WiMAX and 5G frequency bands [1]. The values of $\alpha$ vary as the frequency changes and is higher for higher frequency bands [10–12]. The higher value of $\alpha$ signifies that the loss due to rainfall is higher. The frequency bands used for WiMAX service are 2.4 and 5 GHz bands.

**Observation Based** The base stations of 900 and 1800 MHz frequency bands currently in service from Nepal Telecom in the observation area (Chyamhasingh-Libali area, Bhaktapur) are selected for collecting the power loss or attenuation data

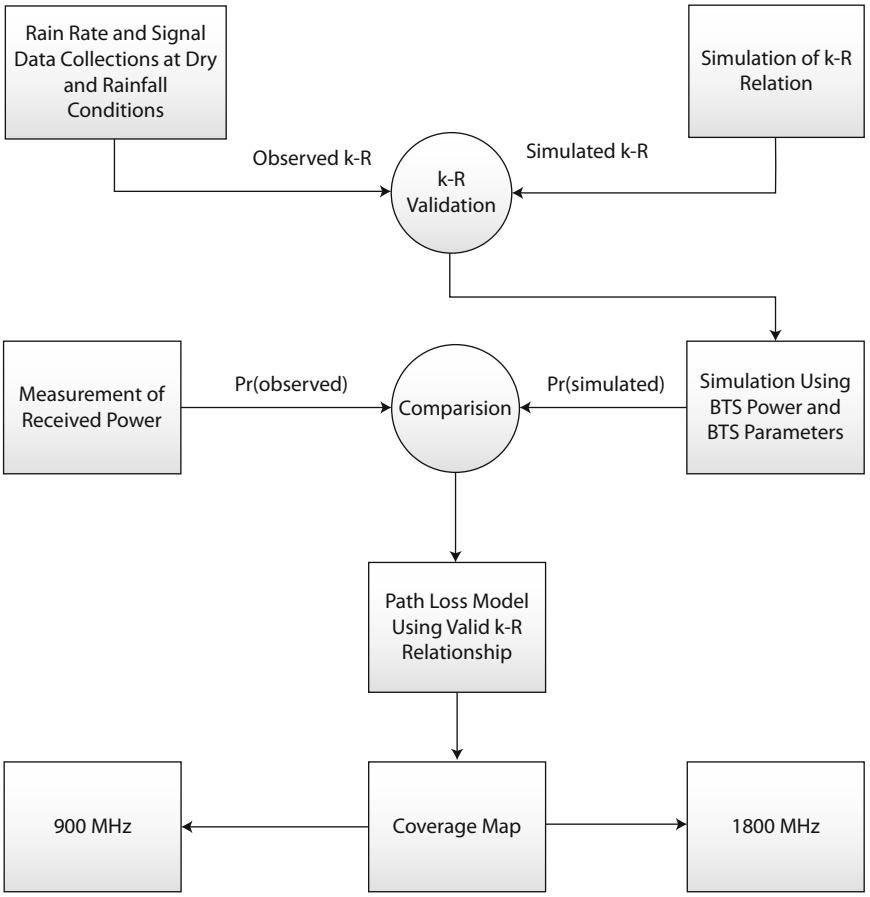


**Fig. 70.1** System flow diagram of research methodology

in dry and wet or rainy cases. Free software, Cellular-Z-installed two android mobile sets (one used for 900 MHz (2G) is Huawei Y541-U02 Model and one used for 1800 MHz (4G) is Redmi Note 7 Pro) are used for collecting the received signal levels from the base stations within the path distance of 1 km.

Since the multipath fading causes the signal attenuation at the corners of high-rise buildings, the line of sight points [13] are chosen for the better result of k-R relationship. In the line of sight points, decreasing of signal level with increase in distance from BTS can be seen clearly which is a requirement of the k-R relationship evaluation. The Google Map with BTS (Base Transceiver System) location, rain gauge location and field points is shown as shown in Fig. 70.2.

Eleven different points were selected for 1800 MHz band, and seven different points were selected for 900 MHz band during the rainfall of rain rate of 18.4 mm/h (as per measurement of rain gauge). The points in loc9, loc10 and loc11 of Fig.

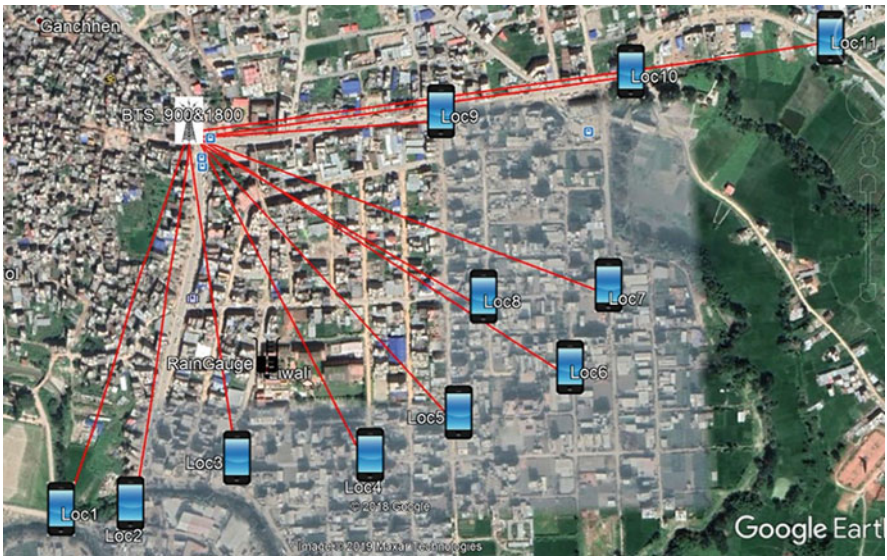


**Fig. 70.2** Experimental setup: with GPS (Global Positioning System) data


**Fig. 70.3** Signal strength change with distance: dry case. (**a**) 1800 MHz (**b**) 900 MHz

70.2 are in line of sight of the BTS but with different heights. The change in signal strength with the increment of distance from BTS to observation points for 1800 and 900 MHz for dry case can be seen in Fig. 70.3a and b. Similarly, plot of the wet or rain condition in different field points of both frequencies can be seen in Fig. 70.4a and b.

In Fig. 70.4, in the signal diagram of 1800 MHz, the attenuation due to rain is clearly visible along the loc9, loc10 and loc11 points in observation area. But in case of 900 MHz, the signal strength change is not clearly visible because the attenuation due to rain is lower for lower frequency.

From the rain gauge placed within 1 km radius from BTS, the value of $R_{max}$ was recorded, and the rainfall rate, R, was calculated using the expression in Eq. (70.11).


(a) (b)

**Fig. 70.4** Signal strength change with distance: rain Case. (**a**) 1800 MHz (**b**) 900 MHz

$$R = R_{\max} * 60/T \tag{70.11}$$

where $R_{\max}$ is the maximum rainfall in mm for time interval T min. Also, from the Cellular-Z software, the received signal levels in dBm were recorded for dry and rainfall conditions. With the distance between the BTS and MS (mobile station), d, and recorded values in dry, $P_{\text{dry}}$, and rainfall, $P_{\text{rain}}$, conditions, the value of specific attenuation, k, was evaluated as shown in Eq. (70.12) [14].

$$k = \left(P_{\text{dry}} - P_{\text{rain}}\right)/d \tag{70.12}$$

**Validation of k-R Relationship** From the above two approaches (simulation and experimental), the k-R relationship of Eq. (70.1) was evaluated. Since the k-R relation is almost linear in nature, the exponent, $\beta$, of $R$ is assumed to be 1 and the remaining linear coefficient, $\alpha$, was calculated for both approaches. And finally, a comparison with the values listed in ITU-R P.838-2 [2] recommendation was carried out for both approaches.

**Finalizing Path Loss Model for Coverage Planning** The final path loss model including path loss due to rainfall is given by Eq. (70.13).

$$P_L(dB) = G_t\,(dB_i) + G_r\,(dB_i) + 20\log\left(\lambda(m)\right) \tag{70.13}$$

$$-20\log\left(4\pi r(m)\right)^2 + K(dB) - k\,(dB/m)\,r(m)$$

Based on the path loss model in Eq. (70.13), the coverage map can be planned for 900 and 1800 MHz bands. Further the handoff threshold parameters can be assigned as per the changes due to the heavy rainfall. The value K(dB) is loss due to different heights of BTS and MS, considered from Okumura and Hata model. For the value k(dB/m), specific path attenuation is obtained from the simulated value and measured value.

### *70.1.2 Results and Discussions*

The main objective of this research work is to find the path loss behaviour of GSM broadband signals that use 900 and 1800 MHz frequency bands, WiMAX and 5G frequency bands in the presence of rain and intercompare the path loss behaviour or coverage.

#### 70.1.2.1 Simulation Result

It is known from the theory that with increase in link frequency or decrease in wavelength the scattering and absorption in raindrops increase resulting the reduction in received signal at MS. Also, with the increment of raindrop diameter, the scattering and absorption phenomena increase significantly, resulting in the increase in extinction cross-sections of the rain drops. The graph of drop size distribution for measured DSD is shown in Fig. 70.5. The plot of simulated output of extinction cross-sections, $\sigma_e$, vs drop diameter, D, for two frequency bands is shown in Fig. 70.6. Here, it is clearly seen that with the increment of frequency and drop diameter, the extinction cross-section increases exponentially. And the exponent in k-R relation defined by ITU-R P.838 is almost linear, i.e. the specific attenuation varies linearly as the rain rate varies. Only the coefficient of $R$ plays an important role in changing the value of specific path attenuation. The plot of simulated $k$ vs simulated $R$ for 1800 and 900 MHz is shown in Fig. 70.7a and b. Using the best curve fitting algorithm, the coefficient of $R$, $\alpha$ is found to be $\alpha = 0.00009$ for 1800 MHz and $\alpha = 0.00003$ for 900 MHz frequencies, respectively. Hence, the expression of Eq. (70.1) for 900 and 1800 MHz becomes as expressed in Eq. (70.14). The simulation for 5G and WiMAX frequency bands was carried out for k-R relationships. From the simulation, the extinction cross-sections for very high 5G frequency band were recorded.

$$k = 0.00009R^{1.00};\ \text{for 1800 MHz} \tag{70.14}$$

$$k = 0.00003R^{1.00};\ \text{for 900 MHz}$$

Here, the value of extinction cross-section is increased highly for very-high-frequency bands. Since the wavelength of very-high-frequency bands is in the range of the drop size, most of the waves are absorbed within the drops. The values for very-high-frequency band are plotted in graph for $\sigma_e$ vs D in Fig. 70.8.

With the simulated values of extinction cross-sections and values of D and DSD, the values of k and R were evaluated using Eqs. (70.4) and (70.8), respectively. The graphs of specific attenuation versus rain rate are shown in Fig. 70.9a and b for very-high-frequency band of 5G (35 and 50 GHz).

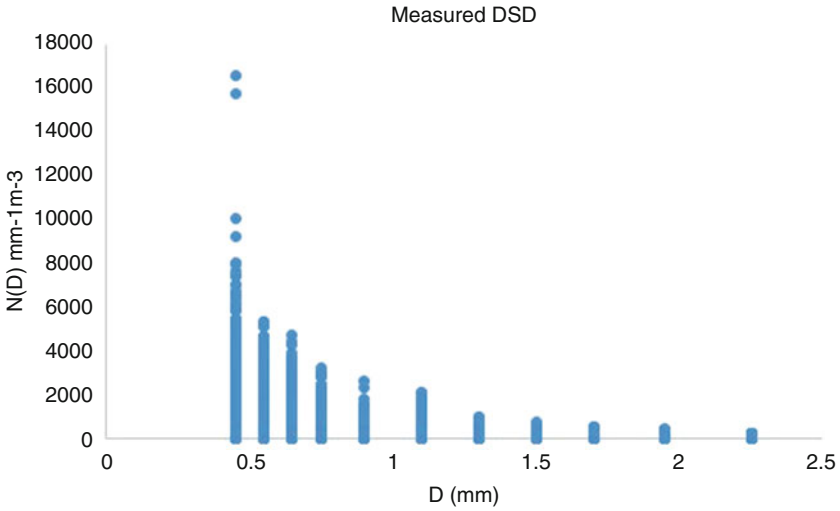


**Fig. 70.5** Drop size distribution graph: theoretical vs measured

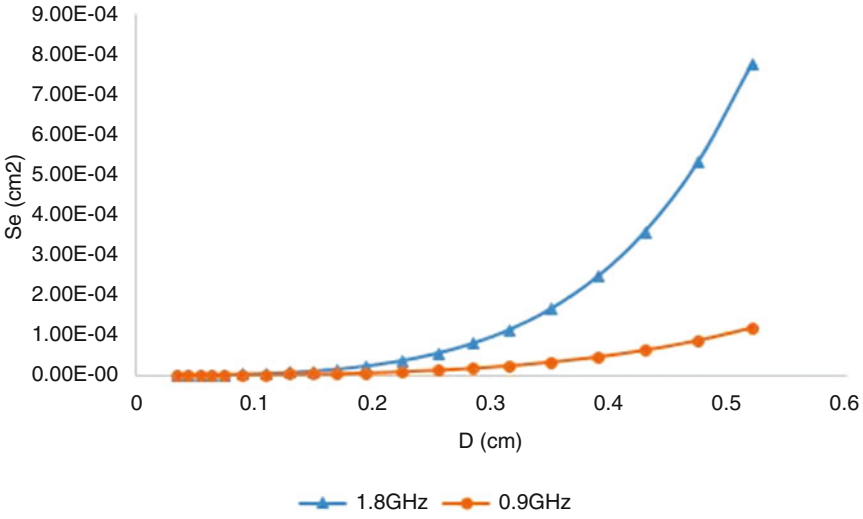


**Fig. 70.6** $\sigma_e$ vs D

From Fig. 70.9, the value of $\alpha$ was evaluated using the best curve fitting algorithm, which in terms gave the attenuation due to rainfall. It is clearly seen that the value of $\alpha$ is increasing as the frequency increases. It signifies that the loss due to rainfall is most important when the frequency bands are higher in 5G services. From the simulation, the values of $\alpha$ are seen higher in 50 and 60 GHz frequencies. The values of $\alpha$ for 50 and 60 GHz are 0.4681 and 0.5221, respectively. With the $\alpha$ values, the attenuation due to rain rate of 18.4 mm/h was calculated which is found

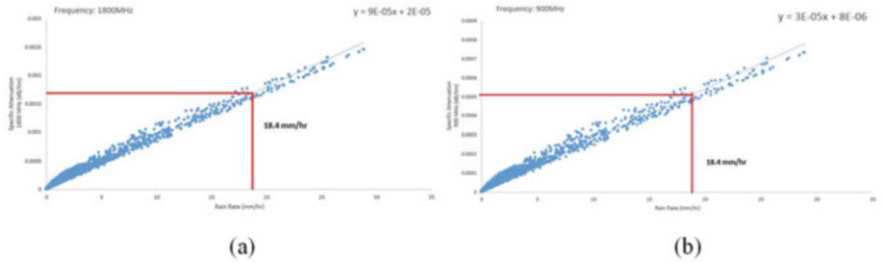


**Fig. 70.7** Specific path attenuation, k, vs rain rate, R. (**a**) 1800 MHz (**b**) 900 MHz

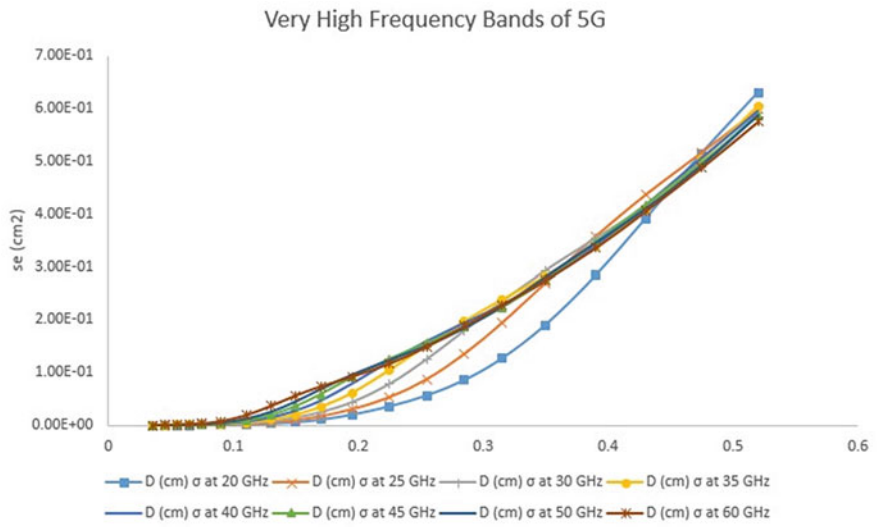


**Fig. 70.8** Extinction cross-sections: very-high-5G-frequency band

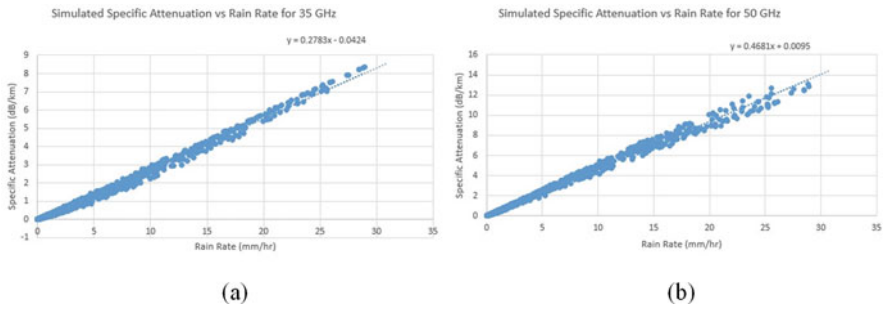


**Fig. 70.9** Very-high-5G-frequency band: k vs R. (**a**) 35 GHz (**b**) 50 GHz

to be 8.613 dB/Km or 8.613 dBm/m and 9.607 dB/Km or 9.607 dBm/m for 50 and 60 GHz frequencies. Since the specific path attenuation values are significantly higher, the signal level changes due to rain affect the coverage of the 5G services and also affect the handover parameters set for dry condition. The k-R relations for 50 and 60 GHz frequencies can be written as shown in Eq. (70.15).

$$k = 0.4681R^{1.00};\ \text{for 50 GHz} \tag{70.15}$$

$$k = 0.5221R^{1.00};\ \text{for 60 GHz}$$

Further, the path loss equations for 50 and 60 GHz frequencies including loss due to rainfall can be evaluated using Eq. (70.13).

#### 70.1.2.2 Experimental/Measured Result

The received signals in different observation points were measured by mobile set. Also, the distance was calculated using GPS values of BTS and MS locations. The received signal was measured in dBm by mobile set. The rain gauge placed at the periphery of 1 km from BTS measured the rain rate data which was found to be 18.4 mm/h. The measured values of received signal levels are shown in Table 70.1. From the measured received signal levels in dry and rainfall cases and the distance value, the specific path attenuation was calculated by using Eq. (70.12). The result obtained was in the dBm/km which was changed to the final unit dB/km using mathematical computations.

**Table 70.1** Field measured received levels

| 1800MHZ | | 900 MHz | |
|---|---|---|---|
| Rx.Level dry (dBm) | Rx.Level rain (dBm) | Rx.Level dry (dBm) | Rx.Level rain (dBm) |
| −65 | −67 | −61 | −62 |
| −59 | −61 | −73 | −74 |
| −67 | −69 | −77 | −78 |
| −75 | −77 | −79 | −80 |
| −65 | −67 | −61 | −62 |
| −71 | −73 | −62 | −63 |
| −73 | −75 | −63 | −64 |
| −71 | −73 | | |
| −61 | −63 | | |
| −59 | −61 | | |
| −69 | −71 | | |

**Table 70.2** Comparison chart of $\alpha$

| Frequency (GHz) | ITU-R P.838-2 | Simulation | Measured |
|---|---|---|---|
| 0.9 | | 0.00003 | 0.00002989 |
| 1 | 0.0000352 | | |
| 1.5 | 0.0000784 | | |
| 1.8 | | 0.00009 | 0.00008587 |
| 2 | 0.0001388 | | |
| 50 | 0.4755 | 0.4681 | |
| 60 | 0.6347 | 0.5221 | |

#### 70.1.2.3 $\alpha$ Value Comparison

Two different results for *k-R* relations were derived from two different approaches. The comparison among the two results and with the ITU-R P.838-2 recommendation was carried out for accuracy of the calculated values. Since all the mobile communications use the vertical polarization, the value of $\alpha_v$ from ITU-R P.838-2 was compared with the calculated values from both approaches. The comparison of $\alpha$ values is listed in Table 70.2.

From the table, it is seen that the simulated and measured values of $\alpha$ are very close and also fit in the ITU-R P.838-2 table value. Though the values of $\alpha$ for 0.9 and 1.8 GHz are not defined in ITU-R P.838-2 recommendation table, the values are in the range of values defined in ITU recommendations for 1, 1.5 and 2 GHz. The simulated values of $\alpha$ are also seen very near to the ITU-R P.838-2 recommendation values for 5G frequency bands.

## 70.2 Conclusion

The two approaches were carried out for evaluating path loss behaviour of the GSM broadband with the frequency bands of 1800 and 900 MHz in the presence of rain. The various rain rate values were considered in simulation to evaluate the accurate k-R relationship, which is the major relation for analysing path loss of electromagnetic waves due to rain. Both approaches gave good result in evaluating k-R relationship. In both approaches, the specific path attenuation is seen linearly dependent on the rainfall rate. So, with higher value of rainfall rate, the path loss will be increased accordingly.

Further, the simulation for different 5G frequencies and WiMAX frequencies was carried out to find the simulated k-R relationships for those frequencies. And also the path loss model and coverage analysis for those frequencies were carried out. The specific path attenuation is seen linearly dependent on the rainfall rate for higher frequencies as well. So, with higher values of rainfall rate, the path loss is increased accordingly. For the very-high-frequency band of 5G frequency, the loss due to rainfall is very much significant and highly affects [15] the coverage of the service.

**Compliance with Ethical Standards**

All authors state that there is no conflict of interest.

We used our own data.

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# Chapter 71
# Investigation on Data Mining and Machine Learning Techniques in Rheumatoid Arthritis Disease Research and Its Outcomes


**Sundar Santhosh Kumar, R. Uma, E. Ramaraj, and P. Subhasri**

## 71.1 Introduction

There are nearly hundred AD diseases that were identified around the world. One among them is rheumatoid arthritis (RA), it is an autoimmune arthritis which means the immune system causes damage and destruction to the health joint cells mistakenly.

RA further affects different parts of our tissues such as skin, lungs, eyes, etc. Many people under the age of 40–50 struggle from morning stiffness, for more than an hour which is obvious primary symptoms of rheumatoid arthritis along with other signs like tiredness, fatigue, etc. The patients with RA have twice the risk of heart attack or a stroke, so early investigation of the disease means to begin medication early.

One percent of people are some extent influenced by rheumatoid arthritis in life [12, 13]. Many researchers have focused their study on RA. The gaps in RA research must be addressed [10]. The objective of this survey is to review the recent study on RA using a machine learning (ML) algorithm. Furthermore, the study highlights the various dataset practiced with several features, and subsequently address certain statistical studies performed for the prediction of rheumatoid arthritis.

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## 71.2 Related Study

Yoo et al. [1] analyzed clinical records of 60 rheumatic patients issued by the Eulji University hospital to predict patients with rheumatoid arthritis. The four factors together with threshold values considered to identify rheumatoid arthritis were RF > 7, anti-CCP > 18, SJC > 4, and ESR > 25 factors. The unsupervised machine learning algorithm of K-means clustering analysis was implemented on these four factors. The explanatory model determined 84% of evaluation results. The author observed that the correlation result was higher with two factors compared with one after the visualization of the K-means model based on the R program.

Parsania et al. [2] work toward a comparative analysis of data mining algorithms on electronic health record of RA, which combines the data from Ayurvedic and Allopathic system of medicine. The selected five classification algorithms executed on the EHR of RA and the results acquired for 100, 500, and 1000 instances. The authors analyzed and concluded that Naïve Bayes presented valid results compared to additional algorithms. The authors suggested altering the Naïve Bayes; several enhanced algorithms can be outlined to attain more consistency and good results. The authors further conclude that the accuracy can be refined by SSOM and Optimal Data Analysis technique.

Shanmugam et al. [3] proposed a system that includes a comprehensive analysis of ML algorithms assigned for RA disease with genetic factors and clinical data. The authors operate on the big data domain termed Machine Learning based Ensemble Analytic Approach (MLEAA), which involves a few phases. The learning phase data are handled by the map-reduce framework, and the outcome of map-reducer was the important featured attributes promoted for the early prediction of rheumatoid arthritis disease. These features were further applied to a rapid miner tool to generate the accuracy of different classification algorithms like Naive Bayes, SVM, AdaBoost, and ANN. A voting method determined the accurate values to predict both affected and unaffected RA patients. The author's ideas for future work suggest choosing algorithms based on real-time RA with genetic variations.

Shiezadeh et al. [4] proposed a model to diagnose RA using an ensemble learning approach. The CRISP-DM model was followed to implement an efficient prediction system. The data were collected from 2564 patients with 600 attributes further reduced to 18 features using selection techniques. Initially, various decision tree algorithms were executed on the dataset. Next, CSBoost algorithm has been explored as the proposed learning. AdaBoost accuracy was higher compared with other decision trees. Further, the ensemble approach was implemented on the dataset with different classification models (decision tree, KNN, SVM, AdaBoost, and CSBoost); CSBoost model accuracy was higher among them. The proposed CSBoost has maximum accuracy and minimum sensitivity. The output displays joints, and the ESR test shows the greatest influence on the diagnosis of rheumatoid arthritis. The authors conclude the proposed model acts as the DSS for physicians.

Garcia-Zapirian et al. [5] focus on finding an automatic classification for fibromyalgia (FM) and rheumatoid arthritis (RA) using machine learning tech-

niques. The dataset consists of 53 FM and 74 RA women patients with medico-social and psychopathological features inherited from questionnaires. The authors confirmed that compared to the SVM classifier implemented for medico-social features, the AdaBoost algorithm classifies patients with FM and RA. The authors conclude that the proposed system circumvents many difficulties faced by the medical tests.

Feng et al. [6] stated early prediction of rheumatoid arthritis can be achieved using clinical trial metadata. Datasets were retrieved from ClinicalTrials.gov. This work is a continuation of homogeneous data patterns from each patient to measure the heterogeneous subsets of data in disease activity. The authors concentrated on four main outcome measures used in rheumatoid arthritis trials. The classification algorithms were trained using several ways for the primary outcome measures. The authors found that the classification model for individual set functions better than the combined set. The placebo set produces a better achievement. The combined set revealed in lower performance because merging the set lost the important features to identify and the measured values cannot signify the original values. The authors implemented various classification rules on the datasets and estimated their performance by Friedman test. The adverse effect set obtained a model with high accuracy compared to serious adverse effects. The authors concluded that the metadata study results with adequate accuracy.

Chin et al. [7] work toward an innovative structure for early rheumatoid arthritis assessment. To experiment with their idea the authors utilized a nationalized clinical database that comprises information both from a rheumatoid arthritis patient and non-rheumatoid arthritis patients. To mine the clinical database, the author's initial step was data preprocessing phase, followed by a risk pattern mining phase where association classification mining and parameter tuning were implemented on the preprocessed data. Eventually, the disease risk pattern was obtained. The model discovered two risk patterns. A well-known risk pattern named Type I and the unknown rare patterns were also identified named Type II, which plays a vital role in assisting unique hypotheses in the clinical trials of rheumatoid arthritis and establish principal augmentation toward their work. Besides, the authors' contribution to the analysis phase was to build the risk pattern viewer structure which facilitates the physicians to enhance the analysis of risk pattern properties, in addition to its distributions. The efficiency of the captured pattern is evaluated using a validation phase where k-fold cross-validation is done. The author states that the class association rule mining approach promotes rheumatoid arthritis disease estimate and reviews report before declaring a specific diagnosis. The authors' study leads to support doctors in patient assessment, along with the feasibility of development in the early discovery of RA.

Botas [8] works toward the feature performance to predict treatment outcome in rheumatoid arthritis. The author states that biological treatments provide a clinical alternative, but there is no biomarker to predict the response code. The author uses the Reuma.pt database, developed by the Portuguese Society of Rheumatology containing only biological treatment patients. Some modifications applied to the dataset to obtain three new datasets, namely, ReumaA, ReumaB, and ReumaBImp.

These datasets compared with different classification methods (Naive Bayes, Bayes Network, Logistic, SVM (SMOTE), and decision tree (J48, Random Forest)) with and without feature selection. Further, three case studies introduced TS (time series data), DS (data summarization), and DR (data representation). The method with the best value in the average accuracy is for SMO in ReumaB and ReumaBImp datasets for TS files after feature selection. ReumaBImp is the only dataset considered best results in the majority of the case studies. ReumaBImp dataset obtained good results without feature selection, from classifiers such as SVM (for TS, DR) and DT (for DS). The author concludes that the case studies containing information about the features perform better than the remaining from ReumaBImp. Another factor extracted from the study of the F-measure is that the lowest value is always in class C1, corresponding to be a moderate responder. Besides, it is possible to forecast the response code in the 24th month in the 6th-month appointment, with an average accuracy of 65%.

Lee et al. [9] designed a study to recognize clusters of RA patients with varied conditions of pain and complex prognoses and treatment decisions. The authors identified and analyzed records from 169 RA patients with pain score criteria (>0) from the Brigham and Women's Hospital Rheumatoid Arthritis Sequential Study. The clustering analysis with the statistics method implemented to obtain subgroups on pain, fatigue, and psychosocial factors. Multivariate analysis, linear regression models, and discriminant analyses are the statistical analysis performed on the variables of clusters to achieve their target. The low, medium, and active levels of inflammation were three subgroups of RA patients derived using cluster analysis which further supports to best fit the data. Nearly 47.3% of patients had average to high levels of pain and fatigue. The majority of patients had minimum symptoms of inflammation but high levels of fatigue, anxiety catastrophes, and sleep disorder, characteristic of chronic pain symptoms.

## 71.3 Comparative Study

This section exhibits the summarization of the literature review in three different table formats. Table 71.1 explicitly shows the objective-based on Proposed Algorithm/Statistical Analysis for Rheumatoid Arthritis. Table 71.2 reports the objective-based on the existing machine learning algorithm for rheumatoid arthritis. And finally, Table 71.3 provides a study on the various dataset used in RA for ML and the conclusion arrived from the research work.

**Table 71.1** Summarized literature review based on proposed algorithm and statistical analysis for rheumatoid arthritis

| Author/year | Title | ML category | ML methods | Proposed algorithm/statistical analysis (if any) | Execution environment | Contribution |
|---|---|---|---|---|---|---|
| Shanmugam et al. (2018) | Design of Rheumatoid Arthritis Predictor Model Using Machine Learning Algorithms | Supervised learning | Classification algorithms – AdaBoost, SVM, and ANN | Machine learning based ensemble analytic approach (MLEAA) | Hadoop framework and rapid miner tool | RA prediction with use of data mining and big data framework |
| Shiezadeh et al. (2015) | Diagnosis of Rheumatoid Arthritis Using an Ensemble Learning Approach | Supervised learning | Decision tree algorithms – C4.5, ID3, CHAID, J48, SVM, KNN, and AdaBoost | Cuckoo search – boost algorithm | MATLAB, SPSS modeler | New classification algorithm called CSBoost along with cuckoo search and AdaBoost methods |
| Feng et al. (2015) | Poster: Classifying Primary Outcomes in Rheumatoid Arthritis: Knowledge Discovery from Clinical Trial Metadata | Supervised learning | Random Forest and J48 | NA/Friedman test | NA | KDD process for RA outcomes |
| Chin et al. (2015) | Mining Disease Risk Patterns from Nationwide Clinical Databases for the Assessment of Early Rheumatoid Arthritis Risk | Supervised learning | Association rule mining | NA/Student's t-test and the frequency and distribution of continuous variable for all patients | NCBI E-utilities web series (SOAP) | Framework for prediction of RA using data mining techniques |

**Table 71.2** Summarized literature review of machine learning algorithm in RA research

| Author/year | Title | ML category | Existing ML algorithm | Execution environment | Objective |
|---|---|---|---|---|---|
| Yoo et al. (2017) | A Study on Prediction of Rheumatoid Arthritis Using Machine Learning | Unsupervised learning | K-means clustering algorithm | R program | Analyze RA using machine learning patterns |
| Parsania et al. (2015) | Comparative Analysis of Data Mining Algorithms on EHR of Rheumatoid Arthritis of Multiple Systems of Medicine | Supervised learning | Classification algorithms – BayesNet, Naïve Bayes, ZeroR, JRIP, OneR, and PART | WEKA tool | Comparative study of RA using classification algorithms |
| Garcia-Zapirian et al. (2015) | Machine Learning Techniques for Automatic Classification of Patients with Fibromyalgia and Arthritis | Supervised learning | AdaBoost classifier and SVM | NA | Study about the presence and influence of fibromyalgia with RA using medico-social and psychopathological features obtained from questionnaires |

**Table 71.3** Summarized literature review with RA datasets and its outcomes

| Author/year | Data source/dataset used | No. of instances | No. of features/vital features analyzed | Outcomes |
|---|---|---|---|---|
| Yoo et al. [1] (2017) | Eulji University Hospital, Korea | 60 (RA patients) | 4/RA factor > 7, anti-CCP > 18, SJC > 4, ESR >25 | The result indicated 84% or more RA patients predicted through the explanatory model. The result of selecting the two factors and finding the correlation is higher than selecting only one parameter |
| Parsania et al. [2] (2015) | Electronic health record (EHR) | 100, 500, and 1000 | Ayurvedic and Allopathic system of medicine [11] | Naive Bayes achieved better performance |
| Shanmugam et al. [3] (2018) | Various hospital from Coimbatore region | NA | 45/gender, age, disease activity, RF, ACR Criteria[a], Joints[b], and HLA DRB1 | Results shown that the classifiers with AdaBoost are with 85% accuracy rate in RA prediction |
| Shiezadeh et al. [4] (2015) | Shiraz University of Medical Sciences | 2564 (RA patients) | >600-> 72 ->18 final features/joint count, ESR, PIP, pj9, pj11, DIS, pj58, sex, pj57, MCP, pj8, pj10, pj12, age, duration, MTP, pj59, and marital stat | Experimental results show that the CSBoost algorithm enhances the accuracy rate along with AdaBoost |
| Garcia-Zapirian et al. [5] (2015) | Ambulatory centers in Neiva, Colombia (Jan. 2013–2015) | 53 women with FM and 74 women with RA | Psychopathologic features[c] and Medical Social features[d] | The result concludes that the psychopathological features are critical to the correct classification, with the medical social features it achieves a high percentage on AdaBoost algorithm to classify the patients with FM and RA |
| Feng et al. [6] (2015) | ClinicalTrials.gov | NA | ACR20, DAS28, AE, and SAE | Early prediction of RA using metadata clinical trials and outcomes with acceptable accuracy |
| Chin et al. [7] (2015) | NHIRD (RA patient, 1997–2008), Taiwan | 1314(RA) and 956,279 (non-RA patient) | inflammatory disorders[e] | Study shown that the psychiatric disorder and AD influences RA |

(continued)

**Table 71.3** (continued)

| Author/year | Data source/dataset used | No. of instances | No. of features/vital features analyzed | Outcomes |
|---|---|---|---|---|
| Catia Sofia Taden Botas [8] (2017) | Reuma.pt database developed by the Portuguese Society of Rheumatology(SPR) | 719 (424 patients taking several biologic treatment) | 40 static and 293 dynamic attributes. Panel Data[f] | The result is better with ReumaBImp dataset, after applying the feature selection and the use of data representation and data summarization in different perspective achieves a good result |
| Lee et al. [9] (2014) | Brigham and Women's Hospital RA Sequential Study (BRASS) | 169 (RA patients with pain score of >0) | Clinical characteristics of the patients[g] and sociodemographic and clinical characteristics of RA patients[h] | Study identified the life style influences RA |

[a]Malar rash, Discoid rash, Photosensitivity, Antinuclear Antibody, and Oral ulcers.
[b]Spine, Proximal Intephalangeal, Distal Interphalangeal, Wrist, Shoulder, Hip, Knee, Ankle, Metatarsophalangeal, Elbow & Foot proximal interphalangeal.
[c]Symptom Checklist-90-R [14], total scales like Global Severity Index (GSI), Positive Symptom Distress Index (PSDI), and Positive Symptom Total (PST).
[d]Social stratum of the participants, age, VAS, occupation, years in school, years with disease, average family income per month and their medication.
[e]Many inflammatory disorders have been discussed alongside RA, such as asthma, atherosclerosis, conjunctivitis, cystitis, dental caries, enthesopathy, erosion of cervix disease, eczema, endocervicitis, fasciitis, gastroenteritis, laryngitis, Meniere's disease, mitral valve disorders, carpal tunnel syndrome, periodontitis, pulpitis, synovitis and tenosynovitis, tonsillitis, ulcers, urticarial, and vaginitis.
[f]The data consists of lifestyle habits, disease activity, functional assessment scores, previous and current therapies, laboratory measurements, and response to biologic treatment registered at each visit. This data is known as panel data.
[g]Swollen joint count, BPI (Brief Pain Inventory) pain intensity, Fatigue, Sleep problems, Hospital Anxiety and Depression Scale depression, Illness burden, and Pain catastrophizing.
[h]Age, Female, White, BMI, Disease duration, Rheumatoid factor positive, DAS28-CRP [15], Tender joint count (28), Patient's global assessment of disease activity (0–100), Physician's global assessment of disease activity (0–100), Sharp/van der Heijde erosion score (0–160), Sharp/van der Heijde joint space narrowing score (0–120), RADAI [16, 17] joint count (scale 0–10), Widespread Pain Index [19] (scale 0–19), Polysymptomatic features [20] of chronic widespread pain (scale 0–31), BPI-sf [18] pain intensity score, Fatigue score, Current DMARD use, Current biologic DMARD use, Synthetic DMARD use, Past use DMARDs, Past use biologic DMARDs, and Past use synthetic DMARDs.

### *71.3.1 Summarized Literature Review Based on Machine Learning*

## 71.4 Analysis and Direction of Study

The comparative study concentrated on the computational contribution done on RA caused from AD. There are many innovative contributions and implementation of existing combinational techniques. Most of the researchers contributed their work in data mining and optimization techniques. From the overall study, the following are the remarkable findings and shortfalls in the contributions of RA and AD respectively:

- Many types of research shows that data mining with optimization techniques gives better performance in RA research.
- Classification techniques gave better performances.
- Since RA contains distinct biological attributes, Naive Bayes algorithms are a probabilistic technique that handles distance valued attributes smoothly and gives better results.
- There are no semi-supervised approaches, or any combinational approaches are not considered in RA and AD research.
- The clinical data of RA patients have to be stored consistently in a distributed environment for diagnosis and treatment enhancement. Data analytics techniques are going to apply in early decision making for RA.
- To create the centralized AD database, cloud storage, and distributed databases are needed. In the future, the research extended to be in advance database storage techniques.
- The remote monitoring patient monitoring model using IoT and mobile healthcare environmental support mechanisms will give better treatment and diagnosis for AD and RA patients.

## 71.5 Smart Healthcare Monitoring Model Using IoT and Big Data

The existing study states the need for the maintenance of electronic health records is mandatory, for both early prediction of AD and diagnosis, once it occurs. The following components are essential for the advancement of the existing processes.

| | | |
|---|---|---|
| *EHR* | – | Electronic health record |
| *ERPMS* | – | Environment Supported Patient Monitoring System (IoT) |
| *Big Data* | – | Storing and analyzing AD and RA data |
| *AD RA Prognosis Model* | – | To analyze and decision-making |

The proposed framework will be the solution in advance for predicting RA caused by AD. The primary clinical data to be stored and analyzed using hidden biomarkers associated with AD and RA symptoms. This model aid in future development and the experimental outcome of our study.

## 71.6 Conclusion

During recent years, notable progress in medicines to heal rheumatoid arthritis was present. From the study, many supervised and unsupervised machine learning algorithms predicted the RA occurrences. The recent RA occurrence in the world population initiated research for further exploration. From the medical point of view, many medicines and advanced testing mechanisms have started. To find disease, to predict RA in advance, and for better treatment solutions, computational techniques have applied. This paper focuses on the study of the contribution made using machine learning techniques in RA research. The outcome of the study reveals most of the research confined to certain levels after finding partial solutions and suggestive pathways. Therefore, the machine learning techniques associated with the RA disease type and their contributions have discussed. This work will be helpful for researchers who are in the field of computational research in RA.

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# Chapter 72
# Coloring Vertices of a Graph Using Parallel Genetic Algorithm


**Shoeb Ahmad, Yumna Fatma Farooqi, and Anand Rai**

## 72.1 Introduction

The problem of graph coloring is a famous NP-complete problem. The graph coloring problem is the problem of assigning colors to elements of graph. Even though the graph coloring algorithm includes the coloring of vertices or edges or faces, the term graph coloring however usually refers to vertex coloring. This paper also the term graph coloring to for coloring vertices of a graph.

The problem of graph coloring is defined as the coloring of vertices in a graph such that no adjacent vertices have the same color using a limited number of colors. This paper also tries to find the minimum number of colors that can be used to achieve such a condition that is the chromatic number of the graph using heuristic techniques.

Graph coloring problem is very interesting from the theoretical aspect as it belongs to the set of NP-complete problems. The practicality of graph coloring problems includes but is not limited to map coloring:

1. Scheduling [1]
2. Register allocation [2]
3. Pattern matching
4. Filling in Sudoku
5. Map coloring
6. Radio frequency assignment [3]

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## 72.2 The Proposed Algorithm

The approach proposed is to use parallel genetic algorithm [4] which is an evolutionary technique [5] to solve the graph coloring problem. Two algorithms are used, both of which run independently. They both use different fitness function and produce their own results. They also try [6] to calculate heuristically the near-correct chromatic number. Two randomly generated data sets are created, and each algorithm receives one set of chromosomes.

### *72.2.1 Encoding*

In a genetic algorithm, a solution is encoded in the form of a chromosome. In our proposed work, a chromosome or a candidate solution is represented as an array of N elements where N is the number of vertices. Each color is represented uniquely by a number, and each vertex in a graph having N vertices is represented uniquely by any number from 0 to N−1. In a chromosome or in a candidate solution, the value at any index i of the array represents the color used to color the vertex i. For example, for a five-vertex graph as shown in Fig. 72.1, a chromosome could be represented as shown in Fig. 72.2, and it means that in the five-vertex graph, vertex number 0 is colored with color number 1, vertex number 1 is colored with color number 3,vertex number 2 is colored with color number 3, vertex number 3 is colored with color number 2, and vertex number 4 is colored with color number 1.

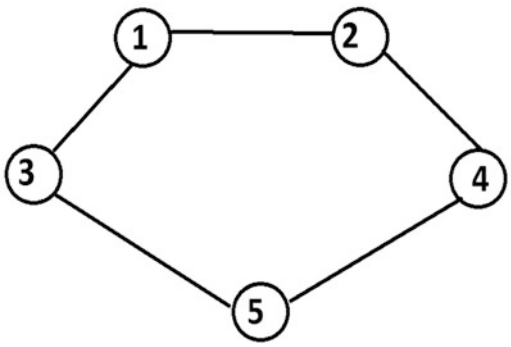


**Fig. 72.1** A five-vertex graph

| 1 | 3 | 3 | 2 | 1 |
|---|---|---|---|---|

**Fig. 72.2** A sample chromosome

### *72.2.2 Algorithm 1*

**Step 1** Create a population of randomly generated 100 chromosomes and initialize tentative chromatic number to an N, where N is the number of vertices.

**Step 2** Calculate the number of collisions for each chromosome, i.e., the number of times we found a vertex having the same color as its adjacent vertex. If the number of collisions is zero, then count the number of colors used, and if it is less than the current tentative chromatic number, then make it a new tentative chromatic number.

**Step 3** Calculate fitness function for each chromosome as the inverse of the number of collisions.
If the number of collision is greater than or equal to 1
Fitness function = 1/number of collisions
If the number of collision is 0
Fitness value = 2

**Step 4** Arrange in non-increasing order of fitness value

**Step 5** Repeat the following 50 times

**Selection**: Select parent1 by randomly selecting one of the chromosomes among the top 50 chromosomes with high fitness value
Select parent2 by randomly selecting one of the chromosomes among the top 50 chromosomes with high fitness value

**Crossover:** Select a random number from 0 to N−1; the selected number will act like the crossover point.
Exchange the content of the chromosome to the right of the crossover point, thus making two new chromosomes.

**Mutation:** With a probability of 0.005, do the following on each of the newly formed chromosome:
Select two random numbers from 0 to N−1 and exchange the value at these two indices.

### *72.2.3 Algorithm 2*

**Step 1** Create a population of randomly generated 100 chromosomes and initialize tentative chromatic number to N, where N is the number of vertices.

**Step 2** Calculate the number of collisions for each chromosome, i.e., the number of times we found a vertex having the same color as its adjacent vertex. Also calculate the number of colors that resulted in conflict. If the number of collisions is zero, then count the number of colors used, and if it is less than the current tentative chromatic number, then make it a new tentative chromatic number.

**Step 3** Calculate fitness function for each chromosome as per given formula.
If the number of collision is greater than or equal to 1, then fitness function = colors conflicting/number of conflicts.

If the number of collision is 0, then the fitness value =2

**Step 4** Arrange in non-increasing order of fitness function.

**Step 5** Repeat the following 50 times.

**Selection:** Select parent1 by randomly selecting one of the chromosomes among the top 50 chromosomes with high fitness value.
Select parent2 by randomly selecting one of the chromosomes among the top 50 chromosomes with high fitness value

**Crossover:** Select a random number from 0 to N−1; the selected number will act like the crossover point.
Exchange the content of the chromosomes to the right of the crossover point, thus making two new chromosomes.

**Mutation:** With a probability of 0.005, do the following on each of the newly formed chromosome:
Select two random numbers from 0 to N−1 and exchange the value at these two indices.

Both these algorithms are run for 25,000 generations.

## 72.3 Conclusion

The algorithm used here is a parallel genetic algorithm. It uses two algorithms which run independently of each other. The algorithm also estimates heuristically the chromatic number of the graph. The result is a quick shift toward the optimum solution. The algorithm also gives the near-correct estimate of the chromatic number. This algorithm can be extended to be applied to edge coloring or face coloring.

**Compliance with Ethical Standards** All author states that there is no conflict of interest. We used our own data.

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# Chapter 73
# Survey on Sanskrit Script Recognition


**Shubham S. Bhurke, Vina M. Lomte, Pranay M. Kolhe, and Akshay U. Pednekar**

## 73.1 Introduction

Optical character recognition(OCR) is a popular approach utilized for recognizing text found in images and convert it into a machine-editable text so that identification of the text with the help of humans becomes faster, efficient, and easy. The Error rates caused by using OCR are less, whereas human errors can be more. Training the OCR efficiently can highly minimize error rates.

## 73.2 Working

### *73.2.1 Pattern Recognition*

Pattern recognition is the technique used to identify different writing style of a single letter, word, or sentences too (Fig. 73.1).

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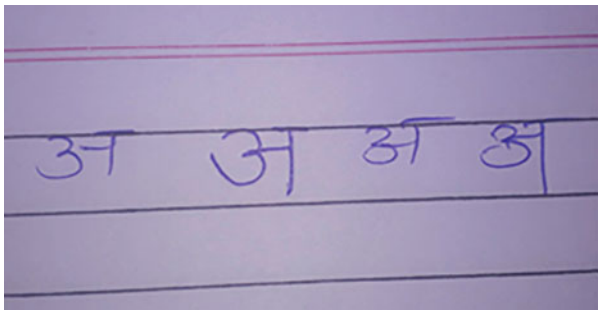

**Fig. 73.1** Different ways of writing a Marathi Alphabet

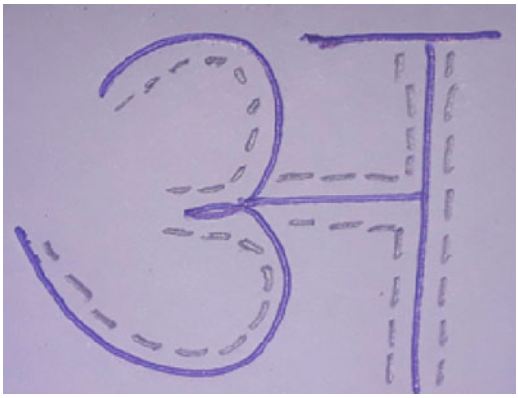

**Fig. 73.2** Identification of geometric patterns

### *73.2.2 Feature Extraction*

Feature detection action will identify the relevant features for identifying the characters present in the image. It does the work of identifying the geometrical shapes like semi-circles, slanting lines horizontal and vertical lines, arcs, etc. (Fig. 73.2).

The recognition of handwritten Sanskrit text is complex when compared to machine-printed text as there can be more noise in the handwritten Sanskrit text (Figs. 73.3 and 73.4).

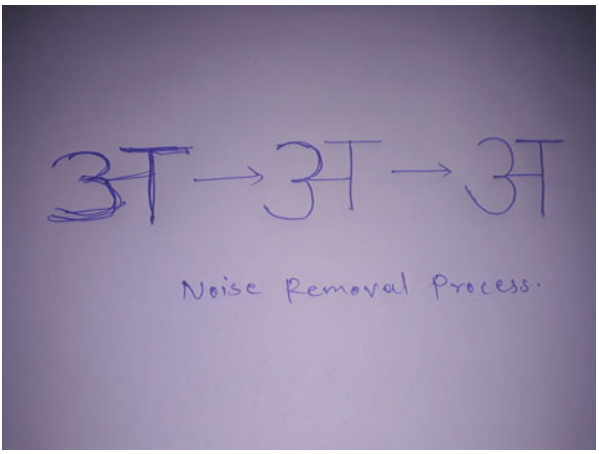


**Fig. 73.3** Noise Removal Demonstration

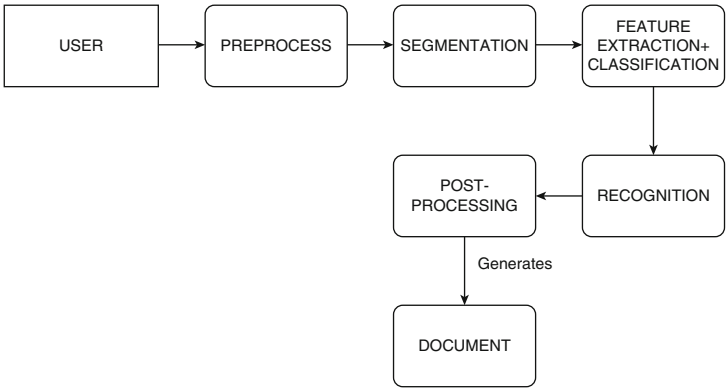


**Fig. 73.4** Workflow

## 73.3 Applications

### *73.3.1 Digitizing Old Documentation*

Many Pothos, Vedas, Bhagavad Gita, Ancient Articles, etc. are written in Sanskrit language. Such old documents degrade with time. Therefore, preserving these documentations using OCR can efficiently be done.

### *73.3.2 Healthcare*

OCR can be used in healthcare to process paperwork such as Doctor's prescriptions in order to save manual work.

### *73.3.3 Banking*

In banking sector cheques can be applied with OCR to reduce manual intervention required to manually add beneficiary name, cheque amount, date, etc.

## 73.4 Methodological Survey

Every research has its own ideology of implementation. A paper had proposed a standardized path recognition algorithm that could build powerful classifiers for acceleration-dependent handwriting and gesture recognition. This system contains acceleration acquisition and signal processing. It also includes the primitive methods of generation and selection as well as the extraction process of the features. The overall handwritten digit recognition rate achieved was 98%, and the gesture recognition rate was 98.75% [1].

A residual convolutional neural network is proposed to solve the task of scene text recognition. The convolutional neural network (CRNN) is achieved by integrating convolutional neural network(CNN) and recurrent neural network(RNN). The CNN does the work of extracting features, and the RNN will encode as well as decode the feature sequences. The Accuracy for both the models Model I and Model J is 90.8%(IC03), 86.5%(IC13) and 91.5%(IC03), 88.7%(IC13) respectively [2].

Recognition of Malayalam characters with the help of wavelet energy and extreme learning machine (ELM) cuts down noise levels of text at different levels. The Accuracy achieved was- ELM- 95.59% by db6 [3].

A recent system will detect the scenes containing text using a unique text-attentional convolutional neural network (text-CNN). It targets text-related sectors found in these images. The Accuracy achieved by testing at various datasets are- ICDAR 2011 - 91.7%, ICDAR 2013 - 93.0%, MSRA-TD500 - 81.0% [4].

A combinational HMM/ANN system for recognizing non-parameterized off-line handwritten text lines was proposed. This method implements techniques to remove slopes and slants from handwritten text lines. The Accuracy and Word Error Rate was 54.3% and 29.8% respectively [5].

An efficient filter based on hybrid approach is required to refine non-text garbage, and a conditional random field with binary components will establish a relationship with these properties to provide a supervised parameter for learning. Accuracy achieved using ICDAR 2005 Dataset was 68.5% [6].

For detecting images in natural scenes, we require a sliding window algorithm which will use stroke width transformation to recognize the text in the image, but it is not efficient for images which are of low resolution and hence will require large amount of time for post-processing. The Accuracy by proposed method for the following dataset- ICDAR 2011:Precision - 0.84,Recall - 0.76, F-measure - 0.80, ICDAR 2013: Precision - 0.88, Recall - 0.74, F-measure - 0.80, SWT: Precision - 0.68, Recall - 0.53, F-measure - 0.60 [7].

Strokelets are midlevel primitives which automatically learn from characters annotations and also the substructures of different granularity. The histogram feature is achieved from identifying individual characters. The Accuracy achieved for- Bag of Strokelets:- 80.7, HOG:-83.2 Bag of strokelets+HOG:-85.6 [8].

Convolutional recurrent neural network is a union of deep convolutional neural networks and recurrent neural networks. It's implemented on coarse level words without needing any extra information for characters. There is no dependency on connected layer of neural networks make it an efficient model. Accuracy achieved for Clean Dataset- 75.1%, Synthesized Dataset- 81.7% and Real-World Dataset- 84.3% [9].

Handwritten Sanskrit words in this research work is recognized using pre-processing segmentation. Freeman chain code is used to represent technique of an image character [10].

A new method of R-CNN creates region of interests(RoI) using a method known as region proposal network(RPN). This generates a multiresolution feature maps which detect texts. But this method cannot detect all types of texts and is confined to horizontal texts. The percentage of various parameters are Precision - 90.2 %, Recall - 81.10%, F- measure - 85.42%, Speed - 0.12 [11].

Deeptext uses prior bounding boxes and ambiguous text category (ATC) data for text detection as well as multilevel region-of-interest pooling (MLRP). This method will classify the text as well as non-text to achieve precise localization. The Iterative bounding box voting scheme and a filtering algorithm filters to provide only the most suitable bounding box for each text instance. The accuracy achieved for ICDAR 2011- F-measure- 0.83, ICDAR 2013- F-measure- 0.85 [12].

Image processing is done through Matlab's neural network. Artificial neural network works well in high noise images, but it is highly dependent on the extraction algorithm [13].

A recent method obtains features by subdivision of characters combined with two step classification team. The accuracy achieved over CEDAR character database is 94.73% and MNIST Database- 99.03% [14].

Deep learning approach when applied with conditional random field classifier give a better output of F-measure. Deep bidirectional LSTM (long short-term memory) design produces high output but is not reliable in unsupervised annotation of sentence boundaries [15].

Scene text localization and detection is done using a composite hybrid and novel approach. Components in raw scene images are detected by FEPS-MSER through and efficient speedily guided filter, edge smoothing, and also eliminating pixels mixed over the edges. Accuracy achieved was 90.56% using benchmark dataset [16].

System is developed using Android, and it even provides us with an insight to algorithm design and performance improvement for extraction in scene text. Accuracy achieved for Chars74K EnglishImg accuracy rate (AR)-0.726, False Positive Rate(FPR) -0.078 Sign: AR-0.868, FPR - 0.075 ICDAR 2003: AR-0.536, FPR- 0.180 [17].

The implemented approach practices wavelet multiresolution analysis to extract features and feedforward back-propagation neural network to achieve recognition tasks. Accuracy achieved was 92% [18].

A DTW-based algorithm is implemented that includes signal pre-processing, motion detection, finding inertial signal, and selecting templates. A basic intra-class to best inter-class using template selection is built. Accuracy achieved for 3D and 2D is 99.80% and 93% respectively [19].

An offline recognition of Chinese texts (unconstrained) is presented. Evaluation of path is done by integrating character classification course geometric and linguistic contexts from Bayesian decision [20].

## 73.5 Live Survey

Some organisations promoting Sanskrit can be found on the website-

1. Sanskrit and Vedic Institutions: https://mhrd.gov.in/sanskrit-vedic-institutions
2. Samskrita Bharati: https://en.wikipedia.org/wiki/SamskritaBharati
3. Sanskrit and Indology Organisation: http://sanskrit.samskrutam.com/en.sanskrit-indology-directory-organisations.ashx

## 73.6 Methodology

| Citation | Segmentation | Feature Extraction | Classification |
|---|---|---|---|
| 1 | Linear Discriminant Analysis | LDA Strategy | Matrix Based Classification |
| 2 | – | VGG or ResNet Model | Multi-class Classification |
| 3 | – | Wavelets | 1. Detail sub-bands 2. Approximation sub-bands |
| 4 | Text-CNN with trained text region segmentation | – | 1. Novel Text-CNN classifier |
| 5 | – | Using grids on the image to obtain 3 values regarding each cell | 1. Slope-MLP 2. Normalize-MLP 3. Slant-MLP |
| 6 | Niblack's Local Binarization Algorithm | MST Building,Edge Cuts | 1. SLPClassifiers 2. MLPClassifiers 3. SVMClassifiers |
| 7 | – | 1. Symmetry axis detection 2. Connected component extraction | 1. CNN classifiers 2. Random Forest classifier |
| 8 | – | Robust character identification and recognition | SVM |
| 9 | Not Required | CRNN(Convolutional Recurrent Neural Networks) | – |
| 10 | Basic Line, Character, Word, Zone Segmentation | – | 1. Printed Character recognization System 2. Handwritten Charater recognization System |
| 11 | – | Multi-RPN (region proposal network) trained using receptive field and setting special anchors | More effective cnn classifier through training VGG16 model, RPN loss function and Faster R-CNN loss function in each repetition |
| 12 | Labelling Process | Diagonal Feature Extraction Scheme | Neural Classifier |
| 13 | Bounding Boxes | Multi-level region of interest pooling(MLRP) | Text and Non-text Classification |
| 14 | Size Normalization | Recursive sub-division of images used for extraction | Two-stage Classification |
| 15 | – | Robust character identification and recognition | SVM |

(continued)

| Citation | Segmentation | Feature Extraction | Classification |
|---|---|---|---|
| 16 | ICDAR | morphological features | – |
| 17 | 1. Adjacent | 1. Pixel-based layout analysis | binary character grouping algorithm 2. Boundary clustering algorithm classifier |
| 18 | Bilinear Interpolation Technique | 1. Daubechies (db4) wavelet | – |
| 19 | Filter Acceleration | Template Genrator | – |
| 20 | character candidate lattice | Candidate Pattern | Statistical language models (SLM) |

## 73.7 Detailed Methodology

| Citation | Pre-processing | Postprocessing | Dataset | Accuracy |
|---|---|---|---|---|
| 1 | General Motion Detection | – | – | LDA:-98% |
| 2 | – | – | MJSynth | Model I−90.8(IC03) 86.5(IC13) Model J−91.5(IC03) 88.7(IC13) |
| 3 | ELM(Extreme Learning Machine) | - | Multiple Datasets such asdb1, db2,db3,sym3,etc | ELM−95.59% by db6 |
| 4 | 1. Sliding- | – | ICDAR 2011 ICDAR 2005:window 2. Two-layer CNN 3. MSERs detector ICDAR 2013 MSRA-T D500 | Precision −0.87,Recall −0.73,F-measure-0.79 ICDAR 2011: Precision – 0.91 Recall− 0.76, Fmeasure −0.82 ICDAR 2013: Precision −0.93 Recall − 0.73,F-measure-0.82 MSRA-TD500: Precision −0.76 Recall− 0.61,F-measure-0.69 |
| 5 | Multilayer Perceptron-MLPs | – | IAM Database v3.0 | Accuracy-54.3 Word Error Rate(WER)−29.8 |

(continued)

| Citation | Pre-processing | Postprocessing | Dataset | Accuracy |
|---|---|---|---|---|
| 6 | Text Region Detector | Learning-based energy minimization method | ICDAR 2005 Multi-lingual | 1st ICDAR 2005- 64.4% 2nd ICDAR 2005- 60.0% Proposed Model- 68.5% |
| 7 | 1. Maximally Stable Extremal Regions(MSER) 2. Slidingwindow scanning | – | ICDAR 2011 ICDAR 2013 SWT dataset ICDAR | 2011:Precision – 0.84, Recall−0.76,F-measure- 0.80 ICDAR 2013:Precision – 0.88,Recall −0.74,F-measure- 0.80 SWT dataset:Precision −0.68,Recall −0.53,F-measure- 0.60 |
| 8 | – | – | – | 91.56% |
| 9 | – | – | Synth | Clean Dataset−75.1 Synthesized Dataset−81.7 Real-World Dataset−84.3 |
| 10 | 1. Smootning and Denoising 2. Normalization | Mirror Image Learning | – | 94.74% |
| 11 | – | Non-maximum suppression (NMS) | 1. ICDAR2013 2. ICDAR2015 3. StreetView Text (SVT) 4. KAIST Scene Text Database 5.ICDAR2017 | Precision −90.2% Recall −81.10% F-measure− 85.42% Speed −0.12 |
| 12 | 1. Binarization Process 2. Sobel Technique | Recognizing index value of text samples to obtain ASCII values | Can be any Dataset for English language | – |
| 13 | Inception-RPN | – | ICDAR 2011 ICDAR 2013 | ICDAR 2011-F-measure−0.83 ICDAR 2013- F-measure- 0.85 |

(continued)

| Citation | Pre-processing | Postprocessing | Dataset | Accuracy |
|---|---|---|---|---|
| 14 | Niblack's Approach | – | Handwritten Character Databases-1. CIL Database 2. CEDAR Character Database CD-ROM-1 Handwritten Digit Database | Best for-1. CEDAR Character Database−9 4.73% 2. MNIST Database− 99.03% s-1. MNIST Database 2. CEDAR Digit Database CD-ROM-1 |
| 15 | – | – | – | – |
| 16 | 1. weighted median filter 2. guided filter | – | Benchmark dataset | 90.56% |
| 17 | 1. layout analysis of color decomposition 2. horizont allignment | 1. Discrete contour evolution 2. Skeleton pruning | 1. Chars74K EnglishImg 2. Sign 3. ICDAR 2003 | 1. Chars74K EnglishImg:accuracyrate (AR)−0.726, False Positive Rate(FPR) −0.078 2. Sign:AR−0.868, FPR −0.075 3. ICDAR 2003:AR-0.536, FPR- 0.180 |
| 18 | 1. Spatial Domain (by using filter masks) 2. Binarization 3. Vertical and Horizontal Scanning 4.LabellingPro-cess | – | Random Dataset having Malayalam Data | 92% |
| 19 | Moving Average Filter | Min Max Template Selection | – | 3D:-99.80% 2D:-93.0% |
| 20 | – | Hybrid language model | CASIA-H WDB | 90.75% |

## 73.8 Research Gaps

| citation | Research Gap |
|---|---|
| 1 | – |
| 2 | Deeper CNN must be used to achieve more accuracy |
| 3 | Small training errors may occur |
| 4 | – |
| 5 | Training the MLP requires labelling of every feature vector |
| 6 | Fails on some hard-to-segment texts |
| 7 | 1. Low contrast characters are not detected 2. Processing speed is relatively slow 3. Characters under strong light are also not detected |
| 8 | – |
| 9 | Performance boosting is not achieved even though depth of convolutional and recurrent layers are extended. |
| 10 | – |
| 11 | Only horizontal text is detected by Multi-RPN |
| 12 | Speed or accuracy is not better than OCR in terms of english text |
| 13 | There is still large scope for improvement with respect to recall and precision |
| 14 | Word Recognition |

## 73.9 Conclusion

As Sanskrit is known to be the language of God in India, it is very necessary to preserve all types of old documentation related to Sanskrit; this gives us the motivation to develop a system that properly identifies and convert images containing Sanskrit text to a document that stores all the recognized text. Multiple ways are presented in this survey which clearly state that each way has been selected according to the language which is provided as input data for the purpose of recognition. For example, algorithm used for recognition of English text may not perform well for Chinese, Malayalam, or any other text. There were multiple systems which were implemented for various languages, but no noteworthy work was observed in Sanskrit.

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# Chapter 74
# Feature Extraction for Software Defect Detection Utilizing Neural Network with Random Forest


**G. Ravi Kumar, S. Rahamat Basha, and G. Anjan Babu**

## 74.1 Introduction

Programming imperfection forecast is a basic movement in programming advancement; foreseeing the product bug early improves programming adaption to various situations and builds the asset usage. Programming imperfection forecast gauges where deficiencies are probably going to happen in the source code. Deformity expectation in programming is the way toward deciding pieces of a product framework that may contain absconds [1, 2]. It could likewise anticipate the defective module in the early stage is a genuine test in programming building. Early distinguishing proof of a blunder prompts a powerful portion of assets and diminishes the time and cost of building up a product and top-notch programming. There are a number of AI systems that have been proposed to programming flaw forecast issue.

The machine learning methods are utilized widely in programming shortcoming expectation issues to foresee the deficiency modules dependent on authentic flaw information, fundamental measurements, and diverse programming registering strategies [3, 4]. Hence, foreseeing the product blames in the prior stage improves the product quality, dependability, and productivity and lessens the product cost. Programming deformity forecast models are fabricated utilizing two approaches: first, by utilizing quantifiable properties of the product framework called program-

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ming measurements and, second, by utilizing flaw information from a comparable programming venture. When manufactured, the product expectation model can be connected to future programming ventures, and henceforth experts can recognize surrenders inclined pieces of a product framework.

Programming deformity expectation is a procedure of anticipating code regions that possibly contain surrenders, which can enable designers to allot their testing endeavors by first checking conceivably carriage code [5, 6]. Deformity forecast is fundamental to guarantee the dependability of today's large-scale programming ventures. Anticipating flawed units precisely enables engineers and chiefs to organize their activities in the product advancement cycle and to address these issues. In flawed programming, a broken unit may result in different components that are difficult to distinguish between human procedures, for example, code survey. Given the huge size, a number of lines of code and intricacy of a commonplace programming venture and a considerably more versatile methodology are required. Recognizing surrenders in programming code anyway turns out to be progressively troublesome because of the critical development of programming code base in both size and multifaceted nature. The significance and difficulties of programming imperfection forecasts have made it a functioning exploration zone in programming building [7]. With continuous frameworks winding up progressively intricate and flighty, halfway because of progressively complex necessities, customary programming advancement methods may confront challenges in fulfilling these prerequisites.

## 74.2 Feature Selection

Feature determination is a pre-preparing strategy utilized in AI to expel unessential and repetitive characteristics to expand learning exactness. Feature selection determination is a dimensionality decrease strategy that lessens the number of credits to a sensible size for preparing and analysis [8, 9]. In differentiation to other dimensionality decrease strategies, include choice doesn't modify the first list of capabilities rather chooses a subset by dispensing with every one of the features whose nearness in the dataset doesn't emphatically influence the learning model [10, 11]. In feature determination strategies, deciding the important and helpful features is one of the key strides in the information investigation process that improves the presentation, diminishes the age of information, and comprehends the qualities of information [12].

The arrangement of features utilized in model development in the main wellspring of data for any learning calculation, in this manner it is critical to choose an ideal subset that will be an agent of the first set. Choosing an ideal subset of applicable and nonexcess features is a difficult assignment. In this manner, there is a need to get an ideal subset of important and nonexcess features which will give an ideal arrangement without diminishing the order exactness.

## 74.3 Proposed Methodology

The proposed strategy can be comprehended as two stages. In the initial step, the learning calculation random forest was prepared and tried on the preparation set so as to choose the best features. The primary significance of this progression is to gauge feature positioning an incentive for each element, after that every one of these features will be rank all together dependent on input features positioning worth. So in this progression, highlights were chosen. In the second step, the chosen selected features were utilized to prepare the neural network classifier with the goal that characterization exactness was improved. Figure 74.1 delineates the structure of the proposed methodology.

Dimensionality reduction assumes an extremely significant job in machine learning, particularly when you are working with many great features. Random forest was utilized to perform include extraction of features in the first phase, while artificial neural network (ANN) systems were utilized to order programming surrenders in the subsequent stage. The random forest as a component extractor was applied to programming imperfection information before preparing the ANN to decrease the measure of repetitive data.

### *74.3.1 Random Forest*

Random forest is a troupe learning technique dependent on characterization and relapse trees [13]. Each tree is prepared on a bootstrap test, and ideal factors at each split are recognized from an arbitrary subset everything being equal. Notwithstanding expectation, arbitrary trees can be utilized to appraise variable significance measures to rank factors by prescient significance. The random forest is utilized to get the component positioning qualities, and these qualities are applied to choose which features are disposed of in every emphasis of the calculation.

The system includes the development of a huge number of decision trees and inside irregular trees; haphazardness is utilized in the accompanying ways:

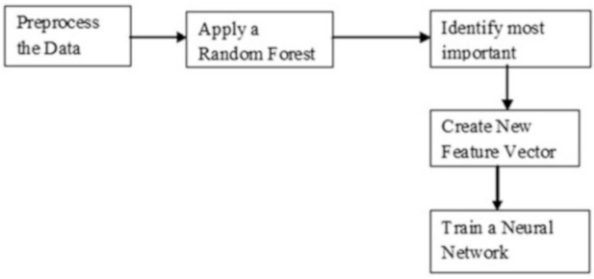


**Fig. 74.1** Proposed framework

firstly, every decision tree is built utilizing an alternate bootstrap test. Furthermore, during the development of every choice tree, every hub split includes the irregular determination of a subset of k factors, of which the best split is resolved. It is particularly useful for huge datasets with several input features since it decreases the commotion, intricacy and running time of the investigation.

### *74.3.2 Artificial Neural Network (ANN)*

An artificial neural network (ANN) is a data preparing worldview that is propelled by the manner in which a natural sensory system in the human mind works. ANNs are utilized broadly for the arrangement of various issues, including characterization, vision, discourse, design acknowledgment, control frameworks, and so on. A huge number of neurons present in the human cerebrum structure the key component of the neural system worldview and go about as rudimentary handling components [14]. These neurons are profoundly interconnected and work in association to tackle complex issues. A counterfeit neuron is a little preparing unit and plays out a straightforward calculation that is basic to the activity of a neural system. The model of a neuron contains the fundamental components like sources of info, synaptic loads, predisposition, adding intersection, and actuation work.

From a guest point of view, ANN can be partitioned into two significant classes dependent on their association topology: feedforward and feed-in reverse neural systems. Feedforward neural systems enable the sign to stream the forward way as it were. The sign from any neuron doesn't stream to some other neuron in the first layer. In feed reverse neural systems, the sign from a neuron in a layer can stream to whatever other neurons whether it very well may go before or succeeding layers. Figure 74.2 delineates the structure of this class of neural arrange.

## 74.4 Experimental Results

The work centers around choosing the significant features in the dataset utilizing arbitrary random forest and neural network system methods. We have used Python programming to experiment with the proposed framework. So as to approve the forecast aftereffects of the examination of the proposed technique, the 10-overlap

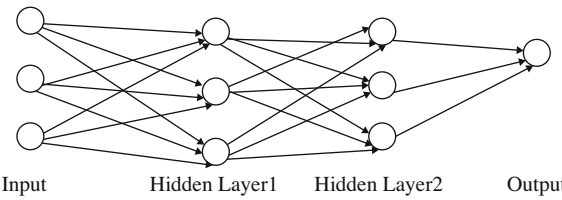


**Fig. 74.2** Structure of neural network

cross approval is utilized. The k-overlap cross approval is normally used to diminish the mistake that came about because of irregular inspecting in the correlation of the precision of various expectation models. The present examination separated the information into tenfold where 1 crease was for trying and ninefold were preparing for the 10-overlay cross approval.

### *74.4.1 Dataset*

The two datasets utilized a PROMISE Software Engineering Repository datasets which are acquired from NASA's Metrics Data Program information vault [15]. One is KC1 which is a C++ program that is involved coherent gatherings of PC programming segments inside an enormous ground framework and another is CM1 which is a NASA spacecraft instrument written in C program. These dataset details are shown in Table 74.1.

An arrangement parameter is utilized as a yield to demonstrate if the product class is defective or non-defective. The remainder of 22 code parameters is programming measurements. These multifaceted nature and size measurements incorporate surely understood lines of code (LOC) measures and Halstead and McCabe measures. Data comes from McCabe and Halstead features extractors of source code. The dataset features are shown in the Table 74.2.

### *74.4.2 Result and Discussion*

The ANN model applied in this investigation are three-layer feedforward neural systems of blunder back engendering with sigmoid enactment work for the exchange elements of info and concealed layer. This work centers around choosing the significant features in the dataset utilizing random forest is incorporating neural system arrangement. The result of the random forest top 10 features of the dataset is shown in Fig. 74.3.

It is seen that the proposed strategy, the forecast precision of KC1software imperfection expectation dataset is 84.90% without irregular random forest and 87.68% utilizing joined neural system arrangement with the arbitrary random forest. It additionally watched CM1 programming imperfection forecast dataset is 88.67%

**Table 74.1** PROMISE Software Engineering Repository datasets

| S. No | Dataset | No. of features | No. of instances | Class distribution |
|---|---|---|---|---|
| 1 | KC1/software defect prediction | 22 | 2109 | Defective – 326<br>Non-defective – 1783 |
| 2 | CM1/software defect prediction | 22 | 498 | Defective – 49<br>Non-defective – 449 |

**Table 74.2** CM1/software defect prediction attributes

| S. No | Attribute | Description | S. No | Attribute | Description |
|---|---|---|---|---|---|
| 1 | loc | Line count of code | 12 | t | Time estimator |
| 2 | v(g) | Cyclomatic complexity | 13 | lOCode | Line count |
| 3 | ev(g) | Essential complexity | 14 | lOComment | Line comments |
| 4 | iv(g) | Design complexity | 15 | lOBlank | Count of blank lines |
| 5 | N | No. of operators + operands | 16 | locCodeAndComment | |
| 6 | V | Volume | 17 | uniq_Op | Unique operators |
| 7 | L | Program length | 18 | uniq_Opnd | Unique operands |
| 8 | D | Difficulty | 19 | total_Op | Total operators |
| 9 | I | Intelligence | 20 | total_Opnd | Total operands |
| 10 | E | Effort | 21 | branch count | Of the flow graph |
| 11 | B | | 22 | defects | Defect/no defect |

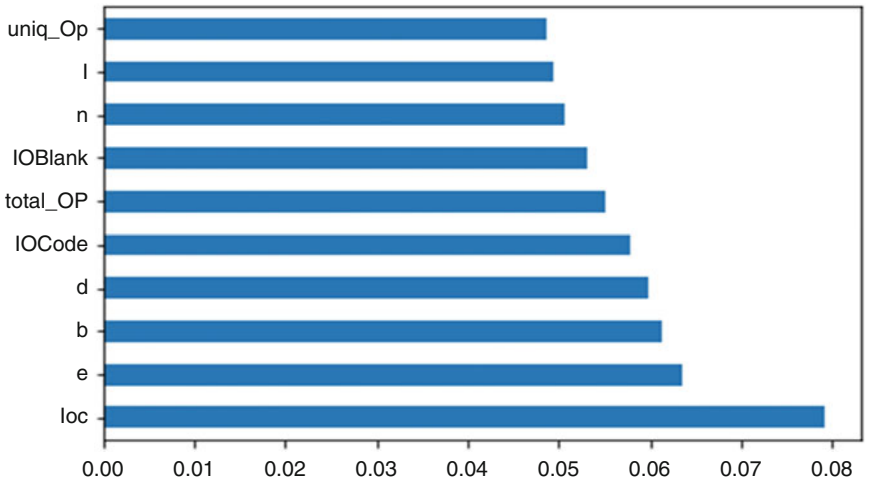


**Fig. 74.3** Top 10 features of weighted random forest

without arbitrary random forest and 90.23% utilizing the consolidated neural system with irregular random forest. These outcomes have appeared in Fig. 74.4.

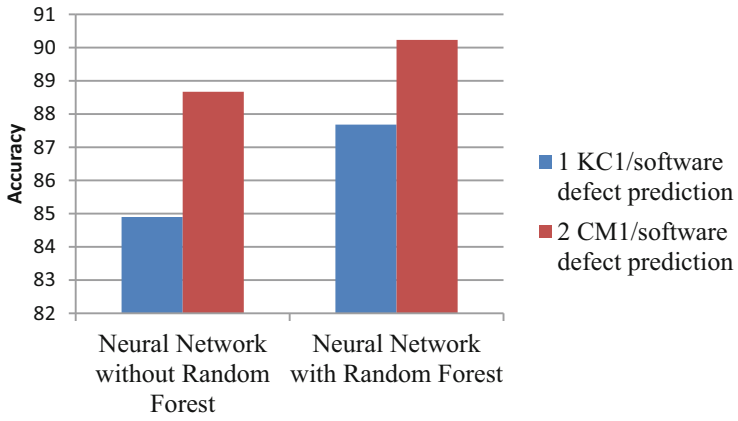


**Fig. 74.4** Performance of the proposed framework

At testing time, the model is utilized to make expectations for every product imperfection in the testing information, and model forecasts are thought about against the genuine programming modules.

## 74.5 Conclusion

Since the beginning and early location of inadequate programming parts encourages programming specialists to ideally profit by time and assets, expands the unwavering quality and improves the programming control process, this paper endeavored to propose a novel strategy to improve the precision of anticipating flawed programming segments. The proposed strategy profits by neural system calculation with random forest method. In this technique, another learning approach was used in feedforward with back proliferation calculation which expanded system productivity fundamentally. The outcomes show that the proposed technique has higher productivity when contrasted with just a neural system model.

**Compliance with Ethical Standards**

All author states that there is no conflict of interest.

We used our own data.

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# Chapter 75
# Sentiment Analysis for Airline Tweets Utilizing Machine Learning Techniques


**G. Ravi Kumar, K. Venkata Sheshanna, and G. Anjan Babu**

## 75.1 Introduction

Long-range social networking sites with the touchy development of social average organizations like Twitter, Facebook, YouTube, Google, Amazon, LinkedIn and Yahoo! have gained so much popularity and have produced a colossal measure of controlled and unstructured information consistently on the web [1, 2]. This exponential development of information prompts a few difficulties like preparing enormous informational indexes, extraction of helpful data from online platforms, creation of informational collections and so forth. In reality, business and associations consistently need to discover purchaser or general sentiments about their items and administrations. Though singular customers additionally need to know the assessments of existing clients of an item before acquiring it, and others' conclusions about political competitors before settling on a democratic choice in a political decision [3–5].

The significance of data on assessment and slant is persistently significant because it chooses the estimation of a specific business in market and aids in basic leadership process. The evaluation may be on a motion picture, an item or a facility. The hypothesis exploration is part of the natural language processing (NLP) and information extraction (IE) process that anticipates attaining the essayist's sentiments which are conversed into positive or negative comments and queries and require breaking down the massive loads of archives [6–8]. Assessment exploration in the same way represented as sentiment mining, which is the field of thinking

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that breaks down the person's beliefs like slants, estimations, examinations, state of minds and feelings in the direction of propositions. It is explained with examples like set of items, managements, associations, societies, individual concerns, circumstances and adduce and their indulgences [9, 10].

The primary undertaking in estimation examination is grouping the extremity of a given book at the archive, sentence or highlighted level whether the communicated feeling in a report, a sentence or a component is certain, negative or unbiased. Archive-level conclusion investigation is the order of the general feelings referenced by the commentator in the entire record message in positive, negative or impartial classes [11].

## 75.2 Sentiment Classification

The feeling categorization is normally figured as a two-class arrangement issue, positive and negative. Preparing and testing information exploit are ordinarily item surveys. Since online audits have rating scores allocated by their commentators, e.g. 1–5 stars, the positive and negative classes are resolved utilizing the evaluations [7, 12]. For instance, an audit with 4 or 5 stars is viewed as a positive survey, and a survey with 1 to 2 stars is viewed as a negative audit. Most research papers don't make use of the unbiased class, which makes the classification issue impressively simpler, yet it is conceivable to use the impartial class, e.g. doling out every one of the 3-star surveys the nonpartisan class.

There are two different ways of arrangements and they are (1) ML and (2) vocabulary-based methodology. In this paper, ML classifiers are actualized in wistful examination and are done in Twitter on the grounds that the majority of the government officials, acclaimed characters (even the leader of different states) and even broad individuals normally update their temperaments as tweets.

## 75.3 Proposed Methodology

The proposed methodology makes use of classifiers to arrange the opinion into positive, negative or neutral circumstances and consists of three stages of progression to meet the requirements. It includes data cleans and pre-processing, relevant feature extraction and sentiment classification using different ML techniques.

### *75.3.1 Data Pre-processing*

The data cleans and pre-processing of the information is one of the essential evolutions as it prepares the simple content for mining, i.e. it gets simpler to separate

data from the content and apply AI calculations to it. In the event that we avoid this progression, at that point, there is a higher possibility that you are working with loud and conflicting information. The target of this progression is to clean clamours that are less important to discover the feeling of tweets, for example, accentuation, extraordinary characters, numbers and terms which don't convey much weightage in setting to the content.

### *75.3.2 Feature Extraction*

The gathered dataset is utilized to separate highlights that will be utilized to prepare the assessment classifier [6, 13]. Experimentation is done utilizing n-gram double highlights. The way towards getting n-grams from the Twitter post is as per the following:

(i) **Filtering:** As part of the filtering criteria, we remove URL connections which are in datasets records before pre-processing.
(ii) **Tokenization:** Tokenization is the way towards separating a flood of content into words, expressions, images or other important components which are identified by tokens. The neglected of tokens turn out to be contribution for additional preparing. Intended for example, parsing or message data mining. Consequently the tokenization is helpful both in phonetics we portion message by parting it by spaces and accentuation marks.
(iii) **Removing stop words:** We expel articles *("an", "a", "the*") from datasets.

### *75.3.3 Machine Learning (ML) Techniques*

ML is make use of artificial intelligence (AI) that caters to frameworks with the capability to following that allow and improve to all intents and purposes without being expressly modified [14]. ML is a focal point around the progression of computer programs that conserve obtain to information and use it to be trained for themselves. There are different ML calculations, among them, we apply artificial neural networks (ANN), decision tree (DT) and support vector machine (SVM) level of computation. We fundamentally utilize SVM, NN and DT classifier to fit into the prepared dataset. In this examination paper, three ML calculations are actualized, and they are assessed to utilize diverse execution assessment parameters. Machine learning techniques are generally used for binary classification and predictions of sentiments as positive, negative or neutral.

### *75.3.4 Support: Vector Machine (SVM)*

Support vector machines (SVM) are supervised gadget acquisition knowledge of class method which makes use of a kernel function to map an entry with metric space whose elements are functions into a new function space where the training is rightly separable. The SVM is a statistical learning set of rules that classify the samples the use of a subset of schooling samples called support vectors [15]. The SVM depicts category by making use of arranging the N-dimensional hyper-plane in an order that appropriately separates the records into categories. It refers to the subsets of records referred to as the "support vectors", and it defines the margin as the space between the hyper-plane and the adjacent support vector [15]. The significance of the SVM is to separate the informational instances into two and training the use of example both from the training records to classify the keeping apart from hyper-plane.

### *75.3.5 Artificial Neural Networks (ANN)*

Artificial neural networks (ANN) are capable of modelling in every way complex problems that are typically using non-linear functions [15]. The ANN is constructed from a pattern or a neighbourhood of several interconnected nodes. Each of these nodes includes input/output data attributes that implement a nearby computation or features. The activation function perhaps a computation with weighted ($W$) sums of inputs ($I/P$) which generate an output ($O/P$) if it exceeds a given threshold level [7, 8]. The output irrespective of the result, may want to function an input to other neurons within the neighbourhood, this process repeated until a final output is produced.

### *75.3.6 Decision Tree (DT)*

Decision tree models are typically utilized in gadget gaining knowledge to study facts and induce the tree and its guidelines in an effort to be used to make predictions [15]. It is a classifier within the arrangement of a tree shape at which point every node is one and the other a leaf node, pointing the value of the criterion attribute or class of the instances, or a decision node. It infers a few explorations to be made on a single-attribute price while using one branch and sub-tree according to possible overall results of the assessment. The decision tree may be used to classify an instance is supported by beginning at the root of the tree and changing it until to reach a leaf node, that provides the category of the example.

## 75.4 Experimental Results

Three ML algorithms, i.e. neural networks, SVM and decision tree classifiers, will be utilized for directing the analyses on tweets of Twitter US airline sentiment dataset collected from Kaggle [16]. We will investigate each strategy as far as concerns me and assess its general execution. This Twitter US airline dataset contains 14,640 instances in which each tweet has been marked as positive, negative and neutral including 2363 positive, 9178 negative and 3099 neutral reviews. The investigation is finished by utilizing Python language, and we've utilized NLTK and scikit-learn's libraries for class of sentiments in the text.

The data is partitioned in two sets. The training set is 70% (10248) and 30% (4392) are applied for testing. Tweets regarding customer sentiment for six US airlines (American, Delta, Southwest Airlines, United, US Airways and Virgin America) were shown in Fig. 75.1.

### *75.4.1 Performance Metrics*

The performance metrics are assessed with the revelation of classifiers and the precision of each different classifier is recognized. The implementation of grouping calculations is approximated with dependent relative by means of the confusion matrix and the approximate point of the accuracy, precision and recall levels as shown in Table 75.1. Consequently, the learning has utilized the four conservative stages of assessment ability by means of accuracy, precision, recall and F1-score to consider the proficiency of the proposed strategy [15]. Hence the four measurements

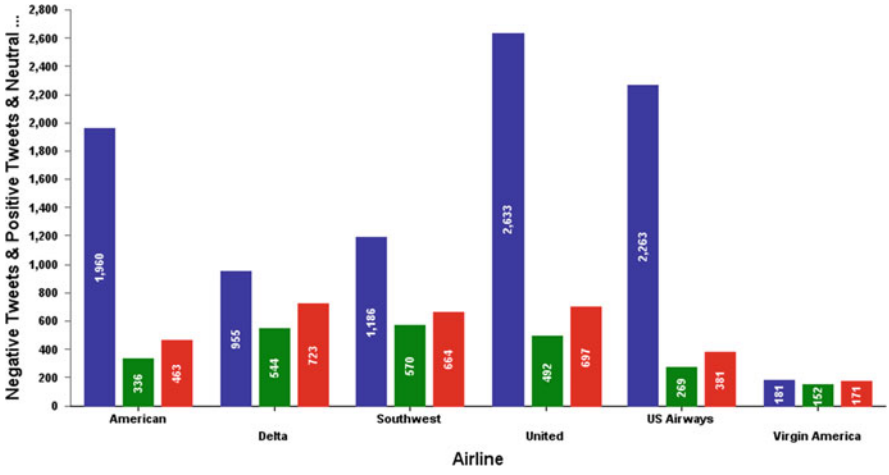


**Fig. 75.1** Tweet sentiments of six US airlines

**Table 75.1** Performance metrics of the various classifiers

| | | | |
|---|---|---|---|
| True positive (TP) = The number of positive samples is correctly predicted. | | | |
| False negative (FN) = The number of positive samples is wrongly predicted. | | | |
| False positive (FP) = The number of negative samples is wrongly predicted as positive. | | | |
| True negative (TN) = The number of negative samples is correctly predicted. | | | |
| Accuracy $= \frac{TP+TN}{TP+TN+FP+FN}$ | Precision $= \frac{TP}{TP+FP}$ | Recall $= \frac{TP}{TP+FN}$ | F1-Score $= 2 * \frac{\text{Precision}-\text{Recall}}{\text{Precision}+\text{Recall}}$ |

are commonly measured for a paired arrangement task with a positive and negative classes such category of inputs are addressed by resources of Table 75.1 with the performance metrics of the various classifiers:

The confusion matrix apiece respective classification methods are presented in Table 75.2 of the US Airline dataset with the confusion matrix of US airlines test data containing 4392 instances.

Every solitary of the parameters depends on confusion matrix framework which is brought forward in relation to the execution of every classifier. The qualities to enumerate the exhibition of the techniques (e.g., accuracy, precision, recall and F1-measure) are gotten from the confusion matrix framework and become visible in Table 75.3 and the same appeared in Fig. 75.2.

We observe the performance of machine learning algorithms in percentage (%) as shown in Fig. 75.2, and the best outcomes were given by neural networks classifier. The neural networks classifier accomplished 75.99% accuracy, SVM classifier 74.24% accuracy which is lower than the neural networks classifier (75.99%) and decision tree classifier 67.38% accuracy.

## 75.5 Conclusion

The airline business is a focused market. In the previous two decades, the business has extended and as yet growing its courses household and international with the extension in the web's improvement and better administrations driven by rivalry. The paper basically addresses the relative investigation of three machine learning calculations that can be utilized to separate sentiments from content of US airline sentiment Twitter dataset. The outcomes show that the neural networks technique got the best outcomes with an accuracy of 75.99%, precision of 75%, a recall of 76% and an F-measure of 74%.

**Table 75.2** The confusion matrix of US airlines test data contains 4392 instances

| Decision tree | | | | SVM | | | | Neural networks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Desired result | | | Output result | Desired result | | | Output result | Desired result | | | Output result |
| | Negative | Neutral | Positive | | Negative | Neutral | Positive | | Negative | Neutral | Positive |
| Negative | 2533 | 154 | 101 | Negative | 2364 | 304 | 120 | Negative | 2588 | 158 | 42 |
| Neutral | 717 | 144 | 58 | Neutral | 335 | 473 | 111 | Neutral | 506 | 351 | 62 |
| Positive | 339 | 65 | 281 | Positive | 155 | 115 | 415 | Positive | 231 | 94 | 360 |

**Table 75.3** Performance of machine learning algorithms in percentage (%)

| ML algorithms | Accuracy | Precision | Recall | F1-score |
|---|---|---|---|---|
| Decision tree | 67.38 | 63 | 67 | 63 |
| SVM | 74.24 | 74 | 74 | 74 |
| Neural networks | 75.99 | 75 | 76 | 74 |

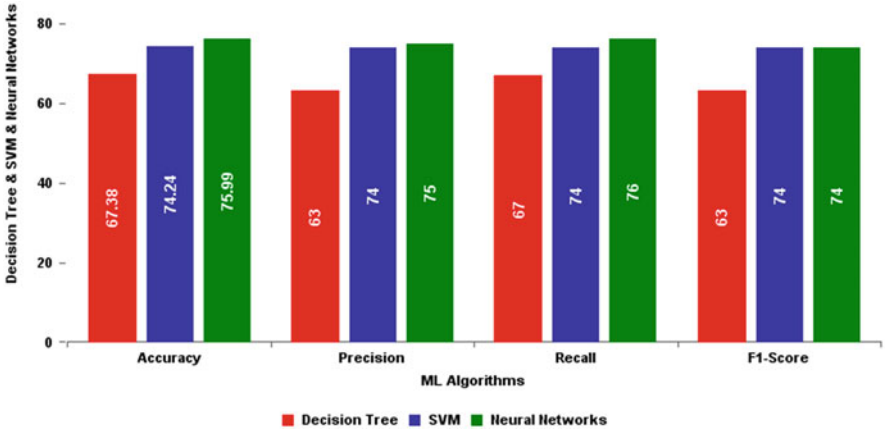


**Fig. 75.2** Performance of machine learning algorithms in percentage (%)

**Compliance with Ethical Standards** All author states that there is no conflict of interest. We used our own data.

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# Chapter 76
# The Innovative Biomarkers and Machine Learning Approaches in Gestational Diabetes Mellitus (GDM): A Short Review


**A. Sumathi, S. Meganathan, and Sundar Santhoshkumar**

## 76.1 Introduction

Gestational diabetes occurs in women during pregnancy period. The causes of GDM [1] may be acute or genetic. The factors influencing GDM are lifestyle, genetic disorders, and previous diabetic occurrences. The data mining techniques are widely used to predict the disease in advance using hidden biomarkers. GDM is one of the leading diseases which occurs to all races of women around the world. The risk of GDM leads to type II Diabetes after delivery to the mother and causes more life-threatening complexities to the infant during birth in a lifetime. The contribution of computer science in biological society is more essential and gives additional support to disease identification and decision-making. Each disease diagnosis tools are associated with software which contains standard testing mechanism. Today medical world requires real-time and dynamic data with historical data for better treatment and care. For that IoT, big data, cloud storage techniques are incorporated with medical data. All these techniques are used on the underlying concepts of data mining and machine learning. The Machine techniques are self-automated which works on exclusive inferential knowledge. The data mining [2] approach used ML [3] to find hidden patterns in large volumes of data. This research work aimed to find suitable classifier for GDM prediction in early stages. A recent study [4] has shown that multiple classifier approaches give good performance than single

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data mining techniques. The ensemble technique is a supervised learning approach that is flexible. The ensemble classifier adjusts itself by building a training set concerning the input data. Since GDM requires different parameters and biometrics for each biomarker concerning the patient, the ensemble classifiers could give better performance.

## 76.2 Machine Learning Approaches in GDM Research

A lot of research works are done in GDM with the use of single DM techniques and ML algorithms. However, it gives a standard solution for static problems in GDM diagnosis like disease prediction, prevalence, and normal tests in the gestation period. The study was affiliated with the contributions of collective use of data mining techniques and machine learning algorithms called ensemble methods. In the year 2013, Thach S. Tran [5] made a GDM prediction study in Vietnam with standard biomarkers age, BMI, and experimented pregnant women by screening OGIT (oral glucose tolerance test) which achieved higher accuracy rate.

In 2014 Srideivanai Nagarajan [6] proposed a new algorithm to improve the diagnosis of gestational diabetes using data mining techniques. This research paper also provides a study for some data mining techniques to analyze the performance of this proposed method. The authors who addressed this research work also throw light on the exploration and utilization of new technologies such as data mining to support the medical decision, which improves in diagnosing the risk for gestational diabetes.

In the year 2017, Hang Qiu [7] used a cost-sensitive hybrid model (CSHM) with logistic regression (LR), Bayesian network (BN), neural network (NN), support vector machine (SVM), and CHAID tree for training and testing the GDM test attributes. The result showed that the collective classifier approach using advanced supervised learning methods like bagging and boosting gives better results. Chang JM [8] in 2017 used placental chorionic surface vascular network (PCSVN) technique with the inclusion of random forest classifier to predict Autism disease possibilities of GDM occurrences in women.

In 2018, S. Saradha and P. Sujatha [9] developed a framework for automatic detection of gestational diabetes using hybrid classifier algorithms of data mining. This paper fully focused on designing an automated system for diagnosing gestational diabetes using hybrid classifiers as well as predicting the highest-risk factors of getting type 2 diabetes after delivery. This paper also compares the existing papers and provides more accuracy related to the existing methods.

In 2018, J Balani [10] identified a new promising biomarker called visceral fat mass for predicting GDM in obese women using the PCA technique. Recently, Enchun Li [11] in 2019 has taken gene expression as an input data of gestational patients to find personalized treatment methods for GDM occurrences. Prema N S

[12] in 2019 compared significant classifiers as single methods with an ensemble method called a voting classifier. The results show the ensemble method achieved good accuracy rate.

## 76.3 Limitations of the Study

The study shows the various data mining classifiers and their outcomes with GDM datasets. Ensemble methods are also applied widely in the identification of GDM in the early stages. Although ensemble methods achieve better performance, they have some significant limitations. The data obtained from a patient with standard biomarkers with metrics give results but could not give optimized results for individuals. The WHO [1, 15] stated that the biomarkers and testing mechanism should be flexible to each patient concerning their race, genetic factors, and family history. Therefore the ensemble methods will give common results based on standard test reports. The correlation of different attributes during clinical trials must be considered in each case. In that view, the ensemble methods have the following limitations:

- Complex to handle collective attributes
- Missing hidden and significant biomarkers
- Failed to give customized solutions
- Difficulty in data analysis
- Complex decision-making
- Lack of technological support

## 76.4 Recent Research Developments in GDM Research

The use of single techniques in GDM prediction is not feasible in different environments. The results and outcomes of the clinical trials and test reports vary based on person, race, and associated infographics. As a next step, the new innovative biomarkers are identified by the researchers, and, in another case, the heterogeneous approaches and its combinations were developed by the researcher in the technological field. The use of the Internet, communication technology, innovative techniques, and biomarkers in the prognosis and early prediction of GDM is explored well in recent times. The studies concerning innovative biomarkers and multiple machine learning approaches are taken for analysis (Table 76.1).

**Table 76.1** Summarized review of GDM research in recent studies

| Author | Title | Generic biomarkers | Additional biomarkers | Techniques used | Innovations | Outcomes |
|---|---|---|---|---|---|---|
| WHO [15] | WHO recommendation on the diagnosis of gestational diabetes in pregnancy | Fasting plasma glucose 7.0 mmol/L (126 mg/dL) 2-hour plasma glucose 11.1 mmol/L (200 mg/dL) following a 75 g oral glucose load random plasma glucose 11.1 mmol/L (200 mg/dL) in the presence of diabetes symptoms | Antenatal care (ANC) | NA | Recommendations related to interventions | Nutritional interventions, maternal and fetal assessment, preventive measures, interventions for common physiological symptoms, and health system interventions |
| WHO [16] | Classification of diabetes Mellitus 2019 | General biomarkers | Specific biomarkers concerning age and type | NA | New subtype diabetes were classified | WHO stated difference of diabetic subtypes before and after pregnancy |
| Tao Zheng [17] | A simple model to predict risk of gestational diabetes mellitus from 8 to 20 weeks of gestation in Chinese women | Maternal age, ethnicity, BMI FPG | TG, TC, HDL, vitamin D3 | Bayesian adaptive sampling, Markov chain Monte Carlo simulation, multivariate Bayesian logistic regression | Personalized application model | Proposed model achieved 95% prediction accuracy |

| | | | | | | |
|---|---|---|---|---|---|---|
| Brittney M. Donovan [18] | Development and validation of a clinical model for preconception and early pregnancy risk prediction of gestational diabetes mellitus in nulliparous women | Pre-hypertension, pre-glycomea, BMI | Race, family history, personal history of cardiovascular disease, preexisting dyslipidemia | California model testing subset, Iowa cohort | NA | Ethnicity-based GDM prediction study done |
| Chunming Xu [19] | Machine learning and complex biological data | NA | NA | NA | Visionary study and need for advanced computation techniques for heterogeneous biological data | Strongly recommended combinational computation techniques |
| Anca Pantea-Stoian [20] | Insulin Therapy in Gestational Diabetes | Weight, BMI hypertension | Metformin, glyburide, insulin therapy, medical nutrition therapy (MNT),physical activity (PA) | Complications in insulin therapy | Patient depending on insulin balancing | Highlighted the importance of automated algorithms in GDM research |

(continued)

**Table 76.1** (continued)

| Author | Title | Generic biomarkers | Additional biomarkers | Techniques used | Innovations | Outcomes |
|---|---|---|---|---|---|---|
| Guarino et al. [21] | Circulating MicroRNAs as Biomarkers of Gestational Diabetes Mellitus: Updates and Perspectives | Abnormal glucose levels | MicroRNAs, a class of small noncoding RNAs found in serum or plasma | NA | MicroRNAs represent potential biomarkers for early GDM diagnosis | The potential use of microRNAs as putative biomarkers of disease as well as a potential cause of GDM complications and $\beta$ cell dysfunction |
| Dias et al. [22] | Molecular Biomarkers for Gestational Diabetes Mellitus | Single-nucleotide polymorphisms (SNPs), DNA methylation, and microRNAs | NA | NA | Investigated GDM in SNPs, DNA methylation, or miRNAs in maternal blood, plasma, or serum in humans | The use of SNPs, DNA methylation, and miRNAs as biomarkers that could aid in the early detection of GDM |
| Lorenzo-Almoros et al. [23] | Predictive and diagnostic biomarkers for gestational diabetes and its associated metabolic and cardiovascular diseases | Glucose homeostasis age and body weight, RBP4, afamin, ficolin-3, and certain miR (miR-16-5p, miR-17-5p, and miR-20a-5p) | Visfatin, omentin-1, fetuin-A, IL-6, PAI-1, and FGF-21/23 | NA | 1,5-Anhydroglucitol anticipate the GDM development, and at the third trimester, a raise of plasma FGF-21 and FABP4 helps an OGTT for GDM diagnosis | GDM affects one out of five pregnancies, leading to perinatal morbidity and adverse neonatal outcomes and high risk of chronic metabolic and cardiovascular injuries in both mother and offspring |

## 76.5 Model-Based Approach

The present medical field needs both technological and medical coordination with a self-automated decision-making system to handle any kind of medical support. The developed countries like the USA [13] are moving toward smart health care with technological advancements. The biological data are inherently complex and in different forms which need multiple approaches to find the best solution. For that, ensemble methods give better solutions for static applications, and further development is needed for intelligent systems to be developed. In GDM prediction the standard medical tests like insulin tolerance test and glucose test are available and give accurate results. The medical tests are a good solution in the medical field to identify and treat GDM in an efficient way.

The role of data mining and machine learning techniques is used to analyze the possibility and occurrence level of GDM disease and its complications. Some of the studies concentrated on the early prediction of the prevalence of the disease with patient clinical trials and family history. The model-based approach could be the next step of the research where technology is associated with biology. The contribution toward the enhancement of knowledge regarding the clinical connection between GDM and QoL was fulfilled [14]. From the recent study, the contribution of computational methods in GDM research provides solutions to problems with specific biological attributes and biomarkers. These methods are static which gives standards results with pre-designed trained models. But the GDM is an emerging research area; the new innovative biomarkers are identified by the researchers to diagnose the disease in advance. It is stated that the new biomarkers should be taken into account.

## 76.6 Conclusion and Future Direction of the Study

The research work has taken leading combinational approaches in GDM prediction. The analysis of existing contributions reveals that the combinational approaches could not give better solutions for smart medical care. The recent research works concentrated on model-based approach and implementation of multiple techniques for each medical complication. The existing techniques in ML and DM are static and need to be customized for each GDM prediction complexities. The flexible model should be developed with new technologies for intensive care for GDM identification and early prediction. The use of IoT, big data, and gene and stem cell data banks will reduce the medical complexities and economic burden to society. The model-based system can be the recommender system for the stakeholders in the medical management system. The maintenance of electronic medical records by the patient and other agencies results in the data repository creation where the medical experts and practitioners are able to access the data from remote places, and this can also be very useful in decision-making and personalized care to the patients. The

SMART-GDM prognosis model can be a better solution for early prediction and prevalence of GDM in an efficient manner.

**Compliance with Ethical Standards** All author states that there is no conflict of interest. We used our own data.

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# Chapter 77
# Load Balancing and Resource Utilization Approach in Cloud Computing Using Honey Bee-Inspired Algorithm


**Rahul Sharma, Ila Sharma, and A. K. Sharma**

## 77.1 Introduction

In recent trends, the most rising way for the computation and storage of the assets is performed through the Internet in cloud computing. In today's time, cloud computing is a fast-growing field in computational lookup and industry. Cloud computing is the net-based computing technology that gives "IT resources as a service" on demand [1]. In the latest years, for storing the statistics by using the World Wide Web, the sole most well-known software is cloud computing. Because of the ability of cloud computing, the customers are growing vastly in recent years. Cloud computing also provides better effective software with enough cost in a blissful way for users [13]. Through the virtualization, cloud computing additionally fulfills the distinctive duties related to the computational. The management of the huge data and supply lightweight services, the industries, and the college are encouraged to hire cloud computing at their place. Even the small- and medium-scale industries are fascinated with cloud computing, because it is not requiring the most important money for the infrastructure and the license for the software program and for the other software-oriented requirements. Due to its minimized upkeep fund and robust functionality of cloud computing in the authorities organizations. Security is one of the ultimate targets of cloud companies imparting cloud computing services. If facts saved in cloud sources, that will be taken or inaccessible for many days due to fact of deteriorating community connection. The industrial loss to the consumer is now not solely be that one unique service is unavailable, but it

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motives a comprehensive risk of the company's presence, due to the unexpected unavailability of IT services. The complete investigation of cloud computing safety hazards, probably mitigation methods, and the highest-quality cloud protection systems are integral for establishing trust in technological know-how and rising security. In cloud computing customers do not have to pay for infrastructure and its setup [2]. The attention of customers is grabbed by cloud computing due to its ability to provide outstanding benefits to the users. Cloud computing can be dealt for any own infrastructure, so it is viewed as an alternate high-quality technique. Most of the corporations utilized the method of cloud computing to host their applications [14]. It additionally satisfies a range of computational needs through virtualization. Industries and academia are motivated by way of cloud computing and utilizing it for a big spectrum of utility demanding excessive computationally and lightweight services. The small-scale and medium-scale sectors of enterprises are attracted by using cloud computing considering the fact that it doesn't require open investments in substructure, software license, and different application requirements. Government sectors also make use of cloud computing due to reduced preservation fee and elevated capacity. Cloud computing is comprised of some principal elements such as scalability, adaptability, flexibility, multiplied reliability, QoS, considerable affinity, and ubiquity. Also, cloud computing has the most important benefits like cost savings, extended scalability, and flexibility.

*Paper is organized into different sections as follows: Sect. 77.2 briefs load balancing and metrics, Sect. 77.3 presents a review of literature, Sect. 77.4 covers proposed methodology, Sect. 77.5 shows simulation outcomes, and Sect. 77.6 contains the conclusion, while references are mentioned at the last.*

## 77.2 Load Balancing

Load balancing is an efficient approach that allocates workload on resources of the node to the corresponding resource on different nodes in a network besides eradicating any of the strolling tasks. Thus load balancing between several nodes of the cloud system grew to become a primary issue in a cloud environment [3]. The process of load balancing is shown in Fig. 77.1.

## 77.3 Review of Literature

Many research works are carried out by several researchers in load balancing surroundings by the use of specific algorithms, but pretty few have been explored to illustrate attributes related to load balancing. These lookup papers are helpful in analyzing the existing work and detecting lacunas which remain unsolved in the modern-day work. Some of them are summarized below.

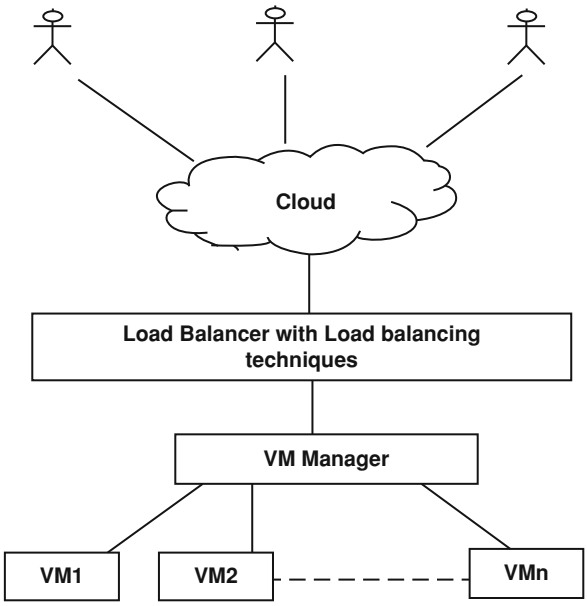


**Fig. 77.1** Load balancing process

In [4, 5], authors developed cloud security with ontology to control, compliances, and threat. They have presented the classifiers in the protection model of risk had faced via cloud operators. The users have high stage protection that was routinely decided and the activated threats have defiance of cloud providers. So the cloud buyers used to formulate the safety policies and to discover the compliance companies with technology. So they semantically developed the ontology to the safety threats models, controls, providers facts have expressed and the cloud protection policies. They are used in cloud protection insurance policies, and, additionally, they encouraged the consumers. In [6], they predicted the effects of existing techniques to survey the symmetric of the cloud security troubles in these environments. For the cause of the cloud professionals to tackle consumers and measure the software program protection of the purchaser-provider walking in the cloud. Then the viable answer of the security software problems in the cloud concepts and it favored to investigate the cloud community. In [7] authors cautioned cloud security to analyze the problem in element with these concepts and examined the hassle of cloud format of perspective, the cloud stakeholder's perspective, cloud service shipping fashions, views, and the cloud supplied characteristics perspective. They analyzed to derive the targeted matters of key facets and specification of cloud protection problems in the provided cloud security solution. In [8], authors presented the security troubles and issues of cloud computing that have illustrated the impact of availability, confidentiality, and integrity as their houses and described the feasible challenges, directions, and present-day solutions. Therefore cloud has emerged as the successful computing paradigm with the company and users. Then they depend on exterior companies to store, process the data, and also make them constantly

available to others. In [9], they offered the vital cloud computing services associated with security, privacy, reliability, and anonymity. Then the furthermost good-sized were safety and providers in the cloud to assure it. So the most important principles of secureness in clouds mean therapy Calculation and the storage has been hosted in databases via cloud providers. In [10], the load balancing method has discussed that it manages load at the server by thinking about the current reputation of all reachable virtual machines to assign incoming requests. A virtual machine assigns a load balancing approach to typically consider the environment-friendly usage of resources. It concludes that the algorithm assigns load optimally & subsequently ignores under or over the use of virtual machines. In [11], presented, enhanced, and throttled algorithm is primarily based on load balancing. While thinking about the availability of virtual machines for a given request and uniform load sharing among virtual machines for several requests served. It improves the response time and analyzes with existing round-robin algorithms..

## 77.4 Proposed Methodology

The research methodology is a systematic plan for commencing the research work. In this section, we discuss the proposed methodology of a honey bee-inspired algorithm, problem identification, objectives of the research, and other essential steps to be carried out for our research.

### *77.4.1 Problem Identification*

We suggest a honey bee stimulated algorithm which targets to distribute the dynamic workload easily to all the hosts in the cloud to acquire an enhancement in both the utilization of sources and the velocity of execution time. It assigns incoming tasks to all reachable virtual machines. In order to acquire balancing and keep away from congestion, the proposed algorithm allocates tasks to the least loaded virtual machine and prevents the allocation of duties to a virtual machine when the version of this virtual machine processing time from common processing time of all virtual machines could become extra than to a threshold value. It leads to a reduction on average response time and processing time of hosts. For desirable web hosting of the digital world, the device developed Hyper verse arhitecture [12]. There are self-esteemed load balancing schemes through which world ground is subdivided into small devices and managed with useful resources of public server.

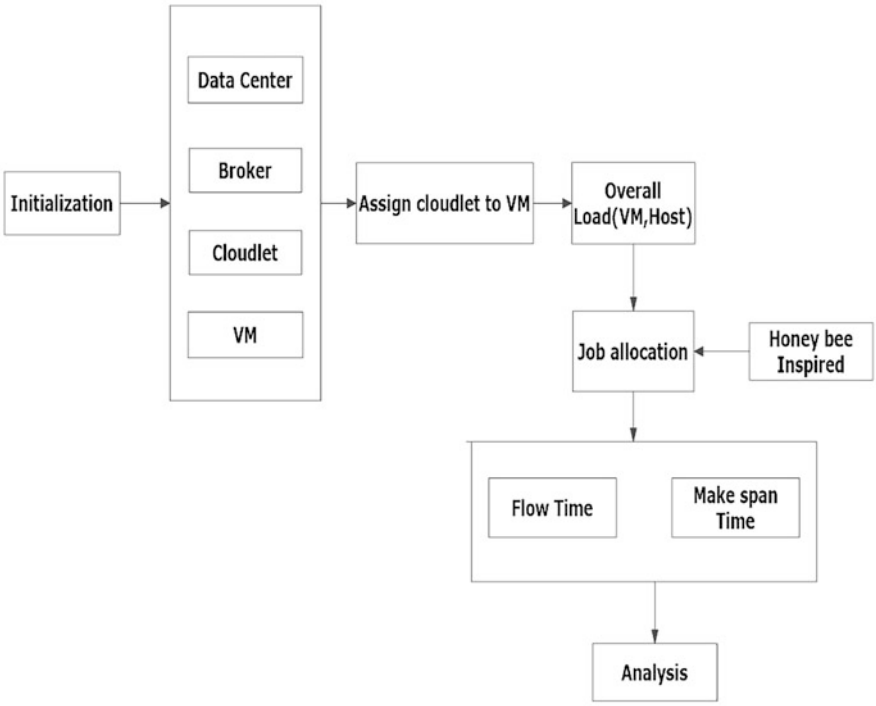


**Fig. 77.2** Working procedure of proposed methodology

### *77.4.2 Working Procedure of Proposed Methodology*

In this methodology, firstly we initialize data center, broker, cloudlet, and virtual machines. After initializing we assign cloudlet to virtual machines. Then after allocating cloudlets to virtual machines, we assign a load to virtual machines. Then, job allocation would be done by the proposed honey bee approach. In the end, flow time and makespan time of jobs are calculated, and obtained results are analyzed and compared to existing approaches. The flow diagram of our proposed methodology is shown in Fig. 77.2.

### *77.4.3 Objectives of Proposed Methodology*

The following are the objectives of our proposed algorithm:

- Well-balanced load across virtual machines.
- Speed in execution time.
- Reduced overall response time.
- The load will be balanced among virtual machines.

## 77.5 Simulation Results

In this section, the performance of the proposed approach is analyzed using CloudSim simulator. Simulation of our work is carried out by utilizing CloudSim, Java NetBeans IDE 7.2.1, and WampServer technologies. Our proposed system is simulated by applying different modules as discussed here.

### *77.5.1 Module Description*

The following modules are utilized in our proposed work:

- Initialization
- Load identification
- Job allocation
- Evaluation

#### 77.5.1.1 Load Identification

Load balancing among the virtual machines is done by cloud simulator. We analyze which virtual machine has the highest space for resources. We assign cloudlets to virtual machines for achieving load balancing and then initialize all RAM size, broker ID, cloudlet ID, and host ID for a particular virtual machine. GUI interface window of workload for virtual machines is shown in Fig. 77.3.

#### 77.5.1.2 Job Allocation

We allocate a job by using the use of honey bee stimulated algorithm. The key thought is to post tasks to the virtual machines until the computer receives overloaded, i.e., load on that virtual laptop end up more than a threshold value. The quantity of tasks presently processing by using this virtual machine is much less than a variety of tasks presently processing with the aid of other virtual machines, and the deviation of this virtual machine processing time from average processing time of all virtual machines is much less than a value. The job allocation of virtual machines is shown in Fig. 77.4.

#### 77.5.1.3 Assigning Workload on Virtual Machines

Assigning workloads on different virtual machines is shown in Fig. 77.5.

The job allocation results such as the execution time of different virtual machines are shown in Fig. 77.6.

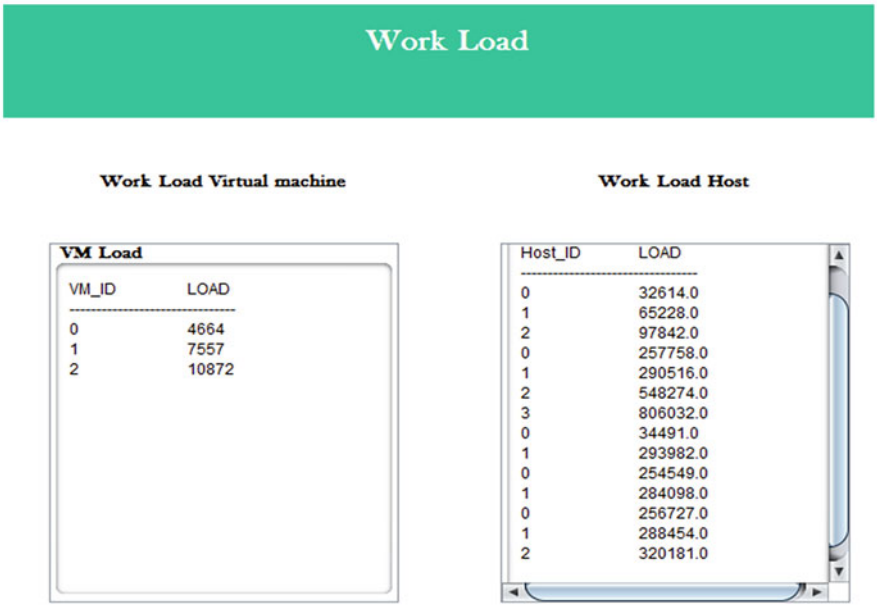


**Fig. 77.3** Initial view of load identification

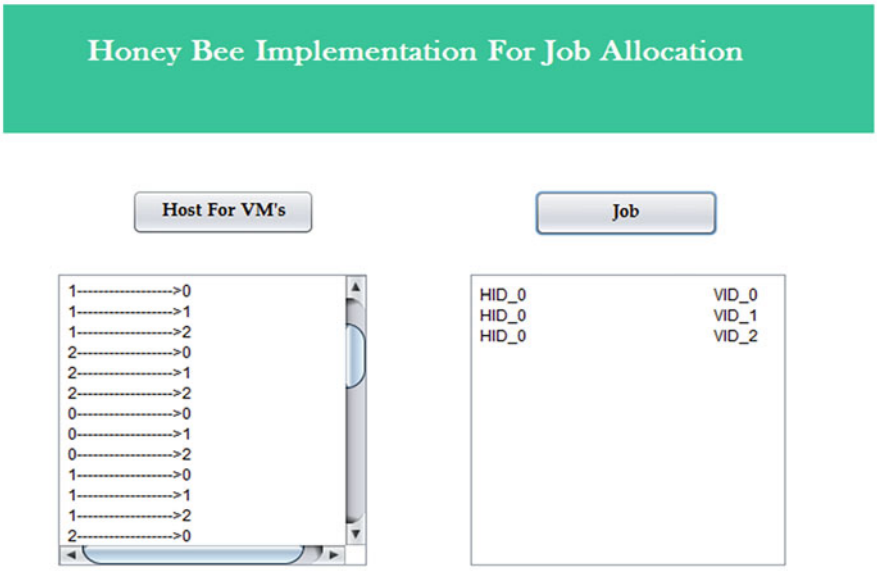


**Fig. 77.4** Job allocation of hosts for virtual machines

From Table 77.1, the graphical presentation of different tasks taken for simulation is shown in Fig. 77.7.

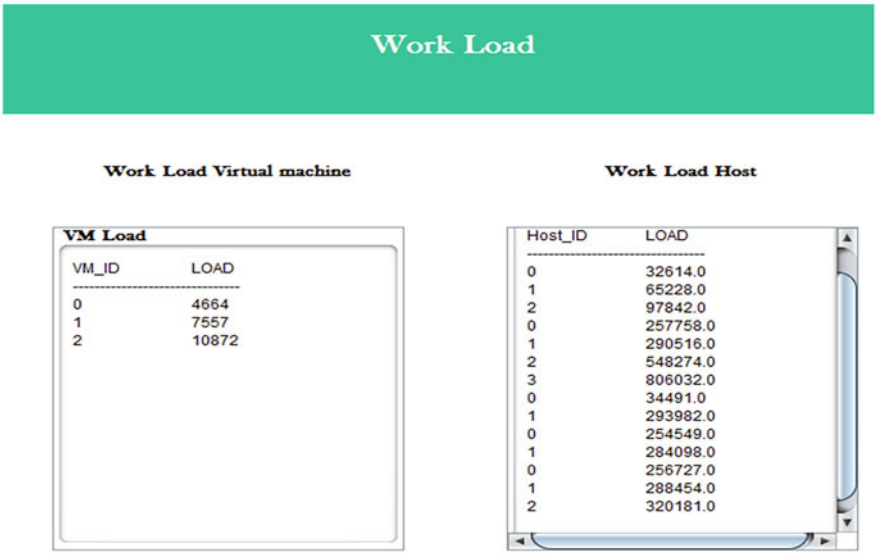


**Fig. 77.5** Assigning workload on virtual machines


**Fig. 77.6** Job allocation results

**Table 77.1** Tasks taken for simulation

| No. of data centers | No. of VMs | No. of cloudlets |
|---|---|---|
| 1 | 2 | 3 |
| 3 | 6 | 5 |
| 5 | 10 | 7 |

From Table 77.2, the graphical presentation of different tasks taken is shown in Fig. 77.8.

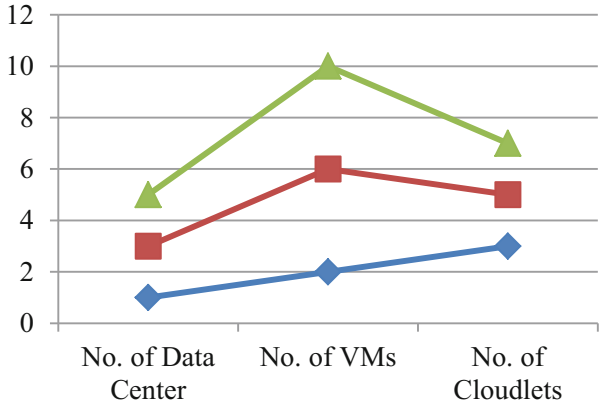


**Fig. 77.7** Graphical presentation of tasks

**Table 77.2** Result analysis of algorithm

| Total jobs | Flow time | Makespan time |
|---|---|---|
| 3 | 8.42 | 6.95 |
| 5 | 20.50 | 60.50 |
| 7 | 21.43 | 78.32 |

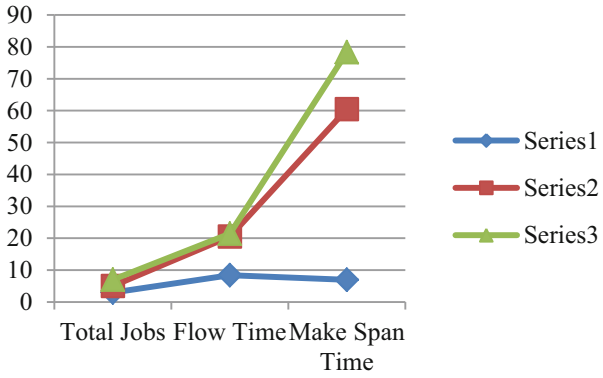


**Fig. 77.8** The graph shows flow time and makespan time

## 77.6 Conclusion

We present a novel approach to perform load balancing in cloud systems by using honey bee algorithm in this paper. For reaching better aid allocation with load balancing strategy, we enforce and use honey bee stimulated algorithms. Using our proposed algorithm distributes the workload of more than one network links in a way that avoids underutilization and overutilization of the resources. This can be acquired using allocating the incoming undertaking to a virtual machine that meets

two conditions, such as a variety of tasks presently processing utilizing this virtual machine is less than a variety of tasks presently processing by using different virtual machines and the deviation of this virtual machine processing time from average processing time of all virtual machines is received less than a value. Therefore, it reduces the response time of virtual machines. We analyzed the workload of each cloudlet. The result of experiments shows the effectivity of the proposed algorithm in terms of execution time, flow time, and makespan.

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# Chapter 78
# Offloading with QOS in the Mobile Cloud Computing Environment

**C. Arun and K. Prabu**

## 78.1 Introduction

In the recent past, the computing procedures are completed simply in the desktop computers (DC) only. The mobile cloud computing (MCC) model is created after completing all the action of the computing process that needs to be completed in the cloud with the help of smart mobile devices (SMDs). Usage of the MDs is growing extremely nowadays [1, 2]. The new survey's outcome is that people are eager to deploy MDs like smartphones (SPs), SMDs, handheld systems, PDAs, iPads, and so on instead of the fixed PCs. So MCC has developed an essential portion of social life currently. MCC is nothing but the grouping of cloud computing, mobile computing, and wireless radio networks [3]. The profits of CC and MC that are shared into the MCC are shown in Fig. 78.1.

Mobile computing is an infrastructure, where the consumer can interact with PC at the period of movement without any practical troubles, and cloud computing is an infrastructure, where the customer can connect with cloud and access the cloud resources on demand [4]. Cloud can derive benefits in numerous methods: IaaS, by Amazon EC2, PaaS by Google App Engine, and SaaS by e-mail services and web applications.

MCC is presented as the addition of cloud computing into movable environments. Using MCC the MDs can access the cloud by the Internet for data processing. MDs must not have any great storage volume and great computational power. All

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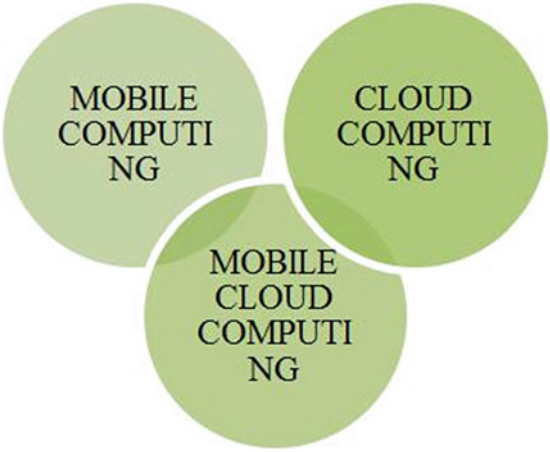


**Fig. 78.1** Basis diagram of MCC

the actions of computation procedure do the external side of the consumer devices inside the remote server in the cloud MCC is stated as a rich MC model that manages numerous properties of numerous CC and technologies in the network toward numerous functionality, vast storage, and movement to provide the bulky number of customers at any place at any time by the Internet in varied surroundings and stages by the principle of the on-demand basis of the pay-as-you-use. MCC introduces new types of facilities and services to the customer to use all the profits of MCC knowledgeably to decrease time and reduce the energy consumption of application performance and increase the amount of data storage of customers' MDs as well as prolong the lifetime of battery of the SMDs. But, certain parts in MCC want essential extra growths, such as BW, NAM, pricing, normal interface, service convergence, latency, quality of service (QoS) energy efficiency, application migration, resource management, etc.

## 78.2 Architecture of MCC

MCC is a mixed mode of MC and CC. The assets of those are jointed and the MCC is created [6]. In MCC there are three portions, which are mobile network, cloud, and ISPs. These three parts are combined and designed the MCC. Figure 78.2 displays the architecture of the MCC.

(a) *Mobile network*: A mobile network is blended by network operators and MDs. MDs may be SPs, laptops, tablets, etc. [2]. These devices and network operators

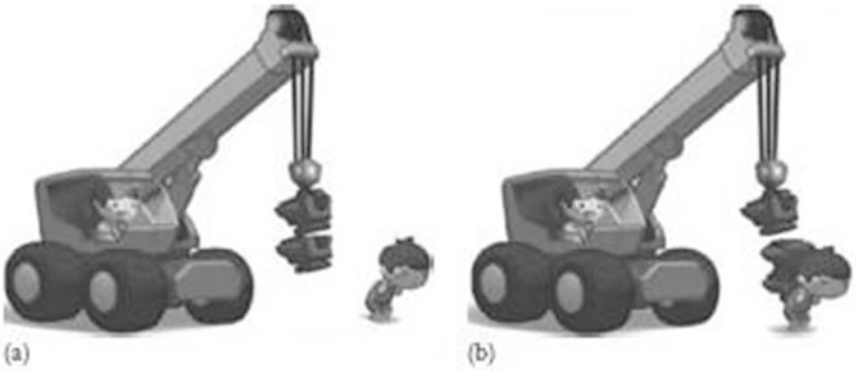


**Fig. 78.2** Offloading models

are linked to the network operator with the service of BTSs or any radio networks. BTSs start the connection and keep the connection between MDs and network operators.

(b) *Cloud service*: Customer sends the req to the cloud controller, and it processes the req and then delivers the service to the customer or user in need [3]. Service delivering layers of the cloud is the Datacenter layer, PaaS, SaaS, and IaaS. DC layer is a collection of interconnected servers using great speed network connections with full energy supply. PaaS is a setting or stage for the customer to construct, install, and test the apps. IaaS is the topmost of the DC layer. The key duty of this is assigning the server and other networking components, hardware, and storage to the customer in an on-demand basis. SaaS manages the software [4]. The customer can use the cloud on demand without installing any app on the customer device.

(c) *Internet service*: It completes the connection between the cloud and MN. The consumer sends the request to the cloud through the Internet. The user can link with the CC with the support of 4G, 3G, 5G, and LTE connections.

## 78.3 What Is Offloading?

Offloading as scattered computing, it deployed to clear this issue. Offloading meant by the handover the data between a PC or device (digital) and digital device (digital) [22]. Offloading is an answer to increase this skill of MDs by transferring computation to additional resourceful PCs, like remote servers. The difference between the architecture of old-style client-server and new age architecture is customer continuously transfers computation to the server. Offloading also varies from the migration model deployed in multiprocessor schemes. The variation is that computation offloading transfers code to servers outside the customers' direct computing situation; for load balancing, data is to be migrated in grid computing.

Transferring for grid computing usually happens from one PC to another PC within similar computing surroundings [23]. These methods decrease application completing time on MDs, thus lessening the energy consumption of both memory and CPU. These efforts could be categorized into two methods.

The first method includes energy-aware offloading of MD program code to the infrastructure [24]. This method trusts on a user to adjust the program to dividing, state transferring, and adaptation to numerous modifications in net settings. Apps are offloaded the only portion of the methods, which profits from distant execution for the reason of energy-aware. This method is known as *partial offloading*. The second method is the job offloading system; all the program/processor of all the VM is transferred to the server. Programmers cannot adjust the application basis code to yield the benefit of computation offloading. This method is denoted as *full offloading*, it decreases the load located on programmers in Fig. 78.2.

Offloading can be denoted as the tool of dividing apps as non-offload and offload able and pieces considering many parameters and then remotely implementing the offloadable pieces. There are no rules for determining which piece of an app to offload, but the user can keep in mind the below-stated points. Offloading can only be activated when considering two things, i.e., the benefits the customer will get and the availability of remote resources.

Offloading transfers computation to an extra resourceful PC, it includes conclusion making about what and where computation to transfer. A huge group of research happens on offloading choices to (1) reduce energy and (2) increase performance.

## 78.4 Categories of Offloading

Offloading can be classified into two diverse collections depending on two diverse standards, as shown in Fig. 78.2

(i) Depending on Material Being Offloaded

A. In the *computational offloading* system, an exclusive computational procedure is transferred between the MDs and the server with CC to increase battery life and performance [25].
B. In *data offloading* system, data are transferred from one jammed network to another [25].

(ii) Time Reduction Approaches

A. *Partial offloading*: An energy-saving offloading method sends MDs code to infrastructure [22]. This is automatically suggested to transfer as minute code as possible by dividing a program and offload computation never offload computation offloading only the energy-hungry portions of the apps. This can be additionally divided into the following:

- *Static dividing system*: The cost of communication depends on the amount of the communicated network bandwidth and data. The computation cost depends on the number of instructions [22]. The proposed customer-server model of offloading is separated into numerous portions: offloading engine, monitors, utilization of CPU, module, and BW of MDs. The time and cost can be achieved before the implementation.
- *Dynamic dividing system*: The machine is a method that only re-offloads the unsuccessful sub-tasks and thus decreases the performance time.

B. *Full offloading*: The full code is transferred to the CC infrastructure, and then the computer operator cannot adjust the basis code [22]. This method does not need to estimate the computation time before completing it. Instead of that, the code is firstly completed on the client with a timeout. The computation is not finished later that the timeout, it is forwarded to the remote server (cloud). The timeout is first set to be the least computation time that can advantage from offloading.

## 78.5 QOS in the MCC Environment

MCC cuts energy and time consumption of app processing and improves the storage volume of MDs. The battery period of these devices is prolonged by the MCC. Still, numerous arenas of MCC are needed and require more developments, such as network access management, bandwidth allocation to the user, pricing, energy efficiency, standard interface, property management, latency, and app relocation.

(a) *Well-organized bandwidth distribution*: The effective resource allocation model has become a developing part of awareness due to the quick growth in the amount of MD users. Fifth-generation network increases the bandwidth volume for customers [7]. MCC needs only LTE or 4G networks. To raise the speed of the process, advanced bandwidth is required.

(b) *Combination of cognitive radio technology with MCC*: It's very valuable for accessing the remote cloud via MDs. These two are combined and miss the performance disadvantages. An MCC situation is based on cognitive radio involves heterogeneous situations. These technologies are utilizing bandwidth efficiently [8]. But consumer mobility and communication failure will make it more critical. So, a new method called cloudlet is introduced in MCC setting to get high QoS.

(c) *Mobile cloud computing with cloudlet*: A cloudlet is a PC or a collection of PCs joined to the net. The nearby mobile devices can access these computers. Using this nearby cloudlet, the cost and time are minimized during the offloading of the task by the mobile devices [5]. Sometimes cloudlet may not be available to the user, and then the mobile device can access the cloud or use its own resources [9].

(d) *Privacy and security in MCC*: MCC can hurt many security issues on mobile devices because of the limited power supply and low processing power. So, it

is hard to control intruders from hacking mobile devices [10]. So, mobile cloud computing must provide multilevel authentication.

(e) *Secure mobile cloud computing*: In the MCC the data processing occurs outside of the mobile devices and inside the cloud. The user need not store anything in their devices. The data stored at one specific place may not be protected in another place due to diverse access instructions [11]. The user also cannot be able to know that the storage places, it is difficult to decide what rules for protecting data [12].

(f) *Resource management*: The resource management system must be developed for mobile devices and servers (CC). The resources are allocated before the execution starts the unnecessary resources also allocated to the user [13].

## 78.6 Usage of MCC

MCC technology is used in many places. Nowadays, MCC applications are used in many areas such as biometric area, mobile vehicular cloud, mobile learning, remote display, mobile health cloud application, multimedia mobile cloud, social mobile cloud, etc.

(a) *Biometric authentication application*: The MDs are able to scan the biometric evidence such as face recognition and fingerprint recognition for the authentication purpose [14]. The scanned data is sent to the cloud for processing. The sample data is already stored in the cloud. The new data is compared with the exciting data, and then the authentication is verified. This is a process that needs a high computational processor. The MCC offers a high computational processor to the client. All the process is outside of the cloud.

(b) *Mobile vehicular cloud*: Using MCC the user can achieve many benefits in the mobile vehicular cloud. Some applications such as route tracking and traffic management are the merits of mobile vehicular cloud [15]. A navigator is fixed in the vehicle. Using this navigator, the traffic is being monitored. As per the client request, cloud will update the best path to the user.

(c) *Mobile learning*: Mobile learning is mainly used in the education system. The user can read and download the source with the help of MCC anywhere at any time [16]. There are two models in mobile learning as a cloud model and a customer model. In the customer model, consumer has to download the mobile learning application from the cloud. Then the consumer has to pay a particular fee for accessing the CC. The consumer can send the request to the cloud for accessing the cloud through mobile devices and access any data from the cloud. The cloud model is verifying the user ID for authentication and response to the user [17].

(d) *Health mobile cloud application*: MCC offers health applications. This model can be split into two models as a patient model and an admin model. In admin, the model is maintained by the hospital side. They provide the unique ID to the

patients and verify the ID at the time of user login. The main work of the admin is uploading the periodical report to the cloud. The advantage of this method for the admin is that they can maintain all the patients' records safely [18]. On the client side, the clients are not required to carry the records all the time, and they can consult any other doctor anywhere.

(e) *Mobile multimedia storage*: The user can store any type of data such as videos, audios, documents, etc. in the cloud using their mobile devices [19]. They can access the data using their user name and PW at anywhere at any time.

(f) *Application in social cloud*: Nowadays, most people are communicating with their friends via social media such as Facebook, LinkedIn, Twitter, etc.; using this, they need not store anything in their devices; all the data are stored in the cloud [20, 21]. So a large amount of storage is gained by the user.

## 78.7 Conclusion

MCC is the fastest-developing technology in these years. Mobile computing and cloud computing plus points are joined, and MCC is invented. In MCC the user can access the cloud during moving position at the normal usage. Offloading includes power consumption in processing an app at the time of communication with the server. In the paper, we are discussed about the architecture of MCC, QoS in the MCC environment, and applications of MCC. Some difficulties are placed in mobile cloud computing such as energy consumptions, security issues, etc. Future research work will overcome these problems, and MCC will be the rich technology to mobile users.

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# Chapter 79
# Behavior Change Communication Using Immersive Technologies: An Instrument for Sustainable Development


**Suparna Dutta and Chander Mohan**

## 79.1 Introduction

Man, as a social being, is predominantly conditioned by his culture. Culture, in a sense, is man's response to his environment. Responses that enabled the early humans to survive were reinforced as sanctioned behavior, whereas those that negated his survival were reproved. Time-tested sanctions and taboos gradually got encoded as tradition. However, human greed, ambition, and myopic and a possessive worldview did considerable harm to such patterns of behavior. The story of the silos that emerged from such claustrophobic approach is obvious today. Yet, we must not overlook the fact that man is essentially a moral being [13]. He has created for himself a civil society that vehemently strives to overwrite the rule: "survival of the fittest." It is this innate humane concern for well-being that underlines the human march toward progress. So, at this perilous juncture where we need to undo certainly committed wrongs, rework our responses, and strive to recreate an almost pristine order, universal *participation* as well as *partnership* becomes indispensable.

## 79.2 Participation: A Prerequisite

Participation is a prerequisite for any developmental initiative to sustain and culminate in the desired manner [2]. Participation could be of many types with

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the lukewarm and/or passive headcount participation at the base to the active, committed, and enthusiastic participation at the decision-making level being the most coveted yet. However, such wholesome participation and bonhomie are illusive because of the silos man has created for himself with greed, arrogance, ignorance, and an exclusivist attitude even though he is essentially a gregarious being [1–3]. A man easily forgets that this self-imposed onion-scale social structure, which he has imposed upon his own civil society, has gradually marooned him in the quagmire of self-defeating and painful isolation [5]. But the process of inclusion from this separation from his fellow beings will be much tougher than that of exclusion [7]. This will simply be because inclusion will have to be a more conscious and well-informed choice that will strike at the root of psychosocial evils like ignorance, arrogance, stigma, prejudice, condescension, hypocrisy, and so on [8–12].

## 79.3 Communication

Communication is a two-way process that is powered by the potency of good feedback. In the absence of feedback, the process remains wedged at the information dissemination level. Though it is quite established that information dissemination is an integral part of the process of communication, it is certainly not communication per se. The two-way process of communication works on the dialogic mode that ensures a healthy discussion and debate which institutionalized, we have a discourse at our disposal which is one of the most desired outcomes of effective communication. However, conversation, by and large, takes place in an ambiance of mutual trust, respect, and friendship. Friendship, in turn, works out better among equals. So, when we are looking at a dialogic mode of communication, the prerequisite is a relaxed environment of affability and bonhomie that induces confidence, hope, and a sense of security. Unless that is ensured, fulsome participation and involvement of the stakeholders cannot be achieved, and this wholesome and holistic participation is infallibly critical in behavior change communication.

## 79.4 The Message, Information, and Visualization

Transfer of message occupies a very high stake in the process of communication, and research in communication is mostly preoccupied with it. The mechanics of message transfer, which often fall in the domain of technology in communication, are common in this approach. Behavior change communicators are concerned with and involved in the efficacy of massage transfer and how the message can influence the minds of the receivers to induce the desired behavior change. In terms of technology, what is of concern here is fidelity as much as bandwidth. But in terms of behavior change communication, it is a visualization of the information that occupies a cardinal position. As human beings, we tend to forget most of the

messages that we are bombarded with day in and day out, but some we are unable to forget and even remember vividly through our lives. This is primarily because these are messages that were communicated uniquely and better than the other messages.

The sender's visualization of the information being by the message is expected to lead to effective communication only if in the practice it obliterates much of the ambiguities that could hamper the process of communication. So, when the sender rightfully and vividly visualizes the message that is to be communicated, he attains efficiency and clarity to choose its right receiver and thereby the right media for the communication of that particular message. This is very key in communication because the media must match both the message and the receiver, and it holds particularly true for behavior change communication where *there is never any room for one-size-fits-all approach*.

Visualization for the receiver is a different ball game altogether. It is progressively being realized that the greater and sharper the *visualization* is for the receiver, the more probable it will be the chance to influence him with the message. This is vital in the paradigm of behavior change communication. The principle that is essentially followed here is that it is better to *see* a message than to *hear* it, but it is the best to *experience* it in order to visualize the message with utmost clarity to get inclined to and eventually influenced by it. It is only this influence that can induce the receivers to participate in the process of dialogue and conversation, which is critical in behavior change communication.

## 79.5 Visual Communication

It is a universal fact that across the globe, we are now a digital screen-savvy generation for whom technology holds immense importance in our communication. The Internet has connected and perhaps even enmeshed people of various cultures into *micro digital communities* that, on a click of a button, laugh together, cry together, and, interestingly, do business together (Dutta and Mehta 2019). What is of great importance here is the possibility that today anyone and anywhere on this planet can connect and communicate, irrespective of the limitations of one's knowledge of cultures, traditions, and languages which was probably not even thinkable in the last century! However, in this new, all infusing digital network, it is the potency and power of visuals that are overriding the power as well as the limitation of words and texts which till now was the main, if not the only, means and vector of human communication. Today, we are once again looking at a language driven by images, drawings, pictures, photos, and motion graphics to communicate and connect. This is the realm of visual communication!

Human communication which marks human superiority in no uncertain terms becomes more appealing with visual tools, aids, and illustrations. Visual language augmented with the help of multimedia options is an excellent facilitator of communication. Tools and techniques using images, illustrations, graphics, diagrams, photographs, and animation accelerate, accommodate, and assist in the

dissemination of even difficult notions, ideas concepts, and information. This is hence a very progressive, interdisciplinary creative domain that rests heavily on information technology, computer science, and cognitive science [4]. The most effective visualizations make the most of the human capacity and flair for noticing and understanding visual information better than text-driven messages. This human penchant, in turn, improves levels of comprehension, retention, and reason. Such visualizations also help researchers and analysts quickly discern and detect patterns appearing within large data sets and help the audiences understand complex ideas [17].

It is believed that messages that stimulate our vision are the ones we get more attracted to, and consequently these are also the messages we understand and remember better than those conveyed through text. A reason behind this is the fact that visual communication generally uses and relies on images and symbols that we are accustomed to seeing around us. For instance, *reading* the word flower and *seeing* its image have different potency and effect. The old adage – a picture is worth a thousand words – still stands tall! Thus, it is but natural that visual communication will have the greatest power to inform, educate, and persuade us not only as individuals but also as a community and society. In this context, various technology-driven media tools and techniques such as graphic design, photography, television, and smartphone gradually have become immensely popular and important in our lives over those like the radio which does not stimulate our vision as much. So, today literacy and education would entail the capacity to examine, interpret, and understand words, images, and illustrations with equal skill, competence, and equanimity, and proficiency would demand the application of this skill across multiple media that we are surrounded with [6].

## 79.6 Media

As per the World Bank, media is the plural of the word medium, which refers to anything and everything used in society to communicate. The prolific presence of media necessitates that, for convenience and operational ease, we classify media into categories. Folk or traditional media is what has come down to us as part of our loquacious culture. It is thus essentially based on the principles and features of narrowcasting, as technology has little to do with this media. So, this is a media that is both personal and personalized and has ample scope for customization. For example, it is undoubtedly folk media which enables the Indians to witness the fantastic ethnic variation of our "national Sita" as we travel across India. In Assam, for instance, we see her in the magnificent Assamese drape around the *mekhla*; in Bengal she is found wearing the white conch bangles marking her invincible commitment to her husband, Lord Rama; whereas, in Banaras, she is found in a mesmerizing Banarasi silk saree! As the dialect changes every few kilometers, so does the image of our archetypal Sita, who is otherwise the intrinsic part of the Indian national sensibility and consciousness and still epitomizes our womanhood

in a pan-Indian scope. Yet, it is the folk media that brings in this marvelous variation in her portrayal that reflects our cultural diversity. This ability to personalize enables the folk media to attain the coveted power and flair for *ownership of content* which is essential in communication, in general, and behavior change communication, in particular. However, narrowcasting limits folk media often to a level of almost smothering it leaving little scope for innovation and experiment.

Mass media overcomes the gross limitations of the former by introducing technology. Mass media is based on the principles of broadcasting. History is witness to the revolution that Gutenberg Press invoked. Interestingly, we are still living the revolution in a sense. However, it is the electronic media that has got the wind in its sail for a very long time and perhaps has a long run ahead. Though technology has covered distance and acquired the outreach yet in the process mass media has lost the personal touch that makes the folk media so charming and endearing. The impersonality of this technology-driven media has also robbed the potency of customization and thereby the power of "ownership of content." Feedback too has been cast aside. Thus, in most instances, mass media remains more or less confined to being only a vital instrument of information dissemination.

Digital media which is revolutionizing the way we communicate is our new choice and option in communication. Digitally driven, this phenomenon of prolifically growing human networking is not restricted either by geography or by culture anymore and, therefore, has now confidently permeated the global fabric, creating what Eric Zimmerman calls the "customized cottages" (Dutta and Mehta 2019). Contacting anyone is not a challenge anymore nor is language a barrier for communication. Due to this digital invasion, we are no longer circumscribed by a limiting society or a definite community. We can, at will, participate or withdraw from a group existence. We can reach out and emote with a new language – a language of communication which is based on drawings, pictures, photos, and moving pictures, as mentioned earlier. This is the twenty-first-century mediated communication that appears new and intoxicating with the possibilities that it offers today [18]. What is heady about this unfolding process is its capacity to absorb the best practices from the folk and mass media. The digital media is capable of both customizing content with enormous personalized attention to the end user and also of outreach which is typical of mass media. So, in this media, it is believed that the communicators are indeed riding the white tiger.

## 79.7 Reversal of Learning

A universal and primary obstacle that hounds development initiatives across the world are popular apathy at best and mass resistance at worst. Such undesirable behavior from the target audience is predominantly due to the paucity of information on the project, lack of understanding and fear, and a sense of loss that grip them because of the *immediate reality* that stares and challenges them. It is a known fact that most development initiatives or projects invoke a sense of loss

in the target audience. This is primarily because most of such initiatives require a detachment from either an existing possession like land or a social practice like open defecation which often appears threatening. Communication is expected to play a vital role here. Right, effective, timely, and optimum information dissemination at this juncture will create the connection and lead to the allaying of fears which often is the cause behind popular resistance. More fulsome communication to address the sense of loss in the target population is in turn expected to lead to the participation of those who are to be the beneficiaries of the project in dialogue and conversation with the developers [9]. In order to sustain the dialogue and ensure enthusiastic popular participation, the audience needs to be made to feel at ease, comfortable, and confident. This ambiance of bonhomie and congeniality can be ensured through what in communication is known as the "reversal of learning" which with ease will convert the beneficiaries into stakeholders by making them "own" the project (Dutta and Mehta 2019).

Such stimulation that evokes "ownership" and a "sense of belonging" is expected to invoke a *possessiveness* which is vital for the people to nurture and become caretakers of development initiatives instead of being hostile to these. Further, none and especially the marginalized will open up and connect when there is little respect for them or where they are getting separated from their ethnicity and roots. Empathy is often a solution to many such psychosocial patterns that obstruct and challenge the human relationship. On the other hand, the innate dignity of the deprived usually makes them shun pity. Interlocutors must thus develop a sense of connecting and discard the weariness of indifference that disconnects the common man. The conscious effort to create the "us" from the "them" which comes from *effective listening* is expected to build the bridge to arrive at the platform for dialogue.

Listening here means the flair to understand the people; genuinely acknowledge their understanding and wisdom; appreciate their lifestyle, rituals, and practices; and accept their worldview [1]. Acceptance need not mean endorsement. But, when acceptance truly happens, a hand in friendship is sincerely extended which is critical to bond the interlocutors in faith and with commitment and confidence in an elusive but much-desired environment of rare congeniality and bonhomie. It is this faith, and the ambiance, that is going to induce the "target audience" or the beneficiaries to listen and understand the message from the "developers" in the requisite spirit. This is the nutshell of *reversal of leaning* where the agents of the development approach the people to learn from them instead of preaching the virtues of the ensuing change that they propose to bring to the people (Dutta and Mehta 2019). The need to learn arises from the fact that the architects of change are outsiders and are by and largely unfamiliar with the subtle nuances of life and philosophy of living that guides the *little communities* that are normally the beneficiaries of development initiatives. Reversal of learning is an integral part of effective communication whose objective is to induce wholesome participation of the recipients of communication in the very process of communication (Dutta and Mehta 2019).

## 79.8 Immersive Technology

Immersive technology attempts to emulate reality or a physical world, and, in this, the efforts are often to not just match but outdo reality [13]. For instance, a rather difficult terrain may be made to appear even more difficult for soldiers under training or medical interns made to operate on a more intricate object. A sense of immersion helps to achieve this which falls in the domain of augmented reality (AR), virtual reality (VR), and mixed reality (MR) [14].

Augmented reality is a real-time combination of live feed from a camera overlaid with digitally generated 3D models, text, sound, and other elements [15]. This combination is simple. There is one layer of live footage, with at least one layer of digitally generated elements. AR provides the user with a composite view where part input is the real physical world and part is computer-generated assets [16].

AR technology can have a huge impact on many industries and individual activities if it is ported practically and conveniently. For example, if a cellphone camera is pointed to a football playground, the score of the ongoing match may be displayed on top of the playground footage. And if a student points the camera of his tablet to a textbook, the diagrams in the book will animate in 3D, which is used as an AR anatomy in the classroom.

Virtual reality or VR, as opposed to AR, is a complete absence of the real-world view. The computer generates a simulation as a replacement for the user's environment. The VR headset primarily blocks out the visual and audio stimulus from the real world and feeds in an artificial rendering to the users' senses. The VR headset blocks out the real world to create a make-believe scene to fool the senses of the user.

As of now, AR seems much more useful in social and commercial situations. VR is largely limited to research and entertainment but with much limited success in comparison to AR. Further, the VR headset is usually bulky and not recommended for extended use and not suitable for people with heart and eye problems. However, it is believed that the underlying technology is changing rapidly and in the next 5 years or so, we can see more commonplace uses of both technologies. One of the reasons behind this is that immersive technology is progressively getting identified in the world of advertisement as their new baby – immersive advertising (Cara, Covarrubias). Though an entirely new advertising format, it is rapidly gaining ground and popularity. Further, though immersive commercials/advertisement is leveraging immersive technology, it is doing so while it still can use today's current media channels and bio-networks (Dutta and Mehta 2019). This is because this emerging technology is taking advantage of a mobile phone's sensory inputs which allow the immersive commercials to respond to the motion of the device. This phenomenon makes immersive technology very effective for mobile advertising. Dovetailing with this is the spread and popularity of smartphone and the propensity to use it to access social media and new technology-driven options which are cutting across the entire social fabric. Gamification, which has already become a favorite of the communicators, too is getting inclined toward developing games that use

immersive technology. Interestingly, students in Canada have developed a VR game that would immerse cancer patients during chemotherapy and, thus, distract them from their pain. Immersive technology allows medical students and doctors to do surgery simulations. AR or MR can even help students learn about the difficult scientific processes or visit historical or futuristic places virtually [Covarrubias Cara].

## 79.9 Conclusion

Behavior change communication is a domain on the hot trot. The intrinsic interdisciplinary nature of this discipline makes it an intelligent and sensible receiver of inputs that others may not be ready to toy with. Coupled with this, the progressive spread and popularity of smartphones and advances in handset technology and in ICT have further revolutionized behavior change communication. It is keeping in pace with this mindless progress and the algorithm of behavior change communication which works on the tenet of "contact-connect-communicate" and with the principle that "seeing" is better than "hearing" though it is best to "experience" the message to believe it; it is believed that immersive technology is going to provide the platform for the receivers to experience the message and get duly and desirably converted [13]. Of course, this is not going to come on a platter. The stakeholders of behavior change communication – the government and its nodal agencies, industry, academia, and collaborative research – are expected to do the job together.

**Compliance with Ethical Standards** All author states that there is no conflict of interest. We used our own data.

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# Chapter 80
# Path Planning of a Series Robots Using A* Algorithm


**A. Chandrashekhar, Urvin Desai, and P. Abhilash**

## 80.1 Introduction

Robots are playing a very important role in fulfilling human needs. Generally, robots are of two types based on their architectures; they are serial and parallel. Many industries are now using serial robots. Serial robots have a very simple design where joints are observed in the form of a series of links that are connected from a fixed base to an end-effector. We can also see serial manipulators have a hand-like structure containing a wrist, elbow, and shoulder [1–3]. Most of the serial manipulators cover large workspace which can be attained by maintaining six degrees of freedom. There are many inflexible joints which are connected either with prismatic or rotatory or revolute joints. Construction of serial robots is very simple, and it is controlled to a more extent, i.e., very accurate, whereas a parallel robot is a system that is more of a computer-controlled mechanical system that has one fixed base and one movable base where the end-effector is connected [4–6]. The parallel manipulator first came into limelight after using it for a flight simulator which was developed by Stewart Gough and called as Stewart Gough platform. To reduce unwanted movement in the robot, a parallel manipulator is designed with very short chains that make the design simple and make the robot very robust compared to other types of robots. A parallel manipulator is designed so that each chain is

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usually short and simple and can thus be rigid against the unwanted movement compared to a serial manipulator. A parallel manipulator usually has a closed-loop structure. The overall stiffness of a parallel manipulator is because of closed-loop structure which maintains the flexibility off-axis of a joint by constraining the effect of other chains. In terms of rigidity, parallel manipulator is more rigid than a serial manipulator, but due to its simple structure, the serial manipulator is widely used than a parallel manipulator. Serial robots are considered more effective and used widely than parallel manipulators. Serial robots are simple to construct, are easy to code, and do not involve complicated equations for calculation transformation matrix and also have a larger workspace. Most of the companies are building serial robots for most of the functionalities required in industries. There are many famous automobile companies that use serial robots in manufacturing automobiles at all levels of production [7]. In this kind of environment, robots with artificial intelligence play a very important role. Robots with artificial intelligence can also be used in mining places which are very hazardous and where there is a great risk for human beings. In a mining plant, human beings can reach to certain distance under the earth easily, but after that, there are many complexities where there is a loss of life also, and in this kind of place, robots with artificial intelligence can serve our needs to a great extent [8–9]. The integration of artificial intelligence with robotics is a great use for humans, and it can serve human beings in many ways by taking not only risky jobs but also boring jobs (Fig. 80.1).


**Fig. 80.1** Serial manipulator

## 80.2 Problem Statement

Serial robots are considered for carrying loads in industries. For this robot, an algorithm has to be fed so that it can plan its path based on the layout of the industry. This manipulator has to consider all the obstacles that come on its way and should be able to choose the path for the different layout of the industry and different setup of obstacles.

## 80.3 Methodology

For path planning, most of the widely used algorithm is A* algorithm. A* is an artificial intelligence algorithm that can make the manipulator think like a human considering all the possibilities and find the optimal path from all the possible paths. MATLAB is used for coding and running the A* algorithm.

## 80.4 A-Star Algorithm

### *80.4.1 Artificial Intelligence*

According to the father of artificial intelligence, John McCarthy, it is "The science and engineering of making intelligent machines, especially intelligent computer programs." Human beings have a very great fortune to think on their own if a computer is given the same power, and then we call it artificial intelligence. It makes a computer-controlled robot or a self-thinking software think on its own and act accordingly. AI is attained by getting a proper idea of the way the human brain thinks, learns, decides, and works while trying to reach a solution.

A-star search algorithm thinks on its own where it uses its brain as a human being to find the shortest path in a very efficient way. This feature makes this algorithm to remain as the most dependent one, and it is used in many games and web-based applications even today.

### *80.4.2 A-Star Algorithm*

A* algorithm was first developed and used by Hart et al. [10]. They used A* algorithm to solve the cost paths where the path with minimum costs is found for the transportation of goods. A* approach is not like other methods as A* also includes the objective of finding of cost of path completion and estimating functions also. There are a lot of improvements in the development of algorithms that are

used for finding the shortest paths or minimize the cost of completing a path. The shortest path planning problem is widespread in many industries like manufacturing, hospital, vehicle routing, telephone call routing, etc.

The A* algorithm was first used and presented by Hart et al. [10]. A* algorithm is based on the Euclidean distance measure. It first identifies the source node, i.e., the starting point, and the destination node, i.e., the endpoint. To complete a path from the source node to destination node, A* algorithm considers Euclidean distance measure which considers a lower bound on what it would take in distance to complete. How A* algorithm works is explained below, for example, in a square grid which contains many obstacles. There will be a source point and a destination point. Our objective is to start at a source point and reach the destination point in the shortest path, and we use A* algorithm for that. At each node, the A* algorithm selects the node based on the cost of movement from the source point to the next node on the grid and estimated the cost of movement from that selected node to the destination point. This is completely based on a guess as we are not exactly aware of the original distance of the destination point until we reach that point.

By using the above working methodology, the algorithm is developed and coded in the MATLAB. When we run the code, it asks to give all the inputs like target position, obstacles, and the starting point. When these all are given, the algorithm calculates the optimal path and follows that path to reach the target. This way it can calculate the optimal path for all the valid layouts in industry and plan its path optimally.

## 80.5 Results

When the code is run, a graph with nodes appears as GUI where the user needs to mention the target point first (Figs. 80.2 and 80.3). After giving the target point, the user has to update the GUI with all the obstacles he wishes to with a left click of the mouse, and for the last mark use right-click. When the starting point is given, the algorithm makes the robot go in all the ways possible from the starting point and traces different routes. It calculates the number of nodes it is going through in each path and measures the count of nodes. Finally, it calculates the shortest path used to reach the target and displays that path which is the optimal path.

Once all the obstacles are set and source and destination points are fixed, then the algorithm starts calculating the shortest path. From the source point, the algorithm searches for all the possible ways to go to the destination point. It first checks the next node whether any obstacle is present or not and plans accordingly. Here, algorithms think like a human being where it learns whether there is an obstacle or not and decides whether it can make the shortest path (Figs. 80.4 and 80.5).

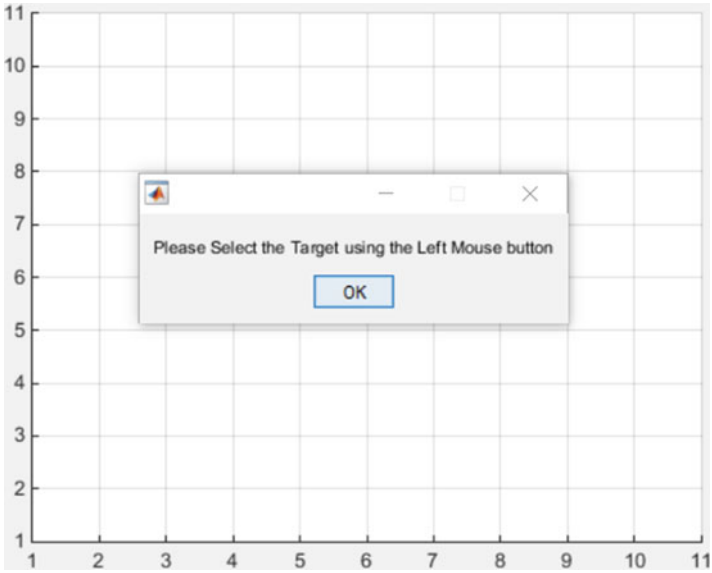


**Fig. 80.2** GUI for giving the target point in a layout

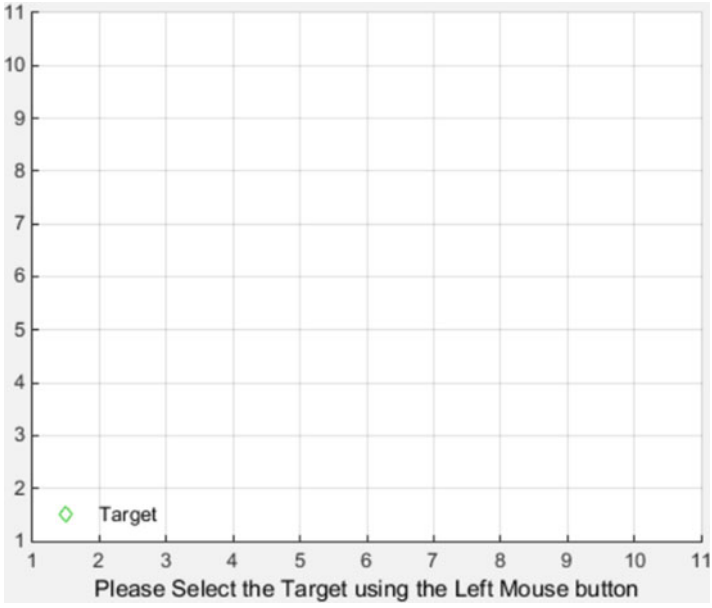


**Fig. 80.3** GUI for giving the obstacles

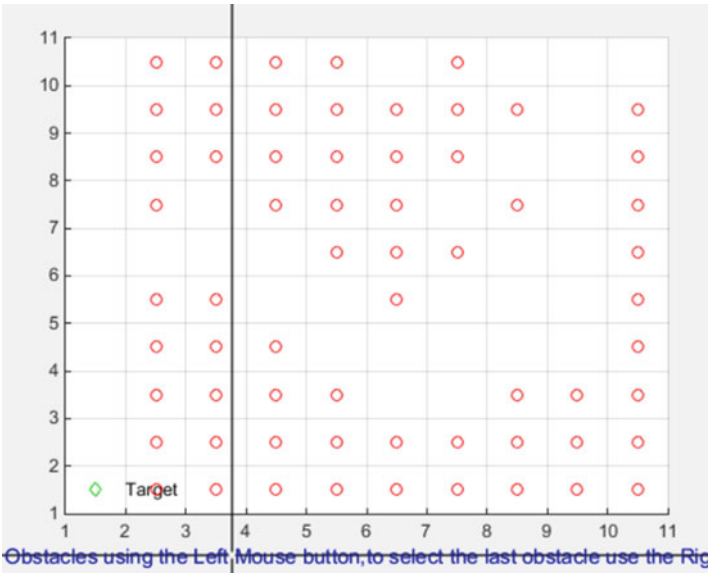


**Fig. 80.4** Layout with target position and obstacles

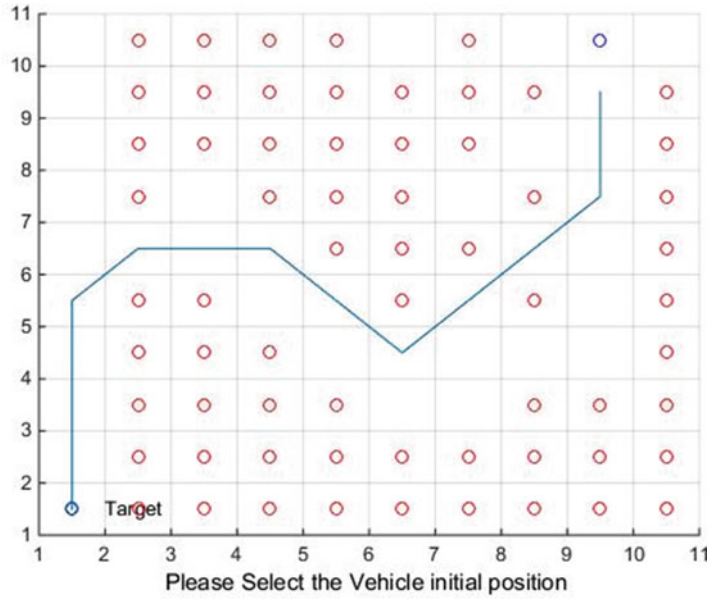


**Fig. 80.5** Optimal path from starting point to target point

## 80.6 Future Scope

This algorithm is fed into a working model of a parallel manipulator and used for tool path planning, network planning, path planning on roads and maps, etc. in real time. This algorithm will be fed into a real-time parallel manipulator and used in a real environment.

## 80.7 Conclusion

Parallel manipulators become one of the best helpers for human beings in works where there is a need for high rigidity and limited workspace. Due to their robustness, they are good for carrying loads and working in hazardous uneven paths. Path planning can help these manipulators in saving time, money, and energy. Artificial intelligence algorithms will definitely make the job easy for a human being. Robots with artificial intelligence using some smart algorithms like A* algorithm can help the industries or any layouts where cost optimization is dependent on the shortest path.

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