Lecture Notes in Electrical Engineering 860

Pradeep Kumar Mallick
Akash Kumar Bhoi
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Preface

The Second International Conference on Electronic Systems and Intelligent Computing (ESIC-2021) which will be held at KIIT Deemed to be University, Bhubaneswar, Odisha, India, from 5th to 6th November, 2021, was jointly organized by World Leadership Academy and Kalinga Institute of Industrial Technology (KIIT) Deemed to be University. The first edition of this conference was organized by NIT, Arunachal Pradesh, and the proceeding was published by Lecture Notes in Electrical Engineering (Volume 686). The essential goal of the Second International Conference on Electronic Systems and Intelligent Computing (ESIC-2021) is to give a stage to both electronic hardware and software to communicate under one umbrella for further improvement of shrewd electronic frameworks. Effective and secure information detecting, stockpiling, and preparing play a significant part in the current data age. The cutting-edge savvy electronic frameworks take into account the requirements of effective detecting, stockpiling, and figuring. Simultaneously, effective calculations and programming utilized for quicker examination and recovery of required data are winding up progressively. Storing and handling of the gigantic measure of organized and unstructured information are getting progressively hectic. Simultaneously, Post-CMOS technologies, Internet of Things (IoT), and Cyber-Physical System (CPS) have been moving with synchronous advancement of hardware and programming and lies over ordinary customer gadgets. The exhibition and productivity of the present just as the future ages of figuring and data handling frameworks are generally reliant upon advances in both design and programming.

Moreover, we would like to extend our sincere gratitude to the reviewers, technical committee members, and professionals from the national and international forums for extending their great support during the conference.

Bhubaneswar, Odisha, India — Dr. Pradeep Kumar Mallick
Ghaziabad, India — Dr. Akash Kumar Bhoi
Madrid, Spain — Dr. Alfonso González-Briones
Bhubaneswar, Odisha, India — Dr. Prasant Kumar Pattnaik

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About the Editors

Dr. Pradeep Kumar Mallick is currently working as Senior Associate Professor in the School of Computer Engineering, Kalinga Institute of Industrial Technology (KIIT) Deemed to be University, Odisha, India. He has also served as Professor and Head of the Department of Computer Science and Engineering, Vignana Bharathi Institute of Technology, Hyderabad. He has completed his Postdoctoral Fellow (PDF) from Kongju National University South Korea, Ph.D. from Siksha Ó' Anusandhan University, M.Tech. (CSE) from Biju Patnaik University of Technology (BPUT), and MCA from Fakir Mohan University Balasore, India. Besides academics, he is also involved in various administrative activities, a member of Board of Studies to C. V. Raman Global University Bhubaneswar, a member of Doctoral Research Evaluation Committee, Admission Committee, etc. His area of research includes algorithm design and analysis, and data mining, image processing, soft computing and machine learning. Now, he is an editorial member of Korean Convergence Society for SMB. He has published 14 edited books, 1 textbook and more than 100 research papers in national and international journals and conference proceedings to his credit. He is currently editing several books with Springer Nature, Elsevier and Routledge & CRC Press. He is also serving as Guest Editor for special issues of the journal like Springer Nature, Elsevier and Inderscience.

Akash Kumar Bhoi B.Tech, M.Tech, Ph.D. currently associated with KIET Group of Institutions, India as Adjunct Faculty and Directorate of Research, Sikkim Manipal University as Adjunct Research Faculty. He is appointed as the honorary title of "Adjunct Fellow" Institute for Sustainable Industries & Liveable Cities (ISILC), Victoria University, Melbourne, Australia for the period from 1 August 2021 to 31 July 2022. He is also working as a Research Associate at Wireless Networks (WN) Research Laboratory, Institute of Information Science and Technologies, National Research Council (ISTI-CRN) Pisa, Italy. He was the University Ph.D. Course Coordinator for "Research & Publication Ethics (RPE) at SMU." He is the former Assistant Professor (SG) of Sikkim Manipal Institute of Technology and served about 10 years. He is a member of IEEE, ISEIS, and IAENG, an associate member of IEI, UACEE, and an editorial board member reviewer of Indian and International journals. He is

also a regular reviewer of reputed journals, namely IEEE, Springer, Elsevier, Taylor and Francis, Inderscience, etc. His research areas are Biomedical Technologies, the Internet of Things, Computational Intelligence, Antenna, Renewable Energy. He has published several papers in national and international journals and conferences. He has 130+ documents registered in the Scopus database by the year 2021. He has also served on numerous organizing panels for international conferences and workshops. He is currently editing several books with Springer Nature, Elsevier, and Routledge & CRC Press. He is also serving as Guest editor for special issues of the journal like Springer Nature and Inderscience.

Dr. Alfonso González-Briones holds a Ph.D. in Computer Engineering from the University of Salamanca since 2018, his thesis obtained the second place in the 1st SENSORS+CIRTI Award for the best national thesis in Smart Cities (CAEPIA 2018). At the same university, he obtained his degree in Computer Engineering (2012), degree in Computer Engineering (2013) and master's in Intelligent Systems (2014). Since 2014, he has worked in different public and private research centers, among them are the BISITE Research Group of the University of Salamanca, where he works on the development of energy optimization systems in homes and intelligent buildings and the development of efficient systems in the agricultural and livestock sector; Virtual Power Solutions (VPS) in Coimbra, (Portugal) or Clemson University (USA), where he worked as a researcher in carrying out a study on decision tree algorithms with a high percentage of efficiency for the recognition of devices that carry out energy consumption, as well as the parameters that help to improve the accuracy of recognition and its detection. He has published more than 20 articles in journals, more than 40 articles in books and international congresses and has participated in 8 international research projects. He is also a member of the scientific committee of the Advances in Distributed Computing and Artificial Intelligence Journal (ADCAIJ) and British Journal of Applied Science & Technology (BJAST) and a reviewer of international journals (Supercomputing Journal, Journal of King Saud University, Energies, Sensors, Electronics or Applied Sciences among others). He has participated as chair and member of the technical committee of prestigious international congresses (AIPES, HAIS, FODERTICS, PAAMS, KDIR). Currently, he is a "Juan De La Cierva" Postdoc at GRASIA Research Group in the University Complutense of Madrid at Software Engineering and Artificial Intelligence Department. He was Project Manager of Industry 4.0 and IoT projects in of the AIR-Institute (https://air-institute.org/), and he was also a lecturer in the Master of Industry 4.0 at the International University of La Rioja (UNIR).

Dr. Prasant Kumar Pattnaik Ph.D. (Computer Science), Fellow IETE, Senior Member IEEE, is Professor at the School of Computer Engineering, KIIT Deemed University, Bhubaneswar. He has more than a decade of teaching and research experience. He has published numbers of Research Papers in peer-reviewed international journals and conferences. He also published many edited book volumes in Springer, IGI Global and Wiley Publication, and he has co-authored the popular computer science and engineering text books, "Fundamental of Mobile Computing," PHI and

"Cloud Computing Solutions: Architecture, Data Storage, Implementation and Security," John Wiley & Sons Inc. His areas of interest include Mobile Computing, Cloud Computing, Cyber Security, Intelligent Systems and Brain Computer Interface.

A Parallel Implementation of FastBit Radix Sort Using MPI and CUDA

Raghunandan, B. Aishwarya, B. Ashwath Rao, Prakash K. Aithal, and Gopalakrishna N. Kini

Abstract The sorting operation arranges the data in an easily reproducible format, making it easy to search and store the data. With the search operation being highly optimized on sorted data, it is no surprise that sorting has become a very important computing operation. Many sorting algorithms have been developed over the years and the main aim is to reduce the time and space complexities for sorting in the worst- and average-case scenarios. Radix sort is one of the non-comparative-based sorting algorithms that performs the sorting operation in linear time. This paper proposes a parallel approach on a variation of Radix Sort namely, FastBit Radix Sort. 9 × speedup is achieved through the parallel algorithm proposed.

Keywords Sorting · Radix sort · MPI · CUDA · FastBit Radix Sort · Parallel sort · Parallel computing

1 Introduction

Sorting is an operation or technique which is used to arrange and rearrange sets of data in a specific order [1]. It is considered to be one of the most basic algorithms in Computer Science due to its wide range of applications. Sorting techniques can be broadly classified as Comparative- and Non-comparative-based techniques. In comparative-based sorting, a comparator decides on the order of the sorted data namely numerical, lexicographical, etc. In a non-comparative sorting algorithm, the order of elements is based on the integer arithmetic on the keys. Radix sort falls into the non-comparative class of sorting algorithms. It has been known to be used as far back as 1887 by Herman Hollerith in tabulating machines [2].

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Radix sort can be implemented with ease by performing modulus operation on each of the data elements and placing them in a count table using the digit obtained. The implementation thus created would have a worst-case time complexity of O(k*n) where "k" is the maximum number of digits for a data element and "n" is the input size. It has been observed by Joo-Young Kim et al. in [3] that the radix computing operation at the bit level is faster than the arithmetic level. In light of this, the Radix sort is modified to obtain the FastBit Radix sort. While the Radix sort extracts the order by performing modulus operation followed by division, the FastBit Radix sort obtains the same through bitwise "AND" operation followed by bit manipulation of the integer mask [4].

With the increasing volumes of data, a sequential sorting algorithm may not be efficient enough for sorting the data. In this paper, we have proposed a parallel algorithm for sorting huge datasets. The parallelization of the sorting algorithm has been performed using two standard libraries: Message Passing Interface (MPI) and Compute Unified Device Architecture (CUDA). MPI is a library specification for message passing, proposed as a standard by a broadly based committee of vendors, implementers, and users [5]. It is used to achieve interaction between processors running in parallel with the help of inbuilt APIs. These API calls can be made using C, C ++ Fortran, etc. CUDA is a parallel computing platform and programming model developed by NVIDIA for general computing on graphical processing units (GPUs) [6]. With CUDA, developers will be able to dramatically speed up computing applications by harnessing the power of GPUs. Using CUDA, one can choose to run the compute-intensive portion of the application on thousands of GPU cores that are running in parallel. These CUDA API calls can be made using C, C ++, Fortran, Python, etc.

The structure of this paper is as follows: Sect. 2 provides a literature survey describing the existing work done by researchers in parallelization of certain sorting algorithms. Section 3 provides a detailed description of the methodology used for developing the parallel algorithm. Section 4 presents the experimental setup and the analysis done to achieve optimum results using the proposed method. Section 5 discusses the results obtained during the experimentation. Finally, Sect. 6 presents the conclusion and future scope.

2 Related Work

A study of various parallel sorting algorithms was performed by Durad et al. in [7], and they had implemented various sorting algorithms using MPI which includes Bitonic Sort, Odd–Even Sort, Shell Sort, etc. to name a few. They compared it on clusters of computers both with and without ethernet for communication between the processing elements. This was to simulate the limited communication bandwidth situation. The performance was analyzed based on the runtimes. While performing the sort in the ethernet cluster, they found that merge sort performs better for large datasets. However, in the non-ethernet cluster, they found that the Radix sort

performed better, and hence, it holds promise for usage in standalone systems. They also concluded that the odd–even sorting performance improved with the added number of processing elements. S. Kumari et al. in [8] implemented a parallel selection sort algorithm in the GPU using CUDA. The algorithm divides the total dataset into blocks that are sorted using radix sort and these blocks are then sorted using selection sort parallelly. They were able to prove that the total time complexity of the whole sorting operation is O(N/p + p * log N/p), where N is the total data size and p is the number of threads in the GPU. The implemented algorithm provided better performance than the odd–even merge sort and the sequential selection sort algorithm. Yildiz et al. in [9] performed a comparison between serial and parallel versions of digit-based Radix sort and bitonic sort on a CUDA GPU environment. They ran it on an integer dataset of sizes up to 2ˆ24 data elements. They noted that for datasets of sizes greater than 2ˆ20 the runtimes of the two algorithms diverged with parallel bitonic sort taking up the lesser time of the two.

Valerievich et al. in [10] implemented parallel quick and shell sorts in CUDA. They found that the shell sort performed better than quicksort on the GPU, which may be attributed to the higher communication needs of the latter. They further demonstrated that while the increase in the number of blocks and threads decreases the execution time initially when increased further above, the execution time increases due to the increase in the communication overheads and noted that this may be reduced using the disparallelization approach.

Further hybrid approaches were devised by Chandrashekhar et al. in [11] wherein they devised a hybrid strategy of using sequential, MPI, and CUDA-based GPU-CPU and hybrid clusters consisting of both MPI and CUDA GPUs for faster parallel sort algorithms. They tested the architectures for Merge, Heap, and Quicksort algorithms. They explored multiple combinations of clusters namely sequential only, MPI only, GPU only, and MPI + CUDA. They demonstrated that Merge sort in MPI + CUDA hybrid configuration gave the best speedup.

Apart from the above, there have been many sorting algorithms that are parallelized. In [12–15], a few sorting algorithms namely Tim sort, Super sort, Cut sort, and Matrix sort algorithms are parallelized using GPU. The researchers have been able to reduce sorting time when compared to sequential execution time.

3 Methodology

The study done in [4] discusses the serial implementation of the FastBit Radix sort algorithm. To parallelize this algorithm, a mixed strategy is used in which the sub-lists are sorted by a sequential sorting algorithm and the merging of the sub-lists is done in parallel between the processes/threads. The general workflow that we followed for parallelizing the existing algorithm is as follows:

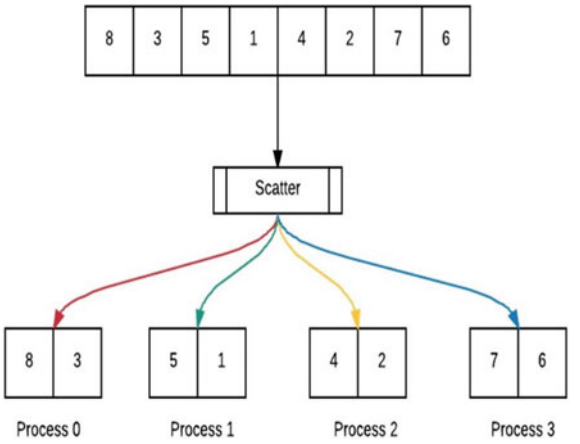

Fig. 1 The given array of numbers is scattered among different processes

Fig. 2 The processes sort the elements within the chunk handled by them

Step 1: Divide the array into unsorted sub-arrays.

For this portion of the problem, we begin with a single unsorted list. This list is scattered to all of the processes such that each process has an equal chunk of the list. Suppose we have 4 processes and a list containing 8 integers, the code executes as shown in Fig. 1.

Step 2: Sort sub-lists.

We sort these sub-lists by applying a serial sorting algorithm. We use the function Sort on each process to sort the local sub-list. After sorting, the processes have the sorted sub-lists as shown in Fig. 2.

Step 3: Merge sub-lists.

The merging of the sub-lists to form a single sorted array is done by sending and receiving sub-lists between processes and merging them. Each initially sorted sub-list (with a size of 2 in our example) provides the sorted result to the corresponding parent process in parallel. That process combines the two sub-lists to generate a list of size 4 and then sends that result to its parent process. The individual processes at each level work in parallel to send the resultant merged array to the parent in the next level. Lastly, the root process merges the two sub-lists to obtain a list of size 8 that is fully sorted as shown in Fig. 3.

In this study, we have tried to show how parallelizing an existing sequential sorting algorithm can give a better performance when considering huge data volumes. Firstly, we have checked the time complexity for the sequential FastBit Radix sort by varying the data sizes and then similarly checked the time complexities for the proposed

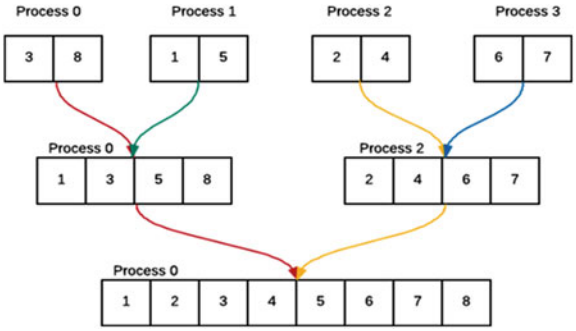

Fig. 3 The merge operation is performed to obtain the final sorted array

parallel algorithm using MPI and CUDA. The following section explains in detail the approach for all three methods.

3.1 Sequential FastBit Radix Sort

The Radix sort modified to work on bit level is FastBit Radix Sort. In FastBit Radix Sort, the data elements are scanned from Most Significant Bit (MSB) to Least Significant Bit (LSB) of their binary representation, and a specified bit position is checked in each pass; the bit position is updated at the end of each pass. The algorithm goes through M passes if the architecture of the machine uses M bits to represent a data element. Each pass starts with pointers "startPointer" and "endPointer" to denote the start and the end of the data array to be sorted. The initial bit position that is taken is given below in Eq. 1.

$$2^{(Totalbitsinthebinaryrepresentationofinteger-1)} \tag{1}$$

A bitwise right shift is performed on the "bitPosition" value by one position at each pass so that the set bit moves from MSB to LSB. In each pass, bitwise "AND" operation is performed on the values at "startPointer" and "endPointer". The bits, thus, obtained are checked to be in order. If they are found to be out of order, they are swapped and "startPointer" and "endPointer" are incremented and decremented, respectively. These steps are repeated for each bit position. At the end of each pass, we find that the data will be sorted in a bit specific format, i.e., there will be a partition of 0's and a partition of 1's. The method is called again for each of the partitions until the partition contains only one element. Once the "bitPosition" reaches the LSB, the sorting is complete and the array obtained is sorted. The advantage that the FastBit Radix sort has over the traditional Radix sort is that the runtime can be optimized by changing the number of bits used in the bitMask depending on the number of bits used by the data type that is being sorted.

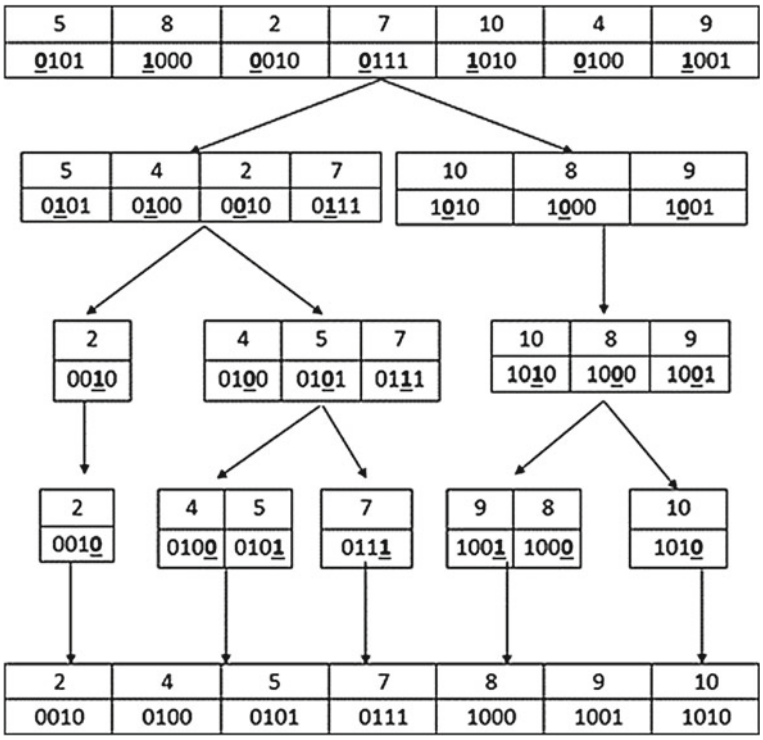

Fig. 4 FastBit radix sort example

An example run through the iterations for FastBit Radix sort is provided in Fig. 4. for the numbers: 5, 8, 2, 7, 10, 4, 9.

3.2 Parallel FastBit Radix Sort Using MPI

MPI has several inbuilt APIs which can be used for message passing between processors within or outside a communicator. "mpi.h" is the header file that needs to be included to be able to use the MPI library. MPI_Scatter has been used to scatter the input array between p processors by diving the dataset into random chunks. Each processor calls the FastBit Radix sort function in parallel, hence resulting in p sorted chunks. The merge function is then called which merges the sorted chunks into a single sorted array in parallel. MPI_Wtime is used to measure the overall time of operation. Figure 5. describes the methodology implemented by the parallel algorithm using MPI.

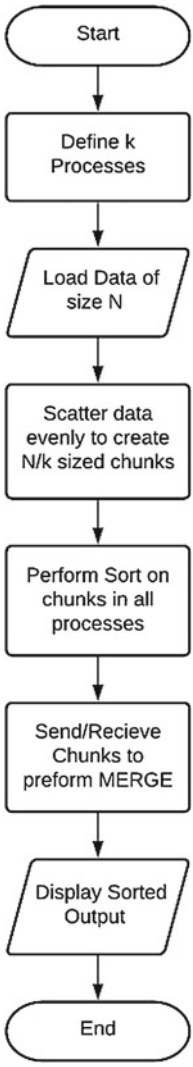

Fig. 5 Workflow of the parallel FastBit radix sort using MPI

3.3 Parallel FastBit Radix Sort Using MPI

CUDA toolkit has multiple inbuilt APIs that can be called by including the "cuda_runtime.h" and "device_launch_parameters.h" libraries. Using C++/C programming language, we can create CUDA kernel function that calls the sort program that needs to run n times in parallel using n threads. Each thread that executes the kernel is given a unique thread ID that is accessible within the kernel through built-in variables. We have defined the number of threads to be a constant value based on the input data size. The sorted arrays obtained from each of the threads have to

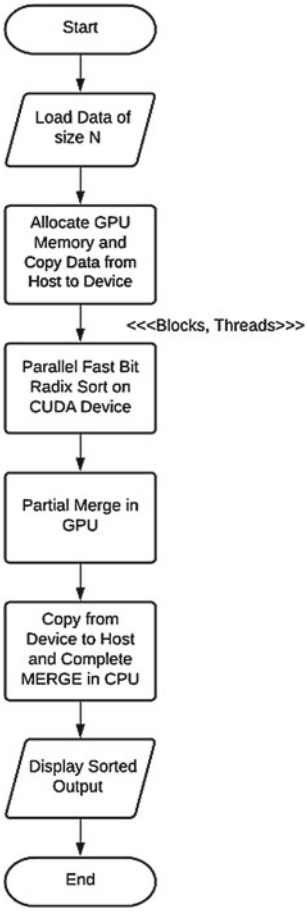

Fig. 6 Workflow of the parallel FastBit radix sort using CUDA

be merged into a single array. Another kernel function is called which merges the results in parallel to finally obtain a single sorted list, and this is done in a hybrid manner where a part of merge is completed in the GPU and the remaining levels of merge are completed in the CPU. Figure 6 describes the methodology implemented by the parallel algorithm using CUDA.

3.4 Setup and Analysis

The FastBit Radix Sort algorithm was implemented in C ++ and the dataset was sorted. This was done for various different sizes of the input data and the overall execution times were noted down. The data sizes were chosen to reflect the different data sizes we would encounter in a real-life application.

While running the tests in MPI, we have direct control over the number of processes that are used for the execution. The best number of processes depends on the combination of the individual sorting time and the communication overhead. The number of data elements was chosen to reflect the effectiveness of the MPI parallelization approach for both smaller-sized datasets and the larger-sized ones. The number of processes was changed continuously to find the best execution time thereby demonstrating the best speedup achieved using this method.

We further explored multiple strategies of achieving the complete sorted output by testing various merging strategies. The first among them was an in-place merge approach wherein we would be swapping the values in the same array by considering two sorted sub-arrays as chunks to be merged. This is an inefficient method as it has O(N^2) time complexity. The next method to be tested was to merge the output sequentially as it arrives or in-order sequential merge approach. This is an effective method if we have a small number of chunks to merge as the time complexity is O(k*N) where k is the number of chunks to be merged. However, as the number of chunks increases, the merging time increases and so does the complete execution time. The next solution which happens to be the most efficient one is to merge the chunks hierarchically as depicted in Fig. 7. previously. This takes O(k*logN) time for completion where k is the number of chunks.

The CUDA program was designed to vary the number of threads depending on the input data size. This ensured that the overheads remained at a minimum and we get the best possible speedup for the given data size. However, this meant that we could only change the input data sizes to check the speedup. In this regard, the execution times were noted by varying the input data size. Initially, the merging was performed in the GPU alone. Though this gave us the sorted output, the time taken for merging the larger chunks was a significant component of the total execution

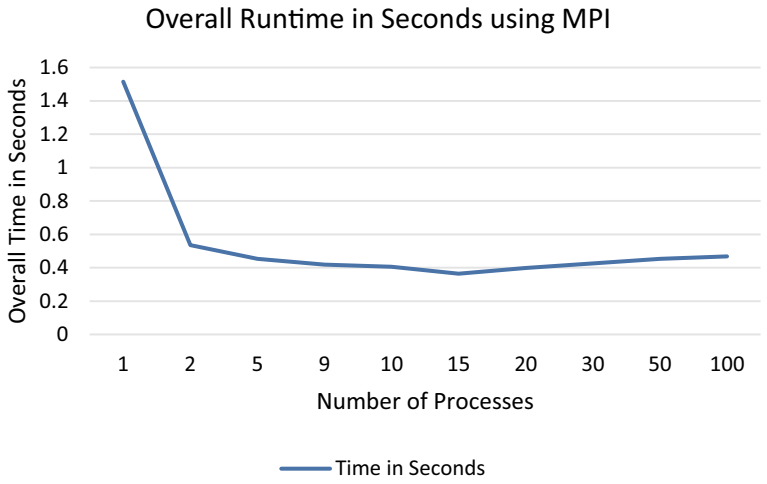

Fig. 7 MPI runtime versus processes for 2,020,456 data elements

time. This prompted us to search for a hybrid approach for merging where we would merge the chunks in the GPU up to a threshold size and the remaining merging was done in the CPU hierarchically. We found the execution time was minimum when the GPU merging was limited to 4096 data elements in individual arrays. The execution times were noted down for the corresponding data sizes.

The metric used for comparing the algorithms and approaches is speedup. This is given in Eq. 2 below. It is the ratio of best serial time and parallel execution time.

$$2^{(Total bits in the binary representation of integer - 1)} \tag{2}$$

3.5 Results

The implementations were tested on a machine with Windows 10 OS and Visual Studio 2010 on an × 64-based Intel i5-10210U CPU and Nvidia MX330. They were written using MPI and CUDA in C and the timing in seconds was noted down. The execution was on a standard dataset [T10I4D100K(.gz)] [16] containing 1,010,228 data elements, and for the 2,020,456-sized datasets, the same dataset was repeated again to create the larger dataset, and the overall runtime was noted. The dataset contained elements from 0 to 999 and contains repeated, reverse sorted, nearly sorted, and reverse sorted with repeated data elements.

In MPI, for given data size, as we increase the number of processes, the chunk size reduces, and hence, the runtime reduces. However, as we increase it further, the communication overhead dominates and leads to runtime saturation. This leads us to choose the number of processes based on the data size to get the least runtime possible.

To get the best runtime for the algorithm, we continuously vary the number of processes starting from 1 up to runtime saturation, and the minimum runtime is considered. Figure 7. compares the runtime changes with the number of processes for 2,020,456-sized input data. The runtime is observed to be minimum when 15 processes are used.

In CUDA, the creation of threads is cheaper both in terms of space and time when compared with MPI. This makes it easier to increase the number of threads and thereby increase the parallelism while handling larger datasets. The number of threads it generates is the same as the input data size. Hence, we test the runtimes for various input data sizes. Figure 8 shows the CUDA runtime comparison with the serial execution runtime.

The time taken for the sorting operations on the dataset, of size 2,020,456, was recorded for the sequential and the parallel algorithms. Table 1. shows the results of the time taken by each of the algorithms for different data sizes (1 k, 10 k, 100 k, 1 M, 2020456[2 M]).

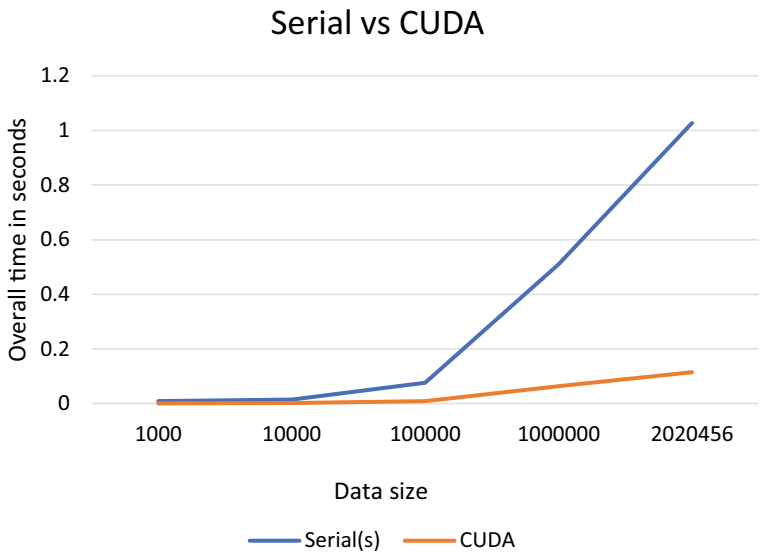

Fig. 8 Comparison of CUDA runtime and serial runtime

Table 1 Comparison of the sorting times

	Serial	CUDA	MPI
Data Size	Time in Seconds		
1000	0.009	0.000412	0.000598
10,000	0.015	0.001780	0.002139
100,000	0.076	0.008755	0.017629
1,000,000	0.509	0.63355	0.181912
2,020,456	1.027	0.114850	0.364129

From Table 1, we can conclude that the time required to sort the data has been reduced significantly by using MPI and CUDA. From Fig. 9, we can observe that the parallel sort implemented in CUDA is the fastest among the tested algorithms. MPI has also given better performance as compared to the sequential sorting algorithm, especially for the larger dataset sizes.

Speedup is calculated as the ratio of the time taken for sequential execution to the time taken for parallel execution. Higher the Speedup, the better the improvement in the processing time. Table 2. shows the speedups achieved by parallelizing the FastBit Radix sort algorithm using MPI and CUDA.

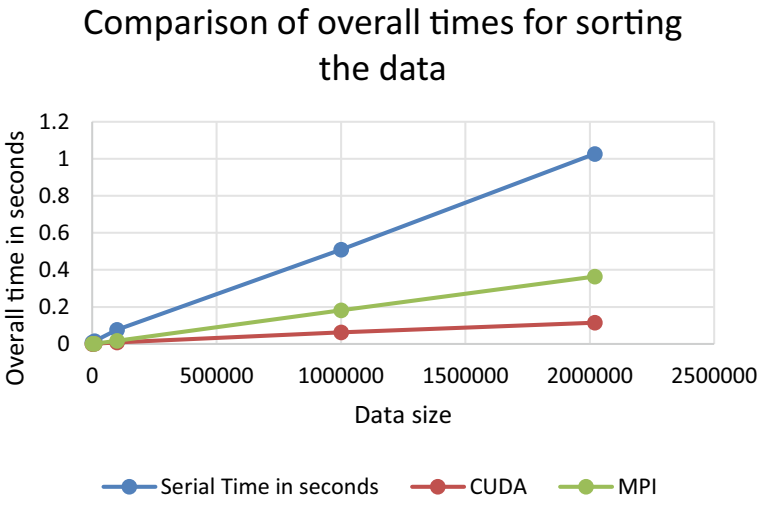

Fig. 9 Comparison of runtimes using serial, MPI, and CUDA

Table 2 SpeedUps achieved using MPI and CUDA

	Speedup
MPI	2.820
CUDA	8.942

4 Conclusion and Future scope

We proposed an approach to parallelize the FastBit Radix Sort Algorithm. It resulted in taking less time for the sorting operation than its sequential counterpart for the same dataset. It provided a speedup of 9 × in the execution time of the sorting as shown in Table 2.

The algorithm may be further improved by reducing the communication overheads. Multithreading applications such as OpenMP could be used to improve the performance in CPU actions.

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Performance Improvement of S-shaped for Wireless Communication

S. Kannadhasan and R. Nagarajan

Abstract High-speed WLAN IEEE 802.11a standard and other wireless communication systems, a wideband S-shaped microstrip patch antenna covering the frequency range of 2 GHz–3 GHz has been created. The length has changed to tune the frequency of the second resonant mode without affecting the frequency of the main resonant mode. To understand the impact of different dimensions factors and to enhance the antenna's performance, a comprehensive parametric research was conducted. To achieve a compact radiating structure that matches the rigorous bandwidth criterion, a low dielectric constant substrate is used. The measurement findings match the HFSS simulation findings almost perfectly. There are many stages in communication systems. Microwave and wireless communication technologies are at their height right now. Small antenna size, low weight, and a basic 2D construction are essential requirements for microwave and wireless applications.

Keywords S-shaped · VSWR · Return loss · Communication system and applications

1 Introduction

With the aid of a Microstrip antenna, all of these requirements may be met. This antenna also has several drawbacks, such as limited gain, restricted bandwidth, and poor polarization. To solve these issues, numerous ways are utilized, such as adjusting the substrate thickness, changing the substrate material, altering the patch form, and so on. For long-distance communication, an antenna with great directional characteristics (high gain) is desired in many applications. As a result, a novel multielement antenna called an array antenna is incorporated. The S-shaped array arrangement

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shown in this research improves both gain and bandwidth. There are many stages in communication systems. Microwave and wireless communication technologies are at their height right now. Small antenna size, low weight, and a basic 2D construction are essential requirements for microwave and wireless applications. With the aid of a Microstrip antenna, all of these requirements may be met. This antenna also has several drawbacks, such as limited gain, restricted bandwidth, and poor polarization [1–5].

To solve these issues, numerous ways are utilized, such as adjusting the substrate thickness, changing the substrate material, altering the patch form, and so on. For long-distance communication, an antenna with great directional characteristics (high gain) is desired in many applications. As a result, a novel multielement antenna called an array antenna is incorporated. The S-shaped array arrangement shown in this research improves both gain and bandwidth. Four S-shapes were added at the end. Each of the four S-shapes is of the same size. Coaxial probe feed is utilized to feed this array design. Using this methodology, we have offered several feed locations, and the spot where we receive the best results is eventually fed with coaxial probe feed. Then, using IE3D software, this design is simulated to get different curves such as the return loss curve, VSWR curve, and so on [6–10].

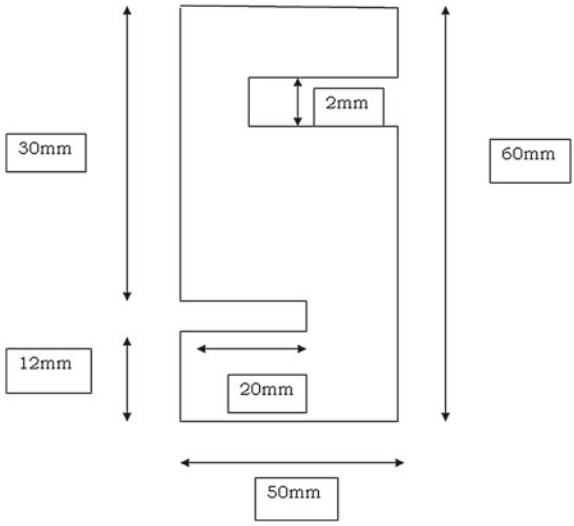
In many high-performance wireless communication systems, microstrip patch antennas are employed for a variety of purposes. They have various disadvantages, including poor efficiency, poor bandwidth, limited gain, and the ability to only operate at microwave frequencies. Tunings are complicated due to the aforementioned considerations. As a result, various slots are established in order to enhance them. Patch antennas are available in a variety of forms, including E, H, V, U, L, and others, making them appropriate for high-frequency applications [11–15].

2 S-shaped Antenna Geometry

With the increasing use of WN (Wireless Networks) technologies in recent years, demand for small, low-profile, and broadband antennas has increased significantly. The microstrip patch antenna has been recommended for these criteria because of its light profile, low weight, and inexpensive cost. By design, the microstrip antenna has a low gain and limited bandwidth. The constraints of restricted impedance bandwidth and low gain have been addressed in a variety of methods, as illustrated in Fig. 1. Because they provide many advantages over the conventional wire and metallic antennas, microstrip antennas have been used in a variety of applications including direct broadcast satellite (DBS) systems, mobile technologies, GPS, and various radar systems. Mobile and satellite communication application: Mobile communication requires small, low-cost, and low-profile antennas. These requirements are met by microstrip patch antennas, and many types of microstrip antennas have been created for use in mobile communication systems.

Satellite communication relies heavily on circularly polarized radiation patterns. Global positioning systems make use of microstrip patch antennas with sintered

Fig. 1 S-shaped antenna



substrates with high permittivity. The general population uses millions of GPS devices to accurately identify ground vehicles and aircraft. WiMax refers to the IEEE 802.16 standard. It has a theoretical range of 30 miles and a data throughput of 70 Mbps. MPA produces three resonant modes at 1.7, 2.3, and 2.83 GHz, allowing it to be utilized in WiMax-compliant communication devices.

A simple GPS repeater is made up of an exterior antenna, a narrow bandpass filter, a low-noise amplifier, and a reradiating interior antenna. The GPS signal is picked up by the outside antenna from the satellite. To collect more satellites, this antenna should have a broad beam and be circularly polarized. A helical antenna and a tiny strip circularly polarized patch antenna are both feasible choices for this purpose. The GPS received by the antenna is passed via a narrow band ceramic bandpass filter. The filtered signal is then routed via a multi-stage low-noise amplifier. The signal is retransmitted within the building, and the amplifier gives the necessary gain. The GPS signal is sent within buildings using an indoor reradiating antenna. A broad beam and circularly polarized antenna are necessary since the GPS receiver may be positioned anywhere within the structure. A microstrip patch antenna is a good option.

3 Results and Discussion

Microstrip patch antennas are becoming increasingly important. This is due to their versatility in terms of possible geometries, allowing them to be utilized in a wide range of situations. Two more of its various benefits are its low weight structure and compatibility with microwave integrated circuits. Furthermore, because of the

simplicity of the construction, these antennas are appropriate for low-cost production. This is also a major property of microstrip patch antennas, which are often employed in mobile communications. As a consequence, in practical applications, size reduction and bandwidth expansion are becoming important design challenges for microstrip antennas. The aim of this research is to create a FR4 dielectric substrate with a thickness of 1.5 mm for a high bandwidth microstrip patch antenna, compare it to prior patch antennas, and then recommend the best one.

The S-shaped slotted patch antenna was created in this research project. The bandwidth attained here is 38 percent of the center frequency, which is much more than the parasitic patch antenna. Due to its appealing properties like cheap cost, light weight, small profile, and conformability, Microstrip Patch Antennas (MPAs) are particularly tempting candidates for usage in a variety of applications. A 3D field solver is used to simulate the performance of the antenna by inputting the dimensions of the actual structure. The antenna is fed via a coaxial probe feeding method as shown in Fig. 2.

The movement of information from one place to another is a wide definition of communication. When information must be sent over a long distance, a communication system is generally necessary. Information is typically transmitted in a communication system by superimposing or modulating it onto an electromagnetic wave that acts as the signal's carrier. The modulated carrier is then received at the desired destination, and the original information signal may be retrieved using demodulation. Over time, advanced approaches based on electromagnetic carrier waves operating at radio, microwave, and millimeter wave frequencies have been developed for this process.

Antennas are the most critical components necessary to form a communication connection in today's contemporary communication sector. Microstrip patch antenna topologies have been the most popular method of realizing millimeter wave

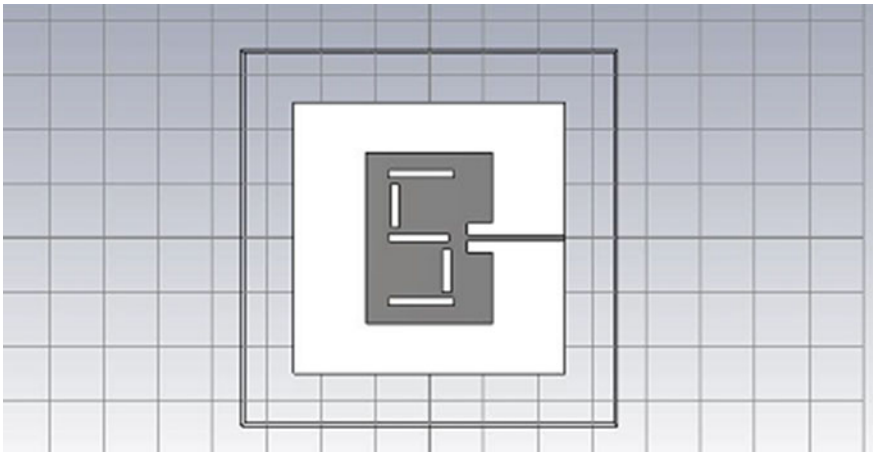


Fig. 2 Simulation structure of S-shaped antenna

monolithic integrated circuits for microwave, radar, and communication applications throughout the years. Designs become very versatile in terms of operating frequency, polarization, pattern, and impedance after the patch's shape and operating mode have been determined. Due to its appealing properties like cheap cost, light weight, small profile, and conformability, Microstrip Patch Antennas (MPAs) are particularly tempting candidates for usage in a variety of applications. The major drawback of MPA, on the other hand, is its limited bandwidth, which may be as low as 1%. These antennas may be used with active devices and printed strip-line feed networks. It has always been a top priority to make strenuous efforts to overcome practically all of the restrictions of traditional microstrip patch antenna characteristics, which are shown clearly in this study and easily comprehended.

Various settings may be seen in the simulated results. First, we looked at the return loss curve to get the bandwidth, then we looked at the VSWR curve to see whether the bandwidth we got was helpful or not. In the ideal frequency range, the VSWR should be less than 2 as shown in Fig. 4. The gain, directivity, and efficiency curves are then taken into account. The bandwidth and gain of a Microstrip patch antenna are the most significant factors. It's tough to increase bandwidth while also increasing gain. The Return Loss Curve (Fig. 3) is the first curve we examine while calculating bandwidth.

The return loss of the proposed antenna for resonating frequencies is 1.5 GHz at −20.02 dB, 2.1 GHz at −15.02 dB, and 2.03 GHz at −26.5 dB, respectively. Because of its low loss tangent and excellent thermal and mechanical qualities, the microstrip radiator has gained popularity. Microstrip antenna was the term given to them at

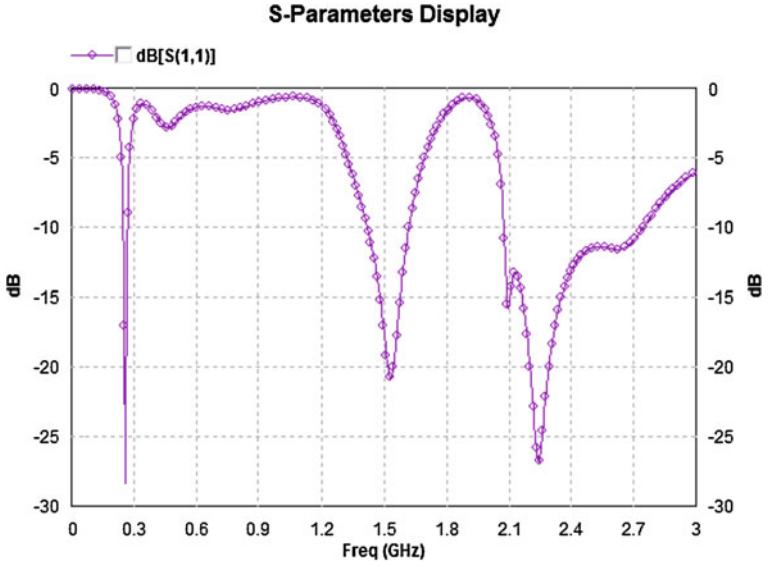


Fig. 3 Return loss of S-shaped antenna

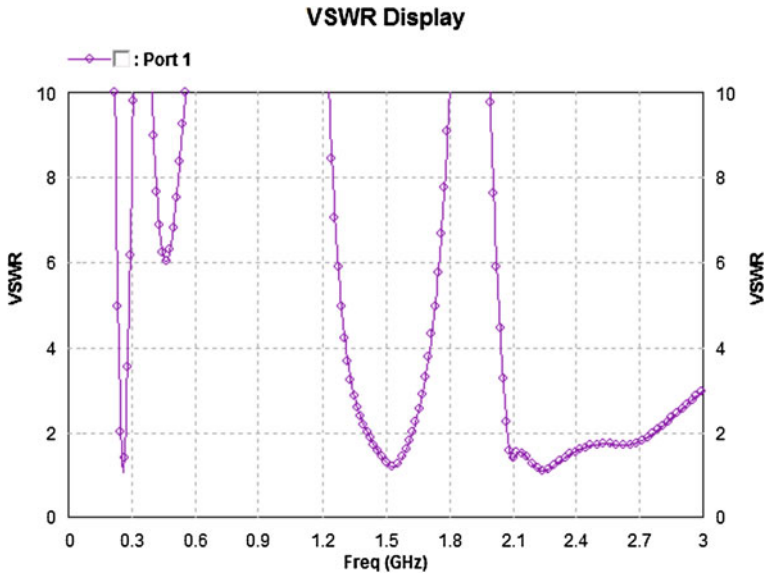


Fig. 4 VSWR of S-shaped antenna

the time. The primary reason for microstrip antennas' actual benefits is that they are very easy to install on planar and nonplanar surfaces, and certain applications were done by flying machines, rockets, and satellite communication, which prompted researchers to look into them. For microstrip antennas, narrow bandwidth was also a major challenge. Following the IEEE invention, this antenna has had extraordinary growth, with all issues being published in the IEEE Transaction on Antenna and Propagation.

A microstrip patch antenna for use in UWB applications is proposed in this article. The antenna is made up of several layers and is called a stack antenna. Figure 4 shows the VSWR of the proposed antenna at resonating frequencies of 1.5 GHz at 1.6, 2.1 GHz at 1.8, and 2.03 GHz at 1.98. The suggested antennas operate over a broad frequency range and meet all of the design criteria for microstrip patch antennas. Based on the above findings, we may infer that the S-shaped microstrip patch antenna has the best return loss for downsizing at 1.5 GHz, which has a broad variety of applications in telemetry, GPS, mobile applications, and amateur radio.

The movement of information from one place to another is a wide definition of communication. When information must be sent over a long distance, a communication system is generally necessary. In a communication system, information is usually transmitted by superimposing or modulating it onto an electromagnetic wave that acts as a carrier for the signal, as illustrated in Fig. 5.

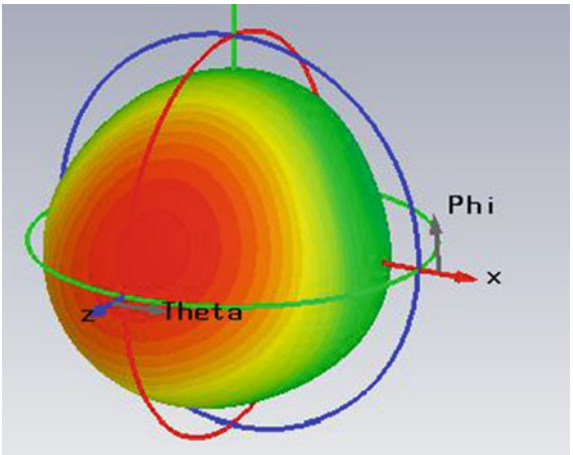


Fig. 5 Radiation pattern of S-shaped antenna

4 Conclusion

Antennas are the most critical components necessary to form a communication connection in today's contemporary communication sector. Over time, advanced approaches based on electromagnetic carrier waves operating at radio, microwave, and millimeter wave frequencies have been developed for this process. Microstrip patch antenna topologies have been the most popular method of realizing millimeter wave monolithic integrated circuits for microwave, radar, and communication applications throughout the years. Designs become very versatile in terms of operating frequency, polarization, pattern, and impedance after choosing the patch's shape and operating mode. It has always been a top priority to make strenuous efforts to overcome practically all of the restrictions of traditional microstrip patch antenna characteristics, which are shown clearly in this study and easily comprehended. In this study, a few obvious negative and important aspects, such as wide bands employing the slotting approach, are addressed. Despite this, practical and competent solutions are currently outnumbered and limited in number, and they face a slew of additional issues and challenges, such as distortion of radiation patterns, gain, structural complexity, and so on. As a result, more remote research is urgently required in this field of study.

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Design of an Automated Stethoscope Using AI, IoT and Signal Processing

Anjitha S. Narayanan, P. A. Prajeesh, Archana Aniyan, and N. R. Archana

Abstract A traditional stethoscope can be used to listen to the sounds made by heart, lungs or intestines as well as blood flow in arteries and veins. Nowadays people are facing more issues regarding their health and sometimes there will be a lack of availability of efficient doctors and also proper attention. In order to overcome these difficulties, an automatic diagnosis using a stethoscope can be made. So, the sounds are converted from analog to digital and compared with the digital data. The system consists of a microcontroller in which different outputs of the stethoscope (sound pattern) are stored and then run an algorithm using these patterns. This system can also be used to transmit the data from one place to another, irrespective of the location where the doctor or the patient is.

Keywords Stethoscope · Analog to digital · Microcontroller

1 Introduction

Many people face health-related issues and sometimes they can't reach the doctors in times of need. Also, there would be a lack of availability of doctors during emergencies. In order to overcome this, an automatic diagnosis system by using a traditional stethoscope can be made, i.e., a smart stethoscope. It can be used by doctors or health professionals through which consultation can be done irrespective of their location. The technology used here includes AI, IoT, and Signal processing.

A stethoscope can predict abnormalities inside the human body just by sensing the sound without the help of a doctor. A smart stethoscope can be used by nurses or health workers or the patient himself and it remotely connects with doctors (In

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case of any problem). All signals can be transferred to doctors in real time. Based on the instructions given by the doctor, nurses are able to capture the sound signals and amplify them. Noise-free signals are sent to the doctors automatically and they can do the check-up.

2 Existing System

A. Normal Stethoscope

- Used in listening to sounds produced within the body, chiefly in the heart or lungs.
- Price is very high (starts from 15,000/-).
- Recording of sounds are not possible.

B. Electronic Stethoscope

- An electronic stethoscope overcomes the low sound levels by electronically amplifying body sounds.
- Price is very high (starts from 20,000/-).

C. Electronic Stethoscope

- An electronic stethoscope overcomes the low sound levels by electronically amplifying body sounds.

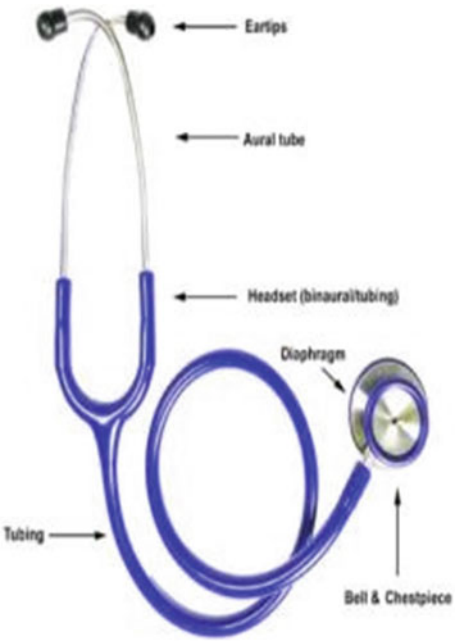


Fig. 1 Normal stethoscope

Fig. 2 Electronic stethoscope

- Price is very high (starts from 20,000/-).
- Recordings of sounds are possible here.

3 Proposed System

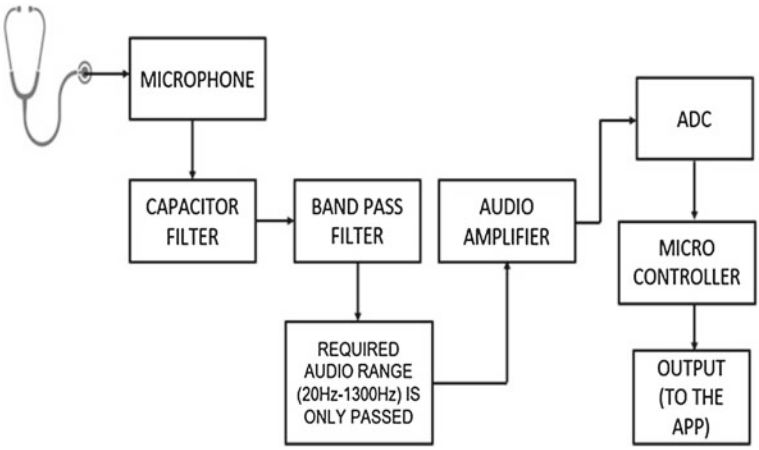
This is a stethoscope that can be used by any health professionals or doctors, working remotely. The doctors provide instructions to the nurses, and based on that, the sound signals are captured from the patients. These signals are amplified and the noise-free signals are sent to doctor automatically in real time. Hence, the diagnosis can be done.

AI is used to predict the condition of the patients for easier diagnosis. This device can also be connected to the Internet via IoT. Data can be stored in the cloud for later references. Apart from real-time monitoring, the doctors can log into their profiles and data access can be done anytime. AI is provided in the system to give alerts, in cases of emergency, to the health professionals so that the doctors can reach the patients quickly. Hence, the patients can be quickly shifted to emergency care. Doctors can listen to the signals by using their normal headphones by connecting to the admin interface either through smartphones or PC. Audio signals also show a graphical representation for detailed analysis. All the existing systems of stethoscopes are not affordable for ordinary people. So this will be a cost-effective product compared to the existing one. An automatic diagnosis by using a stethoscope is done in which the

body of the stethoscope is made up of silicon tubes. The diaphragm is made up of light-weighted plastic.

4 Design and Implementation

A. Block Diagram



The block diagram shows the working of the smart stethoscope. A microphone is connected to the diaphragm of the stethoscope in order to record the body sounds that we hear when we place a stethoscope in our body. The recorded sounds are then amplified by using an amplifier and then the wanted sounds are only taken out by the process of noise cancelling. The body sound that we want to analyse is then saved as an audio file. Through pattern recognition and a categorized database, we can obtain the output. From the output, we can analyse the abnormalities (if any) in the pulse rate, variations in blood level, etc. In case of emergencies, the audio file can be sent to the doctor immediately, and also, the doctor can view it from the app (provided) anytime from any place.

Steps

Step 1: It can be used by nurses or health workers and it remotely connects with doctors. All signals will be transferred to doctors in real time.

Step 2: Uses AI to predict the conditions of patients for easier diagnosis. The device can also be connected to the

Step 3: Apart from real-time monitoring, Doctors can log into their profiles and access the data anytime.

5 Result

A. Mobile App Development

We've created the app named "stethIot". At first, we have to log in/signup. After that, log in to the app and enter personal details like name, age, gender, e-mail id, etc.

And there will be tutorials about where to place the stethoscope. And after that, we are giving an audio input or will be taking a real input from the stethoscope itself.

And Based on the input we give, the result is shown normal/abnormal, i.e., shown in the figure below. If the condition is abnormal, they can further contact the doctor and take the advice.

6 Conclusion

This product can be used by nurses or health workers and it remotely connects with doctors. Moreover, it is a useful product for the people. All signals will be transferred to doctors in real time. With the help of AI, the condition of the patient can be understood.

The device is connected to the Internet by using IoT. Data can be stored in the cloud for later reference. Remotely diagnosing a patient with more observations and measurements increases the chance of more doctors and health officials reaching in for the product.

The never-ending demand for doctors especially during such times of peril puts this product in the prime spot for marketing.

Fig. 3 App logo

Fig. 4 Uploading a file

Fig. 5 Result showing normal condition

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Early Prediction of Cardiovascular Disease Using Machine Learning Algorithms

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Abstract Cardiovascular disease (CVD) is regarded as one of the world's leading causes of death. Individuals who are dealing with various risk factors such as high blood cholesterol, obesity (overweight), hypertension, and diabetes are more susceptible to CVD and thus need early detection. Advancements of technologies are assembling terabytes of data every day from the healthcare industry to keep records. However, this data is not mined well to anticipate the likelihood of a patient getting a cardiopulmonary arrest. Therefore, with the assistance of disparate machine learning and data mining techniques, it is feasible to extract useful insights and discover hidden patterns from the datasets to get a more accurate diagnosis and decision-making. The paper aims to review different research papers with comparative results that have been done on the prognostication of CVD to get an integrated, synthesized overview of machine learning techniques, their performance measures in several datasets and to also make vital conclusions. From the study, we observed that various techniques such as decision trees and artificial neural network (ANN) give the highest CVD prediction system accuracy in different scenarios. This procedure could possibly be useful for cardiologists to forecast the occurrence of cardiovascular disease beforehand and come up with proper medical treatment.

Keywords Data mining · Machine learning · Machine learning techniques · Cardiovascular disease · Decision tree

1 Introduction

The human body consists of internal organs like the brain, heart, liver, lungs, kidney, etc., that are very liable to diseases but among these organs, the heart is considered as the most vital and more prone to disease. Despite leading a healthy lifestyle, the propensity of having CVD due to plaque buildup in arteries causing narrowed blood

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vessels resulting in stroke, hypertension, chest pain, arrhythmia, and other symptoms is frequent [1]. According to WHO, millions of people die every year due to cardiac disease. Electrocardiogram (ECG) plays a crucial role in quickly monitoring the heart's health and detecting the electrical signals produced by it. Heart rates differ widely from person to person depending upon their lifestyle. It's considered to be lower when at rest and higher during exercise. The standard heart rate is typically 60–100 bps (beats per minute). Lower resting heart rate is an indication of good health and wellness. Many doctors suggest a proper nutritious diet and regular exercise to keep the heart healthy. Figure 1 depicts the overview of the 3 phases with the help of ECG signals which shows that heartbeat is moderate.

A lot of factors such as cholesterol level, age, smoking habits, diabetes, genetic mutations, and pulse rate contribute to heart disease. Identifying people at risk of CVD is a cornerstone of preventive cardiology. With the constant boom of data in the healthcare industry, their collection techniques are getting ameliorated on a daily basis through the application of wearable technology and the Internet of Things (IoT). It is impossible for a human being to amalgamate zillions of facts and data and infer the specific patient's malady. Nevertheless, machine learning could be applied as a predictive mechanism to find the insights and patterns in the data [5]. The datasets are largely collected via Kaggle and the UCI machine learning repository.

The robust strategies related to deep learning and machine learning techniques help to foretell the people who are in the similitude of getting the cardiac disease an accurate time, provide affordable services, and save precious lives. These algorithms and techniques can be directly applied to a dataset using various machine learning

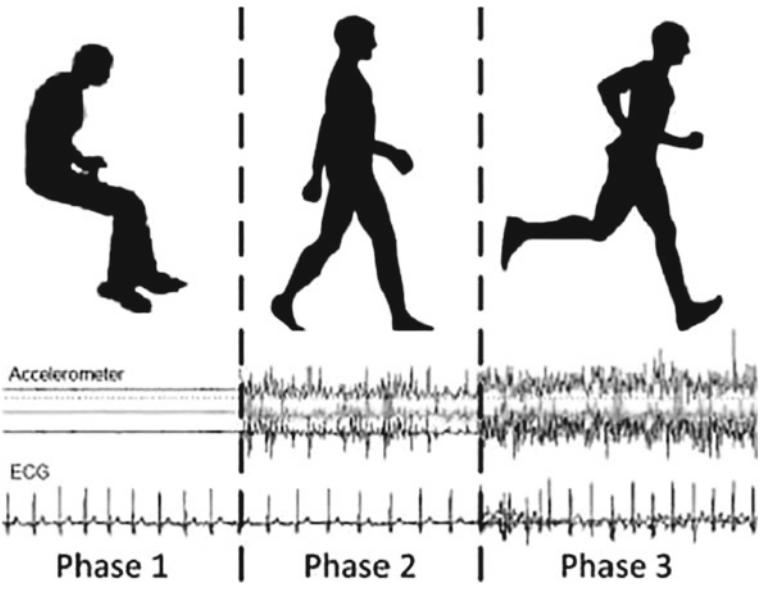


Fig. 1 Phase1: standing; Phase 2: walking; and Phase 3: running [6]

frameworks to draw analytical conclusions. Even though different types of CVD usually have a lot of different symptoms, many have identical warning signs such as respiratory infection, irregular heartbeat, dizziness, loss of appetite, and restlessness. It is a fatal disease which gives rise to more adversities. Table 1 summarizes the different types of CVD.

This article structure is as follows—Sect. 2 presents the various machine learning algorithms used, Sect. 3 of the paper gives a comprehensive literature review, Sect. 4 presents the summary, and Sect. 5 provides a conclusion.

Table 1 Different types of cardiovascular disease, its symptoms, and risk factor

Cardiovascular diseases	Brief description	Warning symptoms	Risk factors of disease
Rheumatic heart disease	Inflammatory disease, heart valves are permanently damages, tonsils in children	Nodules, chest pain, fever, dyspnea, complications during pregnancy	Untreated or under-treated strep infections; over-crowding; age group of 5–15 years are more prone to this disease
Coronary artery disease (atherosclerosis)	when the coronary arteries become too hard and narrow, restricting flow of blood to the heart	Nausea, angina, chest pain, discomfort in the back, jaw, shortness of breath	Smoking, poor nutritious diet, laziness, diabetes, hypertension
Peripheral vascular disease (claudication)	Flow of blood decreases causing blood vessels to block outside of the brain and heart, hardening of arteries	Leg, thigh, buttocks, calf pain or cramping, loss of hair on legs, muscles feel numb	Diabetes, overweight, history of stroke, aging high blood pressure, kidney disease, sedentary lifestyle, drug use, high cholesterol
Deep vein thrombophlebitis (DVT)	Clots of blood in a deep vein, generally occurs in the legs which can dislodge and move to the heart and lungs	Pain, swelling, and tenderness in one leg; warm skin around the areas of the clot; skin turning to a reddish color over the affected area	Long bed rest, injury to veins, obesity, bowel disease, smoking
Stroke (brain attack)	Blood supply gets reduced to part of our brain	Weakness of face and arm, sudden headache, unstable walking	High blood pressure, alcohol intake in excess amount, family history, atrial fibrillation, vision loss

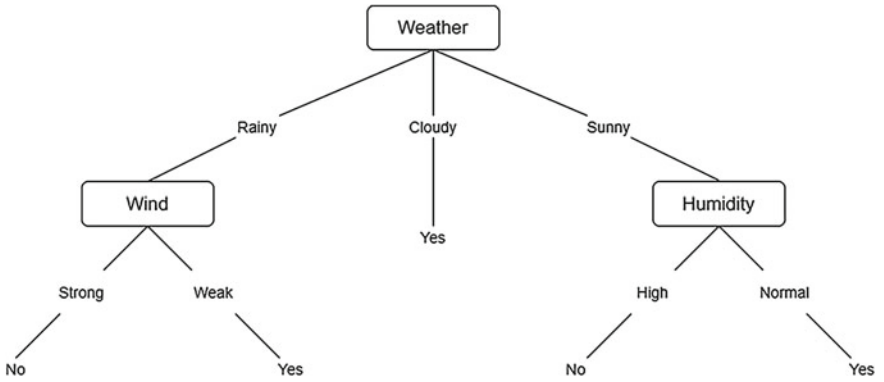


Fig. 2 Decision tree, tree-like structure

2 Exploratory Study of Various Machine Learning Algorithms

2.1 Decision Trees

Decision trees are a type of construction that distributes a large number of records into smaller groups using a set of simple decision rules. It handles both continuous and categorical variables and they are mostly used for classification problems. In decision trees, each tree comprises nodes and branches where every node serves as an attribute in a group for classification, and every branch will act as a value that the node can take. Decision trees aren't very robust on their own but are used in other methods that leverage their simplicity and create some very powerful machine learning algorithms. Recently, it is reborn with new upgrades and those upgrades are advanced methods such as gradient boosting and random forest that build on top of decision trees. The main advantage of decision trees is that without requiring much computation, it can provide a clear indication of which fields are more important for prediction. Figure 2 shows the tree-like structure of a decision tree.

2.2 Support Vector Machine

Support vector machine (SVM) comprises learning models that are supervised in nature. It's mostly used for classification and works on the concept of margin calculation. It finds the best line (decision boundary) that helps to separate space into classes. This line is searched through the maximum margin which is equidistant from the points on both sides. The sum of distance of these two points from the line has to be maximized to get the best result. This line is called maximum margin hyperplane or classifier, and the two points are called support vectors which support

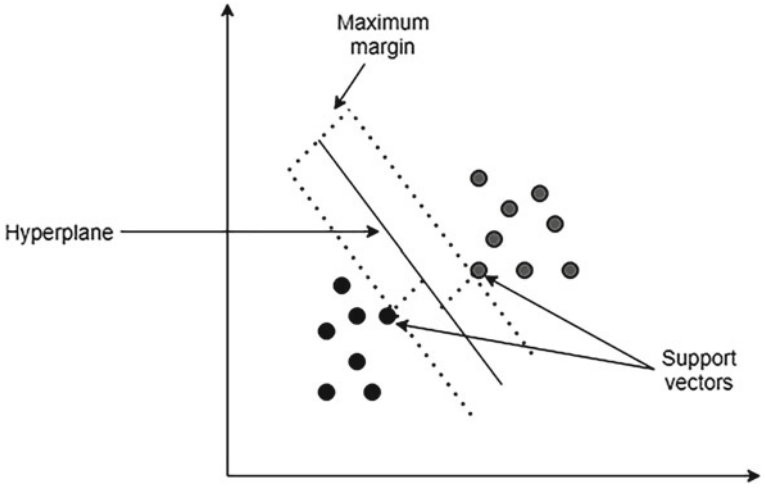


Fig. 3 Support vector machine

the whole algorithm. SVM is better to be thought of as a more rebellious and risky type of algorithm because it looks at extreme points that are very close to the decision boundary, and uses it to construct analysis. That in itself makes the SVM algorithm very special and different from other machine learning algorithms. Figure 3 shows the example of SVM.

2.3 Random Forest

Random forest (random decision forest) is a technique that constructs and integrates various decision trees to get a more stable and accurate prognosis. The random forest works using an algorithm as discussed.

- Initially, random K data points will be taken out of the train set.
- The decision tree will be created using K data points.
- Select the number N-tree of trees and follow the above two steps.
- To select a new data point, create N-tree trees for each data point to predict the class to which it belongs and allocate it to the class that wins the majority vote.

The random forest starts with one tree and builds it up to n-number, which is randomly selected from the data. Though each one of these trees might not be perfect, overall on average it can perform very well, and therefore it is a major advantage of this algorithm. Figure 4 shows an example of a random forest.

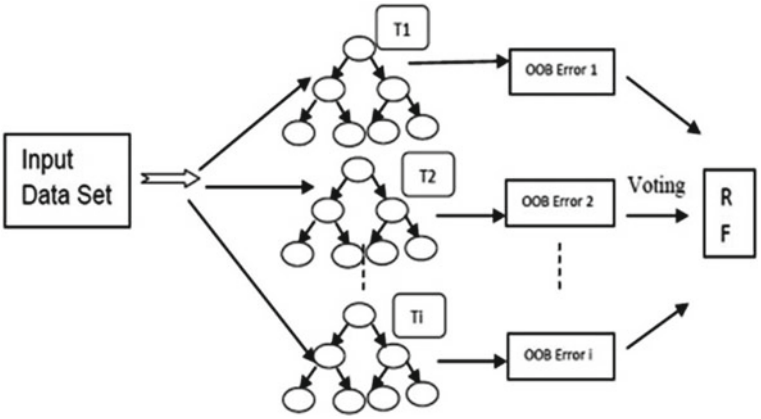


Fig. 4 Random forest [7]

2.4 Naive Bayes

In statistics, Bayes' theorem (Bayes' law) follows the maxim of the conditional and marginal probabilities of two sets of random outcomes from an experiment. It is a family of algorithms which sticks to the standard theory, that each set of features which is classified is free from each other. It is often used to calculate posterior probabilities. Naive Bayes handles both discrete and continuous data. The Bayes model in combination with decision rules contributes to probability independently like hypotheses and studies without considering correlations. The probability model of naive Bayes can be efficiently trained using supervised learning algorithms. It is insensitive to irrelevant features and doesn't require as much training data. Naive Bayes can solve diagnostic problems as it aids to specify if a patient is at high risk of certain diseases.

2.5 Artificial Neural Network

Artificial neural networks (ANN) are vaguely prompted by the biological neural circuit**.** It is considered to be the most useful and powerful machine learning algorithm. An input layer, a concealed layer, and a final output layer make up the three layers. The input layer takes the input which is assessed by the hidden layer. Finally, the output layer sends the calculated output. A multilayer perceptron (MLP), a form of feedforward ANN, is the most common type of neural network. It uses a supervised learning technique called backpropagation (backward propagation of errors) for training. ANN can find complicated patterns in data and thus improve its performance. It has a feature where the failure of one or more cells does not prevent it from generating results, thus making the networks fault-tolerant. It can perform more than

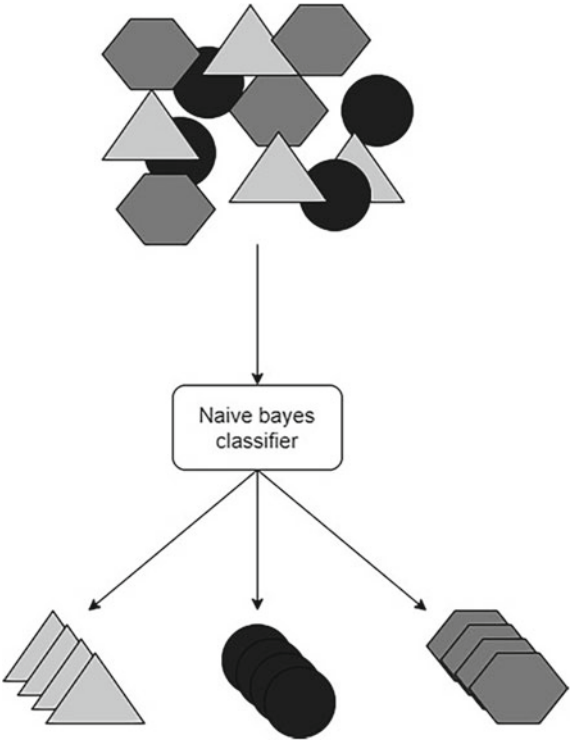


Fig. 5 Naive Bayes classifier

one job at the same time, making it a widely used algorithm for solving complex problems. Figure 5 shows the actual structure of ANN.

2.6 K Nearest Neighbor

K-Nearest Neighbor (KNN) is a kind of lazy learning or non-parametric learning that uses a pliable number of parameters where a function is estimated locally and all enumeration is withheld until classification. It is a smooth algorithm. To get a better understanding of KNN, let's walk through the steps:

- Pick the number K of neighbors. The most common default for K is 5.
- Select the K closest neighbors of the new data point using Euclidean distance. Distances such as Manhattan distance can also be applied.
- Compute the number of data points that fall into each category.
- Assign the newly created data point to the category with the most neighbors.

KNN algorithm fares across all parameters of deliberation. It is frequently used for its low computation time and trouble-free implementation as only the value of

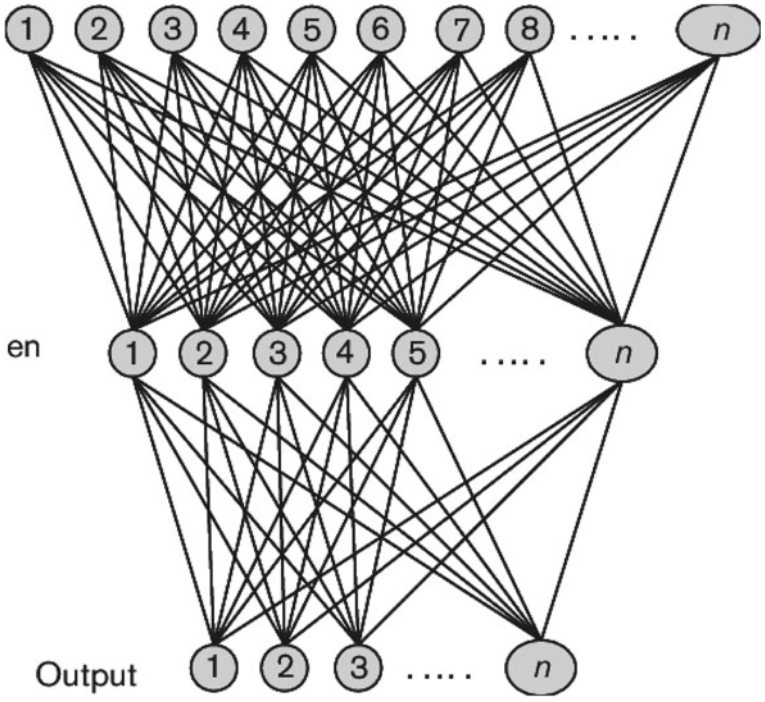


Fig. 6 Artificial neural network of multiple layers and outputs [9]

k and the distance function are required to execute. Figure 6 shows an example of KNN.

2.7 Logistic Regression

A logistic regression model is used to perform predictive analysis (modeling) to estimate the probability of a given output based on input variables, in contrast with a binary classifier. It is incredibly simple to execute and very efficient to train. It has a good baseline that one can use, to compute the performance of other advanced or complex algorithms. It is a valuable model to be selected when different sources of data are combined into a binary classification task. Since a linear model does not extend to classification problems with multiple classes, logistic regression is considered as a solution for it. Figure 7 shows the logistic function graph. The algorithm compresses the outcome of a linear (algebraic) mathematical equation between 0 and 1 using the logistic function.

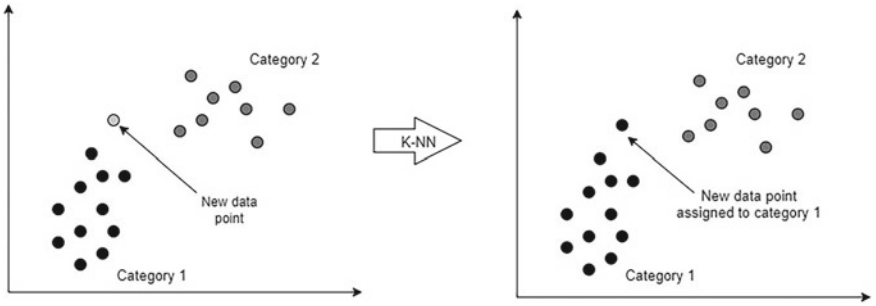
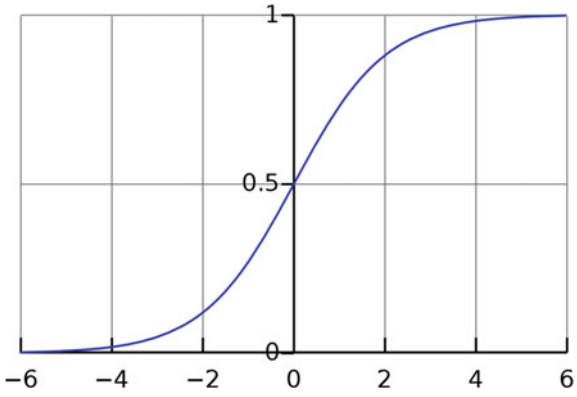


Fig. 7 K nearest neighbor

2.8 Gradient Boosting

Gradient boosting is considered as one of the most robust techniques for constructing predictive models due to its high speed and accuracy. It follows a greedy approach and produces a highly robust solution for both classification and regression problems. It requires three elements to function—loss function, weak learner, and an additive model. A loss function is optimized. To generate predictions, a weak learner is used, and an additive model. In this, the additive model is used to add on the weak learner to minimize the loss function, and finally lower the overall prediction error. It integrates the previous one with the best possible next model. In other words, it tries to develop a new sequential model. Gradient boosting is commonly used as it is generic enough to use any differentiable loss function. Figure 8 depicts the working of gradient boosting.

Fig. 8 The logistic function



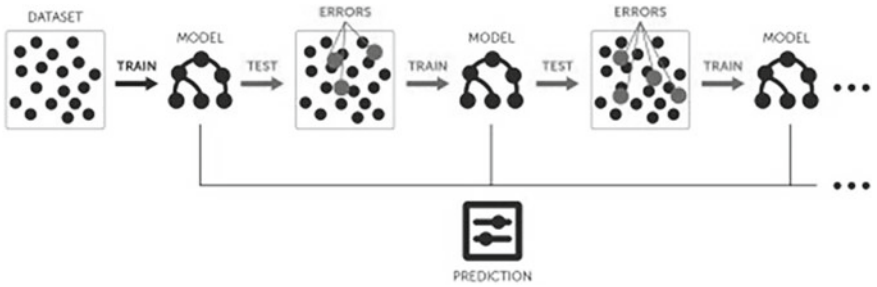


Fig. 9 Working of gradient boosting

2.9 Rough Set

Rough set theory has engaged the attention of many research workers and practitioner workers throughout the world. Methods build on a rough set have broad applications in many real-life projects. It can find a minimal set from data for dimension reduction in classification. They set interconnection with many other approaches such as statistical methods and fuzzy set theory. A rough set solves the problems such as finding the dependency between the most significant attributes, reducing the surplus one, and describing a set of objects based on attribute values. It is widely used for feature extraction, feature selection, decision rule generation, and also for discovering hidden patterns inside the data. Thus, it is valuable to mention that a rough set plays a crucial role in solving prediction problems. Figure 9 connotes the rough set theory concept where the lower and upper approximation sets are known to be crisp sets, and the same sets can also be called fuzzy sets these sets in other variations.

3 Literature Survey

In this paper, the dataset is subjected to a variety of machine learning methods to prognosticate the likelihood of a patient getting cardiac arrest based on various controlled and uncontrolled variables [1]. Parameters, namely age, blood pressure, alcohol intake, gender, chest pain, fasting blood sugar, cholesterol, etc., are considered for predictions of CVD. Initially, the dataset contains some missing records which are recognized and replaced with the most relevant values. The missing values are calculated using the mean method. After preprocessing the data, classification algorithms like SVM, decision tree, and ANN are applied to the dataset. Due to the broad range of relevancy of ANN and its capability to understand advanced or complex relationships along with modeling of non-linear processes, an ANN algorithm is considered as the best performing algorithm with accuracy 85.00%. The conclusion made during this study was that the accuracy of ANN could be more

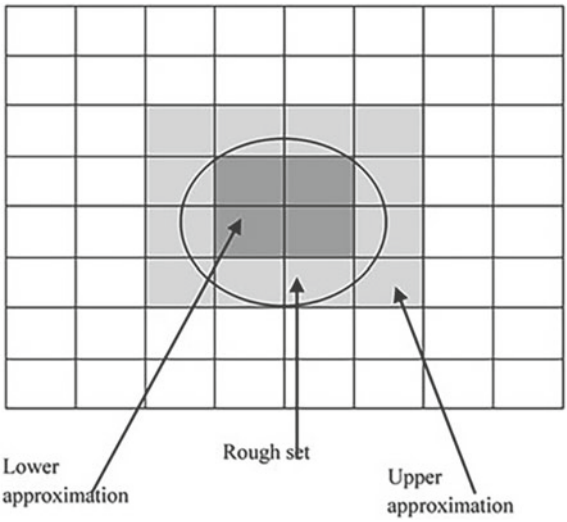


Fig. 10 Rough set theory

precise if a larger dataset is used. Figure 10 indicates the accuracy across various algorithms.

In this paper, support vector classifier, logistic regression, and decision tree are presented to forecast CVD using machine learning paradigms with 301 sample data, and 12 attributes [2]. The entire data is required to split into two parts, one set for training comprises 80% of total are split into two sets and other for testing with 20% of total data. Data visualization techniques are also applied to extract the hidden insights from the dataset which would help doctors to analyze the pattern effectively for further medical diagnosis. Performance assessment is carried through these four algorithms and their accuracy is deliberated. Moreover, while analogizing these classification algorithms, the outcome reveals that the performance of logistic regression is better than the other three algorithms. The precision, recall, F1-score, and support are also calculated for logistic regression. Later, a comparative study is also performed with the UCI dataset using the same algorithms where the support vector classifier provides better results with an accuracy of 86.1%. Figure 11 shows the performance of the algorithm on two different datasets (Fig. 12).

The prediction of cardiac disease using machine learning techniques has been proposed [3]. The dataset is taken from the UCI repository with 13 medical parameters such as blood pressure level, and electrocardiographic results as input. Python programming is used as a tool for data analysis and machine learning paradigm. Data preprocessing is applied to transform the unrefined data into a comprehensible format. The dataset is divided into two parts, 70% for training while 30% for testing. A scatter plot is applied to both the training and test sets to represent patients having heart disease or not. Two classification-based machine learning techniques, naive Bayes and decision tree, are used. Though naïve Bayes can handle enormous, tangled, non-linear dependent data, decision trees perform better with an accuracy

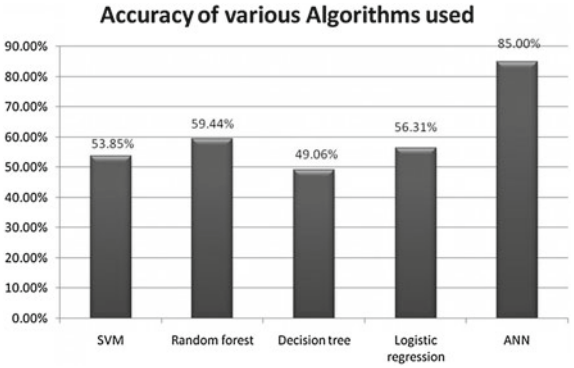


Fig. 11 Accuracy of different algorithms

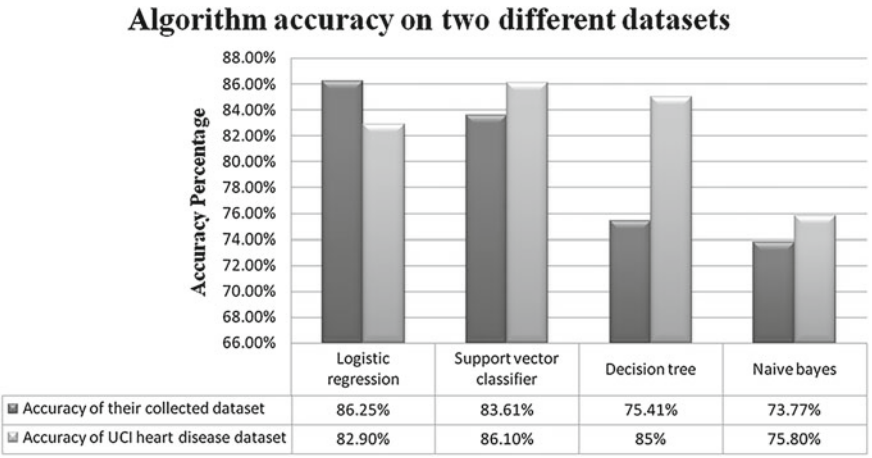


Fig. 12 Algorithm accuracy on two different datasets

level of 91% as this model analyzes the dataset in the tree shape structured format because of which each attribute is completely analyzed.

CVD prediction using machine learning techniques is discussed. A dataset of cardiac disease has been taken from the UCI repository consisting of 14 attributes as input. R language is used as it has the best compatibility with UNIX and Windows and also proffers a better outcome compared to other languages. Data preprocessing is applied to make the mining process more efficient and to avoid fault prediction. The records are classified into a training and a testing dataset. The system also demonstrates powerful visualization using a box plot, scatter plot, and mosaic plot of interrelation and traits of all the attributes for the graphical representation of data. Then, for prediction, SVM, naive Bayes, random forest, logistic regression, and gradient boosting are used. The analogizing of classification algorithms is made

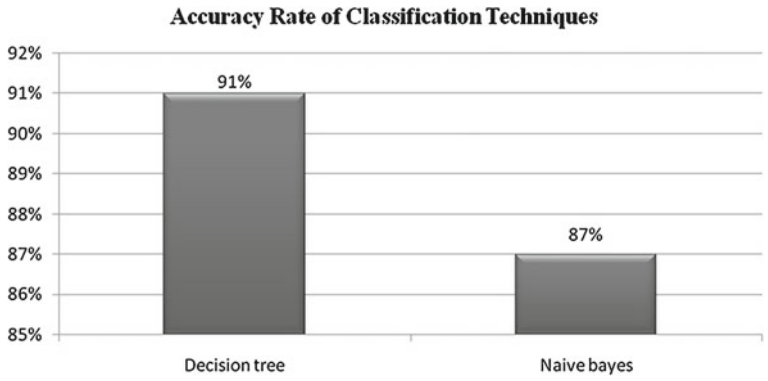


Fig. 13 The accuracy rate of the two models

which signifies that the best performing algorithm is logistic regression. The user interface is designed where the parameters of the patients such as type of chest pain, height, age (in years), resting blood pressure, and cholesterol are recorded, and based on the algorithm, the interface of the system calculates the patient's risk of heart disease.. Figure 13 represents the accuracy of each algorithm tested.

The detection of CVD using a new ensemble classifier is proposed [4]. On a dataset acquired from the UCI laboratory, classification-based machine learning techniques such as decision trees, naive Bayes, multilayer perceptron neural network with hidden layers, and rough set are deployed. Information of 303 patients is collected having total features as 76 where the filtering method called Pearson's correlation coefficient is applied to select the most discriminative features. Hence, 14 attributes such as age, cholesterol, and fasting blood sugar are used in this dataset for prediction. Later applied data preparation, where the missing rate of each feature is calculated. The data is assessed using tenfold cross-validation. Performance metrics such as sensitivity, precision, F-measure, and accuracy are calculated with the usage of a confusion matrix. Here, F-measure combines sensitivity and precision into a single value. naïve Bayes, rough set, and neural network achieve the highest performance on the basis of F-measure. Later, fusion strategy is applied to combine these three best classifiers by weighted majority vote which further improves the accuracy of the model. The statistically revelatory difference in assessing the performance of the classifier is observed by the fusion of outputs which further enhance decision support. F-measure achieves 86.8% outperforming other individual metrics, in the domain of classification. Figure 14 shows the performance of the classifier.

In this research, supervised machine learning methods such as naive Bayes, decision tree, logistic regression, and random forest are used to predict the illness related to cardiac problems [5]. The dataset of cardiac disease patients is taken from Kaggle with 12 essential attributes such as systolic and diastolic blood pressure, chest pain, gender, cholesterol, smoker/drinker, and age to forecast the likelihood of patients developing heart illness. Furthermore, the dataset has been divided into two parts with 70% and 30% of total data used for training and testing, %respectively. The

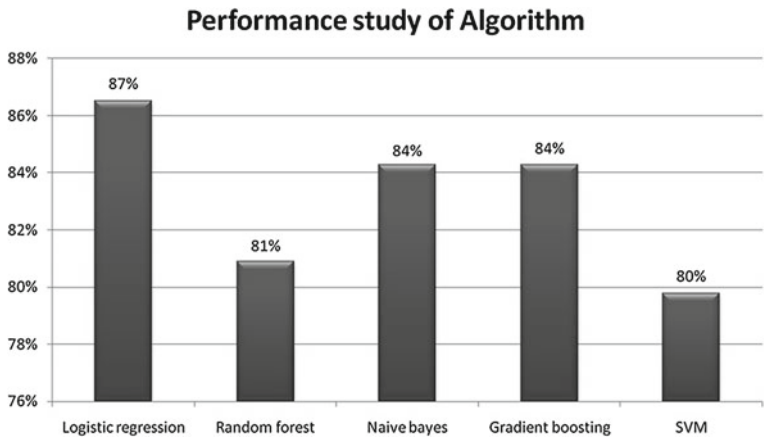
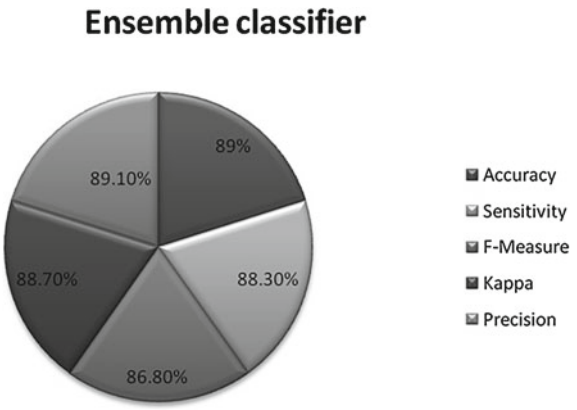


Fig. 14 Performance study of algorithm

confusion matrix (error matrix) is exerted which shows the correlation between all available features and with the help of it and the classification algorithm's precision, recall, F1-score, and accuracy are calculated. The performance-based model is estimated and their results are examined. The testing results show that the decision tree algorithm provides a superior forecast than the other algorithms, with an accuracy rate of 73%. The author later used the technique of dimensionality reduction, where the entities which are negatively correlated are skimmed from the dataset and then tested. As a result, the accuracy of the random forest and KNN algorithm changed either positively or negatively. However, precision values of the decision tree algorithm, before and after the dimensionality reduction, remain the same. It gives the highest accuracy of 73% in both the cases. Figure 15 compares the accuracy (pre- and post-dimensionality reduction) between the algorithms (Fig. 16).

Fig. 15 Evaluation of the proposed ensemble classifier's performance



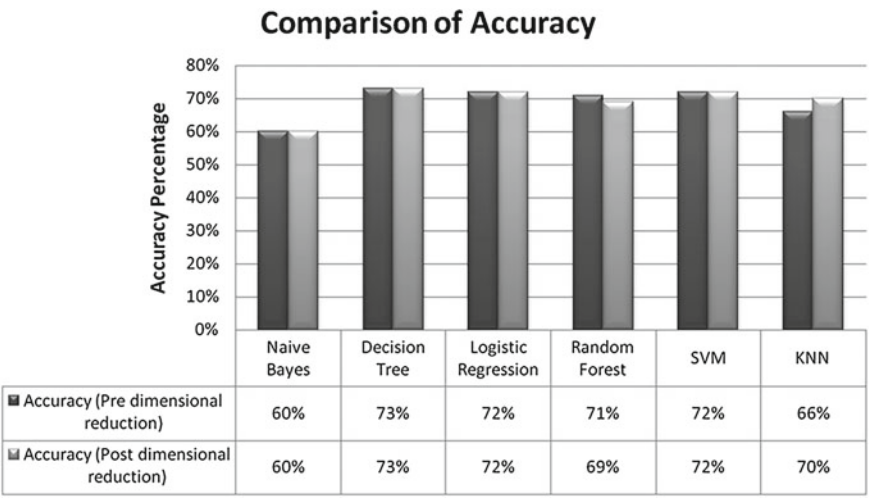


Fig. 16 Comparison of accuracy

4 Comparative Analysis of Machine Learning Technique

Table 2 shows different machine learning techniques used on cardiovascular disease predictions with accuracy.

5 Conclusion

The research examines a variety of machine learning techniques for estimating the total number of CVDs. Machine learning takes leverage of structured and unstructured data sources and therefore plays a crucial role in the healthcare industry. From this study, it shows that decision tree delivers better prediction by providing 91% accuracy consisting of 14 clinical parameters. ANN has also performed well with 85% accuracy. Therefore, we conclude that different methodologies used give different accuracies depending upon the type of dataset taken and tools used for implementation. It is also crucial to note that each domain is non-identical thereby, it is foremost to endeavor various data optimization techniques to escalate the accuracy of the model.

There are numerous upgrades that could be explored in order to increase the system's performance. Hereby, we recommend some of the following observations that need to be considered in future research work to get a more accurate diagnosis of CVD by using a robust prediction system.

- Real data of patients from medical organizations can be incorporated in a large quantity to increase the accuracy of the prediction model.

Table 2 Comparison of machine learning techniques

Author and year	Purpose	Techniques used	Accuracy/Result	
Esfahani et al. [4]	Cardiovascular disease prediction using a new ensemble classifier		Accuracy	F- Measure
		Neural network	86.9%	86.1%
		SVM	75.4%	80.3%
		Naive Bayes	85.4%	84.6%
		SVM (Poly Function)	75.4%	80.1%
		Decision tree	74.8%	77.8%
		Rough set	88.1%	85.7%
Kumar et al. [1]	Performance-based analysis of machine learning paradigms for prediction of cardiovascular disease	Logistic regression	87%	
		Random forest	81%	
		Naive Bayes	84%	
		Gradient boosting	84%	
		SVM	80%	
Krishnan [3]	Prediction of heart disease using classification-based data mining techniques	Decision tree	91%	
		Naive Bayes	87%	
Chauhan et al. [1]	Cardiopulmonary arrest prediction based on various variables using machine learning algorithms	SVM	53.85%	
		Decision tree	49.06%	
		Random forest	59.44%	
		Logistic regression	56.31%	
		ANN	85.00%	
Islam et al. [2]	Efficient forecasting of cardiovascular disease using machine learning paradigms and comparing the accuracy of their collected dataset with that of UCI heart disease dataset		Accuracy of collected dataset	Accuracy of UCI dataset
		Logistic regression	86.25%	82.9%
		Support vector classifier	83.61%	86.1%
		Decision tree	75.41%	85%
		Naive Bayes	73.77%	75.8%

(continued)

Table 2 (continued)

Author and year	Purpose	Techniques used	Accuracy/Result	
Princy et al. [10]	Prognosis of cardiac disease prediction using supervised machine learning algorithms		Accuracy (Pre-dimensional reduction)	Accuracy (Post-dimensional reduction)
		Naive Bayes	60%	60%
		Random forest	71%	69%
		Decision tree	73%	73%
		SVM	72%	72%
		Logistic Regression	72%	72%
		KNN	66%	70%
Akella et al. [9]	Build a predictive model for the detection of coronary artery disease (CAD)	Neural Network	93.03%	
		KNN	84.27%	
		Generalized linear model	87.64%	
		Decision tree	79.78%	
		SVM	86.52%	
		Random forest	87.64%	
Chowdhury et al. [4]	Heart diagnostics Diagnosis machine learning techniques	Decision tree	87.546	
		Logistic regression	86%	
		KNN	87%	
		Naïve Bayes	84%	
		SVM	91%	

- There is a lag between data collection and preprocessing which needs to be addressed.
- Consulting a highly experienced doctor in cardiology will help to prioritize the attributes and to add more vital parameters of cardiac disease for better prediction.
- There is a need to apply more feature extraction and feature selection methods to improve the accuracy performance of the algorithms.
- To lower the overall prediction error, more complex hybrid models should be designed by integrating diverse machine learning and data mining techniques.

- The genetic algorithm is one of the finest and simplest random-based evolutionary algorithms that can be used for optimization which makes the overall performance of intelligent prediction models better.
- To evaluate data in a clinical setting and for better comparison insights in the future study, new analytical frameworks and methodologies, such as regression, association rule, and clustering algorithm, are needed.

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A Decentralized Network to Support Funding with Ethereum Smart Contract

Sayan Mondal and Rajat Kumar Behera

Abstract The study proposes a DeFi System to provide organization-level accountability for real-time crypto-asset transactions, democratizing crowdfunding and financial support by enabling contributors to donate. Recent work in this area has seen a lot of development in crypto assets being stored in wallets, however, currently there are no real-world implementations of smart contracts in Finance. Cryptocurrencies like Bitcoin were invented to make international purchases easier and more secure. In past years, buyers had to use third parties to make purchases because financial institutions did not allow online international purchases. This made business with international buyers and business owners very difficult. We capitalize on the latest advancements of Blockchain and Ethereum leveraging the power of approval-based transactions with smart contracts to provide transparency between the donor and recipient. With the proposed rule-based contract management system, 50% of contributors are able to approve the transaction request to process the same to the targeted Fundraiser.

Keywords Smart contract · Blockchain · Contract · Crowdfunding · Solidity · Decentralized

1 Introduction

Just like a standard paper contract automatically verifies fulfillment, enforces, and performs the terms of a contract, a smart contract [1] is a digital version of the same. Derivatives are used by financial markets to transfer risks from one entity to another. With smart contracts, derivatives which is an agreement with certain terms could be easily written. The derivative practice tends to be standardized, and the adoption of distributed ledger [6] and smart contracts can be seen by the industry. With the invention of Ethereum Smart Contracts, the scope of transaction management became verbose with a rule-based contract system.

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The movement of control and decision-making from a centralized body to a dispersed network is referred to as decentralization in blockchain. Decentralized networks provide various advantages that alleviate some of the problems that centralized systems have. The elimination of a middleman, such as a bank, dramatically speeds up transactions and lowers expenses for users. Decentralized networks are also safer, as the network's nature protects against cyber-attacks by dispersing data among its users rather than holding it in a single spot. A decentralized network's fundamental goal is to eliminate the necessity for a central decision-making authority.

As crowdfunding platforms gain popularity, the number of frauds and scams increase by the day, making potential donors and contributors skeptical and even driving them away. With no unbiased middleman to keep organizers accountable, the funds they raise can easily be spent incorrectly. Another flaw in the existing system of raising money is that these platforms keep up to 5% of the crowdfunded money as profit for themselves and deduct another 5% in transaction fees. Lastly, any centralized service allows free will. As we have seen, large tech companies have been notorious for stepping in and censoring/removing content.

In this research, we present an approach to mitigate the aforementioned risk in potential transactions between the crowdfunding contributors and the receivers by proposing a smart contract-based DeFi system which requires the approval of at least 50% of the contributors for a particular fundraiser when a spending request has been created to transfer the amount to the receiver along with the receiver's crypto address to promote transparency. Our approach consists of classifying and determining the different user addresses and creating a fund manager to initiate the fundraiser where contributors can contribute. These campaign details would be converted into Application Binary Interfaces (ABI) to be read by the Solidity compiler and parsed to make a custom smart contract solution.

The proposed system would be able to allow any user to view details of the funding request which will encourage transparency between the contributors and the organizations. This system would not only make security a key consideration with the help of blockchain's encryption but also add layers of storage to keep the campaign data as well as transaction history secure. With the rule-based contract system of Ethereum, our users will be well assured that their money is safe.

2 Literature Survey

The ideation to shift financial transaction to a decentralized network has been going for over a decade, however, there weren't a very prominent implementation of such an idea before [2]; all transactions travel through banks, financial institutions, and payment gateways under the present money system, which sign off on them and give them legitimacy [7]. Records and transaction data are stored in centers or servers at these centralized places. As a result, a centralized network exists in which all transactions must be confirmed by a financial authority [7].

The main problem with this form of network is that it permits the authorities, in this case banks, to charge fees for monitoring transactions. Second, transaction speeds are constrained by the institution performing the transaction verification. If the bank you're using is closed on weekends, any transfer you make on Friday may not be completed or cleared until Monday. Finally, storing all of your data in one location is inherently unsafe as a target for hackers, thus decentralization is the best option.

A few research studies like (i) 'An Exploratory Study of Smart Contracts in the Ethereum Blockchain Platform' [1] and (ii) 'Validation and Verification of Smart Contracts: A Research Agenda' [2] provide a detailed discussion of Smart Contracts and its workings along with exploring the issues and distributed ledgers for Blockchain. According to the research thus far, smart contracts could express the contractual parties' common understandings and intents by encoding legal contracts written in natural language. A major disadvantage that smart contracts faced was the lack of validation and verification which might result in limiting the scope and space of these systems.

Research papers such as (iii) 'Some Simple Economics of Crowdfunding' [5] are available, highlight the extent to which economic theory, including transaction costs, reputation, and market design, can explain the emergence of nonequity crowdfunding, and provide a framework for speculating on how equity-based crowdfunding can play out, followed by crowdfunding. (iv) 'A virtual cathedral and a virtual bazaar' [6] covers economic analysis, in which they look at the possible benefits and hazards of firmbased and social production models, as well as the conditions that determine whether open or closed innovation models are better.

3 Methodology

The proposed paradigm is based on Ethereum Smart Contracts, and the methodology is detailed below.

3.1 Ethereum Smart Contract

We developed the proposed payment and voting services using Ethereum Smart Contracts. The immutable nature of Smart Contracts combined with the cryptographic difficulty in mining blockchains and in general, it ensures that fraudulence is near impossible. The proposed voting service allows contributors to have a say in what the organization spends its money on. Campaign creators are not able to use the funds raised for their organization unless it is approved by more than 50% of contributors. This brings democracy and transparency to the table.

The decentralized nature of blockchain technology is a trend that is revolutionizing the Web. Without a centralized server in our backend services, users can ensure that our proposed solution can never tamper with existing data.

3.2 Recent Contributions

Few similar ideas which recently shed light on the area of smart contracts in crowdfunding can be (i) 'Smart Contract and Blockchain for Crowdfunding platform' [8], (ii) 'Secure and Decentralized Crowdfunding Mechanism Based on Blockchain Technology' [9], and (iii) 'Crowdfunding Smart Contract: Security And Challenges' [10]; our proposed work minimizes the complexities of the smart contract by removing private key encryption and the need to support a platform to host the contract.

The aforementioned papers have included private key RSA Encryption, Integrity Cost, and Computational Cost and mentioned anonymity transactions as a challenge in their approach. Our proposed solution completely removes the computational and integrity costs, further improving upon the RSA encryption by leveraging a request-based approval schema for security. Since our proposed solution is not a Decentralized platform, it also mitigates the need for anonymous transactions since every individual user would consist of a wallet ID at all times.

3.3 Implementation Intuition

In the proposed work, we leveraged the power of Solidity to build a two-step pipeline, the first being the Factory Contract which stores all the campaigns that have been created and the second one being the metadata and sub-functions of each campaign. To achieve a real-time transaction, we used the solc compiler with a version above 0.4.16 to create the two smart contracts.

This network can either be deployed on a test network or executed locally with test wallets, making it more robust for both the users and developers. The individual sub-functions have error boundaries wrapped around them to always return a debug log instead of a failed transaction. Since this is just a decentralized contract, it can be used with any crypto wallet provider as well as web providers like web three, react run-time, etc. to create/integrate this service as a part of any business application. Finally, we also test the end-to-end behavior of the contract using Mocha, a testing framework.

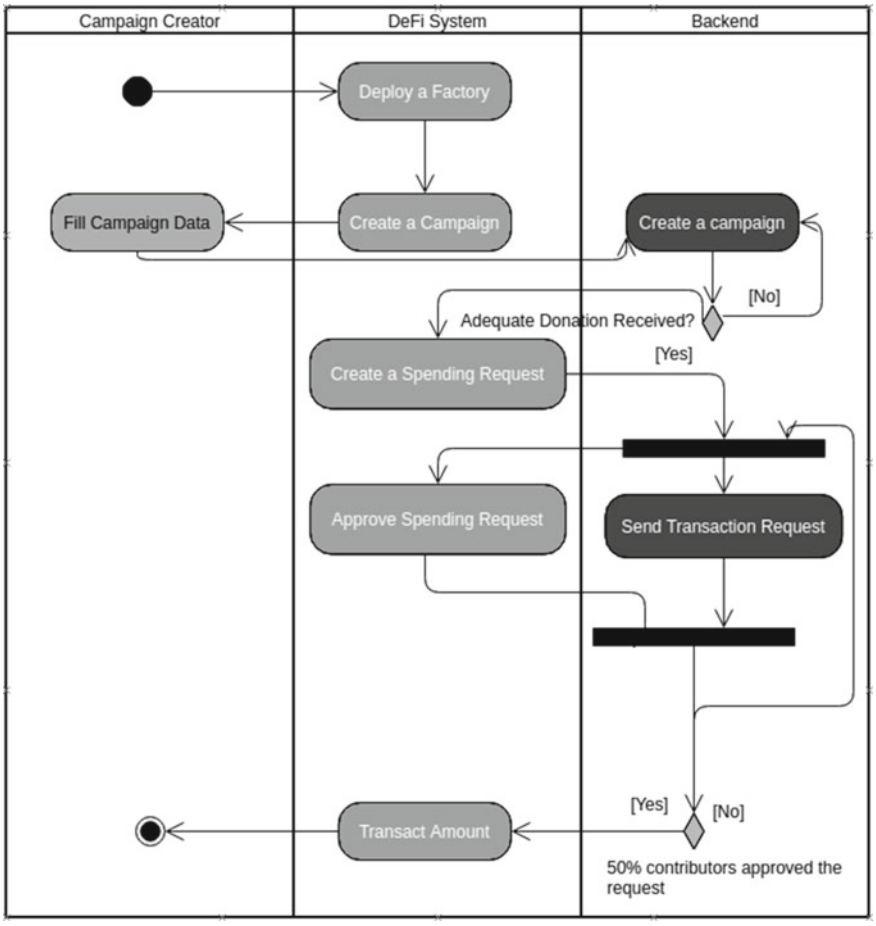

Fig. 1 End-to-end activity diagram of campaign manager donating to recipient

3.4 Campaign Topology

This network we designed encapsulates the two fundamental concepts of the fund manager creating the campaign as well as the general user acting as contributors toward that fundraiser (Fig. 1).

3.5 Configuration

We have created a 2-layered contract/campaign implementation in Solidity, to increase the contract's performance; we've made the contract compatible with

Solidity pragma version 0.9.0. The model we created is a sequential model, which first registers the Solidity campaign in its campaign factory to establish a baseline that other account holders use to contribute to. The environment was initialized with a 3,000,000 gas limit and 0.8.1 Solidity compiler. The default Ethereum virtual machine version has been used to support Ethereum seamlessly. The contract is self-destructed after the test server or wallet of the particular user closes to ensure maximum security.

3.6 Campaign Contract Algorithm

The system was divided into three major tasks, namely creating a spending request, approving the request, and finalizing the request. We used a mutable request array that stored the metadata of the campaign transfer which is accessible to all the users for transparency. Here is how the three main algorithms look like behind the hood:

Input: $\propto$: wallet address, Owner($\propto$): the account address of the Campaign Owner, Receiver($\propto$): the account address of the receiver, β: the unsigned integer value to be transferred, μ: Information about the transaction, δ: Transaction Request, $\forall$: Approvals on δ

Output: The amount β successfully transferred from Owner($\propto$) to Receiver($\propto$)

function createSpendingRequest:
  Push μ into Array of δ []
  Add μ to δ

function approveSpendingRequest:
  if $\cup \in$ User and $\complement \in$ Contributor, Approving($\cup$) is already a $\complement$ && hasn't approved δ
  $\forall$ + 1

function finalizeSpendingRequest:
  if Total($\forall$) > $\frac{1}{2}$ of the unique contributors then
    Owner($\propto$) -> Receiver($\propto$)
    transaction state = complete

Table 1 Test cases and outcomes

Test ID	Test case	Test condition	Expected	Outcome
T01	Create and deploy a factory and campaign	Should create and deploy a factory and a campaign on the current provider	Test should assert the address of the two and return true	Assertion Successful
T02	Marks caller of createCampaign as the campaign manager	Campaign creator account should be the campaign manager	Account 0 should be the campaign manager	Assertion successful
T03	Allow people to contribute money and mark them as approvers	Other account holders should be able to contribute and flagged as contributors	Campaign manager's account should have ethers and the sender should be marked as a contributor	Money was transferred successfully and isContributor was set to true
T04	Allow the campaign manager to create a spending request	Campaign manager can create a spending request for the fund with the required amount of ethers	A Spending request should be created with the metadata and the amount	A spending request was successfully created
T05	Process requests properly—end-to-end test	Run an entire pipeline form contributing to finalizing the spending request	All micro tasks should be successful	End-to-End tasks were successful

3.7 Test Cases and Outcomes

After testing the system and running it through certain use cases, we came up with a few test results as such (refer to Table 1).

3.8 Result and Analysis

The proposed system shows an incremental growth when the number of contributions is compared to the amount of donation received; below is a diagram which refers to this scenario where the total donation in Ethers increases with incremental contributions per hour (Fig. 2).

A major analysis of our results relies on tracking the transaction outcome as well as the transaction logs for the system; Fig. 3 implies the scenario of a successful transfer between the sender A to the recipient B which results in an increased number

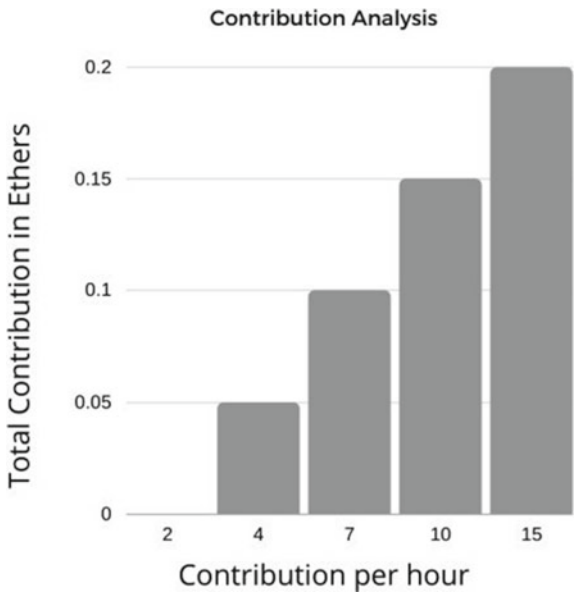

Fig. 2 Contribution trend in terms of duration per hour

of Ethers in the receiver's wallet. Our analysis also relies on the end-to-end test cases mentioned above which ensures the reliability of the system.

Based on the number of transactions, we calculate whether the Campaign manager can go through with the fund transfer to the receiver. The below formula states the calculation of total current approvals for the transaction to be great than half of the total approval count of the contributors where ΔAi denotes the individual approval of the contributor between the respective block number i, and T is the total number of transactions/contributions.

$$T - \sum_{i=1}^{n} \Delta Ai > T - \sum_{i=1}^{n/2} \Delta Ai$$

4 Discussion

The proposed system would be beneficial to the users in terms of cutting off middle management, thus avoiding unnecessary money wastage; it would also ensure data secrecy and security by being a part of the decentralized network. Velocity is a crucial factor when it comes to avoiding latency in transactions which the proposed solution solves by removing any redundant steps and processing the transfer within mere seconds.

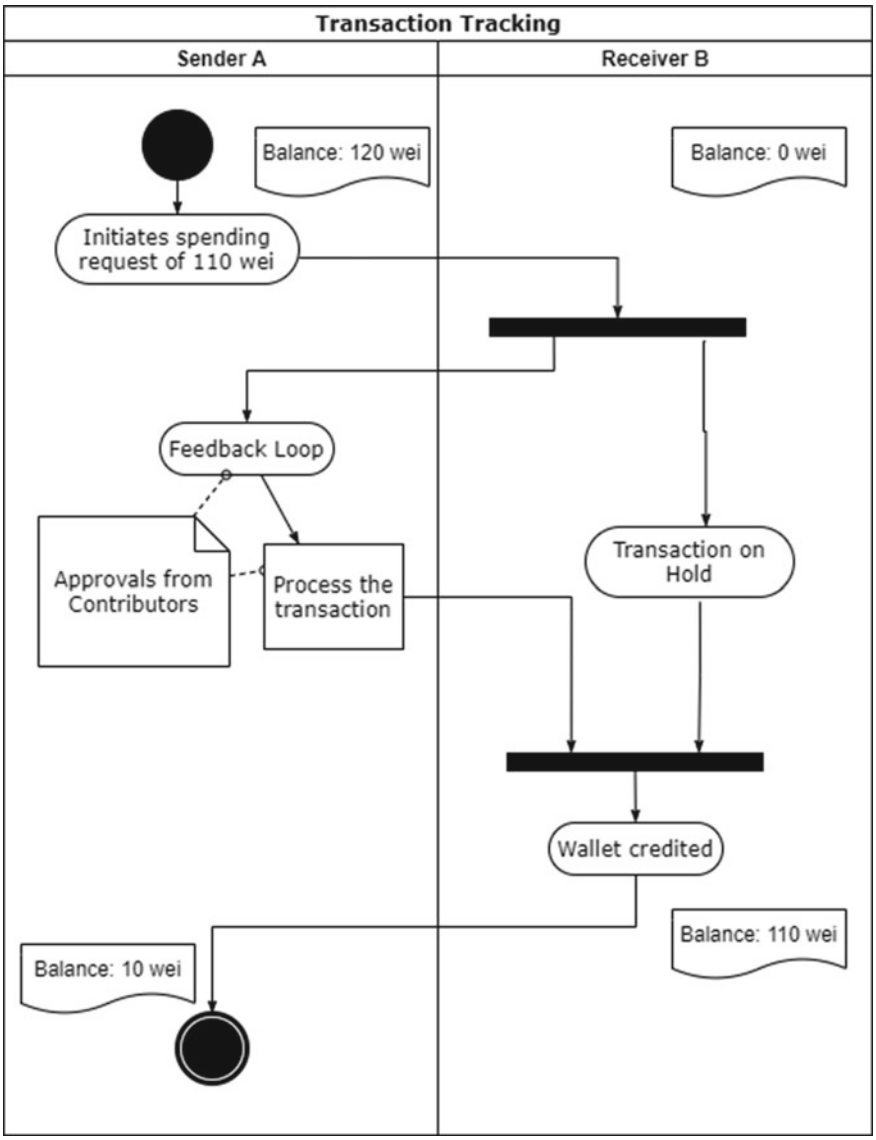

Fig. 3 Transaction tracking scheme

This system would encourage transparency by allowing approval-based voting services for the contributor donations making the organization and recipient transaction history open for everyone to see. This would promote a culture of safety and trust among the users as well as the crowdfunding campaigns/organizations.

5 Conclusion

In this study, we examined the working model of smart contracts and explored different subjective information of Blockchain about contracts and how to create them using different techniques. This study can be an enabler for students/researchers to further improve and achieve wide real-time use cases. We further explained the approach and constraints in the existing system. More work is needed to make the real-time system stable outside of laboratory conditions, and a deeper, finer-tuned contract might potentially improve results.

Flagging important security and centralization issues, this study acts as a solution to solve the same using a rule-based contract approach with a concise and easy-to-use algorithm.

6 Future Scope

We believe there are a few main areas of improvement in our real-time system that need to be addressed in order to continue working on this project.

- We plan to extend this platform for small businesses, startups, and student projects soon. This would be a game-changer as the existing ways to raise money have the aforementioned flaws.
- We also plan to integrate Crypteux with platforms like Coinbase to give users a seamless ability to buy crypto from the platform and allow new users to create crypto wallets.

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A Convolutional Neural Network-Based Approach for Automatic Dog Breed Classification Using Modified-Xception Model

Ayan Mondal, Subhankar Samanta, and Vinod Jha

Abstract The social structure of urban India has been changed and most pet lovers choose the dog over any other kind of pet. The population of adopted dogs is projected at 31.5 million approximately by 2023. With the increase in demand, the fraud cases of selling the right breed are rising day by day. With the demand for different dog breeds, recognizing the correct breed in time by their physical ability, instinct, interaction, and behavior, the body structure is necessary. Recent developments of artificial intelligence have already proven its superiority over the human capability for image classification tasks. The present work has built a Convolutional Neural Network (CNN)-based model to construct a highly accurate dog breed image classifier. In this paper, various state-of-the-art deep CNN models have been applied, and a modified-Xception model has been proposed for improving the overall accuracy. For evaluating the overall classification performance of our proposed methodology, the Kaggle Dog Breed Identification dataset has been used and throughout the experiment, our modified-Xception model has achieved 87.40%, the highest overall accuracy.

Keywords CNN · Dog breed classification · Image classification · Leaky ReLU · Xception

1 Introduction

Nowadays, dogs are the most common pets to be adopted at home. Security personnel also prefer some specific dog breeds for security purposes. As per statistics of the ASPCA [1], nearly 1.6 million dogs are adopted every year. By observation, one can conclude that the intra-class differences in dog breeds are more than the inter-class differences. So, identification of dog breeds becomes very difficult particularly, for the new pet enthusiasts. Dogs are also the most genetically diverse animals on the

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earth. The current advancements of deep learning, especially Convolutional Neural Network (CNN), have already proved its superiority over human capabilities toward object identification. So, CNN-based dog breed identification is very much essential to decrease the complexity of dog breed classification.

Deep Learning is a widely growing field with continuous up-gradation in various domains like image recognition, speech recognition, object detection, data generation, etc. But still, much work needs to be done in this field to explore complex problems. In recent times with the advent of various CNN architectures like Xception, ResNet, DenseNet, etc. and with the help of Transfer Learning [2], improving classification model performance has become quite easier.

This paper aims to classify different breeds of dogs with improved accuracy compared to the existing dog breed identifiers in the literature. To develop the classifier, we have used the Kaggle Dog Breed Identification dataset [3]. The goal was to make a generalized model which would be able to predict the dog breeds irrespective of any class and with higher accuracy. We have experimented with different state-of-the-art deep CNN models like DenseNet201, Xception, ResNet50, VGG19, etc. We have also made some modifications in the Xception model architecture to improve the overall classification accuracy. In our experiment, our modified-Xception model has obtained the highest, 87.40%, overall accuracy on this applied Kaggle Dog Breed Identification dataset. Based on the previous works on this dataset, our classification model accuracy is a cut above the other proposed models in the literature. Hence, the foremost contributions of this article are as follows: (i) proposed a modified-Xception model to identify the different dog breeds; (ii) compared the adopted method with various pre-trained models; (iii) comparative performance analysis between similar previous works and the proposed approach.

The rest of this article has been structured as follows: a quick overview of the related works of dog breed recognition has been provided in Sect. 2, where our proposed methodology has been explained in Sect. 3 in detail. The experimental results and analysis are presented in Sect. 4 and finally, the article ends with the conclusions and future works.

2 Literature Review

From the past decade, many researchers have earlier tried to construct a dog breed image classifier. In most cases, they have used different CNN architectures. Mulligan et al. [3] have used the Kaggle Dog Breed Identification dataset and experimented with Xception followed by a Multi Linear Perceptron (MLP), but got a very low overall accuracy of 54.80%. There is still a chance of increasing the accuracy by applying more neurons and fine-tuning [4]. In the same context, Shi et al. [5] have also used the same Kaggle Dog Breed Identification dataset to classify the different dog breeds. They have applied various pre-trained CNN models, and among them, DenseNet161 has achieved the best overall accuracy of 85.64%. Kim et al. [6] have also used the same dataset to develop their dog breed classifier model. They have

applied proper data augmentation and got the highest overall classification accuracy of 83.22% using the ResNet152 model.

Sinnot et al. [7] have used the Stanford Dog dataset for identifying the different breeds of dogs. They have also used proper data augmentation and got superior classification model performance using the VGGNet model. Their image classification model has achieved an overall accuracy of 85% for 50 classes but, it drops to 63% for 120 dog breeds. In the same context, Ráduly et al. [8] have also used the Stanford Dog dataset. They have used proper data augmentation and hyperparameter tuning. They have applied the ResNeInception-ResNet-v2 model, which has achieved a decent overall accuracy of 90.69%. But, due to its massive amount of weight, it is computationally quite expensive.

Zou et al. [9] have contributed by developing a new dataset named Tsinghua for dog breed classification. They have removed similar images by computing image structural similarity (SSIM). Further, they have applied three different deep neural networks: PMG, TBMSL-Net, and WS-DAN. Throughout their experiment, WS-DAN has provided superior classification performance over the other models. It has achieved around 86.04% overall accuracy for eighty classes, but this accuracy falls to 58.14% on the Stanford dog dataset.

Liu et al. [10] have used the Columbia dataset for dog breed classification. But they have taken traditional machine learning approaches instead of using CNN. They have used SIFT features descriptor and SVM algorithm for their experiment and got only 67% overall accuracy. Borwarnginn et al. [11] have also experimented on the same Colombia dataset. They have implemented the NASNet model, which has achieved 89.92% overall accuracy. In the same context, LaRow et al. [12] have used the same dataset to classify the different dog breeds. As data pre-processing, they have extracted the facial key point from the dog images and have used a 17-layer CNN architecture for feature extraction. They have used the SVM model for classification. But their CNN-SVM approach has achieved a very low, 52%, overall accuracy. Table 1 represents the classification performance of the various implied methodologies in the literature for dog breed classification.

3 Methodology

This section vividly describes our proposed approach to building a CNN-based dog breed classifier model. The main steps of our methodology are data pre-processing, feature extraction, model training, and prediction on the new images.

3.1 Dataset Description

We have experimented on the Kaggle Dog Breed Identification dataset [3] that is collected from Kaggle. This dataset contains 10,222 training images in 120 classes

Table 1 Comparative analysis of the implied methodologies in literature for dog breed classification

Author	Models	Overall accuracy (%)	Used dataset
Mulligan et al. [3]	Xception	54.80	Kaggle dog breed Identification dataset
Shi et al. [5]	DenseNet161	85.64	Kaggle dog breed Identification dataset
Kim et al. [6]	ResNet152	83.22	Kaggle dog breed Identification dataset
Sinnot et al. [7]	VGGNet	63.00	Stanford dog dataset
Ráduly et al. [8]	ResNeInception-ResNet-v2	90.69	Stanford dog dataset
Zou et al. [9]	WS-DAN	58.14	Tsinghua dataset
Liu et al. [10]	SIFT + SVM	67.00	Columbia dataset
Borwarnginn et al. [11]	NASNet	89.92	Columbia dataset
LaRow et al. [12]	17 layered CNN + SVM	52.00	Columbia dataset

and 10,357 testing images. Each image of this dataset is in RGB format of random sizes. Figure 1 represents the graphical plot of the class-wise data size where x-axis and y-axis denote the dog breed name, and the number of data in a particular class, respectively. The Scottish Deerhound dog breed contains the highest, 126, dog images, whereas Briard and Eskimo dog breeds contain the lowest, 66, dog images.

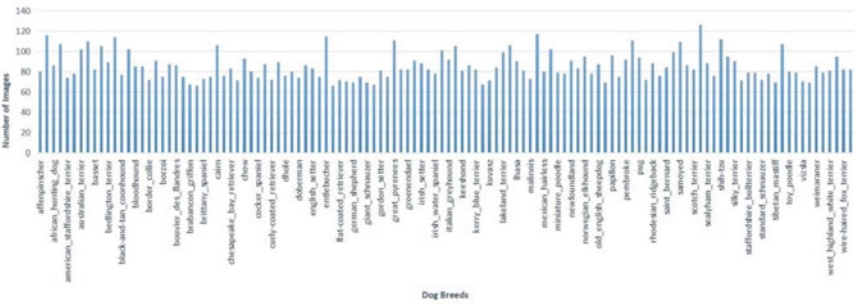

Fig. 1 Graphical representation of class-wise data size

3.2 Data Pre-processing

In the Kaggle Dog Breed dataset, the available test set is not labeled, so it is troublesome to evaluate the classification model performance from this test set. To tackle this problem, we have split the training set into a ratio of 80:20 for training and testing purposes, respectively. To seize the overfitting problem, we have also used various data augmentation techniques. We have applied a width-shift-range of 0.25, height-shift-range of 0.25, zoom-range of 0.2, and horizontal-shift and generated many images from each image of the training set. Moreover, we have resized all images in 224 × 224×3 for our experiment.

3.3 Convolutional Neural Network (CNN)

CNN is a specialized neural network for image classification. It mimics the visual cortex of the animal brain to recognize and process images. CNNs consist of several building blocks such as a convolutional layer, pooling layer, activation function, and fully connected layer. Figure 2 depicts the basic architecture of a CNN model.

The convolutional layer uses convolution operation to find the features from an image. Equation 1 mathematically expresses the convolutional operation.

$$(X * K)(i, j) = \sum_{p} \sum_{q} K(p, q) X(i - p, j - q) \tag{1}$$

where K is the kernel and X denotes the inputs.

Pooling layers generally reduce the dimensions of the feature maps. Thus, the number of trainable parameters decreases and computation time becomes lower. Activation functions introduce non-linearity between the inputs and the outputs. In our methodology, we have used two activation functions: Leaky ReLU and Softmax [13]. We have applied Leaky ReLU and Softmax activation functions in the hidden layers and the output layer, respectively. Leaky ReLU and Softmax functions are mathematically expressed by Eqs. 2 and 3, respectively.

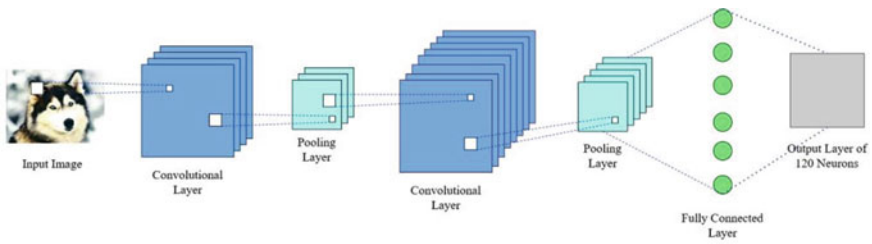

Fig. 2 Basic architecture of a CNN model

$$\text{LeakyReLU(m)} = \begin{pmatrix} am, if m \leq 0 \\ m, if m > 0 \end{pmatrix} \tag{2}$$

$$\text{softmax}(z)_i = \frac{\exp(z_i)}{\sum_{j=1}^{n} \exp(z_j)} \text{fori} = 1, ..., \text{nand} z = (z_1, ..., z_n) \epsilon \mathbb{R}^n \tag{3}$$

where m is the input of Leaky ReLU function, a = 0.01 and z_i is the ith element of the input vector z for Softmax function.

3.4 Modified-Xception Model

In this paper, we have applied various deep CNN models like ResNet50, VGG16, DenseNet201, and Xecption and have modified the Xception model by replacing its top layers with one Global Average Pooling layer, three consecutive Dense layers, 50% dropout in all of them and finally, one Softmax layer. The dropout layers are added to tackle the overfitting problem during model training. Moreover, we have used the Leaky ReLU activation function rather than ReLU [13] in the hidden layers. ReLU is the most popular activation function, but it offers zero output for the negative inputs. As a result, it causes vanishing gradient problems [14] during model training. On the other hand, Leaky ReLU seizes this vanishing gradient problem by offering a small output for the negative values. As a result, the classification performance of the CNN model increases. Figure 3 depicts the architecture of our modified-Xception model.

3.5 Experimental Setup

To classify the different dog breeds, we have trained our modified-Xception model along with the pre-trained models for 100 epochs. The models are compiled with the Adam optimizer having a 0.0001 learning rate and a loss function, namely categorical cross-entropy. Too many epochs often cause overfitting problems in the learning phase of a classification model. To overcome this problem, we have used the Early Stopping algorithm [15]. It halts the training phase whenever generalization error does not decrease. Moreover, we have reduced the learning rate to avoid any stagnation in the model learning phase. Throughout the experiment, we have used the TensorFlow framework for model training and data pre-processing; Matplotlib and seaborn for data visualization on Google Colaboratory.

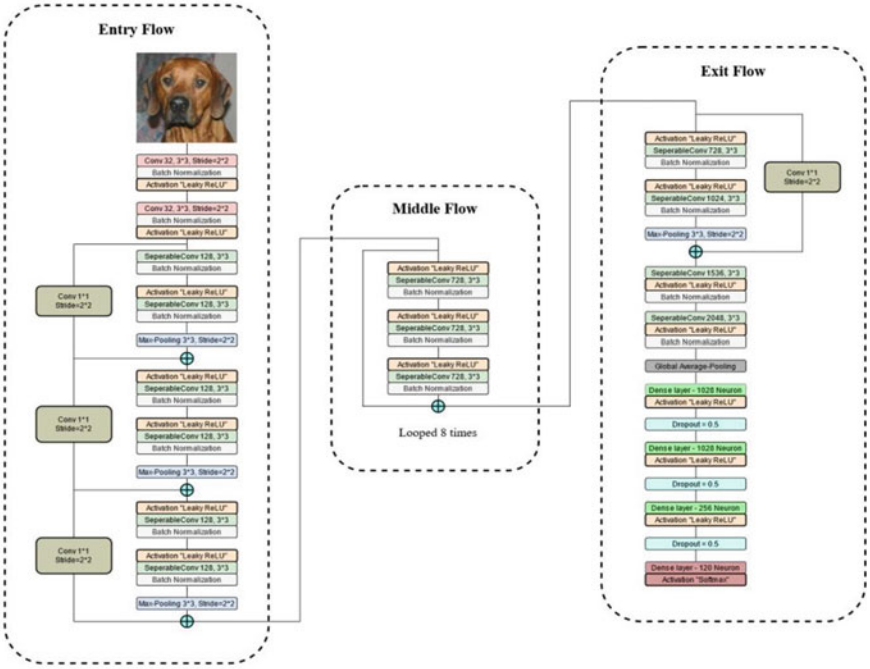

Fig. 3 Model architecture of our modified-Xception model

4 Results and Discussions

Here, we have presented our experimental outcomes and also compared the proposed methodology with the previous works in the Kaggle Dog Breed Identification dataset. We have applied different deep CNN models like ResNet50, VGG16, DenseNet201, and Xception and proposed a modified-Xception model. Figure 4 graphically represents our experimental results.

Throughout the experiment, our proposed modified-Xception model has achieved the highest 87.40% overall classification accuracy, whereas the original Xception model has achieved the second highest 84.15% overall classification accuracy. To find the overall classification accuracy, we have utilized Eq. 4.

$$\text{accuracy} = \frac{A + C}{A + B + C + D} \tag{4}$$

where A is the number of items whose true labels are positive and also classified as positive; B is the number of items whose true labels are negative but predicted as positive; C is the number of items whose true labels are negative and also correctly classified as negative; D indicates the number of items whose true labels are positive but classified as negative.

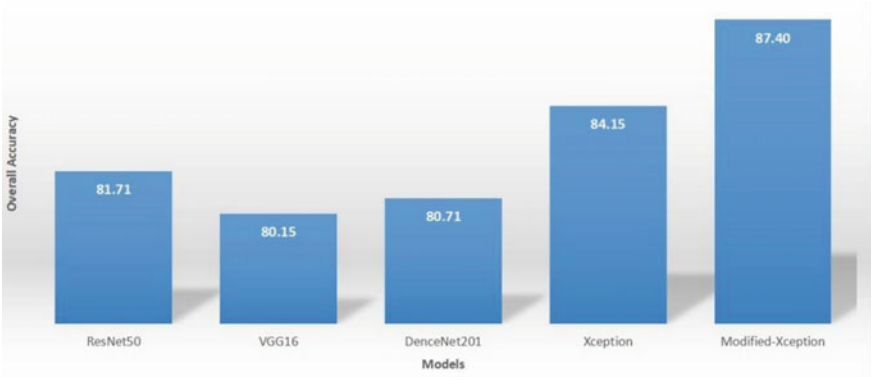

Fig. 4 Graphical representation of the overall accuracy using deep CNN models

Figure 5 depicts the confusion matrix achieved by the proposed modified-Xception model. To evaluate our model performance, we have presented a comparative performance analysis of the proposed methodology with the existing approaches to classify the dog breed images on the Kaggle Dog Breed Identification dataset in Table 2. It

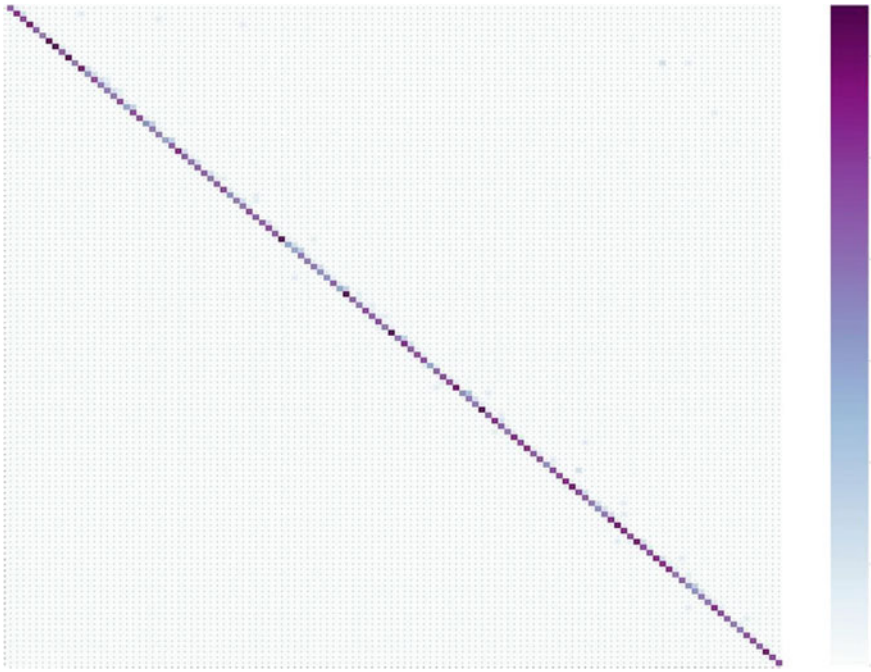

Fig. 5 Confusion matrix achieved by the modified-Xception model

Table 2 Comparative performance analysis between the implied methodology and the previous approaches of literature on Kaggle Dog Breed Identification dataset

Author	Models	Overall accuracy (%)
Mulligan et al. [3]	Xception	54.80
Shi et al. [5]	DenseNet161	85.64
Kim et al. [6]	ResNet152	83.22
Proposed method	Fine-tuned Xception Modified-Xception	84.15 87.40

can be observed that on this dataset, our proposed model has achieved better accuracy as compared to others.

Our methodology also provides a decent recognizing rate to recognize the new images. To recognize a particular image, our proposed modified-Xception model takes around 1.56 ms.

5 Conclusion

This article briefly investigates the ability of the CNN model to classify the different dog breeds. We have also shown the usefulness of using Transfer Learning and fine-tuning techniques for image classification tasks. Here, we have demonstrated the importance of proper data augmentation and pre-processing to improve classification accuracy. Our proposed modified-Xception model has achieved the highest 87.40% overall accuracy on the Kaggle dog breed identification dataset. In the future, we intend to work on a very deep Densely Connected Neural Network and ensemble network models for further improvements. However, our work will inspire the researchers to introduce more developments in dog breed identification.

Declaration The authors have no conflict of interest to declare those are relevant to the contents of this article.

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Feature Extraction and Feature Sheet Preparation of Real-Time Fingerprints for Classification Application

Annapurna Mishra, Satchidananda Dehuri, and Pradeep Kumar Mallick

Abstract A fingerprint classification system groups fingerprints according to their characteristics and therefore helps in the matching of a fingerprint against a large database of fingerprints. Data preparation is one of the very important tasks of research work. Unless we build a quality database, we cannot ensure quality output from the model developed to achieve the objectives of this research. Hence, in this chapter, we fully gave our attention to the preparation of a primary database to recognize the fingerprints. Additionally, we are also using fingerprint databases which are commonly available in the public domain for validating our models.

Keywords Database · Fingerprint · Realtime · Classification

1 Introduction

Fingerprint analysis is done on the many standard databases available online [1]. This work is focused on creating a fingerprint database extracted from the collected real-time fingerprint images. This database is called the real-time database. The fingerprints are collected from a group of students of Silicon Institute of Technology, Bhubaneswar, through a fingerprint sensor from five basic classes of the Henry system. The fingerprint images are captured via available fingerprint sensors in the market. So a collection of 50 fingerprints sensed from five basic classes are stored, and the database finally in terms of extracted features is created for further processing tasks. In this work, the arch and tented arch (class 4 and class 5) are considered as one

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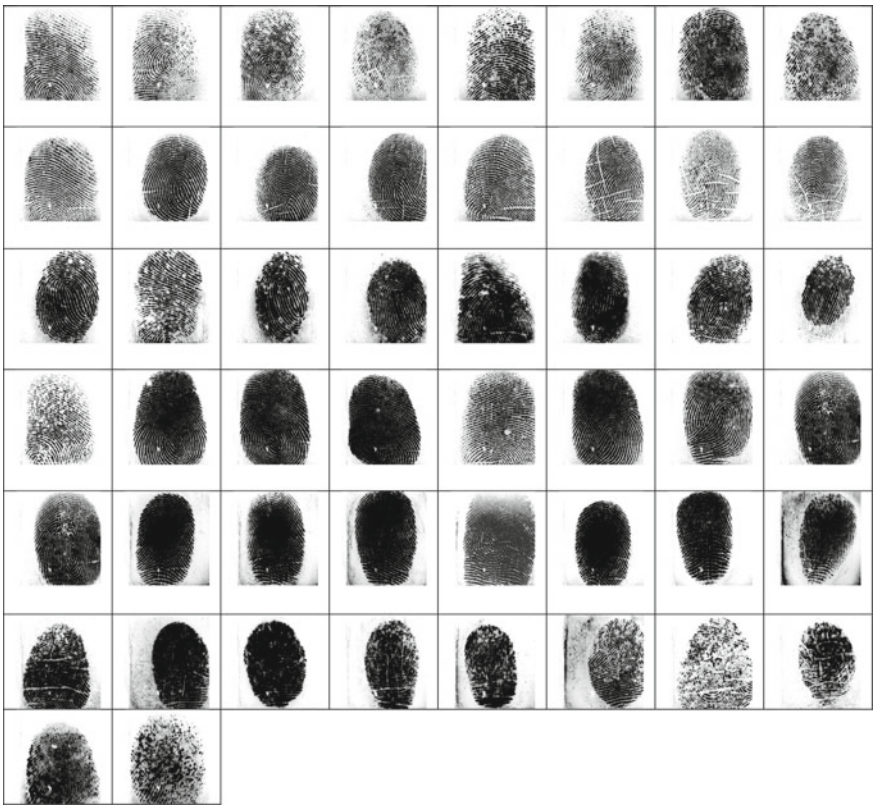


Fig. 1 **a** Real-time database of 50 fingerprints. **b** Real-time database images of left loop fingerprints. **c** Real-time database images of right loop fingerprints. **d** Real-time database images of whorl fingerprints. **e** Real-time database images of arch fingerprints. **f** Real-time database images of tented arch fingerprints

class as class4 to avoid misclassification. So here the database consists of 4 classes of fingerprints. A subset of the samples is present in Fig. 1.

In Fig. 1a–f, we can see the different classes of fingerprints given with respect to their class value. Scrutinizing this pattern at various levels discloses various types of characteristics that are global feature and local feature. The features are collected in terms of feature vectors of each individual fingerprint.

2 Feature Extraction

The 'Feature' is the minute physical detail present in the fingerprint in the form of ridges and furrows which define the category of fingerprint in terms of class details. Each fingerprint is different from the other with these minute details which need to

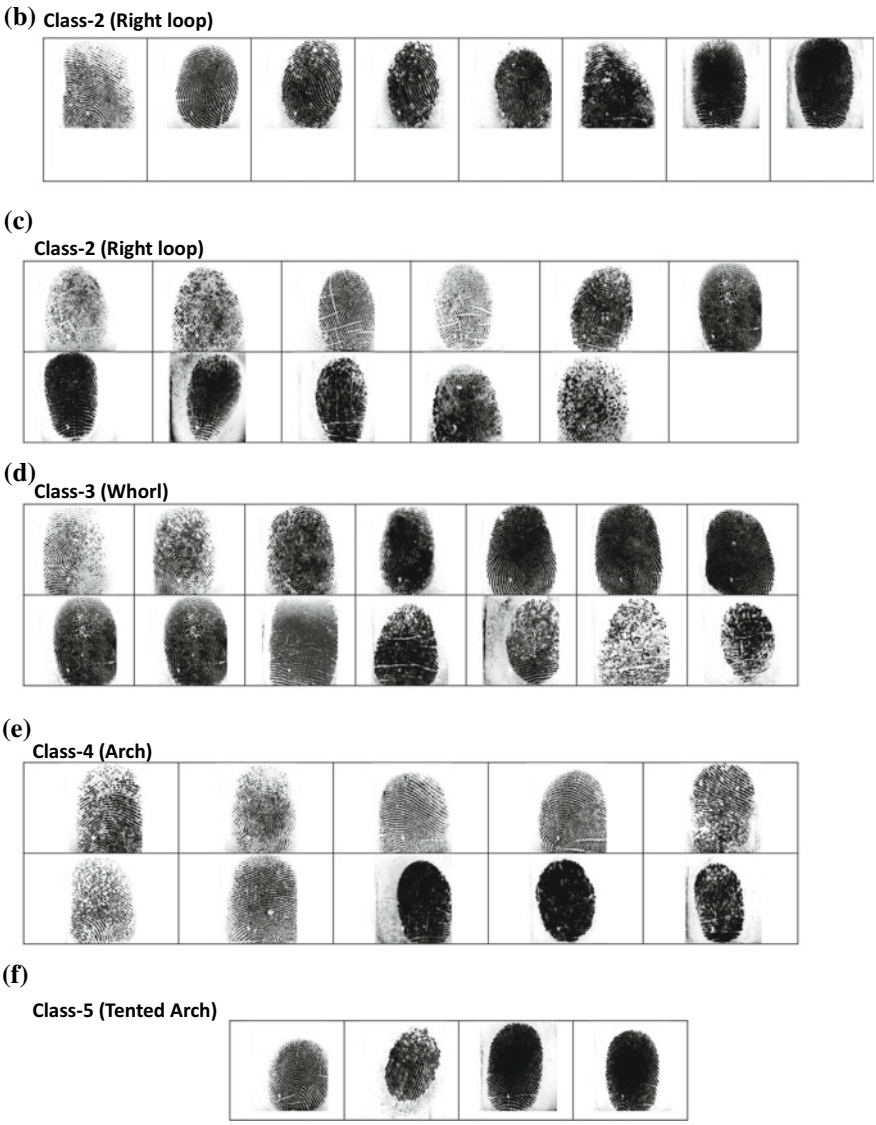


Fig. 1 (continued)

be extracted using different methods to identify the fingerprint [2, 3]. The process of drawing out the hidden attributes from the 2-dimensional image is called feature extraction.

A fingerprint can be described by using quantitative measures associated with the pattern flow or oriented textures called features of a fingerprint [4]. Analysis of the oriented texture is an important aspect of research in practical applications.

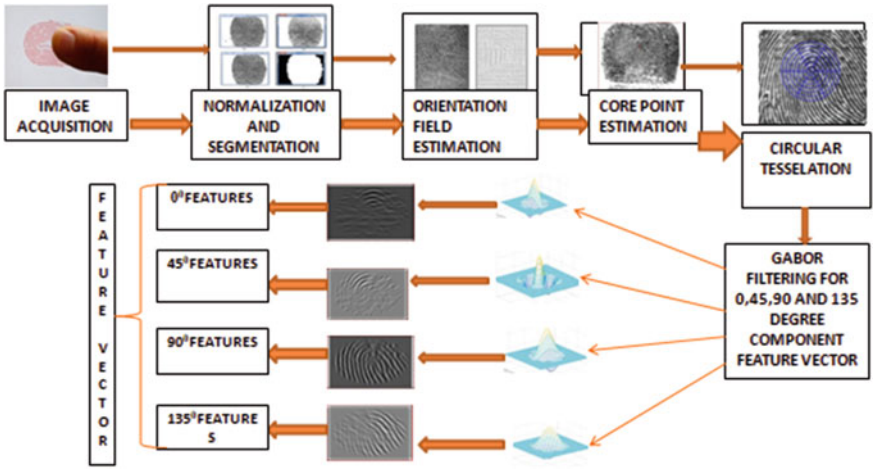


Fig. 2 Feature extraction process

Farrokhina et al. [5] described the Gabor filter bank method that can be used to describe the global representation of texture by the image decomposition method. Daugman et al. [6] have represented the translated and scale-invariant texture representation for human iris using the Gabor wavelet coefficient method, but it was not considered to be an efficient one, as it is not rotation-invariant. Prabhakar et al. [7] presented a method for fingerprint texture representation by extracting the reference point, and the region surrounding the reference point is further divided into cells [8]. The information contained in each cell is further extracted using spatial frequency channels and represented in an ordered fashion called features. The steps involved in the Gabor filter bank using spatial frequency representation of features are as shown in Fig. 2 [9]:

- Image Acquisition (fingerprint capture process),
- Normalization and segmentation of the pixels of the fingerprint image,
- Orientation field estimation from the normalized image,
- Estimation of the core point from the orientation field,
- Circular division of the selected portion of the image, and
- Gabor filtering of the sectors in different angular directions.

The collection of features in all angles to form the feature vector or fingercode [10].

During feature extraction, we have followed the following steps in this research. Here, a generic technique is proposed for representing fingerprint texture that lies in collecting one (or more) invariant points of reference of the texture following its orientation field [7, 11]. The core point or point of reference is divided into six sectors. Those six sectors are again sub-divided into six subsectors in each sector forming 36 subsectors. Each sector is then analyzed for the information present in the

spatial frequency channels. Features are collected from the subsectors and used as the representation of the fingerprint class [12]. Now, these representations of features represent the local information of the tessellated sector that reflects the invariant characteristics of the global relationships present in the local fingerprint patterns.

The following steps are used in the proposed feature extraction algorithm.

First, the core point (center point) which is also called the reference point is defined, and taking this point as the center, the surrounding region is spatially tessellated into sectors.

Then, convert the tessellated image in the form of component images that describes the ridge structure, and from the component images generate the feature vector combining the sectors.

2.1 Feature Code Generation

The steps of the feature code generation algorithm are as follows.

Select a reference point or core point for spatial tessellation (circular in our case) around the reference point taking it as the center. It is called our region of interest (ROI). Divide the ROI into a set of component sub-images, to preserve global ridge and furrow structures called sectors. Calculate the standard deviation in each sector to create the code [13, 14].

2.2 Core Point Location

The orientation field is smoothened in the local neighborhoods and defined as O'. Initialize E, an image which contains the sine components of the smoothened orientation field

$$E(i, j) = \sin\left(O'(i, j)\right) \tag{1}$$

For every pixel in E(i, j), integrate pixel intensities into regions R1 and R2 as shown in Fig. 4 and assign the corresponding pixels by the value of their difference.

$$A(i, j) = \sum_{R1} E(i, j) - \sum_{R2} E(i, j) \tag{2}$$

Now the maximum value is calculated and is defined as the core point (Fig. 3).

Fig. 3 Detected core point (red dot)

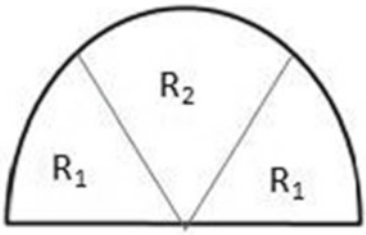


Fig. 4 Regions for integrating pixel intensities

2.3 Tessellation

Tessellation is a process of dividing the circular extracted orientation field into different equal-area sectors as shown in Fig. 5. It is mainly used to make the fingerprint features rotation-invariant [7, 15]. The equations show the formula to achieve tessellated output.

$$S_i = \left\{ (x, y) \middle| \begin{matrix} b(T_i + 1) \le r \le b(T_i + 2), \theta_i \le \theta \le \theta_{i+1}, \\ 1 \le x \le N, 1 \le y \le M \end{matrix} \right\} \tag{3}$$

where

$T_i = idivk,$
$\theta_i = (imodk)\left(\frac{2\pi}{k}\right),$
$r = \sqrt{(x - x_c)^2 + (y - y_c)^2}, \theta = \tan^{-1}\left(\frac{y - y_c}{x - x_c}\right)$

Fig. 5 Tessellated fingerprint image

2.4 Filtering

The Gabor filtering is done in the frequency domain, which can be represented by the following expression:

$$G(x, y; f, \theta) = \exp\left\{-\frac{1}{2}\left[\frac{x^2}{\delta_x^2} + \frac{y^2}{\delta_y^2}\right]\right\}\cos\left(2\pi f x'\right) \tag{4}$$

Figure 6 shows the output of the Gabor filter for different angle orientations. For the pixels in sector Si, the normalized image is defined as

$$N_i(x, y) = \begin{cases} M_0 + \sqrt{\frac{(V_0)\times(I(x,y)-M_i)^2}{V_i}}, if\, I(x, y) > M_i \\ \\ M_0 - \sqrt{\frac{(V_0)\times(I(x,y)-M_i)^2}{V_i}}, otherwise \end{cases} \tag{5}$$

where M0 and V0 are desired mean and variance values, respectively [16, 17]. In this work, we have taken M0 and V0 to be 100. Mi and Vi can be determined as follows:

$$M_i = \frac{1}{n_i}\sum_{k=1}^{ni} I_k(x, y) \tag{6}$$

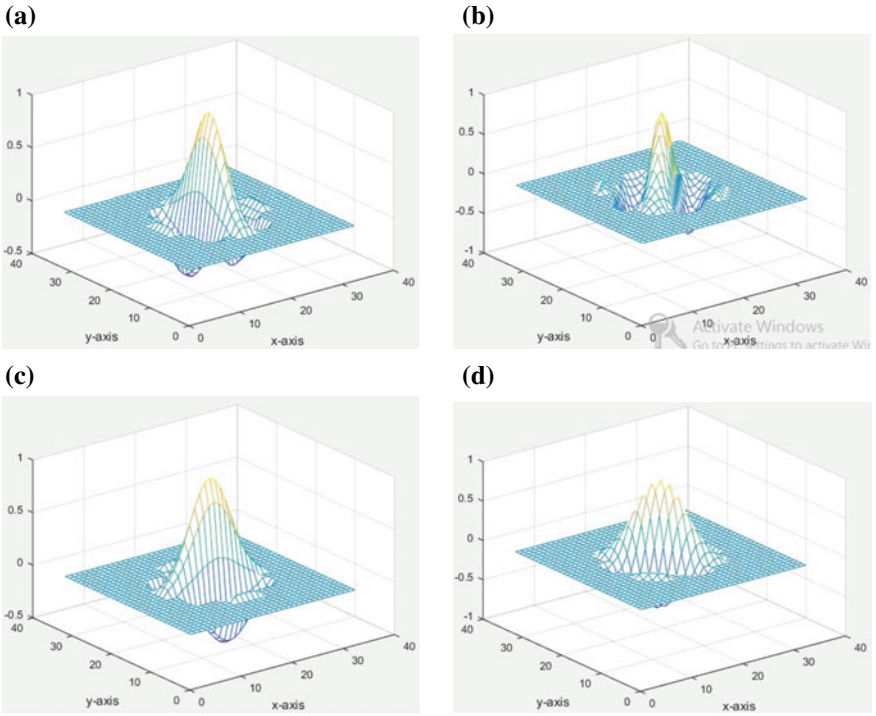


Fig. 6 Output of Gabor filters of window 33 × 33 pixels **a** 0° **b** 45° **c** 90°, and **d** 135°

$$V_i = \frac{1}{n_i} \sum_{k=1}^{ni} (I_k(x, y) - M_i)^2 \tag{7}$$

where Ik(x,y) is the kth pixel in sector Si.

The normalization is done sector-wise. Normalized and filtered images are shown in Fig. 7.

2.5 Feature Vector

Each sector S_i is further sub-divided into six subsectors. So for the given six sectors, we have thus 36 subsectors. The core point acts as one subsector and the region outside the circular region is also considered as another subsector. So together it forms 38 subsectors for which the component images in four angle directions (0°, 45°, 90°, 135°) is calculated. The feature vector or feature code defines the standard deviation $F_{i\theta}$ of the collected component images for sector Si and is given as

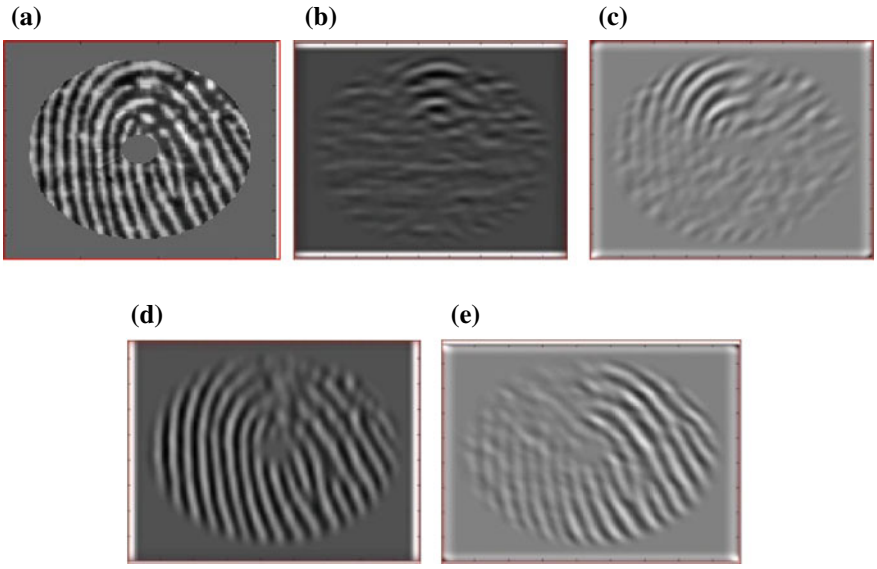


Fig. 7 **a** Normalized image **b** Image component of 0° **c** Image component of 45° **d** Image component of 90° **e** Image component of 135°

$$F_{i\theta} = \sqrt{\sum_{k_i} (C_{i\theta}(x, y) - M_{i\theta})^2} \tag{8}$$

where ki represents the number of pixels present in Si and Miθ represents the mean pixel intensity present in Ciθ (x, y). Since we have considered the innermost circle as one sector and the region lying outside the ROI as another sector, the 152-dimensional feature vectors are created as shown in Fig. 8.

3 Statistical Analysis of the Dataset

Statistical analysis is the method of collecting, exploring, and presentation of large data for discovering different patterns in the form of trends [6, 18]. This analysis process is used for research and other Government as well as industrial applications for decision-making, for example, mean defines the average value where standard deviation defines the spread of the values. Basically, standard deviation shows the spread of the data toward high or low values. A high value represents more spreading and low values represent the numbers close to average. The margin of error is double the standard deviation. Researchers have considered that the values that are bigger than two or three times of the standard deviation are important values [3, 19]. The statistical analysis of the fingerprints is given in Table 1.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	4.68E+05	4.30E+05	4.18E+05	3.49E+05	2.81E+05	5.54E+05	4.14E+05	4.80E+05	4.82E+05	4.22E+05	3.94E+05	3.97E+05	3.86E+05	4.78E+05	3.98E+05	4.06E+05	4.35E+05
2	2.96E+05	2.80E+05	2.56E+05	1.98E+05	1.76E+05	3.23E+05	2.45E+05	2.88E+05	2.73E+05	2.63E+05	2.40E+05	2.50E+05	2.40E+05	2.90E+05	2.38E+05	2.47E+05	2.66E+05
3	3.27E+05	2.95E+05	2.94E+05	2.02E+05	1.63E+05	3.43E+05	2.12E+05	2.67E+05	3.02E+05	2.86E+05	2.33E+05	2.44E+05	2.54E+05	3.19E+05	2.14E+05	2.55E+05	2.71E+05
4	2.79E+05	2.68E+05	2.44E+05	1.62E+05	1.48E+05	3.35E+05	2.22E+05	2.81E+05	2.50E+05	2.50E+05	2.44E+05	2.46E+05	2.46E+05	2.72E+05	2.12E+05	2.21E+05	2.50E+05
5	4.59E+05	3.93E+05	4.01E+05	2.97E+05	2.70E+05	5.66E+05	4.01E+05	4.77E+05	4.85E+05	4.07E+05	3.69E+05	3.68E+05	3.61E+05	4.92E+05	3.96E+05	4.12E+05	4.59E+05
6	4.53E+05	3.42E+05	3.57E+05	2.65E+05	2.41E+05	4.95E+05	3.57E+05	4.32E+05	3.78E+05	3.59E+05	3.33E+05	3.47E+05	3.30E+05	4.27E+05	3.44E+05	3.73E+05	4.06E+05
7	3.03E+05	2.45E+05	2.47E+05	1.73E+05	1.56E+05	2.83E+05	2.14E+05	2.37E+05	2.38E+05	2.56E+05	2.37E+05	2.35E+05	2.28E+05	2.78E+05	2.06E+05	2.31E+05	2.54E+05
8	3.15E+05	2.85E+05	2.72E+05	1.94E+05	1.49E+05	3.07E+05	2.32E+05	2.69E+05	2.42E+05	2.69E+05	2.30E+05	2.31E+05	2.49E+05	2.81E+05	2.15E+05	2.22E+05	2.46E+05
9	4.95E+05	4.78E+05	4.65E+05	3.76E+05	3.09E+05	5.71E+05	4.64E+05	5.02E+05	5.10E+05	4.62E+05	4.12E+05	4.08E+05	4.26E+05	5.03E+05	4.25E+05	4.23E+05	4.56E+05
10	4.18E+05	3.67E+05	3.72E+05	2.77E+05	2.37E+05	4.59E+05	3.09E+05	3.78E+05	3.76E+05	3.69E+05	3.58E+05	3.63E+05	3.52E+05	4.03E+05	3.04E+05	3.28E+05	3.59E+05
11	4.15E+05	3.94E+05	3.83E+05	2.85E+05	2.36E+05	4.61E+05	3.44E+05	3.79E+05	4.07E+05	3.90E+05	3.77E+05	3.86E+05	3.65E+05	4.18E+05	3.28E+05	3.40E+05	3.73E+05
12	2.77E+05	2.44E+05	2.42E+05	1.52E+05	1.30E+05	3.00E+05	2.17E+05	2.63E+05	2.16E+05	2.36E+05	2.38E+05	2.48E+05	2.32E+05	2.52E+05	2.08E+05	2.18E+05	2.43E+05
13	3.68E+05	2.79E+05	3.00E+05	2.15E+05	2.43E+05	4.56E+05	3.64E+05	3.97E+05	3.82E+05	3.09E+05	2.77E+05	2.87E+05	2.76E+05	3.78E+05	3.49E+05	3.53E+05	3.78E+05
14	2.66E+05	2.50E+05	2.35E+05	1.51E+05	1.26E+05	3.10E+05	2.11E+05	2.52E+05	2.30E+05	2.39E+05	2.13E+05	2.24E+05	2.18E+05	2.54E+05	2.02E+05	2.23E+05	2.50E+05
15	2.22E+05	2.07E+05	2.04E+05	1.09E+05	9.42E+04	2.58E+05	1.93E+05	2.23E+05	1.79E+05	1.99E+05	2.01E+05	2.09E+05	1.93E+05	2.09E+05	1.81E+05	1.83E+05	2.09E+05
16	2.66E+05	2.47E+05	2.51E+05	1.36E+05	1.08E+05	2.75E+05	1.92E+05	2.19E+05	1.99E+05	2.39E+05	1.87E+05	1.90E+05	2.22E+05	2.42E+05	1.77E+05	1.96E+05	2.23E+05
17	5.11E+05	4.57E+05	4.23E+05	3.70E+05	3.07E+05	5.64E+05	4.43E+05	5.14E+05	4.48E+05	4.58E+05	4.12E+05	4.19E+05	4.00E+05	4.89E+05	4.35E+05	4.54E+05	4.88E+05
18	5.09E+05	4.39E+05	4.26E+05	3.58E+05	2.93E+05	4.86E+05	4.28E+05	4.41E+05	3.66E+05	4.35E+05	3.70E+05	3.72E+05	3.80E+05	4.47E+05	3.90E+05	3.71E+05	4.09E+05
19	3.85E+05	4.18E+05	3.68E+05	2.91E+05	2.14E+05	4.33E+05	3.35E+05	3.77E+05	3.38E+05	3.93E+05	3.60E+05	3.73E+05	3.54E+05	3.66E+05	3.25E+05	3.43E+05	3.73E+05
20	3.29E+05	3.26E+05	3.04E+05	2.08E+05	1.70E+05	4.20E+05	2.84E+05	3.48E+05	3.20E+05	3.06E+05	2.84E+05	2.83E+05	2.95E+05	3.30E+05	2.67E+05	2.92E+05	3.25E+05
21	3.90E+05	3.82E+05	3.46E+05	2.63E+05	2.13E+05	4.51E+05	3.30E+05	4.06E+05	3.53E+05	3.66E+05	3.51E+05	3.57E+05	3.44E+05	3.75E+05	3.34E+05	3.52E+05	3.74E+05
22	4.86E+05	4.39E+05	4.24E+05	3.50E+05	2.96E+05	5.70E+05	4.14E+05	5.11E+05	4.55E+05	4.38E+05	4.37E+05	4.46E+05	4.01E+05	4.70E+05	4.07E+05	4.03E+05	4.33E+05
23	4.77E+05	4.43E+05	4.15E+05	3.13E+05	2.38E+05	4.66E+05	3.62E+05	4.09E+05	3.95E+05	4.21E+05	3.61E+05	3.57E+05	3.88E+05	4.35E+05	3.38E+05	3.60E+05	3.94E+05
24	2.65E+05	2.80E+05	2.39E+05	1.68E+05	1.24E+05	3.08E+05	2.09E+05	2.53E+05	2.46E+05	2.55E+05	2.49E+05	2.57E+05	2.41E+05	2.58E+05	1.92E+05	1.93E+05	2.19E+05
25	3.78E+05	3.63E+05	3.24E+05	2.39E+05	2.13E+05	4.28E+05	3.48E+05	3.83E+05	3.47E+05	3.50E+05	3.21E+05	3.27E+05	3.22E+05	3.68E+05	3.36E+05	3.50E+05	3.93E+05

Fig. 8 Features of different fingerprint images

Table 1 Statistical features showing mean and variance of feature code

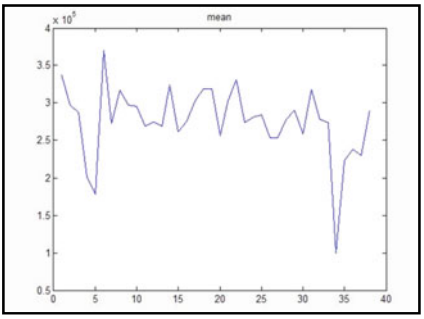
S. no	Feature-code	Mean (Min)	Mean (Max)	Standard Deviation (Min)	Standard Deviation (Max)
1	0°	3.7031	9.9792	1.2113	4.8005
2	45°	1.3172	2.8791	1.4193	6.2991
3	90°	1.0578	7.9973	2.5917	5.3141
4	135°	1.2310	2.8247	1.5852	6.2816
5	Total feature vector	7.99	9.9792	2.59	4.8005

Table 1 shows the collected mean and standard deviation values collected from the feature vector for different angle orientations and finally for total feature vector.

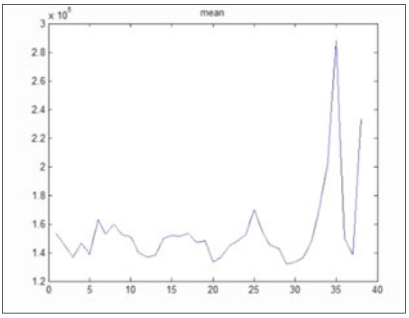
The mean and standard deviation plots are used to check the variation of mean in different groups of data as done by the analyst. Mean plots are used with ungrouped data to determine the change in mean value with time. From Fig. 9, we can see that the mean plot of different angular orientations is almost the same whereas the total feature vector combining the angles is changing continuously. Mean plots are used along with standard deviation plots. The mean plot checks for a shift in location whereas, the standard deviation plot checks for shifts in scale. Also, Fig. 10 reflects the change in variance with the shift in scale value for the feature vectors.

4 Conclusion

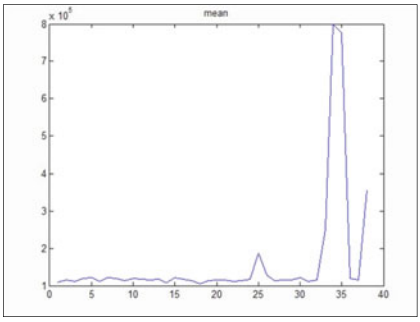
Here, we have performed the feature extraction of real-time fingerprint images using the Gabor filter bank method. Here, each fingerprint is divided into 6 sectors which are again divided into six equal divisions to form 36 subsectors. These 36 subsectors



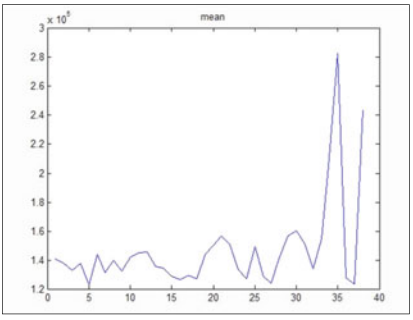
(a) Mean of 0 degree features



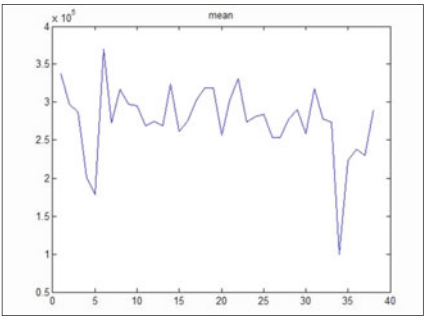
(b) Mean of 45 degree features



(c) Mean of 90 degree features



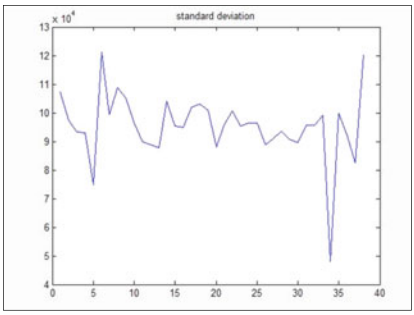
(d) Mean of 135 degree features



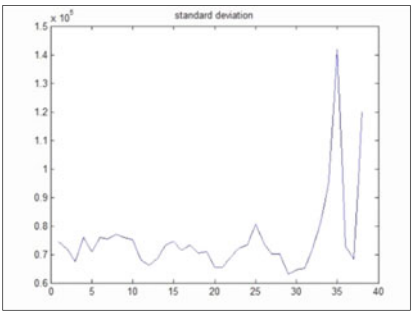
(e) Mean of total feature vector

Fig. 9 Statistical Features (mean) of different angle oriented fingerprint feature code in 9**a** to 9**e**. **a** Mean of 0 degree features. **b** Mean of 45 degree features. **c** Mean of 90 degree features. **d** Mean of 135 degree features. **e** Mean of total feature vector

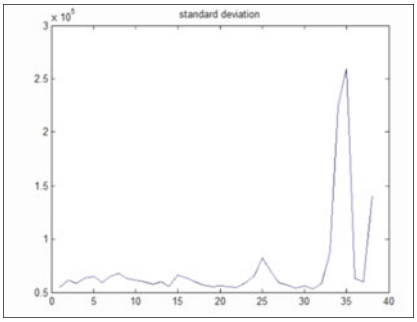
including the core-point as one subsector and the outside region as one subsector form 38 subsectors and each subsector is again passed through the Gabor filter bank for four different angles of 0, 45, 90, and 135 degrees. Each angle shows the extracted feature in that direction and combining the four angular features the feature vector



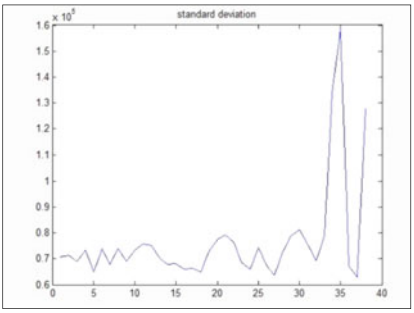
(a) Variance of 0 degree features



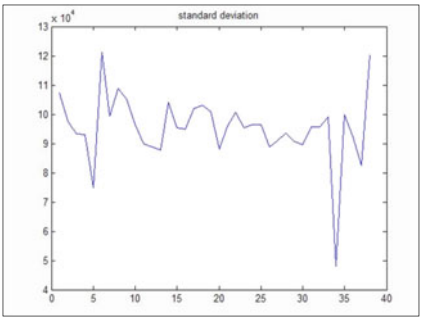
(b) Variance of 45 degree features



(c) Variance of 90 degree features



(d) Variance of 135 degree features



(e) Variance of total feature vector

Fig. 10 Statistical Features (variance) of different angle oriented fingerprint feature code in 10**a** to 10**e**. **a** Variance of 0 degree features. **b** Variance of 45 degree features. **c** Variance of 90 degree features. **d** Variance of 135 degree features. **e** Variance of total feature vector

or finger code is formed. This generated finger code is used for classification using different classification algorithms.

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Performance Analysis of Machine Learning and Soft Computing Techniques in Diagnosis of Behavioral Disorders

Preeti Monga, Manik Sharma, and Sanjeev Kumar Sharma

Abstract Behavioral disorders are primary psychological human disorders that represent a disturbance in an individual's behavior, emotional and cognitive system. These human disorders can be well diagnosed using emerging machine learning and soft computing techniques. Here, different behavioral disorders, their symptoms, and associated consequences have been identified and summarized. The key intention of this work is to highlight the applications of machine learning and soft computing techniques used in the diagnosis of these human psychiatric conditions. The use of these methodologies in the diagnosis of behavioral disorders is limited, compared to other human diseases (diabetes, cardio, cancer). Several machine learning and soft computing techniques, viz., SVM, ELM, KNN, CNN, and fuzzy inference have been used to diagnose different behavioral disorders. As per the literature, the highest accuracy rate achieved in the diagnosis of attention deficit hyperactivity disorder, conduct disorder, tic disorder, and anxiety is 98.62%, 85%, 90.1%, and 97%, respectively. However, there is still a promising opportunity to use these techniques to examine the symptoms and history to diagnose the problem, develop tools to assist psychiatrists in predicting psychological disorders, and support patient care.

Keywords Behavioral disorders · Machine learning (ML) · Soft computing (SC) · Attention deficit hyperactivity disorder (ADHD) · Tic disorder · Conduct disorder (CD) · Anxiety

1 Introduction

Mental health disorders encompass many emotional and behavioral disorders, including dissociative disorders, disruptive disorders, anxiety, persistent developmental issues, and behavioral disorders. In the last few years, behavioral disorders have been more prevalent among children and adolescents. Behavioral disorders (BDs) are characterized by severe disruptions in an individual's behavioral, psychological, and intellectual systems [1]. The existence of BDs indicates a problem with

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the cognitive, physiological, or developmental processes that support emotional and behavioral functioning [2].

Past studies revealed that the presence of these BDs can be one of the major reasons behind peer rejection, risky behavior, impulsive nature, social isolation, and academic difficulties [3–6]. These consequences have a considerable detrimental influence on the person, the family, and society. Therefore, it is essential to diagnose these BDs as early as possible. The function of a psychologist can be reinforced with machine intelligence as technology evolves. Many psychological/diagnostic approaches have aimed to detect behavioral disorders with various methods. Algorithmic and data mining techniques may be used to determine the problem, assist in clinical reasoning, or perform logical operations on large databases [7–10].

Behavioral disorders are defined and classified both in the DSM-IV and the ICD-10. These two commonly used guides provide the most widely recognized criteria for classifying mental and behavioral problems.

As per ICD-10 under F90-98, there are eight types of BDs usually found occurring in childhood and adolescence [10]. The categories, their types, and behavior associated with five major BDs are depicted in Fig. 1. Identification and management of these symptoms are quite important as they helps in.

- Efficiently lowering the impact of suffering and disability.
- Healthier behavior with improved educational outcomes.
- Better, happier, and healthier bonding with their family, friends, and peers.

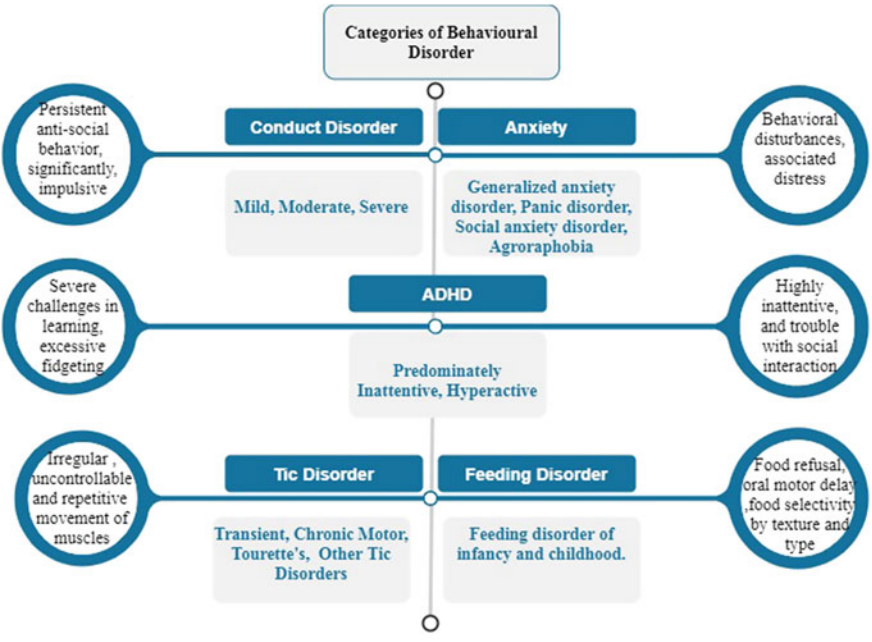

Fig. 1 Classification of Behavioral disorders

- Providing better understanding with parents and teachers of the adolescent with behavioral disorder.

This study of behavioral disorders presents a concise review of various ML and SC approaches for their classification and diagnosis. With the ease of availability of data related to individuals' mental health status, ML and SC techniques are proposed to improve our understanding of these conditions and better support clinical decision-makers of mental health. While the success of SC/ML techniques in other diseases, their utility, and effectiveness in diagnosing BDs remain unknown. There is no major review from the current literature emphasizing the diagnosis of major behavioral disorders such as Anxiety, ADHD, CD, and Tic disorder. Section 2 briefly summarizes the review process followed in this study. Section 3 highlights the key findings from the literature on the diagnosis of BDs. Section 4 illustrates the discussion. Finally, the concluding remarks and future scope are presented in Sect. 5.

2 Methodology

A comprehensive search technique is designed to identify unbiased and relevant research papers relevant to the diagnosis of a behavioral condition. A three-step procedure was used to access all the publications on the related topics for a comprehensive analysis of the literature. Each section has been designed to act as a guide for locating pertinent literature. Figure 2 shows the overall review strategy.

Screening of manuscripts was performed using certain keywords that emphasize the use of the ML and SC technologies in categorizing and diagnosing additional BDs. The data has been screened off for the years ranging from 2010 to 2020.

The exclusion criteria were based on.

- Studies without sufficient empirical analysis or comparisons of benchmarks.
- Studies on languages other than English (for example, Chinese, Arab, and Dutch).

Following thorough research on the title, abstract, and content of the publication, this study finally picked 64 articles.

3 Review

Behavioral Disorder diagnosis requires very long-term and prolonged participation of physicians, parents, and teachers. If a patient is incorrectly diagnosed, it may profoundly affect their intellectual and emotional growth. Early and reliable identification of these syndromes can help to control the symptoms through adequate care. In line with the conventional clinical signs and symptoms, there is a need to identify more specific and realistic criteria that can improve the diagnosis of these disorders. Clinical observation usually relies on benchmark data collection methods,

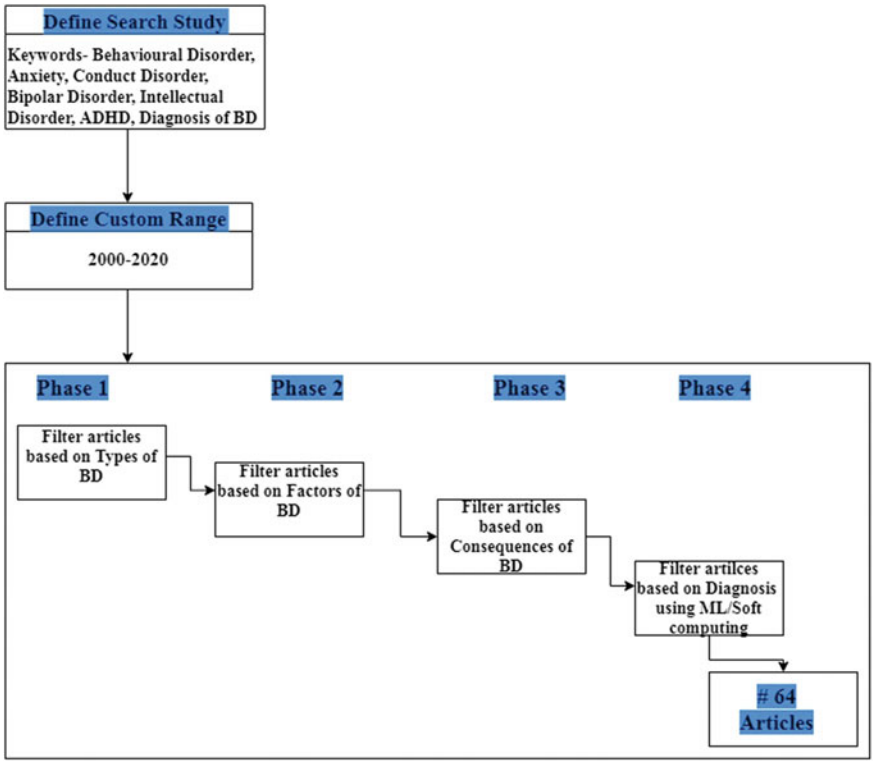

Fig. 2 Research methodology

including questionnaires, interviews with parents and children, and clinical observation. Many researchers have adopted more objective techniques like Magnetic Resonance Imaging (MRI) and Electromyogram (EEG) to identify the subjects with BDs. Within cognitive clinical psychology and psychiatry, ML and SC models can significantly influence diagnosis, prognosis, treatment prediction, and monitoring biomarkers. These techniques can help mathematically model the psychiatric process of clinical decision and not develop a complete expert tool.

ML is the study of computer algorithms that automatically improve through experience and data utilization. These techniques highlight various optimization problems due to fast convergence, high levels of performance, and simplicity [11, 12]. SC is an ensemble of techniques that use inaccuracy and uncertainty tolerance to create tractability, strength, and low-cost solutions. SC techniques often include different types of Deep Learning (DL), Fuzzy Systems (FS), Fuzzy Logic (FL), Evolutionary Computation (EC), Neural Network (NN), Neural Computing (NC), Genetic Algorithm (GA), and Probabilistic Reasoning (PR) [13, 14]. These techniques can be utilized in the medical field to analyze the patient's health history to determine the disorder, develop tools to assist psychiatrists in predicting psychological disorders,

and support patient care [11–16]. The remaining part of this study will emphasize the usage of ML and SC in diagnosing BDs.

3.1 Diagnosis Using ML and SC Techniques

The rest of this section will briefly emphasize the application of ML and SC technologies to resolve ADHD, CD, TD, and anxiety diagnostic issues.

3.1.1 Attention Deficient Hyperactive Disorder (ADHD)

De Silva et al. [17] proposed a decision-making assistance system for ADHD detection utilizing data on eye movement and magnetic resonance imaging. The system achieved a classification accuracy of 82% using eye data and 81% using fMRI data. Beriha [18] proposed a computer-aided diagnosis (CAD) technique to distinguish ADHD children from other children having behavioral disorders like anxiety, depression, and conduct order which achieved an accuracy of 100%. Pemg et al. [19] designed a classification model using the extreme learning machine (ELM) algorithm to find an effective way to diagnose ADHD with an accuracy of 90.18%. Kim et al. [20] found that no objective biological tests were possible to solidly predict the administration of methylphenidate (MPH) in ADHD. The support vector machine method provided 85% classification accuracy for predicting MPH response and paved the way for future work. Delavarian et al. [21] developed a decision-making assistance system that differentiated kids with ADHD with a 96.2% accurate neural network from similar behavioral conditions such as anxiety, depression, disorders, and co-morbid depression.

3.1.2 Conduct Disorder (CD)

Tate et al. [24] developed an ML model to evaluate the wider population for the possibility of conduct disorder, social behavior, hyperactivity/inattention, and peer relationship problems and investigated the performance of the proposed model over standard logistic regression techniques. Zhang et al. [25] explored the classification ability using supervised ML on MRI data to distinguish Conduct disorder from healthy controls. They achieved accuracy in the range of 77.9–80.4%. Zhang et al. [26] developed a model to classify CD subjects with structural MRI using an optimized 3D AlexNet CNN technique. With an accuracy of 0.85, it attained a great classification performance. Tor et al. [27] proposed a model with the help of EEG signals for automatic diagnosis of CD and ADHD using empirical mode decomposition (EMD) and discrete wavelet transform (DWT) method. This model achieved an accuracy of 97.88%.

3.1.3 Anxiety

Chatterjee et al. [28] proposed a method of automated assessment of anxiety disorder based on heart rate and used Bayesian Network with an accuracy of 73.33% to categorize individuals with anxiety disorders. Katsis et al. [29] developed a new system for evaluating activity levels based on physiological signals for patients suffering from anxiety disorders. Neuro-Fuzzy System achieved the highest classification accuracy for this model. Dabek [30] presented a model of neural networks that can estimate the probability of psychiatric ailments such as anxiety, depression, and post-traumatic stress problems, with an accuracy of 82.35%. Zhang et al. [31] used the SVM technique to diagnose social anxiety disorder using resting state fMRI and achieved an accuracy of 76.25%.

3.1.4 Tic Disorder (TD)

Baru et al. [35] presented a CNN model for the classification of motor and vocal tic disorder using wireless channel data and attained an accuracy of more than 97%. Greene et al. [36] used SVM to classify children with tic disorder with 70% accuracy based on MRI data. Yin et al. [37] proposed a fuzzy system to assist radiologists using computer-aided diagnosis. The characteristic-point-based fuzzy inference system (CPFIS) helped the radiologist to increase its accuracy from 87.5 to 91.7%.

4 Results

The existing research validates that different performance metrics have been used to evaluate the performance of the distinct ML and SC techniques. Some key performance indicators are sensitivity, p-value, the area under the curve, and accuracy. ML and SC techniques have been found to play a vital role in the diagnosis of BDs. These techniques not only aid in data analysis but are also very effective in determining the relationship between diagnosis, treatment, and prediction of results. Table 1 represents the performance of different ML and SC techniques in the classification and prediction of BDs.

As per the available data, the predictive rate of accuracy achieved in diagnosing ADHD, CD, Anxiety, and TIC is 84.6% to 100%, 85% to 97.8%, 71.4% to 90.1%, and 70% to 97%, respectively. SVM is found to be the most utilized classifier in the classification of these four BDs. The use of EEG signal and MDTCWT is found to be the best possible combination for better classification and diagnosis of ADHD. KNN methodology is found to perform better than other strategies for CD. Additionally, SVM proves to be a more prominent diagnostic approach for anxiety. Likewise, CNN proves to be more successful in diagnosing Tic disorder.

Table 1 Performance for BDs using different ML and SC techniques (#: not mentioned)

Reference	Behavioral disorder	Classification and prediction techniques	Modality	Accuracy	Sensitivity	p-value	Area under curve
[18]	ADHD	Particle Swarm Optimization tuned Back Propagation Neural Network (PSO-BPNN)	EEG signal features	100%			
[19]	ADHD	Extreme learning machine (ELM) algorithm	3D MR images	90.18		< 0.0001	0.857
[20]	ADHD	SVM	Methylphenidate response	84.6			0.84
[21]	ADHD	Neural network with radial basis function classifier	Rutter's behavioral disorders questionnaire)	96.2	95%		
[22]	ADHD	KNN	EEG signals	96.1			
[23]	ADHD	Modified Dual Tree Complex Wavelet Transform (MDTCWT) method	EEG signals	98.62			
[25]	CD	3D CNN	Structural MRI	85	87%		0.86
[26]	CD	SVM	Structural MRI	80.4	87.5%		0.78
[27]	CD and ADHD	KNN	EEG signals	97.8	96.68%		
[31]	Anxiety	SVM	Resting-state fMRI	76.25	70%	< 0.001	
[32]	Anxiety and Depression	SVM + LR	Sensor signals	80			0.92
[29]	Anxiety	Neuro-fuzzy system	Physiological signals	84.3			
[33]	Anxiety	SVM	Clinical questionnaires	90.1	84.38%	< 0.001	

(continued)

Table 1 (continued)

Reference	Behavioral disorder	Classification and prediction techniques	Modality	Accuracy	Sensitivity	p-value	Area under curve
[34]	Anxiety	Random forest tree	Depression, Anxiety and Stress Scale questionnaire (DASS 21)	71.4	91.9%		
[35]	Tic	CNN	Wireless channel information (WCI)-based image data	97			
[36]	Tic	SVM	fMRI	70			
[37]	Tic	Characteristic-point-based fuzzy inference system (CPFIS)	Tomographic brain imaging	91.7			

4.1 Clinical Decision Support for BDs

Standard statistical tools in the clinical setting like interviews, rating scales, and questionnaires can be deployed to train ML and SC techniques to classify and diagnose BDs. These tools can assist physicians in anticipating proper responses to data in the identification of BDs. A clinical decision support system based on ML and SC techniques is generally convenient and can help increase therapeutic efficacy. These support systems help provide support at community and individual levels, especially in remote areas where primary healthcare workers are only available. Many standard rating scales are available that can help collect data and have been widely used in clinical perception about BDs. Table 2 highlights common rating scales used for assessing various behavioral disorders.

Table 2 The common rating scales used for BDs

Evaluators	Rating Scale	Disorder	Language	Items/Scale
Parent/teacher	Disruptive Behavioral Disorder (DBDS) rating scale [38]	ADHD, CD, ODD	English Georgian	45 items, 4-point scale
Self	The Adult ADHD Self-Report Scale (ASRS-v1.1) Symptom Checklist [39]	ADHD	English, Japanese	18 items, 5-point
Teacher/Parent	Vanderbilt ADHD Diagnostic Teacher Rating Scale [40]	ADHD, ODD, CD, Anxiety	English, Greek, Spanish	35 items, 4-point scale
Teacher/Parent	ADHD-FX [41]	ADHD, Inattention	English	32 items
Self/Teacher/Parent	ADHD Rating Scale IV [42]	ADHD	English, Spanish	18 items, 4-point scale
Parent/Teacher	The SNAP-IV Teacher and Parent Rating Scale [43]	ADHD	English	26 items, 4-point scale
Parent/Self	Weiss Functional Impairment Rating Scale Self-Report (WFIRS-S) [44]	ADHD	English, Chinese, Thai Persian, French Japanese, Turkish	Self—70 items, Parent—50 items, 4-point scale
Parent/Teacher	Conduct Disorder Rating Scale (CDRS) [45]	Conduct	English	40 items, 4-point scale

(continued)

Table 2 (continued)

Evaluators	Rating Scale	Disorder	Language	Items/Scale
Parent/Teacher	Revised behavior problem checklist (RBPC) [46]	Conduct, Socialized Aggression, Attention problem, Anxiety withdrawal, Psychotic behavior, Motor excess	English, Spanish	89 items, 5-point scale
Parent/Teacher	Child Behavior Checklist (CBCL) [47]	Conduct, ODD, ADHD, Somatic, Anxiety, Affective problems	English, Latino Spanish	118 Items, 3-point scale
Self/Parent	The Youth Anxiety Measure for DSM-5 (YAM-5) [48]	Anxiety Disorders and Specific Phobias	English	50 items, 4-point scale
Self	Spence children's anxiety scale [49]	Anxiety	English, German, Chinese, Spanish,	45 items, 4-point scale
Self/Parent	Screen, for Child Anxiety Related Disorders (SCARED) [50]	Anxiety Disorders	English	41 items, 3-point scale
Self	Kutcher generalized social anxiety scale for adolescents (k-gsad-s) [51]	Anxiety Disorders	English, French, Spanish, Urdu	32 ITEMS, 4-point scale

ODD = Oppositional defiant disorder

4.2 Datasets

It has been perceived that different datasets have been mined to classify and diagnose different BDs using ML and SC techniques. The brief details of these standard benchmark datasets have been depicted in Table 3.

No doubt, researchers have started to use distinct ML and SC techniques to diagnose different BDs. However, they have to face the following challenges in designing an effective expert system for the same. Multiple studies, in particular, have developed prediction models using both clinical and non-clinical data, with promising preliminary results. However, to train such models, datasets are required with a large amount of data. These prediction models outperform low-resource datasets for high-resource datasets because their learning is dependent on the amount of training data.

Table 3 Standard Datasets

Disorder	Name	Attributes	Nature of data	Repository
ADHD	EEG database data set [52]	4	Multivariate, Time Series	UCI
	Reddit ADHD dataset [53]	5	Sentiment Analysis	Kaggle
	ADHD-200 dataset [54]		Resting-state fMRI	Kaggle
	EEG data for ADHD/control children [55]	5	EEG visual attention data	IEEE Data Port
	Focus: EEG brain recordings of ADHD and non-ADHD individuals during gameplay [23]		EEG signals	IEEE Data Port
Anxiety	Online Gaming Anxiety Data [56]	55	Textual	Kaggle
	Anxiety and Depression Psychological Therapies [57]	50	Textual	Kaggle
	Dasps database [58]		EEG signals	IEEE Data Port
	UBFC-PHYS [59]		Video recordings, Blood Volume Pulse (BVP), and ElectroDermal Activity (EDA) signals	IEEE Data Port
	Student Social Anxiety Survey [60]	7	Textual	Kaggle
	Manifest Anxiety Scale Responses [61]	50	Textual	Kaggle
	Depression Anxiety Stress Scales Responses [62]	42	Textual	Kaggle

The datasets should be balanced with all the fields adequately filled. However, all the shortlisted papers for this review did not meet the criteria to prove its efficiency on the ML and SC techniques used. A robust model should be noiseless. The training of the ML algorithms can be carried out using various types of data based on interviews, demographics, health records, medical records, treatment history, and rating scales. Diagnoses of BDs typically rely on judgments from psychiatrists and patient self-reporting. For better results, the data needs to be noiseless. There is a real challenge to collecting unbiased and noise-free data for the training of the models.

5 Conclusion

The presence of behavior disorders can significantly affect an individual's physical, mental state and may further induce life-threatening human disorders. The diagnosis and treatment of BDs are challenging as they require an integrated multidisciplinary effort on the part of healthcare providers, families, and individuals. In the last few years, ML and SC methods have drawn significant attention from researchers to aid in the early and precise diagnosis of distinct BDs. The key objective of this work is to accentuate the performance of different ML and SC techniques in the diagnosis of these disorders. The existing literature witnessed that the predictive accuracy achieved in diagnosing ADHD and anxiety is 98% and 90.1% using MDTCWT and SVM, respectively. Likewise, KNN and CNN are found to be the best fit in the diagnosis of CD and Tic disorder with the predictive accuracy of 97.8% and 97%, respectively. It has been found that several researchers have put their effort into designing different diagnostic models for individual BDs. However, no significant attention from the research community has been laid down to develop an integrated and therapeutic model for the diagnosis of multiple human BDs. This study indicates a dire need for an innovative and intelligent decision support system that can be trained using multi-model data fetched from clinical data, signals, questionnaires, neuroimages, sensor data, and medical history. Therefore, there is an opportunity for hybridization of deep learning, ML, and SC techniques for better performance in diagnosing BDs. These methodologies can be used to analyze a patient's data, diagnose the problem, design resources to help doctors predict mental health problems, and enhance the quality of healthcare.

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A Systematic Review on Low-Resolution NILM: Datasets, Algorithms, and Challenges

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Abstract The active large-scale deployment of electrical smart meters throughout the world offers opportunities to analyze smart meter data to generate numerous innovative applications, Non-Intrusive Load Monitoring (NILM) is one such application that goes beyond remote and precise billing. The NILM has been a popular and growing methodology for monitoring the energy profile of a household building and disaggregating overall power consumption into individual appliance usage. The device-level energy consumption information would assist users to understand their device usage behavior and take required actions to reduce energy consumption. This paper systematically reviews the NILM approaches exclusively for low-resolution smart meter data. This review highlighted the low-resolution energy datasets and their feature measurements, the state-of-the-art algorithms explored and developed for low-resolution NILM systems. Furthermore, this study discussed the challenges related to the low-resolution NILM model performance, data scarcity, three-phase data, etc. Finally, the existing research gaps as well as potential research directions in the Indian context are described in detail.

Keywords Energy disaggregation · Low-resolution NILM · Machine learning · Deep learning

1 Introduction

India is the world's third-largest producer and consumer of electricity, as well as the fourth-largest emitter of CO_2 [1]. India's energy sector accounted for 68.7% of greenhouse gas emissions. The residential sector's energy consumption is 24.01% and is increasing year after year [2]. Electric production and consumption are major sources of CO_2 emissions. Rapid urbanization causes high energy demand, ultimately burdened to the limited energy resources, so it is highly essential to manage the energy

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expenses. One of the solutions is monitoring the load behavior and load energy consumption patterns for efficient and effective energy utilization. The problem of effective energy consumption monitoring has attracted a lot of researchers. The prior work reported in [3] divided the load monitoring system into two categories.

1. Intrusive Appliance Load Monitoring (ILM)
2. Non-Intrusive Load Monitoring (NILM)

The ILM technique utilizes a single measurement device connected to each home appliance, leading to increased costs and complexity, however in NILM, only one measuring tool is required to find the individual information about the device [3]. Due to its non-intrusive nature, NILM has a major benefit that it does not require to modify the existing building infrastructure. NILM finds a better solution to disaggregate the total power into the individual device level power consumption. Energy Disaggregation is generally worked on Software as a Service (SaaS) or sensor-based solution to classify fine energy consumption data from whole aggregated data. With the help of customer electricity usage patterns logged by the NILM system, recent electronics companies such as Samsung Electronics, ABB, LG, Apples, and others projected that efficient management of electricity demand saves $6 million. Hence, appliance-centric electricity management and monitoring have equal importance [4].

The concept behind NILM was first introduced by G.W. Hart in 1992, based on steady-state active power feature. Many researchers have been proposed several NILM techniques that are based on Factorial Hidden Markov Model (FHMM), V-I trajectory, Wavelet Transform, Graph Signal Processing, Neural Network, Machine Learning, genetic algorithms [5]–[9], additional methodologies can be found in [10]–[12]. Large availability of energy datasets like REDD, AMPds, etc. many of these are listed in [13] encouraging to the researchers to adopt NILM in various applications like scheduling appliances to reduce peak hour demand [14], smart home energy management including ambient parameters [15], anomaly detection in appliances [16], developing household characteristics [17], non-technical losses reduction[18].

According to the recent development in NILM, a very few review articles on NILM have been published in the last 15 years. Most of the reviews [12, 19, 20] briefly elaborated with specific approaches for appliance classification, supervised/unsupervised learning, event/non-event feature detection/extraction, and performance measure metrics. Furthermore, articles like [21, 22] reviewed different degrees of freedom of NILM technique. However, a complete overview of low-resolution NILM is missing up to now, based on datasets, input features, disaggregation approaches as well as research challenges particularly in machine learning and deep learning area of research. Thus, this paper contributes a complete overview of state-of-the-art NILM techniques based on low-resolution smart meter data. The main contributions of this work in each section are specified as follow:

1. This paper summarizes the existing status of NILM research in Sect. 1.1, providing essential details.
2. Sect. 1.2 illustrates a structured review of data acquisition and low-resolution energy datasets with their specifications and future research directions.

3. This study describes the feature extraction and detection in terms of macroscopic features and it is presented in Sect. 1.3
4. An overview of state-of-the-art algorithms utilized in the low-resolution NILM with machine learning and deep learning approaches is discussed in Sect. 1.4.
5. Finally, this paper summarizes the research gap regarding NILM performance comparison, multiple input features, data scarcity, and three-phase datasets are discussed in Sect. 1.6. Furthermore, this study also points out the future direction of research in Indian context.

We hope our contributions will inspire future researchers and lead to new achievements.

1.1 Smart Meter Rollout and Low-Resolution NILM

India expected to rise in electricity by 79% in next decade, with this energy production enhancement, nation needs to cut down Aggregate Technical and Commercial (AT&C) losses below 10% by the year 2027. To achieve this aim, India forms Advanced Metering Infrastructure (AMI) along with the new range of smart meters. Under Smart Meter National Programme (SMNP), Government of India has been working on to replace 250 millions of conventional meters by new Smart meters [23]. The active large-scale roll-out of electrical smart meters throughout the world offers opportunities to analyze smart meter data to generate numerous innovative applications; one of such applications that go beyond precise and remote billing is Non-Intrusive Load Monitoring (NILM).

It is vital that some usual NILM nomenclature be clarified and how that applies to the data being utilized. Internally, smart electric meters sample voltage and current signals at different frequencies. These frequencies categorize as low- and high-frequency ranges. The raw data can be produced directly, or the averaged value can be calculated and produced such as, the root mean square (RMS) value of voltage and current. For better understanding of smart meter data categorization, we cited low-resolution data as low frequency data.

The high- and low-frequency smart meter data with NILM are discussed briefly in literature [24]. The low-frequency sampling approaches are the ones that utilize information generated at rates below the AC Fundamental frequency (50 Hz in India). However, the high-frequency sampling approach utilizes data generated higher than AC fundamental frequency usually up to few KHz. The benefits of using high frequency data should be pretty evident as this preserves all the signals and allows to extract the greatest amount of information. This is revealed in [25], However, obtaining high-frequency data is costly in terms of both hardware and installation time. On the other hand, the loss of information at low frequencies can be compensated without the need for additional hardware installation. In practice, the resolution of a smart electric meter maintained lower than 1–60 s due to limitations in data storage, data handling, and privacy protection. This leads to motivate researchers to

investigate NILM with low-resolution smart energy meter data with existing building infrastructure. For more information about NILM with high- and low-frequency characteristics, researchers can refer [26].

1.2 Fundamentals of NILM

The primary purpose of NILM is to break down or disaggregate the overall amount of power drawn into its component. The resulting power in a residential building is the total power consumption of each electrical device. Therefore, the goal is to determine how much electricity is consumed by each appliance. The aggregated power of N devices with respective time T is specified in Eq. (1)

$$P(t) = P_{noise}(t) + \sum_{i=1}^{N} P_i(t) t \epsilon \{1, T\} \tag{1}$$

where;

P_i= Power of each appliance.

P_{noise}= power of unwanted signal.

In order to solve the problem of power disaggregation, many different ways have been developed, the most common is to calculate P_i for $i = 1, 2, 3, \ldots, N$, from $P(t)$. According to Eq. (1), variations of power disaggregation expression are described in [24, 27]. When an issue is solved using machine learning, particularly deep learning, it is referred to as a regression problem. Although most publications employ only the active power component, the aggregation signal may also be solved by other information such as apparent power, reactive power, and current.

1.3 NILM Framework

From the recent literature review [13, 15], NILM has the following working stages:

1. Data Acquisition: Electrical signals (current, voltage, Active Power, reactive Power, Harmonic contents) are collected from measuring meter (Smart meter or by using specific Hardware) at the low or high sampling rate.
2. Feature Extractions and Event Detection: Individual appliance has its own load signature or feature pattern that leads to differentiate one appliance from another. The Event is nothing but change in electrical signals with respect to time. This transition includes appliance ON/OFF, operational mode change, and speed variations.

3. Load Classification and Energy estimation: By using features extracted from the above stage, identify which appliance is operated at a given time with power consumption. This stage includes inference and learning of models.

2 Data Acquisition and Low-Resolution Energy Datasets

The very first stage of NILM system is data acquisition or data collection. This stage has a significant role in developing NILM algorithms for a specific application. Data acquisition is associated to electronic measuring devices. Typically, a NILM system is equipped with a voltage and current sensor module that is connected to the main power line. Depending upon the data acquisition framework, the communication devices have the task of transferring measured data over a communication network [4]. Currently, NILM data have been transferred via different wireless communication protocols and stored on the server/cloud. [28].

The market offers a variety of measuring meters with different sample rates [29]. The selection of measuring meters depends on the requirement of application. The data acquisition is discussed here in terms of the sampling rate of the measuring equipment. Sampling frequency in Hz is referred as low, whereas sampling frequency in KHz and above is high. Commercial smart meters are capable of capturing low-frequency energy signals, while high-frequency signals are acquired with special acquisition boards and equipment, high-frequency data are costlier in terms of hardware and software and required more communication bandwidth to transmit the data. [25].

Companies like Neurio Technology [30], Smappee [31], ENTERTALK [32], etc. brought a straightforward solution for data acquisition with plug-in devices. These provide basic functionality of data acquisition with some considerable drawbacks regarding sampling rates, flexibility, and cost [29].

Table 1 lists the NILM energy datasets explicitly for low-frequency sampling rate. From Table 1, datasets such as RAE, I-BLEND collect data from entire domestic buildings, which are referred to as aggregated data, and Traceback, Dataport are such datasets that gather data at both aggregate and appliance levels. On the other hand, just a few datasets from the business sector are available as shown in Table 1. Due to higher energy consumption in commercial sector, the implementation of NILM techniques will save more money than in the residential sector. The survey discovered that the majority of datasets focused on home appliances, with only a few datasets (such as COMBED) contributed to dataset of office appliances. Table 1 depicts the differences in electrical features, to the difference in disaggregation results.

Each dataset has a different recording length, ranging from 1 week to several years. To adopt a universal cost-cutting strategy, researchers can conduct a comparative study of different countries' usage patterns, by recording data in a consistent manner. Comparing and testing NILM algorithms might be difficult due to differences in sample frequency between datasets. From Table 1, it is cleared that a very small

Table 1 Low-resolution datasets with data captured location, data stored duration, different sampling rates, measurements, and published year

Serial number	Dataset	Location	Duration	Number of houses	Sampling rate	Purpose	Year	Measurements
1	REDD	USA	1 month	6	1 Hz (aggregate), 1/3 Hz (appliance)	Residential	2011	I, V, P
2	Tracebace [33]	Germany	1 day	–	1 Hz (appliance)	Residential	2012	P
3	Smart [34]	USA	3 months	3	1 Hz (aggregated and appliance)	Residential	2012	V, P, S, F
4	HES [35]	UK	1 and 12 months	251	2 min and 10 min (aggregated and appliance)	Residential	2012	P
5	Dataport [36]	USA	4 + years	1200 +	1 Hz to 1 min (aggregated and appliance)	Residential, commercial	2013	P, S
6	AMPds [37]	Canada	1 year	1	1 min (aggregated and appliance)	Residential	2013	f, V, pf, I, Q, S, P
7	iAWE [19]	India	73 days	1	1 Hz (aggregate), 1 Hz or 6 s (appliance)	Residential	2013	E, V, pf, I, Q, S, P
8	IHEPCDS	France	4 years	1	1 min (aggregated and appliance)	Residential	2013	I, V, P, Q
9	ACS-Fx	Switzerland	1 h	–	10 s (appliance)	Residential	2013	I, P, Q, pf
10	BERDS	USA	1 year	1	20 s (aggregated and appliance)	Commercial	2013	P, Q, S
11	ECO[38]	Switzerland	8 months	6	1 Hz (aggregated and appliance)	Residential	2014	I, V, P, pf

(continued)

Table 1 (continued)

Serial number	Dataset	Location	Duration	Number of houses	Sampling rate	Purpose	Year	Measurements
12	GREEND [39]	Austria/Italy	1 year	9	1 Hz (aggregated and appliance)	Residential	2014	P
13	RBSA [40]	USA	27 months	101	15 min aggregated	Residential	2014	V, P, Q, S, E
14	COMBED [41]	India	1 month	6	30 s (aggregated and appliance)	University Building	2014	I, P
15	DRED [42]	Holland	6 months	1	1 Hz (aggregated and appliance)	Residential	2015	P
16	REFIT	UK	2 years	20	8 s (aggregated and appliance)	Residential	2015	P
17	OPLD	Singapore	-	-	1 Hz (aggregated and appliance)	Commercial	2016	P, S, I
18	EEUD [43]	Canada	1 year	23	1 min (aggregated)	Residential	2017	P
19	ESHL	Germany	4 years	–	0.5–1 Hz (aggregated)	Lab equipment	2017	I, V, P
20	RAE [44]	Canada	72 days	1	1 Hz (aggregated)	Residential	2018	I, V, P, Q, S
21	ENTERTALK [45]	Korea	29–122 days	22	15 Hz (aggregated and appliance)	Residential	2019	P, Q
22	I-BLEND [46]	India	52 months	7	1 min (aggregated)	Commercial	2019	V, I f, pf, P
23	IDEAL [47]	UK	–	255	1 Hz	Residential	2020	E
24	CU-BEMS[48]	Thailand	18 months	1	1 Hz (appliance)	Commercial	2020	P, E

subset of countries (like UK, USA, Canada, Germany) contributed to energy datasets, thus it is necessary to develop country or region-specific energy datasets.

3 Appliance Feature Detection and Extraction

Individual appliance has its own load signature or feature pattern that leads to differentiate one appliance from another. The load identification in NILM is highly subject to the feature uniqueness of the appliances. So, the feature extraction methods have major role in the NILM system. The feature extraction process involved the extraction of important information from voltage and current signals through the signal processing techniques. The unique features are highly dependent on the sampling frequency of the data; this data rate is nothing but the output by measuring instrument.

The data rate separated into two groups depending upon the sampling rate, these are macroscopic and microscopic, and these are also called as low frequency and high frequency, respectively [49]. This paper reviews the feature extraction of low-frequency data rate, further these are divided into very low, low, and medium, whereas high-frequency data are categorized into high, very high, extremely high ranges. Table 2 shows the respective sampling rates with utilized features.

Most of the features employed power variables with respect to time. These power variables are voltage (V), current (I), active power (P), reactive power (Q), apparent power (S), power factor (PF), phase angle, and total harmonic distortion (THD). Most employed feature is active power and is widely used in [3, 50–54].

3.1 Macroscopic Features

Feature extracted from aggregated low-frequency data (from medium to very low range) is called macrolevel or macroscopic feature [55]. Generally, the macroscopic feature includes real power and reactive power variants. The actual power consumed during operation by an electric appliance is called real energy, However, unused

Table 2 Macroscopic and microscopic data rate

Parameter	Data rate
Very low	Slower than 1 min
Low	1 min to 1 s
Medium	Faster than 1 Hz to fundamental frequency (50 Hz in India)
High	Fundamental frequency to 2 kHz
Very high	2 kHz to 40 kHz
Extremely high	Faster than 40 kHz

power produced by capacitive and inductive components is reactive power, which gives further information to simplify appliance identification process [10].

Initially, the macrolevel features were examined by EPRI and MIT institutes [3, 56]. From these investigations, it is possible to detect the occurrence of an appliance being turned on or off by measuring actual and reactive power in relation to time and the accompanying positive and negative changes. Later, the MIT researchers expanded their work to apply to an industrial building's aggregate load [51]. After filtering out the sudden peaks, their research found that the appliances would have a lengthy transient period and low reactive power. As a result, ref.[11] discovered that employing transitory events as additional signatures can improve appliance detection. From recent studies, it is observed that all high-frequency data is analyzed with event-based feature extraction whereas low-frequency data is analyzed by event as well as non-event-based approach.

Feature detection in low-frequency NILM complicates the disaggregation process due to low sampling; however, the key benefit is that low-frequency data may be easily accessed without the need for any additional hardware. Considering the low sampling rate, appliance feature generation using eigenvector and to match the features during testing time pattern recognition methods has been proposed in [57]. Study [58] disaggregates total domestic electricity usage into five different categories of load. Here, evaluation made between various sparse coding algorithms. Furthermore, accuracy of a Support Vector Machine (SVM) classifier based on features is also suggested but not demonstrated. In [59], authors considered power levels and ON/OFF duration as a feature to identify appliances, both features computed with normal distribution and Weibull distribution, respectively. This work proposed maximum likelihood classifier and subtractive clustering technique, an event-based approach improvised result by exhibiting temporal relations among appliances features. Various feature extraction methods have been projected over the period of time, the related literature can be found in [10, 15].

4 Energy Disaggregation Algorithms

Energy disaggregation finds an effective and efficient solution for extracting appliance-level data from an aggregate data with an appropriate set of algorithms. In order to identify individual load data from aggregated consumption data, various disaggregation algorithms have been developed. The categorization of disaggregation algorithms is based on system learning approach and can be classifies into two major categories, one is supervised and other is unsupervised. Appliances are well labeled in supervised learning whereas unsupervised learning does not require. The energy disaggregation algorithms used in this section are heavily influenced by machine learning and deep learning area in NILM with low-resolution data.

4.1 Preprocessing

Before using the disaggregation algorithms, the raw data are transformed. The following section discusses the pre-processing steps.

(1) Resampling

Since datasets have missing values because of the failure in measurement or transmission equipment, resampling technique is utilized to get sampled data uniformly. In literature [60, 61], the original dataset has been up-sampled to the higher frequency. For on/off classification of appliances like TV, washing machine, and rice cooker, data have been down-sampled to 0.03 Hz from 10 Hz [32]. Furthermore, the study concluded that to avoid performance degradation, the sampling rate for classification task should be at least 1 Hz whereas and for regression task, it should be 3 Hz. The effect of resampling on disaggregation is carried out in numerous studies [32, 62–64].

(2) Normalization

To normalize the data, a variety of approaches have been used, the majority of methods compute the mean over the entire training set in order to normalize the training data. To reduce the statistical sensitivity of the data to outliers, prior to normalization, arcsinh employed to transforms the data [44]. Study [34] carried instance normalization whereas [146] revealed that batch normalization produced better results than instance normalization. The studies [40,147] found that L2 normalization yielded the best results.

4.2 Post-processing

Post-processing is a strategy for addressing the validity of disaggregation results in order to improve NILM further. The article [65] presented an optimization-based strategy to ensure the summing of disaggregated loads is as near to the genuine aggregate consumption as possible. The authors of [66] discover that partial activation of neural networks impacts appliance power. As a result of this, the mean also affects the ground truth. To overcome this, Ref. [66] proposed to use median, which is relatively unaffected. To improve disaggregation results, Ahmed et al. [67] use Generative Adversarial Networks (GANs) technique.

4.3 Machine Learning-Based Approach

1. **Hidden Markov Model (HMM):**

HMM is an example of unsupervised learning model and is widely used for the disaggregation of load having low-frequency data resolution. HMM has been

well discovered in the literature [22]. The Hidden Markov Model is constructed with data preprocessing stage, then it calculates the hidden events and observed events using k-means clustering [54]. Hidden events identify appliance on/off state while the observed events associate with the energy consumption of each load. The transition matrix is used to identify the state transitions of the appliance. The various versions of HMM explored in NILM application are, Factorial HMM (FHMM), Conditional (FHMM), Conditional Factorial Hidden Semi-Markov Model (CFHSMM), Factorial Hidden Semi-Markov Model (FHSMM) [68].

Numerous algorithms have been developed that make use of various kinds of HMMs and have proven outstanding outcomes. The fundamental constraints of classical Markov models, on the other hand, have remained unsolved. Though, the fundamental constraints of classic Markov models remain unaddressed. Though several researches have been conducted employing HMM and its variants, it is observed that as the appliances on the power line increase, the time complexity exponentially increases. A limitation in the ability to classify multi-state appliances is a result of the fact that many Markov models are based on first-order Markov chains [69].

2. **Support Vector Machine (SVM)**

When it comes to machine learning, SVM has been one of the most powerful algorithms. Data extraction and classification based on identified patterns are advantages of this method [9]. To separate the samples, SVM uses either a linear kernel (which uses the features in original feature space) or a non-linear kernel (which uses features in higher-dimensional feature space) [70]. Since the data in this work are from the four CFL lamps in 16 potential electrical network topologies, the author constructed this as a 16-class problem.

In [71], the SVM learns about a specific electrical appliance's features. With good accuracy, the trained network identifies the specified electrical item and calculates the total household power used.

3. **Sparse Viterbi Algorithms**

Reference [72] proposed a novel algorithm that addresses the Viterbi algorithm's efficiency issue. The author demonstrates a strategy created on super-state Hidden Markov Model (SSHMM) with the Viterbi algorithm variation. In SSHMM, a super-state represents the power status of appliances, which can be either on or off. Each combination of appliances has its own super-state, which results in the disaggregation of appliances with complex multi-state power features.

4. **Decision Tree (DT):**

Decision tree-based NILM is a supervised technique with a modest level of complexity that can be trained with a small amount of labeled data. Decision trees are rule-based models that are simple and easy to visualize once they have been constructed. The difference between two successive active power

measurements, referred to as ΔP, used as a training feature [73], furthermore, the system performance improved using active power (P) as additional feature[74].

5. **K-Nearest Neighbor (KNN):**

   Another type of supervised learning is KNN, in order to employ KNN dataset must be a labeled dataset. The value of K is determined based on the validation set, which contains 60% of the labeled data. In article [75], KNN demonstrated on the AMPds2 dataset and shows that KNN has potential to disaggregate appliances like, dishwasher and clothes dryer. The study achieved a classification accuracy of 95% by considering active and reactive power as an input feature, whereas the accuracy degraded to 73% by taking only active power as a feature. Study [73] describes a number of various strategies for pre-processing data in order to reduce the effects of noisy data. The KNN tested on two datasets, namely, REFIT and REDD.

4.4 Deep Learning Based

The majority of NILM systems are based on hand-engineered features taken from the aggregated power stream. Deep learning algorithms have demonstrated their capacity to solve numerous complicated problems in a variety of applications in recent years, including speech recognition, computer vision, and asset status monitoring, among others. Recently, researchers have been investigating deep learning methods such as recurrent neural network (RNN), convolution neural network (CNN), and autoencoder (AE) in the NILM problem to better classify appliances and disaggregate energy [70, 76]–[78]. It has been established that deep neural networks (DNN) can be used as a multi-class classifier for discriminating between different appliances using deep learning techniques [79].

1. **Recurrent Neural Network (RNN):**

   A neural network implementation that permits connections between neurons of the same layer is known as a recurrent neural network. Sequential data such as the readings of power usage in NILM are ideally suited for RNNs [78]. Article [80] proposed RNN in NILM to disaggregate the appliances. Author compares Combinatorial Optimization (CO). The results show that CO lags behind RNN in those cases, while RNN may operate well in unknown cases. However, significant progress must be made in order to improve the RNN performance for multi-state appliances in the near future.

2. **Convolution Neural Network (CNN):**

   For machine vision, image processing, and natural language processing, CNN has proven to be a very successful modeling system. Motivated by recent advancements of CNN, ref.[76] used the model to disaggregate appliances from total household data. When it comes to training the model, CNN has a significant advantage over other methods because it does not require hand-crafted features.

A supervised (CNN)-based approach was adopted in [81], which is trained on small subset of aggregated data. To enhance the disaggregation performance of CNN, author considered time of the day as an additional feature.

3. **Long short-term memory (LSTM):**

   LSTMs have been successfully applied to a number of sequence applications, such as automatic speech recognition and machine translation. To overcome vanishing gradient issue rises in RNN, ref.[76] adopted LSTM architecture, which employs a 'memory cell' with all gated input, output, and feedback loops. Multiple feature with four-layered bidirectional LSTM is adopted in [60]. The performance evaluation in this work showed that the MFS-LSTM method is more computationally efficient, scalable, and accurate in a noisy environment, as well as generalized to unforeseen loads, when compared to standard algorithms.

5 Performance Metrics

The efficacy of NILM algorithms is based on the outcome of the performance evaluation metrics. Numerous assessment metrics have been employed to assess the performance of event detection/classification and energy estimation, as well as to compare the findings. For the NILM system, first performance evaluation performed by G. W. Hart [3], in which a fraction of correct event identifications and a fraction of total energy consumed employed. The effectiveness of energy disaggregation is assessed by calculating the difference between the estimated and actual consumed energy. For low resolution energy disaggregation systems, many metrics related to estimated error, such as standard deviation of error (SDE), root mean square error (RMSE), average error (AE), energy error, and R-squared are commonly employed in [27]. As the details of performance measurements are outside the scope of this article, they can be found in [26] with mathematical expressions.

6 Discussion and Challenges

6.1 Performance Comparison

The NILM algorithm's performance is evaluated in a variety of ways. In the studied literature, MAE and F-score were the most commonly used metrics to measure predicted energy use and appliance on/off condition for low-resolution NILM. The results have been acquired by a variety of algorithms that are completely distinct. The following are the opinions associated with model performance comparisons:

- Approaches that are published should provide a set of standard metrics, set of assumptions and set of constraints.

- For model cross-validation, there should be a standardized evolution procedure for defining training and testing conditions.
- Authors should make their code publicly available; this will simplify the retraining of models for comparison with new ways.
- Trained models may be published too, as the computer vision community does in [82]. Only trained models from [83] have been made publicly available.

6.2 Multiple Features

Numerous authors made advantage of a variety of different input features. The literature [60, 84] present the findings of a comparison of multiple input features. The research article [85] specifically makes use of reactive power (Q). According to the authors, Q has been found to have an impact on the F1-score in both the AMPds and the UK-DALE datasets. They discover approximately 12.5%, a significant improvement in the seen evaluation situation. Furthermore, an improvement of approximately 8% in the unseen evaluation scenario across all of the investigated appliances.

The observed improvement is minor or negative for pure resistive loads, such as a kettle or an electric oven, which is unusual. Therefore, hypothesize made in such instances, reactive power does not give any information, but rather is only background noise. The features such as P, Q, I, S versus P, using distinct performance metrics, such as mean absolute error (MAE), normalized root mean square error (NRMSE) and the root mean square error (RMSE), examined in [86]. The benefits with the extra features are substantially larger in this work: roughly 40%–50% for all measures. Depending on the outcomes, conclusion made those additional features other than P can help disaggregation better. No judgments can be drawn about the amount of improvement due to the wide range of outcomes. It may be worthwhile to investigate what aspects, e.g., architectures, can best utilize information from attributes other than P.

Except for [85], all outcomes are from observed evaluation scenarios. This implies extra features help to estimate an appliance's power usage. The amount of accuracy they can provide to disaggregate type of appliance (Type I, II, III for details refer [12]) is unknown. It would be fascinating to look into a bigger feature set.

6.3 Data Scarcity

The biggest difficulty with applying NILM is the scarcity of labeled data. It is possible to adapt semi-supervised deep learning to low-frequency NILM, overcoming the data scarcity problem in practical applications.

In the Netherlands, Net2Grid is a company that assists power utilities with NILM compliance and management. In a demonstration, they emphasized the fact that high-quality data are needed for greater accuracy of NILM system [87]. They further

pointed out that appliance with different program or different settings has different load patterns, therefore necessitating numerous observed cycles. The authors of [32] analyze low-frequency NILM approach with the implementation of deep neural network (DNN), in which disaggregation error depends on different households utilized for training. They investigate that disaggregation error falls continuously in proportion to the number of houses added to the training dataset till 40 houses. Therefore, both literatures show that complicated machines require a high diversity of training data to generalize fresh data successfully. Both studies conclude that sophisticated machines require a high degree of diversity in their training data in order to successfully generalize to previously unseen information. This finding is, at the fundamental level, known as 'data scarcity'.

6.4 Data from Three-Phase Appliances

The European countries like Switzerland, three-phase power supply arrives at main distribution board then it separates into single phases. However, multi-phase electric appliances like pool pumps, electrical storage heaters, heat pumps, and electric vehicles charging stations provide a significant challenge to energy conservation measures. In order to disaggregate information from all three phases, it is necessary to use the NILM algorithm. Datasets that contributed three-phase appliance data are: ECO[38] and iAWE [19]. NILM algorithm is required for these three-phase appliances in order to disaggregate information from all three stages. One of the most difficult challenges to overcome when developing a method that should work in every household is the fact that multi-phase equipment can be connected in any number of different ways. In order to be invariant to these permutations, the outcome of the low-frequency NILM technique must be consistent.

6.5 Prospect of NILM

Taking future speculation, one can imagine a variety of scenarios and possibilities for the NILM industry. Considering rapid growth of the Internet of Things (IOT), in the future, appliances may be programmed to be conscious of their own energy usage and able to communicate information to the outside world through their own communication interface. In order to have this, it is necessary to create a business case for appliance manufacturers and provide the groundwork for interfaces and protocols. The exponential growth in computing power of edge devices (gateway devices) will soon enable NILM close to the meter without transmitting data to a cloud service. In this circumstance, NILM algorithms can learn and improve on local data. In order to be success in NILM, the learning problem must first be phrased in such a way that the data from the meter may be used to create future improvements.

6.6 Indian Outlook Toward NILM

We are seeing changes in power generation, regulatory measures, and consumption patterns in India's power sector, which is undergoing rapid transformation. This environment allows Discoms (Distribution Company) to transition from being just an electricity supplier to being an energy service provider by lowering costs, engaging with customers to help them save energy, and improving the overall customer experience. The country's smart metering initiatives are perfectly timed to facilitate this transition. Discoms should look beyond metering, billing, and collection efficiencies to get the most out of their smart meter investments with utilizing NILM technology.

Utility companies can use granular data on household electricity usage to assess and design appropriate mechanisms to manage rising demand at the consumer level. Many households have insufficient information about their electricity usage because they tend to over- or under-estimate their appliance usage. Discoms could encourage consumers to use electricity carefully by providing daily or weekly information about their usage, as well as assist them in making the best appliance purchase decisions. For example, discoms could provide individualized advice to households about the potential savings from switching to a more efficient air conditioner. Routine feedback to consumers on their own consumption via their electricity bills or via mobile communication could also help to reduce consumption.

6.7 Conclusion

To summarize, this paper gives an overview of the literature on NILM with low-resolution smart meter data. NILM is being investigated because it has the potential to benefit a wide range of applications. This is coupled with the realization that low-resolution data will almost probably become readily accessible on a large scale in the near future. This study involved articles that use machine learning and deep learning approaches to separate appliances from aggregated low-frequency data. The study reviewed many degrees of flexibility offered by these approaches. The fundamental study of energy disaggregation is presented and is followed by lists of low-resolution datasets, shown in Table 1, which provides details of datasets in terms of location, recorded data at aggregated level as well as appliance level, duration of recorded data, number of houses, measurement parameters, etc.

Numerous difficulties were identified, related to data scarcity, model performance comparison, outlook toward NILM in Indian context, three-phase energy datasets for NILM and many more, these opinions are resulting in valuable conclusions and recommendations for future studies. Comparing multiple NILM systems is still time-consuming, although there are fresh methodologies and mathematical tools that have not yet been implemented. Although it is still missing in the current literature, this contribution may prove useful.

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A Pragmatic Study on Management with Autocratic Approach and Consequential Impact on Profitability of the Organization

Vikas Sharma

Abstract This paper analyzes the impact of the tyrannical approach in the management functions and its impact on the growth of the organization and employees. The autocratic approach is not only negative for the health of the organization but its impact is catastrophic in the absolute sense. For every organization three "M", i.e., Management/ Machines/ Manpower are extremely important around which the progress of the organization revolves. It should always be the priority of the management to maintain harmonious relations with the employees to get the maximum and qualitative output from the machine. Hence, it becomes imperative to researchers to conduct a thorough survey in some of the organizations to study the reasons for their poor performance. Moreover, it is also essential to ascertain the management approach toward establishing a conducive and congenial environment among their workforce. Several rounds of personal interview sessions were conducted with the officials of the selective organizations who had suffered immensely due to the tyrannical way of handling of the management. Results show that the concept of negative leadership is associated with some basic adverse behavioral categories which include despondency, indiscipline, de-motivation, slackness, lack of trust and confidence, work honesty, etc. Tyrannical leadership causally damages the environment of the organization. The main characteristics of tyrannical management include negative feelings and attitudes among the employees. This study also reveals the circumstances in which the management becomes a tyrant and its aftermath effects.

Keywords Autocratic · Management · Catastrophic · Organization

1 Introduction

The key purposes of every organization are to generate profits for future growth, and the profits depend on two undisputable variables. One and the foremost factor is to have a satisfied and competent employee base without which nothing is possible in any organization. Second is the satisfied customers' base which of course depends

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upon the quality and price of the products. It has been a recognized attribute as an emergent attribute (appertain to births, such as height, brainpower, alluring, and self-confidence) and effectiveness traits as the fundamental component of administration itself born with certain attribute such as faith, brainpower, visionary, and willpower has the qualities becoming a leader but there is an only influence on the difference between leaders and followers during the study.

No one can even dream that without the efforts and perseverance of satisfied employees, a satisfied customer base can ever be created in the market. It is only the team of satisfied employees in any organization which ultimately creates satisfied customers by way of producing quality products at competitive rates and keep their customers satisfied by way effective deliveries of the produced goods to them in time. This one is the only established tool for generating profits in the organization.

The purpose of writing this paper is to highlight some of the salient features which adversely affect the growth of the organization due to the tyrannical behavior of the top management. Human resources and human values are the most important factors in the success of the organization which is directly linked with the prosperity of the employees. However, in some of the cases, the management with some parochial approach refuses to accept the importance of its employees and leads the organization in such a manner that is much on the autocratic model. Even the employees also succumb to the pressure because of many reasons and family constraints hence force them to continue to work in the suppressed environment without many choices available to them. Moreover, the management, on the one hand, continues to run the organization with high-headedness ignoring the basic interests of the employees same as, on the other hand, the workers too become indifferent and redundant for the growth of the organization and continue to work with no major contribution.

Quite often than not, it is seen that the management becomes a tyrant and abusive due to the helplessness of their employees who cannot afford to leave the organization because of various family constraints despite inhuman conditions. Moreover, the management too starts exploiting their employees and behave in such an autocratic way which brings more dissatisfaction and frustration among the employees. Nevertheless, it is also seen that even the good work done by the management for the welfare of the employees yields not many positive results as employees are always suspicious and skeptical of the intention of the top management. Employee's confidence level remains shattered and every policy no matter how good it may be, for the benefit of the employees is seen with doubts in the absence of mutual trust and confidence.

It is also true that the organizations fail not because of the scarcity of raw material and other resources, but rather the inhumane attitudinal behavior of the management.

These conditions arise mainly due to the following practices of governance in the organizations:

- An unconditional ruler rules without restrictions.
- An unconditional ruler exercises power in a harsh/cruel and unethical manner.
- An unconditional ruler takes the decision on whims in a highly irrational manner.

The study proves that such autocratic persons are in themselves a very fearful person engulfed with the feeling of insecurity with the highest level of negativity. Such persons need to remind themselves time and again that they are the boss and exercise their authority in such a way that it becomes harmful for the organization and to themselves as well.

2 Review of Literature

- Mohammad Younes Amini, Shakila Mulavizada, and Homauon Nikzad (2019) discussed. That employees are the most important and effective asset for achieving the goal of the organization. The organizational capital efficiently and effectively enhances the employee's tendency. Organization which utilizes this asset (employees) management style is considered to be the effective determinant to increase employee dedications. To need effective management and teamwork to enhance decision-making.
- Management skills and career enhancement influence more the selection of CEOs and career basis in family friends than by the nepotism in context of family and friends that suggest the quality of a leadership-as discussed by Salvato et al. (2012).
- Tsaiet al. (2009) concluded the negative relationship between the level and the CEO annual turnover. The family CEOs establishing themselves in their family firm assigned by the level and CEO annual turnover.
- Kesner and Sebora (1994) explored the impact of CEO succession on the fate of organizations. The literature has not slowed down; in fact, after 10 years more emphasis is being given to the antecedents, alien, and the CEO succession.
- Weak relationships between employees at different organizational levels and senior management were the most common cause of stress and burnout, lowering construction workers' job satisfaction (Janssen and Bakker 2002). The construction (manufacturing) industry necessitates a high level of work. Poon, Rowlinson, Koh, and Deng (2013–14) argued that work load, tight budgets, and ambitious deadlines are major sources of stress, whereas Ibem, Anosike et al. (2012) argued that work load, tight budgets, and ambitious deadlines are major sources of stress. Chen and Ye (2011) discovered that individuals with senior job burnout have low organizational commitment and low job satisfaction.

3 Problem Statement

The Company Manager has failed to achieve his target of profitability for the organizations. The latest survey conducted by CCL (Center for Creative Leadership) revealed that almost 50% of senior managers in the profitable planning for the industry fail to achieve the target. Some issues that arise in the workplace Senior

employees in huge firms have the manager's function with minimal risk, but they nevertheless fail to perform well and produce poor results in the workplace.

4 Research Methodology

Research Type: Exploratory Research followed by Descriptive Research.
Sample Type: Conventional Random Sampling
Sample Size: 46 respondents from manufacturing industries of Bikaner Rajasthan.

The present study is a work under qualitative research, and for this research we have collected both types of data, primary and secondary. Primary data has been collected with the help of questionnaire and personal interviews on the basis of convenient sampling. Secondary data has been collected from articles published in various magazines, journals, and newspapers along with the websites.

In order to collect the primary data, 100 persons of different manufacturing organizations were interviewed through a well-structured questionnaire on a five parameters and analysis by the Likert scale and attitude of the respondents. However, to arrive at the nearest results, parametric tests such as t-test and factor analysis have been applied to justify the findings of the research. Out of the total 46 respondents, it is found that only 46 respondents answered in a much relevant way and hence the results are based on the above population of 46 respondents.

5 Data Collection Instruments

To follow the Likert scale method for the study and used for amplitude balance of contrary forces and give the responses to the survey's main question for the conceptual study, Likert's management style tool was used.

6 Data Collection Technique

Participants can obtain more responses on the basis of qualitative research whenever asking the open-ended question on research objectives. The research benefits deeper insight into distinct responses by questionnaires as relevant and understanding the soundness of each response.

7 Hypothesis

The hypothesis follows:

H0: There is an important relationship between the management approach and employees working culture satisfaction.

H1: There is an important relationship between the management approach and the impact on profitability of the organization.

8 Purpose of the Study

The main objectives of the research are as follows:

1. To study the attitude of the employees working in the tyrannical environment.
2. To study the impact of tyrannical management on the growth of the organization.

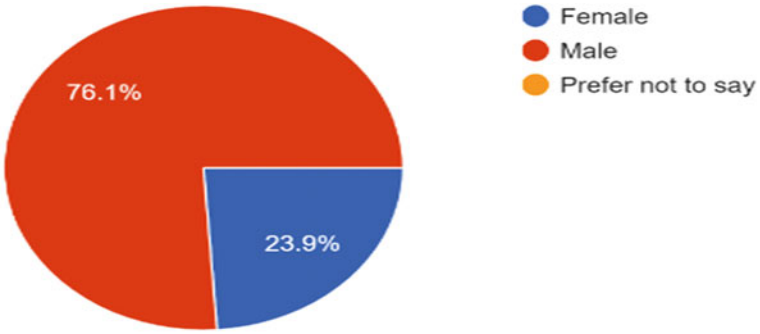
9 The Study's Importance and Scope

The study only looked at how participative managers, higher authority, and leadership styles influenced employee and worker performance, which includes carrying out defined responsibilities, meeting deadlines, and being effective and efficient in doing work and achieving organizational goals. The data set is from the most recent decade, 2019–2020.

The policy of the organization has been clear for all employees. Basically, the autocratic management approach does not take any other way, contrary opinions into consideration, which makes the vision of the organization simpler. Employees who go against company policies often do not stay with the organization for long.

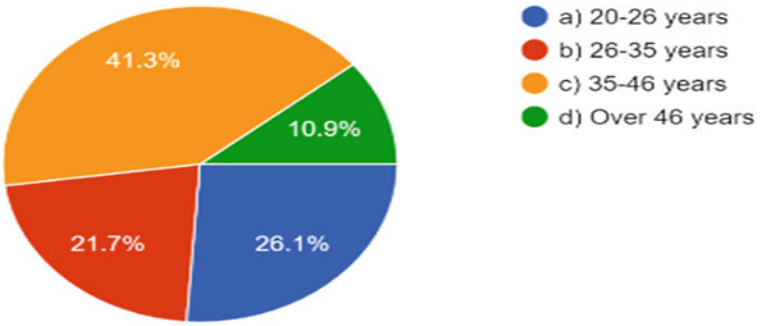
10 Data Analysis and Interpretations

The process and procedures are included in qualitative data in which data collected from respondents are explanation, analysis, understanding, and interpretation of the participants and their situations and followed by data analysis process, the employee's experience with the occurrence of organizational profitability is in the result section. During the study analysis, the qualitative study must describe only the experience of the employees (participants) with the circumstance to prevent the effect of the personal bias.



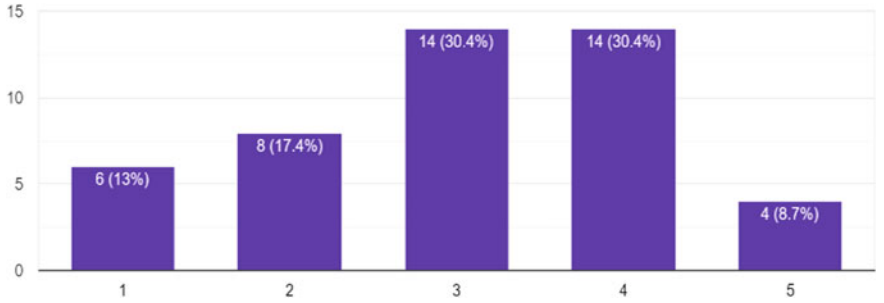
Demographic factor—gender

Pie chart of gender in Fig. shows the percentage distribution of the respondents according to gender: 23.9% of respondents were female and 76.1% were male. The following Figs. are :



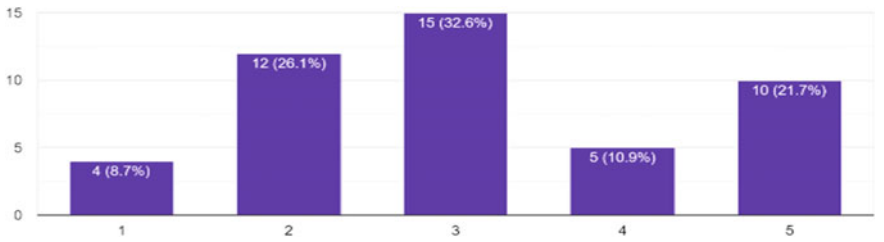
Demographic factor—age

The respondent is divided into four age groups: 20 to 26 years, 26 to 35 years, 35 to 46 years, and 46 years and above. People in the 35 to 46 age group make up the largest group, at 41.3 percent of the total respondents. The 20 to 26 group and 26 to 35 group make following, with 26.1 percent and 21.7 percent of the respondents, respectively. Over 46-year-olds make up 10.9 percent of the respondents. Those aged 46 years and above hold the smallest share of the respondents, at 10.9.2 percent.



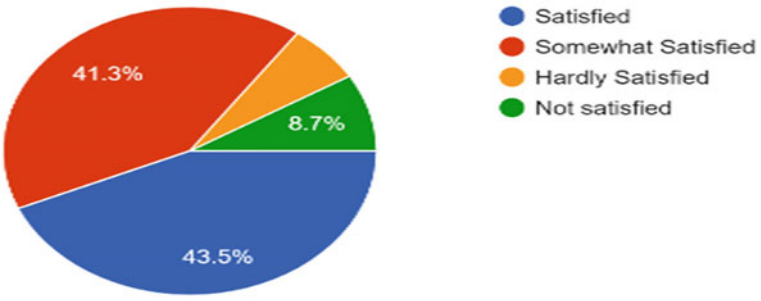
Work schedule allows to spend time with family and friends

A column chart is used to show a time spent with family and friends during working schedule comparison among different people or it can show a comparison of spending time with family and friends on scale third and fourth 30.4 percent and 30.4 percent, respectively, out of total 46 respondents.



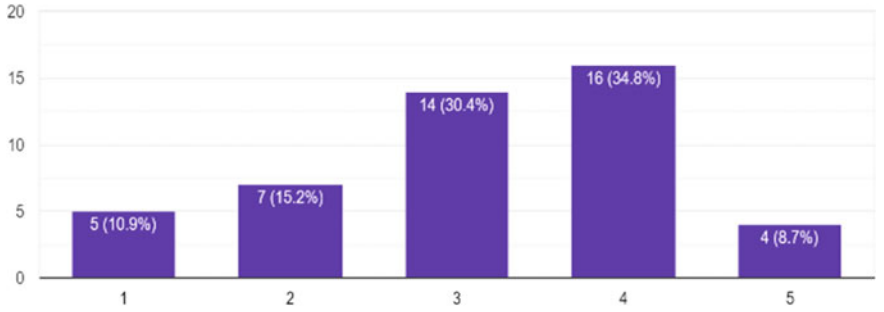
Recognition of work

The height of each column is proportional to the percentage (26.1 and 32.6) of people who know hard work and success in work.



Level of satisfaction with work–life balance

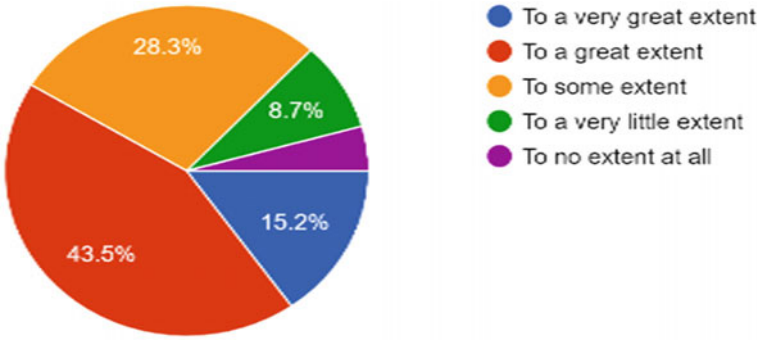
The pie chart shows the satisfaction level of the employee When it comes to the **work environment**, over 43.5 percent of the respondents are satisfied or 41.3 percent somewhat satisfied with their jobs.



Level of satisfaction with compensation benefits

The column chart shows the 34.8 percent satisfied and 30.4 percent natural with the current compensation and benefits offered by the company.

The gauge our respondents' understanding of business to covered the 43.5 Present to a great extent and 28.3 present to some extent very shot part that covers to a very great extent but we can say that state clearly the objectives of the team.



Communication through manager

11 Findings

The study confirmed that the tyrannical style of working by the management irrespectively becomes responsible for the adverse growth of the organization. Hereunder are the few findings which researcher has observed during the course of the research work. The researcher has found out that leadership plays important role to determine the fate of the organization. In particular, it is only the leaders who shape the culture of the organization and become role model through their behavior among employees and develop inter- and intra-personal relationships between themselves and their

followers. However, the tyrannical style of management de-motivates employees with low spiritual intelligence.

This paper examines the leader's destructive behavior and its impact on work place. Some of the major findings are as follows:

1. Tyrant leaders get consensus of their employees on every task more through intimidation and fear than group thinking.
2. Employees go along despite their own doubts which leads to "pluralistic ignorance", in which subordinates are unaware that others are concerned about a decision.
3. Employees who work for tyrannical managers are less likely to question his or her ideas. As a result, workplace tyranny is more likely to foster group thinking, which leads to necessary decision-making.
4. Tyrant leaders act one way toward subordinates which gives destructive effect over the long term in the organization.
5. It is also found out that under the tyrannical leadership, it is difficult for a subordinate to resist or attempt to mitigate the harmful effects of tyranny, which ultimately leads to employee complacency.
6. It is definite that under the tyrannical leadership, the employees always work in fear and dismay and put all strains to open their opinion for the betterment of the organization.
7. The employees foresee their career prospect with the negative growth and do not contribute much as they think that their opinion would not carry any weight in the eye of the management.
8. It was also observed that the organization leadership becomes tyrant in the event when they realize that the employees were not in a position to change due to their personal constraints.
9. Employees also realize that their future are not secure and bright yet they work without much contribution.
10. According to the study findings, the annoyance caused by a small (heart-touching) tyrant is most severe for workers with the best future prospects.

12 Conclusion

It is a fact the tyranny in some form exist in all the organization. Managers often use their authorities much or little oppressively, capriciously, and vindictively which lead to antecedent consequences. The situation becomes grimmer when management starts taking the benefit of the situation knowingly fully well that in all situation employees are going to remain in the organization and in no way can afford to resign or leave the organization due to some personal or family constraints.

The high-headedness of the management in the organization can send the organization in the wrong direction. Normally employees lost the mutual trust in the management and even do not hesitate to express their feelings in the market. With

the results suppliers and customers get susceptible and start developing some alternate source to fulfill their needs. The growth starts showing negative indication by way of losing customer base and suppliers' confidence. Management starts putting the blame on the employees for ignoring the systems and directions which leads to more serious ramifications. Nevertheless, if we do the psychology analysis of this tyrannical attitude of the management, we will find a tendency of psycho fear in the mind of the top management officials with a very high degree of complex which compels to show off the authority at every occasion and get the employees and subordinates convinced forcefully of their viewpoints.

Therefore, it is always advisable to all employees to be mentally prepared to face the tough time in the organization. It is a fact that without the satisfaction of the employees the organization can tread to only destruction which is imminent and has to come one day. Therefore, it is better for the employees to take appropriate steps to face this situation and the dooms day is not very far off.

The growth of any organization is largely dependent on its employees, and an employee would require excellent interactive communication to combat the consequences of small autocracy. To take on an autocracy, an employee would also need a high level of self-assurance and dedication.

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Demystifying Effective E-learning Through Gamification

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Abstract E-learning through gamification is the commonly used education system, which is supported by Information Technology. The study emphasised on the factors affecting e-learning through gamification. The study further elaborates the outcomes of the e-learning through gamification. Due to extensive use of gamification, it becomes imperative to study and understand different aspects of it to bring in innovation into it. Secondary data has been put to use in this study to create a model of gamification. Also, essential elements and results which are based on effective learning model for gamification are analysed. By using the following elements in e-learning during gamification goal orientation, achievement, competition, reinforcement and fun orientation the following outcomes have been derived as follows: motivation, satisfaction, engagement, effectiveness, efficiency, experience and knowledge acquisition.

Keywords E-learning · Gamification · Effectiveness · Student satisfaction

1 Introduction

E-learning is the commonly used education system, which is supported by Information Technology. To deliver information for training and education telecommunication technology is used by e-learning [1]. E-learning is offered as an integral part of the student learning experience in higher education. It is currently widely used by campus-based colleges as well as universities that provide distance education to students [2]. Using e-learning as a tool various educational institutes and universities are explored to achieve goals like motivation and satisfaction, and effects such as high efficiency of students and effectiveness. The absence of technical knowledge and understanding of developing e-learning content is one of the biggest impediments in development of e-learning tools. Disruptions like the one brought forward

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by COVID-19 have shown how innovative use of available technologies can help overcome understanding and technological hurdles. COVID-19-driven lockdowns have driven world to use e-platforms for teaching students not only in the higher classes but also in primary to secondary classes. Making the study material available in cloud storage, sharing pre-recorded lectures through YouTube and WhatsApp has made e-learning almost as productive, motivating, and efficient as classroom teaching.

Ability of educational games help students not only to gain knowledge but also to help students learn skills like effective communication, problem-solving, and collaborative approach. It has made it a very promising tool in learning process. Such games, without rewards, help in learning just by enticing inherent desires of win and enjoyment, and thus it leads to better engagement [3]. A game which brings high level of engagement and requires following given instructions is not only difficult to develop and takes lot of effort and time, and it also comes with a drawback that it can focus only on one objective which is chosen by the designer. Additionally, such games require specific pedagogy and infrastructure in classroom which might not be possible at all levels and places. Contrastingly, concept of gamification uses simple approach of game thinking to integrate game design in already being used pedagogy. This improves student engagements and also motivation to learn and teach.

Gamification has been defined by [4] as use of elements of game design in a context which can be called non-game, this is rapidly growing though its fairly new. Gamification as a concept is quite different from educational games and other serious games. Serious games refer to designing games for pure entertainment, whereas only game elements are employed in gamified applications. Gamification as a term was coined somewhere in 2008 when its first documented use can be seen, but it gained some steam in 2010 [4]. Having said so, the concept is not as recent as the term itself. Badges and ranks have been in place since long and they certainly have game elements built in them. Similarly, non-monetary incentives also incorporate game elements.

2 Review of Literature

There is a constant increase in the number of studies with regard to gamification in different directions. The topic has a great potential and is in its developing stage. As a result, many scholars are working on this topic. To control and get the benefit of this technology, concerted efforts are required to harness the literature and active knowledge for fruitful use [5]. While effort have been put to extract the literature on gamification, past studies have been very resolute in their capacity. Further it supports the platform for further research.

Gamification enhances the pleasure and engagement of education without affecting its credibility. Gamification encourages learners to study by providing positive feedback, and as a result, they are pushed forward and become more engaged and motivated to learn. Gamification can be a strong motivator for kids to study as well

as read more [6]. Role of instructor is also very crucial, they must help and accommodate the student's by involving them in learning process, encouraged to become more involved, and they were provided some feedback [7]. Gamification's integration into the field of e-learning in higher education involves e-learning management systems. In e-learning, the model comprises crucial features. The elements indicated in the model are mostly responsible for e-learning errors. E-learning should be built in accordance with current technology. The primary stages of development are analysis, planning, development, implementation and assessment. The user experience is critical at all stages of e-learning development of online applications, which should contain gamification components [8]. The e-learning system not only provides for high-quality training, but it also allows for statistical analysis of various factors included in log files in order to evaluate the success of technological and pedagogical instruments. The popularity of the application among users, as well as the increase in the number of users, serves as indicators of the system's motivating features and tools [9].

Gamification can be used in different fields. It can be used to advertise a business and its product, in political aspect and many more. For example, nowadays, the companies are promoting gamification in selling their products and services. Further it is also used in promoting well-being of the employees by associating with third-party vendors. By applying the solution to the real-world problems, gamification is gaining more momentum in today's world. With advent in technology, it is growing day by day [10]. Number of factors are responsible for student satisfaction in e-learning environment. Many authors suggest that there are six primary aspects that influence satisfaction: course, student, technology, system design, teachers and external influences [11–13]. Various authors have written about e-learning in students' experience and higher education [14, 15]. Not much information is available about the reason behind why some users discontinued online learning after their first experience [1]. There are numerous reasons for learners' lack of effectiveness, motivation, efficiency, and pleasure in e-learning. Few of them are ignoring the primary stages (analysis, planning, development, implementation and evaluation) of development of e-learning, imperfectly managed projects, use of unsuitable motivational techniques, unsuitable selection of personnel, wrong collection of demographic data of students, inappropriate graphical interface and erroneous implementation of e-learning in form of technological and technical implementation. With the help of gamification effectiveness, engagement, efficiency and motivation can be enhanced in e-learning. Gamification applies the game dynamics and mechanics of video games in non-gaming applications (Fig. 1).

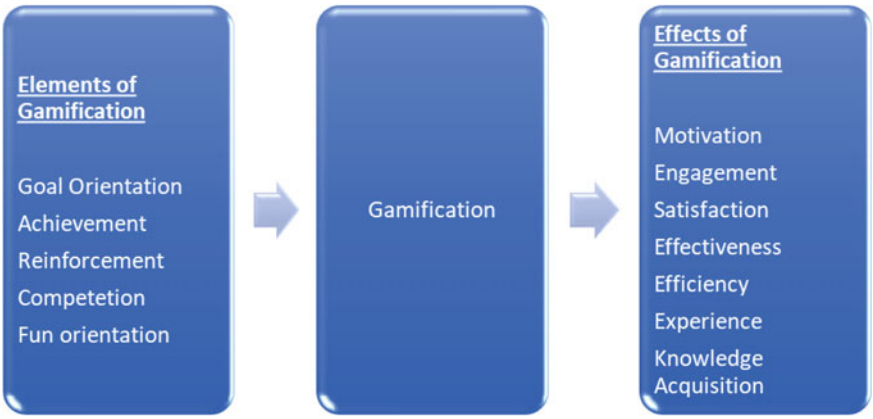

Fig. 1 Conceptual model

3 Objectives

The study emphasised on the factors affecting e-learning through gamification. The study further elaborates on the outcomes of the e-learning through gamification.

4 Research Methodology

In the wake of extensive use of gamification, it becomes imperative that we study and understand different aspects of it to bring innovation into it. Secondary data has been put to use in this study to create a model of gamification. Also, essential elements and results which are based on effective learning model for gamification will be analysed.

5 Data Analysis and Interpretation

5.1 Elements of Gamification

Following five elements can be identified on the basis of literature review:

(i) Goal orientation.
(ii) Achievement.
(iii) Reinforcement.
(iv) Competition.
(v) Fun orientation.

Goal Orientation: The structuring of games in such a way that they have multiple levels of goals is extremely important [16]. Completion of various short-term goals leads to completion of a mid-term goal, completion of a set of such mid-term goals leads to completion of long-term goal, and in turn the final objective. Short-term goals can be further divided into various tasks. With progress along the short-term to long-term goals through mid-term goals, the challenges become bolder. Calibrating the difficulty of goal to be achieved with the skill set of player ensures engagement of player is sustained [17–19]. The layers or levels thus facilitate systematic progress of a learner from beginner to an expert, demonstrating his skills and also knowledge. One important factor influencing motivation and engagement of a learner is clearly defined goals.

Achievement: Accomplishment and achievement are the terms which are used fungible. The sense of gratification increases as the players are recognised for their achievement, which helps in increasing their engagement and motivation. Therefore, to improve learner's achievement and engagement, the concept of recognition of achievement is applied in educational games. Ranks, badges, awards and stars are given as rewards to the learners for their achievements.

Reinforcement: Behavioural learning models show that learning can be enhanced by verbal praises or intangible rewards [20]. Therefore, to reinforce and to create a strong feedback structure the games have incorporated in them reward system based on players performance. To boost positive reinforcement in educational games, virtual currency or points are offered to the learners, to promote learning from games. Whereas negative reinforcement or feedback helps the players with required knowledge or skills to achieve their goals quickly.

Competition: Not only competition forms a bedrock of any game but is also basic expectation from it. As per [21, 22], motivation in a game is drawn from inbuilt rewards of game and competition. When game is used in educational perspective, competition has a vital role to be played in learning by improving focus and enhancing engagement. The players develop a sense of control when the rules are unambiguous and are enforced in strict manner [23]. This also helps in higher engagement among players [24]. The flexibility to create some rules within larger framework furthers the cause of higher engagement and improves motivational levels, and this also encourages discovery in learning process, discovery is integral part of active learning.

Fun Orientation: Understanding well and thus absorbing even better goes hand in hand with fun one has during learning process [24]. It has been observed, people deeply engaged in fun-filled learning usually are less conscious about time [24, 25]. For almost all, with exception being a negligible number, games have fun as integral part. Similarly, for any educational game to achieve its objectives of engaging and motivating learners, fun has to be built in as an essential component.

Outcomes of Gamification

E-learning coupled with gamification is targeted and designed towards generating highest possible levels of efficiency, satisfaction, effectiveness and motivation. Such models are based on modern concepts and leanings of old school education and more modern e-learning. Learning becomes more effective when the learner has

opportunity to participate actively in learning process, is experiential, has effective feedback system and has practical implications [26]. In 2011, a theoretical analysis on gamification being used as effective tool for learning through effective engagement in e-learning was made by [6].

It appears gamification and e-learning both put together potentially have positive effect on student motivation. For the experience to be highly motivating and participative, a huge amount of effort is required. It requires humongous effort first in designing and secondly in its implementation [27]. [28] feel that the current frameworks and models are less appropriate and need improvement to become effective gamified learning place. Understanding the users better is one of the most important aspects when designing gamification in higher education as most of the students there have already crystallised career and personal goals.

Students taking higher education choose courses with high level of awareness about the outcomes of courses thus chosen. Objective of integrating gamification in learning is further reinforcement of their feeling of importance of such education in defining their future. Gamification becomes an effective tool in bringing the personal goals and the process of e-learning on same page. In e-learning, the rules, limitations, requirements, guidelines and time frames should be clearly defined leaving no space for ambiguity. By breaking larger objective into smaller ones, gamification lays emphasis on making objectives clearer and thus motivating. It is so, simply because, smaller objectives give sense of achievement more frequently and therefore improve motivation in learning process. There should be graphical presentation of progress made by student.

A balance between the skill set of students and learning material sets harmonic flux in learning and motivation of students, and this is the best way of learning for students. Positive feedback should be used as reward to appreciate student's learning from various activities. Such positive feedback reinforces self-esteem in students while keeping them motivated. [29] feel that individual learning comes from positive feedback. A clarity should be there for students as to what they are going to learn in e-learning and how this knowledge is going to be useful to them. Flexibility is a basic element of e-learning as it gives freedom of anywhere and anytime to students, leading to autonomy and flexibility in learning reducing fear of e-learning. Like any other learning platform e-learning too has poor performance and abandoning of learning as integral part, gamification encourages to continue learning despite failures.

5.2 Motivation Leads to Gamification

Intrinsic motivation is another way to encourage behaviour. In this designer creates such a system that helps the users to find their own reasons for behaviour engagement rather than giving rewards. Self-determination theory given by [30] is behind this. According to them three factors, i.e. autonomy, relatedness and mastery are related to a healthy mental attitude and intrinsic motivation of an individual. Autonomy

lets the learners pick what they desire rather than others commanding what they do. Relatedness is the feeling where individual feels that he is not alone, individual feels better about a given task when he came to learn about others who are also engaged in the same task. The learner is confident about the knowledge and skills he gained can be defined as mastery. Game designers use elements which increases internal motivation rather than using external motivation by giving rewards. Games are not only played to get good scores, it's one of the many objectives, in addition to this people play games to explore different narratives and make some decisions which appear new innovative and interesting and also to play and compete with other people. A lot of other tools in form of designing game are handy to designer which can lead to improving the inbuilt motivation elements in a game.

6 Conclusions

The study emphasised on the factors affecting e-learning through gamification. The study further elaborates on the outcomes of the e-learning through gamification. Use of gamification in educational and professional training segments is growing very fast. Gamification is a productive tool for learning through effective engagement in e-learning. Study shows various elements of gamification results into motivation, effectiveness, engagement, satisfaction, efficiency, experience and knowledge acquisition.

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Impact of Strategy-Related Competencies on the Performance of Highly Effective Employees: An Empirical Study of Telecom Companies of North India

Uttam Sahay and Gagandeep Kaur

Abstract Competency and performance are correlated, because only a competent person can deliver effective performance. The research has been conducted with the aim to find the relationship between the competency variables and the performance of highly effective employees of telecom companies based in Punjab, Haryana, and Himachal Pradesh. For the purpose of the research, data has been collected from the private telecom sector employees. There were three competency variables identified which are related to driving strategic objectives of a company along with five indicators of highly effective performance. For the purpose of research, correlation has been applied and the result shows that there is a significant relationship between competency variables and the performance of highly effective employees. The research findings can be integrated into all the human resource practices related to managing employee's life cycles. This can also help to revisit their competency framework and add these tested competencies to achieve strategic organizational objectives and success.

Keywords Highly effective performance · Behavioral competencies · Organizational success · Competency-based management practices · Telecom companies

1 Introduction

The success of organizations has always been evaluated against the financial outcome of profits and loss to measure their performance, value, and health. Over a period of time, the softer aspects like employee attitudes, qualities, and perceptions are now being acknowledged and valued as significant lead indicators of employee conduct and performance leading to organizational success. An employee may have a different

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impact owing to their varied attributes in the workplace, but it is the attitude, behavior, and skill which actually determine his or her work performance. Some of the significant organizational benefits of effective use of competency management are reduced cost of training, reduced employee attrition, and increase in overall employee productivity and organizational success [1]. In the contemporary world, the study of competency and its impact on organizational success has assumed great focus as companies are emphasizing employees' effective performance at work as a basis of distinctive benefit for organizational success. For any organization, organizational development is a key facet of the human resource department that regulates planned organizational efforts, aimed to improve organizational effectiveness through well-planned and executed changes in systems and processes to build a superior workforce.

An organization's position in the market and its performance depend upon the quality of intangible assets which it possesses, i.e., human resources. Deployment of efficient employees plays a significant part in organizational success and is treated as a critical enabler and provides the firm a competitive advantage. Competency-based people management practices play a noteworthy part in augmenting the efficiency of human resources in an organization. It has been well-defined by various researchers and organizations in various ways. Competency-based management is the latest tool used in managing human resources functions. It highlights specific competencies utilized in an assigned job, and helps in individualized administration and development of individual competency within their chosen growth paths [2]. In view of this, competencies are related and specific to company's requirements and jobs that are being performed to get desired results. A people process which is based on competency-based human resource management principles drives job-specific competencies to accomplish chosen goals and objectives. It relies on expected outcomes and the requirements of an organization keeping in view an employee at the center rather than from the position held by the employee [3]. Competence-linked people management process includes the apt application of the competency model, since the competency framework by itself cannot deliver added value without the support of human resources management [4]. Human competence has strong relations with workplace performance. Competency analysis and gap study can be included in usual working tasks. Experts agreed mostly to assigning competencies to tasks [5]. On similar lines, organization-wise competency framework and competency rating are related to selection and job performance, employee attrition, and managerial development needs of talent and succession planning [6].

2 Review of Literature

An essential aspect in the study of organizational behavior is to study, as to how behavioral/personal traits (competencies) of an employee impact the performance and success of an organization. Employees' job performance at work has been given more importance and has been treated as a predictor of business competitive advantage to enhance the overall organizational effectiveness and get success.

The socio-economic transition of societies and the increase of economic knowledge have contributed to that power of knowledge is an important means for prosperity and wealth [7–9]. In view of a market perspective, knowledge and information seem to be a critical element in sustainable long-term organizational success. Competency is simply explained as a grouping of knowledge, skills, behaviors, motives, perception of self, social role, and specific function of the subject which an individual uses to accomplish a job [10]. Competencies are "a cluster of related knowledge, skills, and attitudes that affect a major part of one's job (a role or responsibility), that correlates with performance on the job, that can be measured against well-accepted standards, and that can be improved via training and development" [11]. Managing competencies required to deliver desired results has been rated as one of the important instruments to get organizational success. Investments in developing people both in terms of money and time have been found as major activity taken by companies as it helps in improving the competencies of an employee who in turn gives higher performance and collectively achieves organizational success. While an employee's motivation at work drives performance, the skills, knowledge, and attitude he demonstrates at work play a noteworthy role in delivering desired results [12]. It is an individual's abilities which actually explain the type of behavior needed by businesses to accomplish an extraordinary performance [13]. Proper utilization of individual competencies impacts successful individual performance as well as company's performance and success [14]. Literature around performance management have concentrated on processes that help increase proficiency and organizational performance [15]. During performance appraisal practice along with having an impartial assessment of main objectives, the behavioral attributes necessary to deliver are also appraised and they are provided clear advice about the desired standards of proficiencies and their current status at which they are. As per the Human Resource Management Digest 2019, there are certain competencies which help to differentiate between superior and average performance. Some of the competencies which drive superior performance are the ability to lead high achievement orientation, ability to give directions, ability to persuade, and ability to innovate. Other competencies related to both mediocre and high performers are verbal communication, ability to organize, ability to seek information, analytical thinking, and ability to plan. A few latest competencies added to drive higher performance are thematic analysis, ability to comprehend rules and regulations, collaboration with multi-stakeholder and having technical knowledge, and ability to manage people and to manage finance. In another research work, [16] tried to find the relationship between the competencies of managers with the organizational performance. The results suggest that four competencies which caused variation in productivity of business were motivation toward success, ability to develop fellow team members, team leadership, and creating influence. There are numerous competencies of managers and their influence on the overall organizational success [17]. There is not a common competency which is suitable in all circumstances. Effective management of competencies needs a balance between managing social and emotional characteristics; a perfect equilibrium of both is necessary to provide the best outcomes. Theoretically, it can be said that competencies at large have a direct impact on employee performance, and can be used to predict different levels

of organizational performance [18]. It was also found that competencies related to human resources and employee's job satisfaction also lead to employee's performance on the job [19]. It can be said that building competencies and knowledge in both product and services sectors help to increase performance at work and help achieve performance targets [20].

Employees are the most important pillars for reaping success for any organization. Dedicated employees are crucial to elevating small organizations into huge corporates. But the conundrum lies in how to make an employee effective enough, or how to identify an effective employee? A highly effective employee is characterized by overachievement of key performance indicators and setting benchmarks for superior performance. Their performance is expected to be scalable, replicable, sustainable, and aligned with ideal behavioral competence at work. Effective employees are valuable assets for any organization. They are go-getters, self-starters, and initiators, who are curious and do not rely much on others. It is very tough to find a high-performing employee. There is a huge difference between mediocre and highly effective employees. Mediocre employees fulfill their responsibilities and their daily tasks while on the other hand, highly effective employees also plan efficiently for their future and find a scope of improvement in every role that they perform.

It is mentioned by Steven Covey (1989) in his book "7 Habits of Highly Effective People" [21] that there are seven habits that elevate an individual to become highly effective in the workplace. The journey of delivering superior performance has to pass through three stages first being independence, second being interdependence, and the third is working on continuous improvements. All the seven habits are very elaborately explained with behavioral attributes attached to each of them. All seven habits talk about behavioral competencies leading to superior performance. All of these seven habits indicate personal competencies that if developed well will help individuals deliver superior performance and a worthwhile career.

Having considered all these, the Focused group discussions with industry experts, peers, Heads of Departments following five behavioral indicators were identified which actually explained highly effective performance:

- Over-Achieving Pre-Determined Goals/Objectives;
- Always Doing Right Things;
- Delivering Quality of Products and Services;
- Optimization of Available Resources;
- Deliver Sustainable Results.

Another important construct of the study are the competency variables and competency indicators attached to each competency variable. An extensive literature review of the competency frameworks of telecom companies have been conducted along with associated literature available to identify these three competencies related to strategic orientation which are Analytical Thinking, Innovation and Improvement, and Ability to Learn and Develop. All the competencies are related to an individual's ability to plan for the future.

Analytical thinking was identified as a competency for Reliance Jio and was mentioned in Spencer and Spencer [22] also, while applied thinking of Vodafone

and business acumen of Idea were found closely related to analytical thinking during the focused group discussion. Innovation and Improvement was a prominent competency variable of Idea, managing for innovation for Tata Teleservices, facilitating change and innovation for Airtel helped the focused group discussion to select this competency for discussion. Ability to learn and develop as a competency variable got featured in almost every framework like develop self and others' ideas), Organizational and personal learning (Tata Teleservices), Change (Vodafone), Empowering and developing (Bharti Airtel), People development (Aircel), and Develop self and others (Spencer and Spencer).

The above construct was also supported by a review of literature. Managing data with rigorous analysis assists in taking informed business decisions and gives a perspective as to what happened and predicting what may happen in future [23] which help in ensuring business completive advantage. As opposed to the mechanical and traditional view [24] which helps in driving better performance. The use of data to be better informed and as a competency has become a convincing action agenda for human resource managers [25] to deliver higher performance. Similarly, [26] as well as Gray [27] found analytical skills to be an important future workplace competence. Rooted in this is the increasing expectancy of the human resource (HR) function to realize how workforce analytics and analytical skill apprises the business and drives success (DiClaudi [28]).

Similarly, Innovation and Improvement in an organization is becoming an important factor in the survival of a company [29]. It is important to note that around 50% and 80% of economic prosperity is the result of innovation and knowledge. An organization should invest more on workplace innovation as it helps in driving organizational success [30]. On similar lines, it was found that employee innovative behaviors play a dominant role to improve the quality of both service and customer satisfaction which gives a competitive advantage over others [31].

Ability to learn and develop is related to efforts made by an individual employee for himself to grow and thereby helping the organization also to grow as a whole in long run [32]. Thus, there exists a direct association between an employee's ability to learn and develop and it is work performance. A competent employee would be more content with the job, will be more dedicated with the job, and his performance naturally would be better. Competent, satisfied, and dedicated employees will work hard and deliver high levels of organizational success [33]. Many companies do not value the importance of people development. They only put emphasis on accomplishing organizational goals. On the contrary, if organizations put focus on employee developing activities, this would help in building required competencies for better performance. With enhanced skills, they would be able to develop their own growth plans and thus help to grow organizational effectiveness.

Learning and Development initiatives also ensure that employees can acclimatize flawlessly to the latest technology which helps in augmenting the effectiveness and output of both the individuals and organizations [34]. A skilled workforce constitutes an important means of competitive advantage in the competitive international marketplace [35]. Employee training also has a positive incidental impact and also

impacts individual's self-confidence, which enhances their job satisfaction and helps them to perform better [36].

The competency models of all the telecom companies were studied along with available literature around behavioral competencies. The idea was to make a cluster of competencies which are strategic in nature and can help an organization to plan for the future. About 50 competency variables were studied and through focused group discussions with HR Heads, Functional heads, Industry experts, and a few highly effective employees collaborated and decided to list Analytical Thinking, Innovation and Improvement, and Ability to learn and develop as three competency variables which will enable a company to plan for future; working on these competencies will make the organization future-oriented. Analytical thinking will stimulate the analysis of the current trends of business and can also predict future business scenarios and can help an organization to optimize the resources to meet future needs and be contemporary and relevant in the future. Ability to innovate and improve is directly linked with the future of any organization. Any organization which is adaptable to fast-changing customer requirements should work on its ability to innovate and be relevant. Similarly, ability to learn and develop equips an organization to provide various learning platforms for employees to be skilled and trained on the new abilities which are required for the future and make the organization dynamic in view of the fast-changing customer requirement.

As a business strategy, the organization will invest in new technology and equipment to be future-ready, and for that, improving all these competencies will provide a huge competitive advantage to a company in the future. Though there were enough evidences found to suggest that there is an association between competence and performance, there are very limited studies around the central theme of the topic which is to measure the effect of competency variables on the performance of highly effective employees.

3 Research Methodology

The research methodology includes the data and the statistical evidence to support the purpose of the research and the hypotheses formulated for such research. The research is empirical research; the data has been collected in the form of structured questionnaires from the highly effective employees of Indian telecom industries. The data was collected from four telecom operators of India. The sample size is 530 employees of telecom companies that includes Idea, Vodafone, Bharti Airtel, and Reliance Jio.

Based on the available literature related to the competency framework of telecom companies and through focused group discussion, a questionnaire was prepared which consists of different kinds of questions designed to achieve the objectives of the research. A pilot test of the questionnaire was also done. The pilot study helped to know and address a few issues related to the questionnaire. The exercise helped in building a better understanding of competencies, fine-tuning the definitions and

attaching the right behavioral indicators to each competency variables. Considering the feedback of the pilot study, all the changes were incorporated in the questionnaire to design and administer the final questionnaire to be used in the survey.

3.1 Objective of the Study

To study the Impact of Strategy-related competencies on the performance of Highly Effective Employees of Telecom Companies in North India.

3.2 Hypotheses

In this study, hypotheses pertaining to study the effect of various competency variables related to strategy such as analytical thinking, innovation and improvement, and ability to learn and develop on highly effective performance whose indicators are over-achieving goals, doing right things, delivering quality product and services, optimization of resources and deliver sustainable results were formulated. These hypotheses are listed below.

H_{01}: Analytical thinking is not significantly correlated with highly effective performance.

$H_{01a:}$ Analytical thinking is significantly correlated with highly effective performance.

H_{02}: Innovation and improvement is not significantly correlated with highly effective performance.

$H_{02a:}$ Innovation and improvement is significantly correlated with highly effective performance.

H_{03}: Ability to learn and develop is not significantly correlated with highly effective performance.

$H_{03a:}$ Ability to learn and develop is significantly correlated with highly effective performance.

Cronbach's alpha method was employed to test the reliability of the scale (Table 1).

3.3 Sample Size

For collecting the primary data, researcher approached a much higher no of respondents (750), just to ensure that he is able to get the required samples; out of 750 respondents, 530 valid responses were received. The responses received were Bharti Airtel 154 (29.1%), Vodafone 130(24.5%), Reliance Jio 82 (15.5%), and Idea 164

Table 1 Reliability of the questionnaire

S. No	Sections of Questionnaire	Cronbach's Alpha
1	Section C. Perception of highly effective performance	0.834
2	Section D. Perception on importance of behavioral competencies on work performance	0.899
3	Analytical thinking	0.854
4	Innovation and improvement	0.901
5	Ability to learn and develop	0.88

Table 2 Sample size details

Sample size				
Telecom company	No. of target respondents	Valid responses	Percentage (%)	Percentage of valid responses (%)
Bharti Airtel	200	154	77	29
Vodafone	200	130	65	25
Reliance Jio	150	82	55	15
Idea	200	164	82	31
Total	750	530		100

(30.9%). The distribution of 750 questionnaires to all four telecom companies was Bharti Airtel 200, Vodafone 200, Reliance Jio 150, and Idea 200 (Tables 2 and 3).

4 Research Methods

To analyze the data and to validate the hypotheses, a number of statistical tools were used to draw useful implications for managers to derive a high-performing culture across levels in the different verticals of telecom operators. Statistical tools like descriptive statistics, Karl Pearson Correlation Matrix, FGD technique, Statistical Package for Social Sciences (SPSS), and MS-Excel were used to analyze the data to reach logical and meaningful conclusions.

5 Results and Discussions

To find the relationship between the performance of highly effective employees and behavioral competencies, Pearson correlation is calculated. All the hypotheses were tested and the results are presented according to the hypotheses. The statistical

Table 3 Demographic profile of the respondents

Demographic profile of the respondents			
Main category	Sub-Categories	Responses	Total responses
Gender	Male	384	530
	Female	146	
Educational qualification	Graduate	272	527
	Diploma holder	83	
	Postgraduate	160	
	Doctorate	5	
	Any other	7	
Age	up to 27 years	194	530
	28–37 years	216	
	38–47 years	87	
	48–57 years	32	
	Above 58 years	1	
Association with organization	0–3 years	230	530
	4–7 years	145	
	5–11 years	99	
	12–15 years	48	
	Above 16 years	8	
Position in organization	Team member	335	530
	Supervisor/In Charge	92	
	Vertical head	70	
	Head of department	33	

result shows that all three competency variables are correlated with highly effective performance.

Analytical thinking is moderately correlated with highly effective performance (Pearson correlation $r = 0.350$) and this association is significant ($p = 0.000$).

Similarly, the competency variable of Innovation and Improvement is also found moderately correlated with highly effective performance (Pearson correlation $r = 0.366$) and the association is found to be significant ($p = 0.000$).

On similar lines,there was a moderate correlation with Ability to Learn and Develop was also found with highly effective performance (Pearson correlation $r = 0.384$) and the association was significant ($p = 0.000$).

Thus, all the null hypotheses are rejected and alternate hypotheses are accepted. Hence, statistically it was found that all the three strategy-related competencies are significantly correlated with highly effective performance (Table 4).

The findings are summarized as under.

Table 4 Summary of the hypotheses

No	Hypotheses	Accepted/Rejected	Significance (p value)	Pearson correlation (r)
H_{01}	Analytical thinking is not significantly correlated with highly effective performance	Rejected	0	0.350
H_{01a}	Analytical thinking is significantly correlated with highly effective performance	Accepted		
H_{02}	Innovation and improvement are not significantly correlated with highly effective performance	Rejected	0	0.366
H_{02a}	Innovation and improvement are significantly correlated with highly effective performance	Accepted		
H_{03}	Ability to learn and develop is not significantly correlated with highly effective performance	Rejected	0	0.384
H_{03a}	Ability to learn and develop is significantly correlated with highly effective performance	Accepted		

It was found that all the three competencies were significantly correlated with highly effective performance. It was also found that the behavioral indicators of all the competencies have differential impacts on driving highly effective performance for each of the categories of employees. There is a noteworthy association of competency variables with employee's work contentment which helps an employee to perform a job [37] and competency variables create a significant influence on a worker's performance [38].

6 Recommendations

A human resource management system based on a competency framework is recommended for improving the competency of human resources by integrating the same with various HR processes and various people processes.

The integration of competencies in people practices depends on the organization's strategic requirements, available resources, and ability of the human resources team. Competency-based management thus assumes huge importance as organizations use them to drive employees to drive superior performance leading to organizational success.

The findings of the study reinforce the fact that competency variables impact the performance of highly effective employees. The assumption is thus established that if you have to drive highly effective performance in an organization, one has to use the competency framework in every aspect of human resource management. To drive highly effective performance at work, these three competencies related to strategy can be integrated with the complete life cycle of an employee by integrating the same with the processes related to Talent Management which includes Talent Acquisition, Managing Poor Performance, Career, and Succession Planning through Assessment and Development Centers, Coaching and Mentoring, Learning and Development, Rewards Management, etc.

Important managerial implications can also be derived from the study. These three competencies have been tested by highly effective employees of major telecom companies which are required to deliver highly effective performance. All managerial actions can be realigned in view of the recommendations and accordingly people-related strategies can be developed.

This model will help the leadership to create awareness among all the stakeholders that the demonstration of right competency behaviors at work help in delivering highly effective performance and leaders to overall organizational success. It is an attempt to empirically and analytically study the relationship between competency variables and highly effective performance. It was found that how competencies and right behaviors impact the performance of highly effective employees in an organization, hence strongly recommended that they should be integrated into HR processes to increase organizational productivity, and efficiency. It is strongly recommended that organizations should revisit their competency framework in view of these findings which will give a new direction to the organizational development and effectiveness initiatives.

In the talent acquisition process, the competency-based interviewing using Behavioral Event Interviewing (BEI) assists in identifying the right fit of candidates meeting the required job competencies of that position. During the interview, assessment of the desired level of behavioral descriptors of each competency is done by using the critical incident technique.

The candidate will be hired only when he is able to show the behavioral indicators leading to deliver highly effective performance. The benefit of this is that the organization gets a candidate who has been evaluated on the required level of identified competency which is required to deliver highly effective performance. Thus, the entire process of talent acquisition becomes quite robust as the process checks functional expertise, competencies, and behavior that a candidate is required to deliver highly effective performance.

Another important managerial recommendation is to integrate the complete talent management framework into these findings. It should cover the process related to

talent segmentation, talent assessment, talent development, succession, and career planning in any organization. While specific training programs can be created in view of the requirements of talent management, a set of general training programs can be created against each competency variable in alignment with the behavioral indicators that can be developed by the organization so that mass level and broad base training programs are imparted to increase the overall level of employee performance. Competency-based training ensures employees receive the right training which reinforces knowledge, skill, and attitude in the job to deliver highly effective performance. Similarly, the performance appraisal and management process can also be integrated into the competency framework. Mostly, all performance management frameworks are woven around measuring performance against set targets which are largely measured in certain numbers or targets. The behavior that actually helps to deliver low or high is seldom measured by the manager. The findings can add another element to the appraisal process where the manager can assess the behaviors demonstrated to deliver performance. The findings can also be integrated into the performance reward and recognition framework of an organization. Employees who are demonstrating identified and tested behavior at work will be rewarded. This will create a ripple effect among others, and they will also get motivated to demonstrate the right kind of behavior at work.

7 Theoretical Contributions

There is a general understanding that competencies enable superior performance and various models have been created keeping this assumption in consideration. It is also largely assumed that in any organization people who deliver more do things differently, but the question was "has this been tested"?

The research's theoretical contribution is that the assumption has been successfully tested on three competencies and validated by employees who are highly effective, assessed, and rated by their respective organizations.

8 Conclusion

Some people demonstrate exemplary performance in comparison to people delivering average results having the same job responsibilities, titles, and compensations. The objective of the study was to find this distinction. If we are able to find out these competencies, organizations will start hiring candidates who can deliver superior performance or help others to develop similar capacities. This will lead organizations to dramatically improve their productivity and success multifold. While it is not possible to turn every employee into a highly effective employee, having identified such competencies one can select candidates who possess enhanced abilities in certain areas and can become highly effective by delivering superior performance. In

addition, the knowledge gained through the study can also help employees at large to work in accordance to enabling behaviors related to these competencies to enhance their performance. The study's findings provide a frame of reference that a number of human resources processes like talent hiring, performance management, talent management, learning, and development can be aligned with these competencies to deliver superior performance. Accordingly, the existing competency model can be revisited on the recommendation to produce great competitive advantage when they are linked to delivering strategic business results.

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Deep Learning-Based Rumor Detection on Social Media

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Abstract Rumor detection is a highly prominent issue especially during this pandemic that requires adequate attention and addressal. Citizens confined to their homes rely on the use of smartphones, and other devices by means of social media and online news publishing websites so as to gain thorough insights into various topics of public interest. However, due to this very convenience, since there exists a large plethora of articles published, the human judgment and capability to distinguish news to be true or false is often clouded due to the increasing consumption. Thus, there arises a need to separate and distinguish news articles which are true from the articles that circulate false news that often cause confusion and unnecessary panic with rumors being circulated around.

Keywords Rumor detection · Deep learning · Bi-LSTM

1 Introduction

Due to the rise in the use of Social Media, and the introduction of various convenient portable devices which provide access to the Internet, the accessibility to knowledge has never been easier. The enormous availability of various social media applications and news applications has made a plethora of information and knowledge accessible within one's fingertips. This very convenience and access has not only made human lives easier but has also made it difficult to discern rumors.

Existing methods utilize Machine Learning methods with limited features for training the data. A realistic measure can be achieved by utilizing more features such as sentiment and other user-based features. This is done because these features help in understanding user behavior and its correlation to rumors. The project utilizes Deep Learning-based methodologies for enhancing the dynamic ability of the model

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to distinguish rumors and non-rumors. It also utilizes the incorporation of word embedding vectors.

2 Background

2.1 Literature Study

Jain et al. [1] utilized Support Vector Machines. The article extraction is done by means of retrieving the title from RSS feeds, the features involving author, title and content are extracted and then the validation is done by applying the trained classifier on the given article and also verified with the user input gathered from browsing if the article exists in multiple websites or not. The model's performance resulted in up to 93.50% accuracy.

In [2], they define a certain threshold which utilizes the number of likes feature and if the number of likes feature contains a value less than the threshold, it makes use of a content-based classifier and if greater or equal to the threshold, it utilizes a social interaction-based classifier which makes use of Logistic Regression and Harmonic Boolean label crowdsourcing on Social Signals.

The approach utilized by [3] involves the collection of news stories from legitimate news websites and the same is done for Facebook posts through GraphAPI; stories and articles are further processed to determine if there exists any content similarity between both; the comments and replies for each post are utilized for sentiment analysis using VADER. This is then followed by the use of ML algorithms and then compared based on accuracy, precision and recall.

The comparison in [4] showed that Deep Learning methods performed better in accuracy, precision and recall.

In [5], a weightage factor was assigned to rumors because rumors are a minority class; this is done by assigning this weighing factor to terms that frequently occur within the rumors class, while also utilizing tf-idf scores and adding this score to the standard tf-idf score.

The study in [6] compares existing Machine Learning approaches. The approaches considered are JRip, ZeroR, Naive Bayes, Random Forest, OneR and Hoeffding Tree.

The approach in [7] utilizes a methodology where the rumor label is not treated as a binary classification rather it is classified into 4 classes, namely true, partially true, partially false and false. The approaches utilized here are, namely K-Means Clustering and Support Vector Machines.

The study in [8] considers various types of features that can be considered. The features were categorized into Content-based features and Context-based features. Each of them was further classified into Lexical, Syntactic and Semantic under Content-based features followed by User-based and Network-based under Context-based features.

Hybrid deep learning approaches are utilized in [11]. Here, a CNN-RNN hybrid-based approach was utilized in the application of rumor detection.

2.2 Existing Features

Utilization of user-based features such as Users that have a bio, Users with a display picture, Whether User is a verified user or not, average number of followers, average number of posts posted by users, duration of user's account and identification of how prominent the user's account is by considering followers: following ratio and average number of retweets.

Content-based features are character count, number of stop words used, grammatical-based features through POS tagging through Natural Language Processing, considering if there exist question marks and exclamations, average length of posts for a particular topic or event, sentiment score of posts, calculating overall sentiment of a post's comments or thread and time series data.

3 Methodology

3.1 Overview

A hybrid deep learning approach is adopted with the addition of more features for higher accuracy and capability to detect rumors. This approach is compared with individual algorithms' performance as well as with Machine Learning algorithms. The addition of word embedding vectors is considered so as to represent various words as vectors. This is done in order to determine whether the existence of certain words with higher frequency within the rumors class possesses a correlation to it being a rumor or a non-rumor.

The system will utilize one of the hybrid deep learning approaches Bi-LSTM with the use of word embedding vector - GloVe. This is then compared with existing machine learning classifiers and the individual performance of Bi-LSTM and LSTM. The training data for the machine learning classifiers are mostly user- and textual content-based data which are derived during the pre-processing phase. And for the Bi-LSTM with word embedding, Bi-LSTM and LSTM, the training data input is the textual content of the tweet.

3.2 Logistic Regression

Logistic regression utilizes a hypothesis that limits the cost function within the range of [0,1]. Linear functions fail to represent this due to their likelihood of having values beyond this range.

$$0 \leq h_\theta \leq 1 \tag{1}$$

Logistic Regression is very efficient at classifying unknown records, and can interpret model coeffcients as indicators of feature importance. However, the major drawback with Logistic Regression is the assumption of linearity between the dependent and independent variables. Moreover, its usage is restricted to only predicting discrete functions.

3.3 Decision Tree

The Decision Tree algorithm involves splitting the data continuously according to certain criteria until a tree representation is obtained. The tree consists of 2 entities, namely decision nodes and leaf nodes, where the decision nodes represent the criteria to split the data and the leaf nodes represent possible outputs that can be derived based on the criteria. The criteria involved are often based on attributes values in the dataset. This splitting operation is done until the leaf node can be determined for each attribute based on the decision criteria.

3.4 Random Forest

Random Forest consists of a large number of individual decision trees that operate as an ensemble (a group of trees). Each individual tree splits out into a class prediction and the class which possesses the most votes becomes the model's prediction. While some trees may vary inaccurately, the rest of the numerous tree predictions will be right, so as a result, the group of trees is able to proceed in the right order neglecting the inaccurate ones. Thus, its capability to have multiple decision trees and then combine them in order to get a more accurate prediction makes it ideal for both classification and regression problems.

3.5 Long Short-Term Memory Networks

LSTM consists of 3 gates, namely input gate, forget gate and output gate. Within the LSTM, the cell state carries information in a sequential manner and acts as the memory unit of the network which makes it capable of carrying relevant information needed throughout the processing of an entire sequential data, thus, data present in earlier processing steps can be used in the later steps as well. The gates are neural network units capable of determining which information is relevant and can be stored in the cell state. The gates' functioning is based on sigmoid function and is referred to within LSTM as sigmoid activations. The range of values varies between 0 and 1.

The forget gate determines the information that is to be carried over. The data from the preceding hidden state and the data repressing the input is passed through the sigmoid function; the values lie within the range of [0,1]; values that are immediate to 0 can be discarded and values immediate to 1 are retained. Input gate is utilized so as to update the cell state. The input and data from the prior hidden state are passed directly to the sigmoid function which determines the values to be updated by transforming their values within the range [0,1]. This is then followed by passing the hidden state and input through the tanh function which transforms the values between -1 and 1. This is then followed by the product of values from the sigmoid function and the tanh function, followed by the sigmoid function's value determining which information is to be retained from the tanh value. The cell state involves the calculation of the dot product between the forget vector and the cell state. This is done in order to drop values present in the cell state that are immediate to 0. Pointwise addition is performed on the output of the input gate which updates the cell state to newer values that the neural net can find pertinent. The output gate determines the next hidden state. The prior hidden state along with the input is passed into a sigmoid function. Then the resultant cell state is passed to the tanh function. The product of the tanh function value and the sigmoid function value determine which information the hidden state should carry over. The output is the hidden state. The new cell state and the new hidden state are then carried over to the next step. The input gate decides the information which is relevant to add from the current step. The output gate then decides the next hidden state.

3.6 Bi-directional Long Short-Term Memory Networks

Various Hybrid Deep Learning approaches other than Bi-LSTM include ConvLSTM which integrates both CNN and LSTM architectures and CNN-RNN which utilizes both CNN and RNN. Hybrid Deep Learning was adopted to improve the output of sequential data. Bi-LSTM utilizes a sequence processing model that comprises 2 LSTMs where one LSTM passes the input in a forward direction and the other in a backward direction and then concatenates both the results for every processing step. This effectively increases the amount of relevant information that can be considered

which helps in increasing the context availability and understanding. This makes the model capable of predicting which words follow and precede a particular word for a given sentence. The addition of an LSTM that runs backward helps preserve information by utilizing the combination of 2 hidden states which are capable of preserving data from both forward and backward directions.

3.7 Word Embedding Vectors

GloVe is capable of procuring vector representations for a given textual data input. The importance and usage of word embeddings are that they can be utilized for grouping words that are synonyms to each other in context and meaning in a similar representation. Each word is mapped to one word embedding vector and their distributed representation is contingent on the usage of words. Thus, due to this, the words that are utilized in similar sentences will be stored in vector form with similar representation.

GloVe's approach to word embedding representation is based on the co-occurrences or the frequency of a word in the entire document. The embeddings of GloVe represent numeric probabilities of whether a certain word and another word can appear together or not. Since the predictive modeling aspect is taken care of by utilizing Bi-directional LSTM, GloVe word embeddings will be utilized.

The pre-processing step in Fig. 1 involves the conversion of rumor events data in json format to csv. More features were also introduced and added along with the existing features during the conversion from json to csv format.

This is then followed by the EDA phase involved in analyzing the distribution of data in order to ensure if there exists a fair distribution between rumors and non-rumors within the overall data as well as for each and every event in the training dataset. The inference can be drawn from the data by visualizing them.

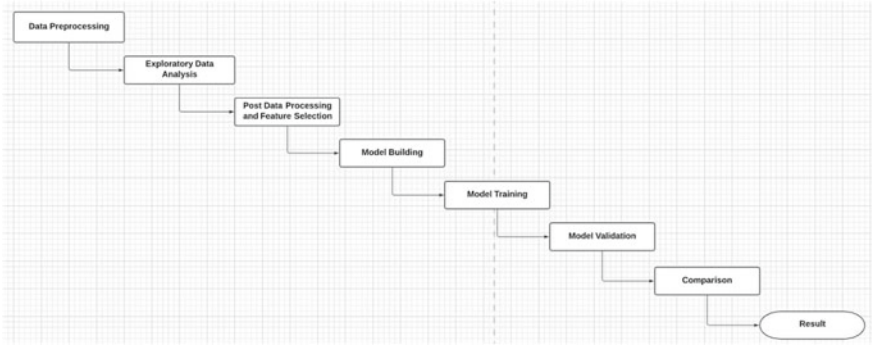

Fig. 1 Rumor detection workflow diagram

In the post-data processing and feature selection, the attributes that are not necessary are dropped and label encoding is applied for those features that are in textual format.

The model building phase involves identifying algorithms that will be effective for the application and implementing a few ML algorithms.

The model validation involves generating a classification report where metrics are generated in order to compare the algorithms' performance and finding which performed the best among them.

For both LSTM and Bi-LSTM in order to implement and compare the performance of them individually with Bi-LSTM utilizing word embedding vectors, the textual content of the tweet is utilized as the feature in the post-data processing stage and within that stage, pre-processing techniques are applied on the tweet's text.

From Fig. 2, the textual input is converted into word embedding vectors and then utilizing GloVe word embedding, it is passed to the Bi-LSTM model for training. The training occurs in such a way that one of the LSTMs passes the input vectors

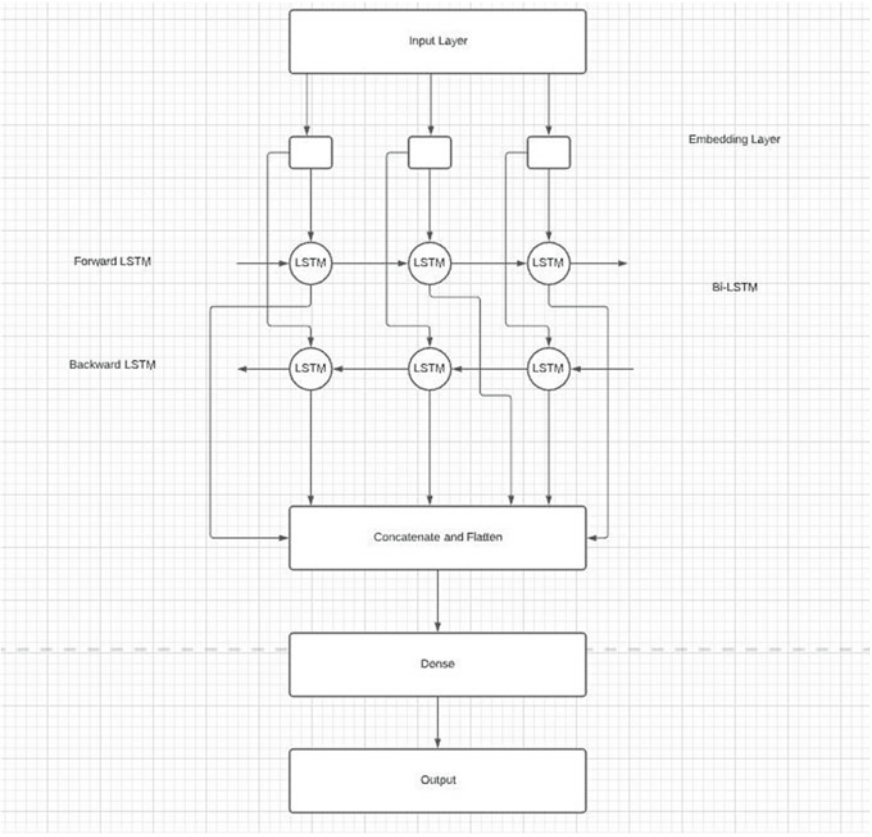

Fig. 2 Architecture diagram

in a forward direction and the other in a backward direction. The resultant vectors are then combined in the concatenate and flatten step. This is to increase the context availability. Thus, the model's capability of predicting words immediately follows a particular word present as a vector and the word that precedes it.

4 Experimental Setting

4.1 Data

Pheme-rnr-dataset was used. The dataset comprises Twitter data from 5 real-life events, namely Ottawa shooting, Charlie Hebdo shooting, Ferguson unrest, Sydney siege, also known as Lindt Cafe Siege and German Wings Flight 9525 crash. The dataset contains Twitter conversation threads for these events. Each event contains its own directory with 2 separate folders containing the tweets categorized as Rumors and Non-Rumors.

5 Experimental Results and Analysis

From Table 1, it can be inferred based on the F-1 score that Random Forest had the best performance among the 3 machine learning classifiers. From Table 2, based on the accuracy, Random Forest again was the most effective. After the model training for both LSTM and Bi-LSTM and considering the first epoch training accuracy to compare them, it is observed that utilizing a hybrid deep learning approach has a

Table 1 Machine learning algorithms comparison

Algorithm	F-1 Score	Precision	Recall
Logistic regression	0.78	0.64	1.00
Decision tree	0.76	0.76	0.76
Random forest	0.83	0.76	0.91

Table 2 Performance comparison of algorithms

Algorithm	Accuracy(%)
Logistic regression	63.71
Decision tree	69.92
Random forest	75.52
LSTM	86
Bi-LSTM	90
Bi-LSTM with GloVe	85

slightly better performance compared to the individual unidirectional approach. With GloVe, it is slightly lesser but close to the LSTM'S and Bi-LSTM's accuracy. The utilization of deep learning approaches possesses higher accuracy compared to that of machine learning approaches. This makes deep learning approaches superior in their capability to detect rumors to that of machine learning approaches.

The result has shown an increase in the accuracy when deep learning approaches were utilized. This is possibly due to the higher context availability present due to the utilization of the hybrid deep learning approach and word embedding vectors. The selection of Bi-LSTM among other hybrid deep learning approaches was due to the capability of having the input fed in both forward and backward directions which increases the context understanding and availability as the model will be capable of predicting input forward and backward. Having tested out the machine learning classifier approaches and the individual performances of LSTM having also shown that Bi-directional LSTM is more beneficial than unidirectional LSTM, hence, the utilization of hybrid deep learning approaches can significantly enhance the context availability needed in the application of detecting of rumors.

6 Conclusion

Since the ability to attain contextual understanding is higher in the case of deep learning approaches, the accuracy in predicting and distinguishing rumors is higher. The utilization of word embedding vector GloVe performed better than machine learning classifiers and was close in terms of accuracy to the individual deep learning approaches of unidirectional LSTM and Bi-directional LSTM.

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Fake News Predictor: A Random Forest-Based Web Application for the Prediction of Fake News on Social Media

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Abstract The fake news is one of the main concerns nowadays. There are different groups who spread fake news and use that to gain popularity or defame others. In the domain of fake news analysis, our main focus is to help the users to understand whether news is true or fake. The existing models present in the market analyze news based on the text or some time by fact checking in the Internet. These types of model are very time-consuming. Our model is designed based on the identification of the pattern of comment, reaction, and share count on any news. Based on these parameters the proposed model predicts whether the news is real or fake.

Keywords Streamlit · Random forest · News type · Fake news

1 Introduction

Social media is becoming a strong media platform and day by day more are using social media. People are using it for different purpose starting from chatting, sharing info, job searching, the list is endless [1]. One of the biggest uses of Facebook is to get news of the world and people are browsing through the Facebook news, rather than watching TV [5]. Even nowadays mainstream media are also posting news on their Facebook pages. But one problem with this thing is that we cannot verify the news shared or published by the media [1]. So, many times it happens that news shared are not only fake but also cause violence. Even media are also sharing news which is half-true or politically biased or completely fake. So this causes problem for common people [2]. So, the question genuinely rose how much we can rely on Facebook news [4]. Our fake news analysis is based on the following parameters: comment, share, and reaction count, news agencies which has published. Based on these parameters it can predict whether news is real or fake.

The main objective of the proposed model is to get an idea of how social media is becoming a new weapon for propaganda and a hub for fake news [10]. Fake news spread thousands of times faster than the real one and the fake news spreaders use

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social media as a platform for fake news to spread. News generally shared on social media are half-true or completely false and politically motivated [7]. To understand how fake news controlling our day-to-day activities and our lifestyle, everyday many events are happening throughout the world like protest, election, new technology, etc. [8]. The way these things should be presented is now in the hand of social media and the media. Often these things are represented in a way that will benefit them.

2 Literature Review

With the growth in spread of false information through the social media platforms, it is of necessary importance for individuals and societies to be able to judge the authenticity of it. Fake news is not a new trend it has been used from very early to spread propaganda, but it is a commonly occurring phenomenon in recent days. There are many ways to identify the wrong information. By conducting a systematic literature review, authors identified main approaches currently available to identify fake news and how these approaches can be applied and modified for different situations in different situations [5]. Fake news detection topic has gained a great deal of interest from researchers around the world [7]. Many people are more involving in this topic and got researcher's attention [9]. Discussion on news events has become a routine of people's daily life. The news such as various bad events from natural phenomenal or climate is unpredictable. Sometimes fake news are broadcasted for an event that creates confusion among the people. So, there is a need of a system to detect it. Internet is one of the important tools which involves large number of persons as its user. There are different social media platforms which user used for [2]. Every user can make a post or spread the news through the online platforms. So, it is easy for the user to spread lies on Internet and they use fake accounts for it [10]. So there is growing demand for system which can predict the reliability of that news [3].

To summarize our survey, in our modern era where everyone relies on various online resources for news. Increasing social media platforms like Facebook, Twitter, etc. have facilitated the exponential increase in the number of fake news spread [6]. The spread of fake news has far-reaching consequences like from the creation of biased opinions to swaying election to violence between different societies for the benefit of certain candidates. This proposed model is made to differentiate between real and fake news and guide the people to believe on the true news.

In the following sections, proposed model and its features have been discussed in Sect. 3. The experimental analysis of various selected algorithms suitable for predicting label variable from the dataset has been discussed in detail along with its comparison graphs and reason for being selected in Sect. 4. The experimental result, the machine learning web application and its features have been discussed along with its interface design and working functionality after which why it is being called an automatic dataset updating application has been discussed with details and proofs

in Sect. 5. Finally, conclusion has been drawn from the experiments and researches and references have been given in Sect. 6.

3 Proposed Model

The proposed model will be a user-driven custom input web app which will predict the type of the news and the probability of its predicted type news on its own based on user input like the type of post whether it is a link or video or text, where it is posted, on which platform, etc. which is different from the existing models on Streamlit platform coded in Python by using random forest classifier algorithm to predict. Also the model can automatically increase its accuracy on its own without any human interaction by appending the user inputs with its original dataset on a real-time basis.

Figure 1 shows the workflow model of our proposed model where on giving the required inputs mentioned in the bubble boxes to the machine learning model will predict the type of news and show its prediction percentage.

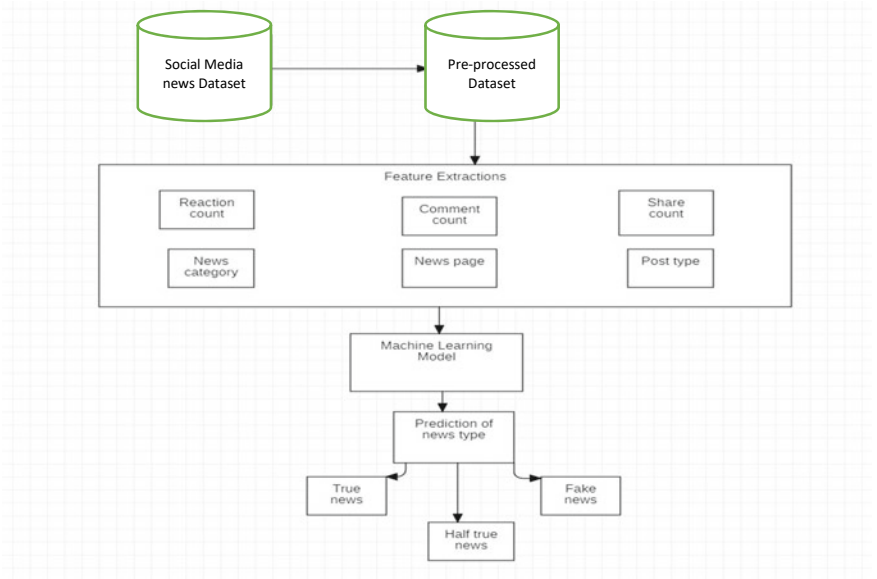

Fig. 1 Workflow diagram of proposed model

Category	Page	Post Type	Rating	Debate	share_cou	reaction_c	comment_	Day
2	1	4	4	0	96	146	15	19
2	1	4	4	0	25	207	108	19
3	8	1	1	0	52	131	25	19
3	8	1	3	0	1640	2676	284	19
3	8	1	1	0	748	1417	71	19
3	8	1	3	0	272	2409	53	19
3	8	1	1	0	309	2167	49	19
3	8	1	2	0	203	2115	40	19
3	8	1	2	0	33	204	28	19
3	8	1	1	0	87	707	24	19
3	8	1	2	0	244	813	77	19
3	8	1	3	0	51	86	12	19
1	9	1	3	0	483	5317	101	19
1	9	4	3	0	688	3329	37	19
3	4	1	3	0	14	35	9	19
1	9	1	3	0	4030	24066	331	19
2	1	1	3	0	2	37	25	19
1	9	1	3	0	33767	27185	3129	19
3	4	1	2	0	3304	1996	220	19
2	1	1	3	0	3	24	6	19
3	4	1	1	0	18	32	12	19
3	4	2	4	0	500	467	16	19
3	4	1	3	0	74	154	92	19

Fig. 2 First 23 values of the news dataset

4 Experimental Results and Analysis

4.1 Dataset

Figure 2 shows the modified dataset that we have taken for our research purpose from the raw dataset from Kaggle after converting all the categorical values to numerical values, filling missing values with the median set. This dataset comprises category of the post (whether it is a link or a page), page on which the post has been made, post type, debate on it, share count, reaction count, day of the post, and comment count as input columns and rating of the post as label column to be predicted by the app.

4.2 Correlation Metrix of Our Data

Figure 3 shows the correlation values between various columns of the dataset with given color indexes on the varying range of correlation values.

Since we are focused on predicting the type of the news, we take rating as the target variable.

We have taken three algorithms of classification for our dataset:

- Random Forest Classifier (RF).
- K-Nearest Neighbors Classifier (KNN).

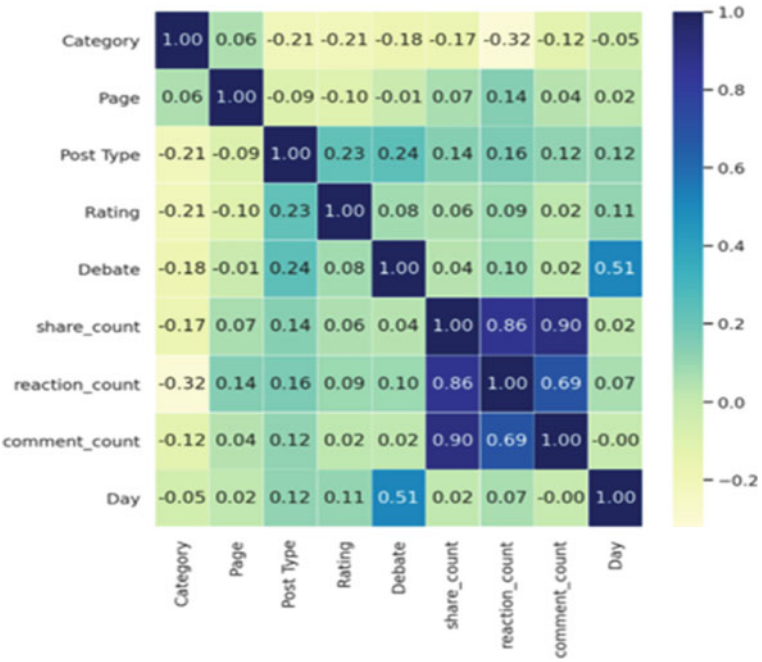

Fig. 3 Correlation values between different variables in the dataset

- Logistic Regression Classifier (LR).

And we have done an analysis of f1-score, recall value, model score, accuracy, and ROC curve of the above algorithms on our dataset. We have also hyperparameterized each and every algorithm using normal parameter tuning and random search CV hyperparameter tuning.

4.3 Scores of Our Model

Table 1 depicts the model names used in this research analysis and its accuracy scores and it is clear from the table that RF comes to be the best with 78.1% score.

Table 1 Models and its accuracy scores

Model	Accuracy (%)
LR	**73.96**
KNN	**70.45**
RF	**78.11**

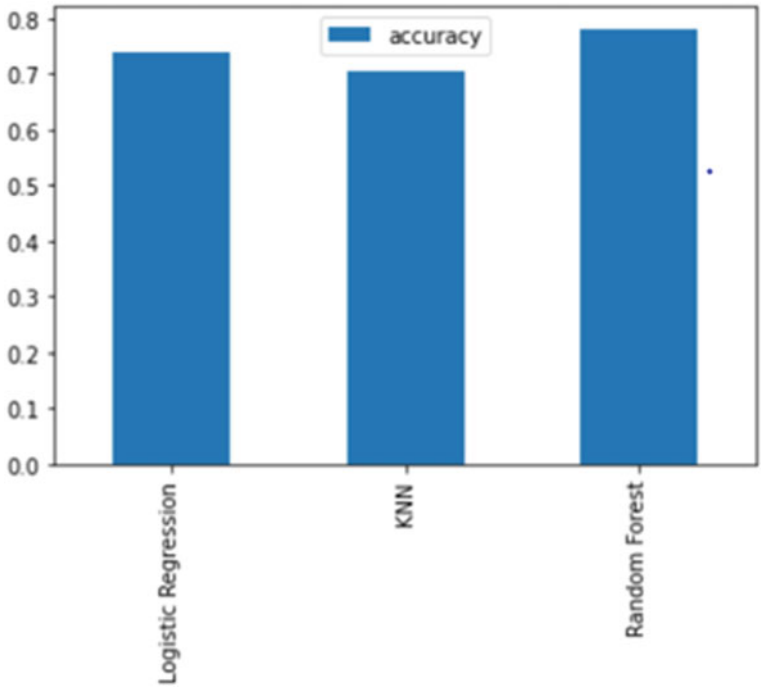

Fig. 4 Comparison graph between the model accuracy scores

4.3.1 Visual Representation of the Accuracy of the Models

Figure 4 depicts the graphical comparison and analysis between the accuracy scores of the three algorithms.

4.4 Score of KNN After Tuning

Figure 5 depicts the maximum accuracy score of KNN model after simple parameter tuning which comes to be approximately 75%.

4.5 Hyperparameter Tuning of RF and LR

Table 2 depicts the accuracy scores of logistic regression and random forest classifiers after hyperparameter tuning and KNN after simple parameter tuning. Since random forest accuracy scores come to be the best, it is being selected as the final model for predicting the news rating of the given dataset as shown in Fig. 1.

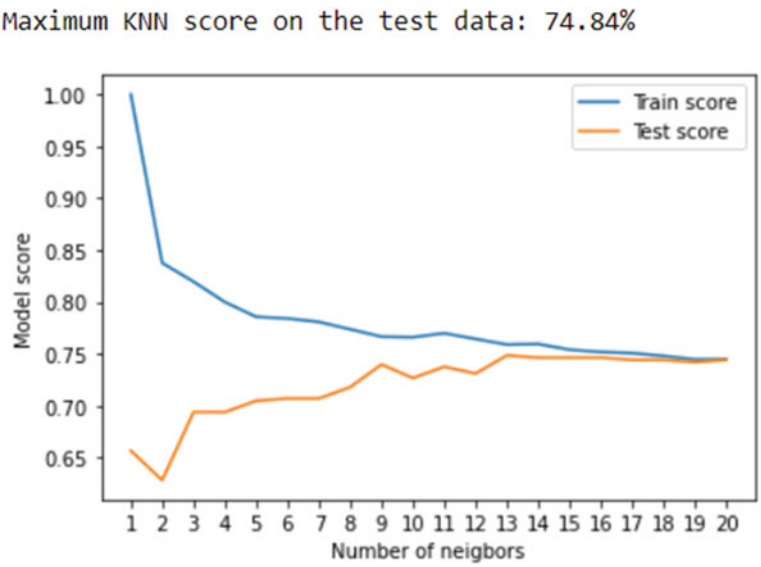

Fig. 5 Train test scores of KNN after tuning

Table 2 Accuracy model scores of LR and RF after tuning

Model	Accuracy (%)
LR	**75.05**
RF	**79.43**

4.6 Classification Report

Table 3 depicts the classification report of our modified dataset with mixture of true and false, mostly false, mostly true, and no factual content being the rating of the news giving the precision (fraction of relevant values from retrieved data), recall (fraction values that are of interest from retrieved data), and f1-score (harmonic mean of precision and recall) values.

Table 3 Classification report of our dataset

News type	Precision	Recall	F1-score
Mixture of true and false	0.43	0.21	0.29
Mostly false	0.67	0.11	0.18
Mostly true	0.82	0.96	0.88
No factual content	0.76	0.49	0.60
Macro-average	0.67	0.44	0.49
Weighted average	0.77	0.79	0.76

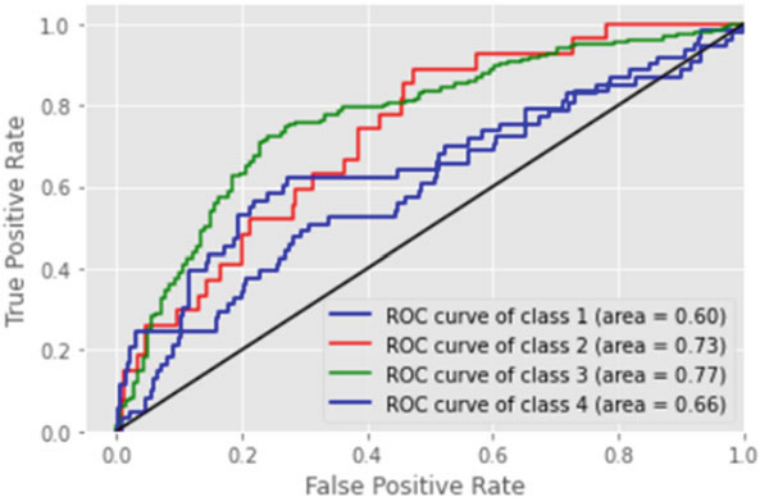

Fig. 6 ROC curve of the four classes, i.e., four types of news

4.7 ROC Curve

Figure 6 depicts the ROC curve of the different types of rating of the news. The index is mixture of true and false is class 1, mostly false type news is class 2, mostly true type news is class 3, and no factual content.

5 Fake News Predictor Application

5.1 Interface and Input

Figure 7 depicts the web app interface which will predict the rating of the news based on user input of the input columns mentioned in Fig. 1. This web app has been made using Streamlit library of Python 3.7 on which machine learning codes have been embedded with user interaction features of Streamlit. The entire dataset is the default training set whereas the user input feature is the test dataset.

Figure 8 depicts the prediction made by the fake news predictor app based on user input which comes to be mostly true. Also the app shows the prediction probability of all the rating types thus giving a proper justification of its own prediction.

Fig. 7 Predicting app features

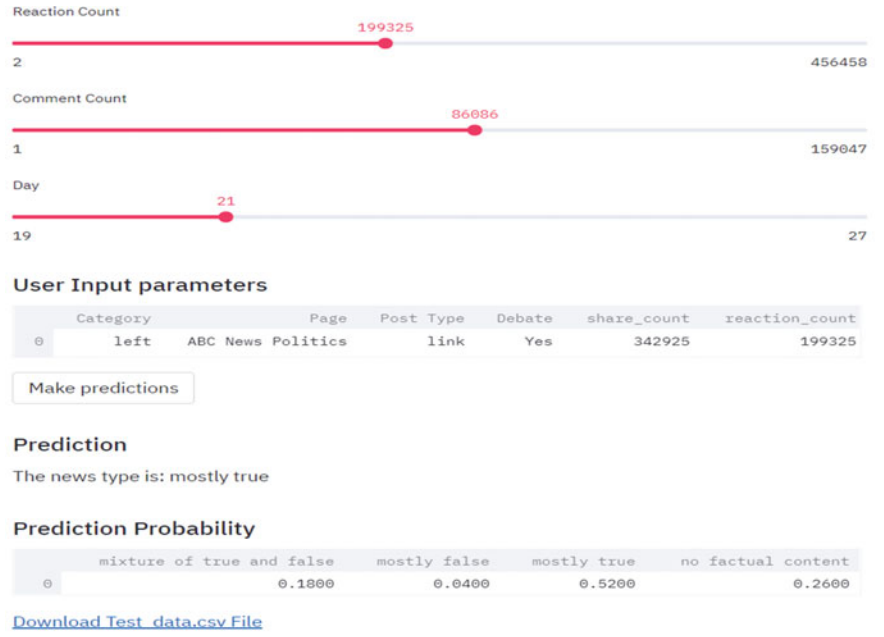

Fig. 8 Prediction made by the app on given features

5.2 *Fake News Predictor App Automatic Updation of Dataset*

The proposed model is a self-driven model who takes the user input along with its own dataset on its own, not involving any human interaction on its part. Hence, we can say the more the model is used by users across the globe, the model will increase its accuracy on its own by appending the user inputs also without any knowledge of the user. Figure 9 shows the strength of the dataset before prediction is made by the app and we can see that the total dataset strength is 2285.

Figure 10 shows the strength of the dataset after a prediction is made by the app which comes to be one more row than the previous figure, i.e., Fig. 9.

After making a prediction:

The total strength becomes 2286 and also the user input of the last try is captured thus becoming a live real-time artificial intelligence model. The working model can be found at https://share.streamlit.io/aritra1311/fake-news/predict.py.

2276	2	3	1	3	0	174	1394	626	27
2277	2	3	1	3	0	171	484	320	27
2278	3	4	1	3	0	108	162	5	27
2279	3	4	1	3	0	76	149	3	27
2280	2	3	1	3	0	66	543	163	27
2281	3	4	1	1	0	308	435	512	27
2282	3	4	1	3	0	100	173	10	27
2283	1	9	2	4	0	24499	47312	1375	27
2284	3	4	1	3	0	2	23	3	27
2285	2	3	1	3	0	8	95	47	27

Fig. 9 Number of entries before prediction

2277	2	3	1	3	0	171	484	320	27
2278	3	4	1	3	0	108	162	5	27
2279	3	4	1	3	0	76	149	3	27
2280	2	3	1	3	0	66	543	163	27
2281	3	4	1	1	0	308	435	512	27
2282	3	4	1	3	0	100	173	10	27
2283	1	9	2	4	0	24499	47312	1375	27
2284	3	4	1	3	0	2	23	3	27
2285	2	3	1	3	0	8	95	47	27
2286	1	1	1	3	1	342925	199325	86086	21

Fig. 10 Number of entries after prediction

6 Conclusion

Nowadays, we are very much dependent on social media for news but it is not sure that weather the news are real or fake. So, lot of times users are influenced by fake news and that leads to many problems like riots, violence, mob lynching, etc. So, to help the common people whether the news shared is fake or real news this web application can be very much useful. Here user can give some input related to the news and it will predict whether the news is real or fake or half-true. This machine learning model achieves an accuracy of 80% and this web application can help the user to be aware of fake news and aware others also. The automatic updation of dataset and data sharing without user involvement in this proposed model is an added advantage.

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A New Single-Phase Asymmetrical Multilevel Inverter Topology with Reduced Switching Devices for Different Pulse Width Modulation Techniques

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Abstract A multilevel inverter is a widely used electrical apparatus for the purpose of power conversion. The unique topology of an asymmetrical inverter is suggested to obtain the same output voltage with lower losses using a less number of switches and DC input sources when compared to traditional topologies. The suggested topology delivers an improved output waveform having low total harmonic distortion (THD) and less switch count leads to a reduction in the size and overall installation cost of the inverter circuit. In this paper, a nine-level asymmetrical multilevel inverter is analyzed by MATLAB/Simulink R2013b software version, and a comparative study of THD analysis between different pulse width modulation (PWM) techniques and required power components between conventional and proposed topology is done.

Keywords Modulation · Inverter · Distortion · Topology

1 Introductions

An inverter is an electrical apparatus made for power conversion. It is used when the supply is DC power and our requirement is AC power. Inverter plays a key role in operating household appliances when failure of AC supply occurs [1, 2]. The operation of MLI can be done not only with lower fundamental switching frequency but also with higher fundamental switching frequency. In the present-day scenario, inverters are manufactured using MOSFET or IGBT transistor. The history of multilevel inverters began in the mid-1970s. A multilevel inverter is designed to convert the lower level direct current input into the desired alternating current output. A two-level inverter is a key element for MLI.

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In cascaded H-bridge topology, the voltage levels at the output terminals depend on the total number of H-bridges used in a circuit, whereas each H-bridge is a combinational structure of four switches and four diodes. Also, the number of required input DC sources is equal to H-bridges used in the MLI circuit. The advantage of this topology over the other two topologies is that it does not need any capacitor or diode for clamping purpose [3, 4].

In flying capacitor MLI topology, capacitors are used for clamping purpose. Theoretically, this topology is able to design infinite voltage levels, but in reality, it provides six levels of voltage due to practical limitations.

In diode-clamped MLI topology, only one DC input source is required to supply the power, whereas the required number of switches is twice the DC split capacitors required to obtain AC output voltage. This topology offers high switching efficiency at fundamental frequency but a group of capacitors should be precharged.

Generally, the classification of a multilevel inverter can be done in the following two types: symmetrical and asymmetrical. If all the input DC sources have the same magnitude, it is called symmetrical MLI, while if all input DC sources have different magnitude, it is called asymmetrical MLI. The paper suggests a unique asymmetrical nine-level multilevel inverter topology using different types of pulse width modulation techniques which needs less number of switches compared to traditional inverter topologies [5].

2 Proposed Topology

It is clearly observed from the general structure of the proposed topology shown in Fig. 1 that it requires N voltage sources (V_1, V_2, V_3, …, V_N) of different magnitudes and (N + 5) unidirectional switches (S_1, S_2, S_3, S_4, …, SN+5) for generation [3 N−(1/2){1 + $(-1)^N$}] levels of the output voltage at load terminal. To attain the equally spaced levels of output voltage, the magnitude of voltage sources for the general structure of the proposed topology can be determined as follows:

$$V_N = \left\{ \begin{array}{cc} V_{DC} & \text{for N} = 1 \\ V_{DC} & \text{for even N i.e. N} = 2, 4, 6, \ldots... \\ 2V_{DC} & \text{for odd N \& } N \neq 1 \text{i.e.} N = 3, 5, 7, \ldots... \end{array} \right\}$$

In this paper, the proposed topology is applied for nine-level inverter shown in Fig. 2, which needed three voltage sources (V_1 and V_2 are of same magnitude but V_3 of different magnitude) and eight unidirectional switches (S_1, S_2, S_3, S_4, S_5, S_6, S_7 and S_8). A unidirectional switch is a two-quadrant switch that provides bidirectional conduction and unidirectional voltage blocking capability.

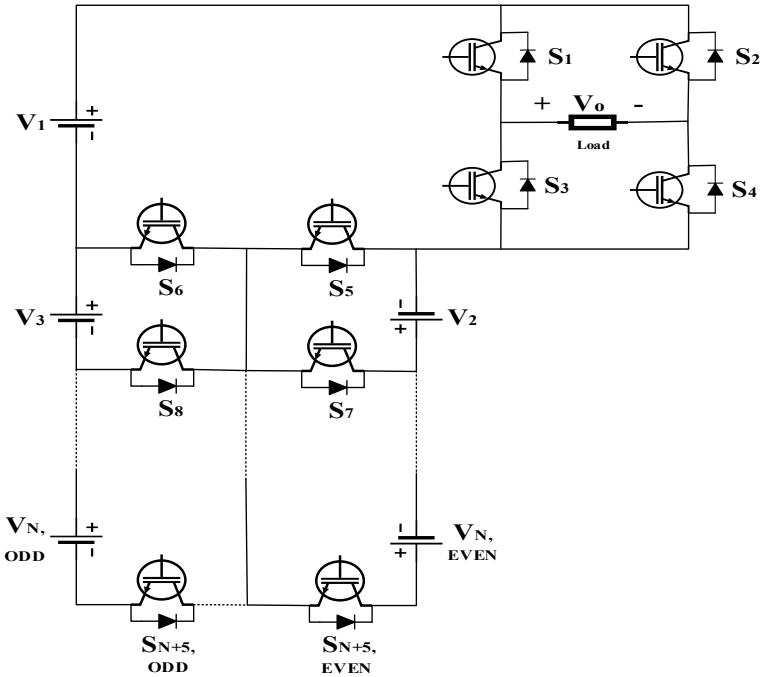

Fig. 1 The general structure of the suggested topology

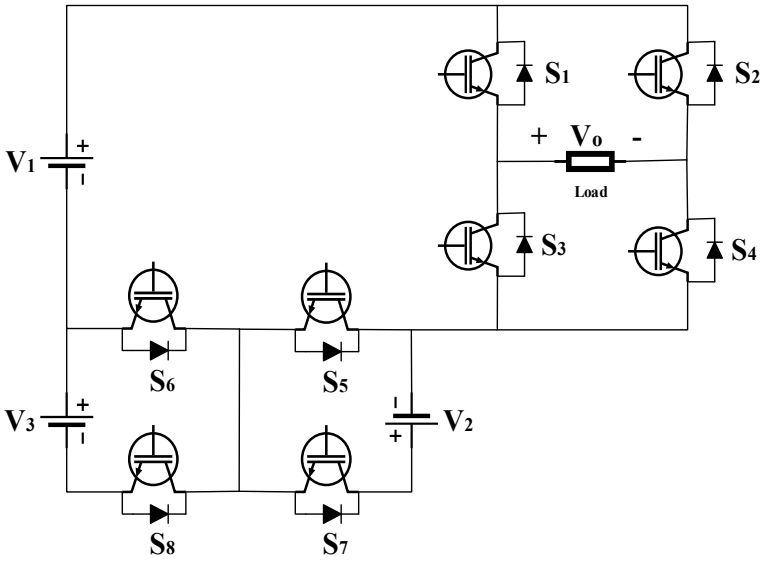

Fig. 2 Proposed nine-level asymmetric MLI structure

3 Operating Modes of Proposed Topology

See Fig. 3.

4 Pulse Width Modulation Techniques

Implementation of PWM techniques is done to obtain the gate signals required for operating switching devices. The purpose of PWM modulation techniques is to control the output side fundamental voltage with mitigation of harmful effects of harmonics. In PWM modulation techniques, sine wave is taken as reference wave and triangular wave as carrier wave. (N − 1) carrier waves are required for N-level voltage generation between load terminals. On comparing reference wave with carrier wave at every point, a gate pulse is generated [7–9].

To study the THD analysis of nine-level asymmetrical multilevel inverter, PDPWM, PODPWM, APODPWM and COPWM techniques are applied.

4.1 Phase Disposition (PD) PWM Technique

In this technique, all applied carrier waves having the same amplitude and frequency are in the same phase with each other (Fig. 4).

4.2 Phase Opposition Disposition (POD) PWM Technique

In this technique, all applied carrier waves have the same amplitude and frequency, but carrier waves applied above the zero reference have a 180° phase difference with respect to carrier wave applied below the zero reference (Fig. 5).

4.3 Alternate Phase Opposition Disposition (APOD) PWM Technique

In this technique, all the carrier waves have a 180° phase difference with respect to their neighboring carrier wave. But all the carrier waves have the same magnitude and frequency (Fig. 6).

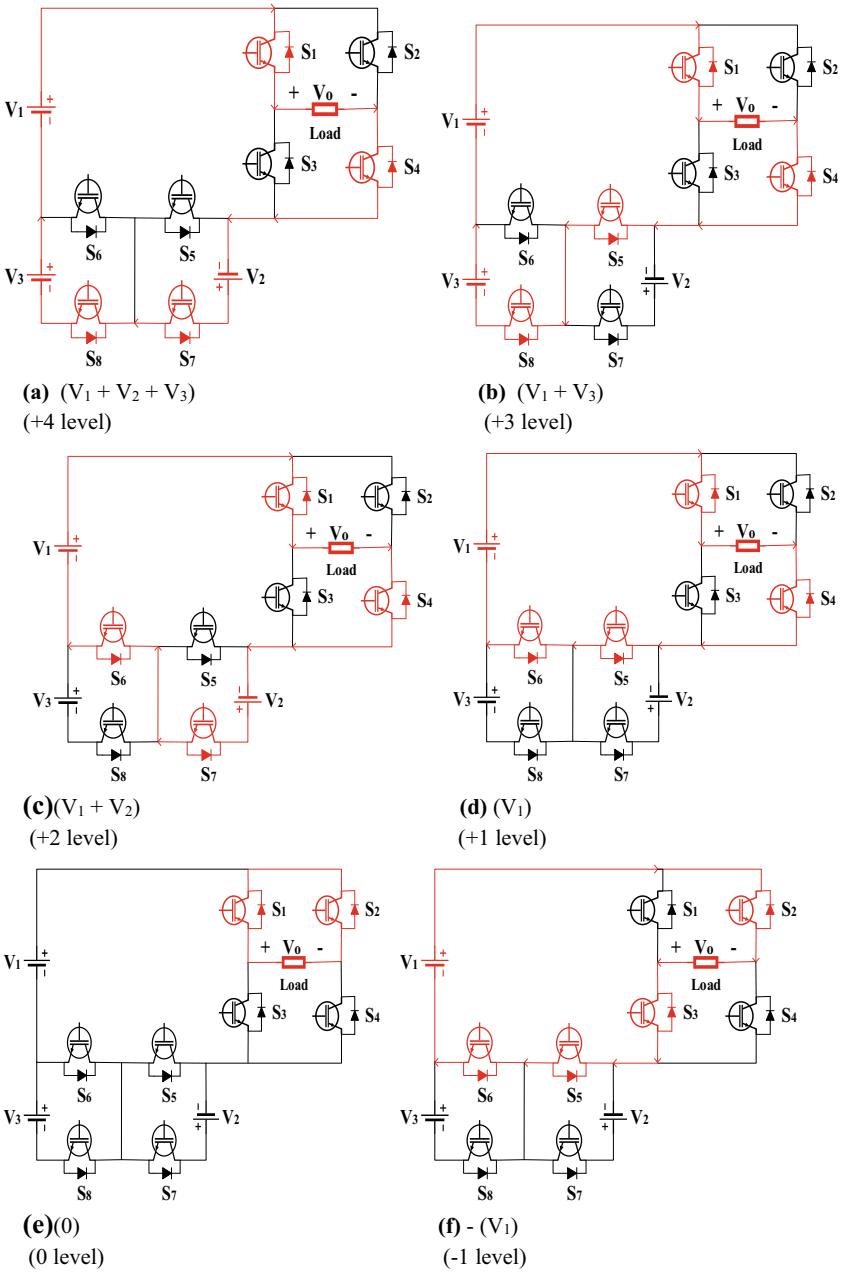

Fig. 3 Figures (**a**-**i**) are operating modes of presented nine-level asymmetrical MLI

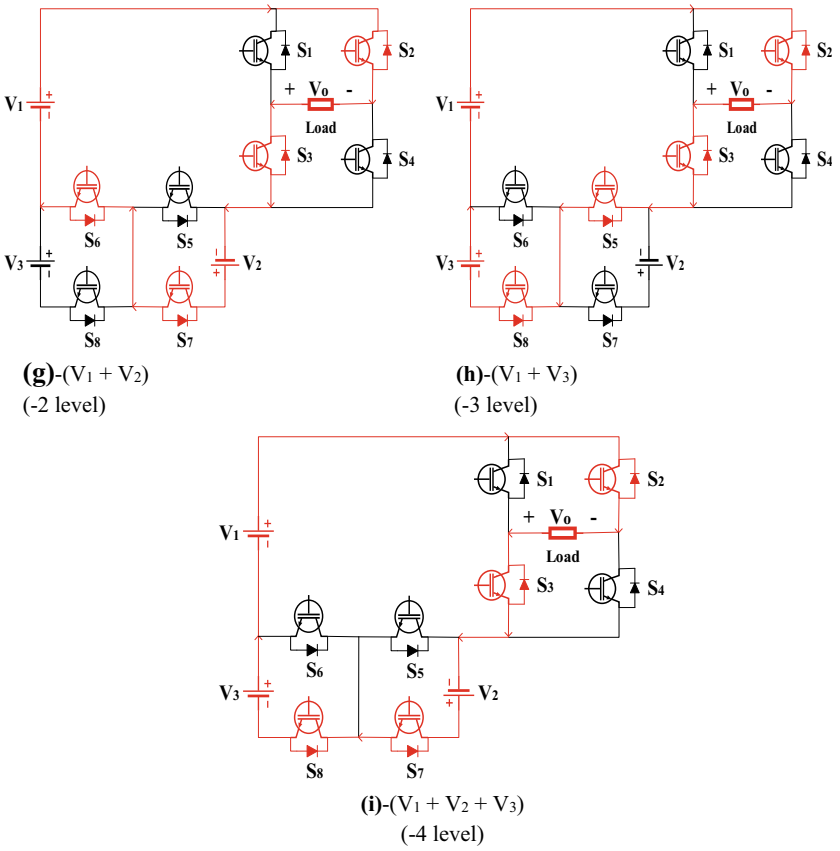

Fig. 3 (continued)

4.4 Carrier Overlapping (CO) Technique

The whole carrier waves which are used in this technique are the same frequency and amplitude but the band occupied by each carrier wave is overlapped with the band of the neighboring carrier wave. The overlapped vertical distance between each carrier wave is half of the amplitude of carrier wave (Fig. 7).

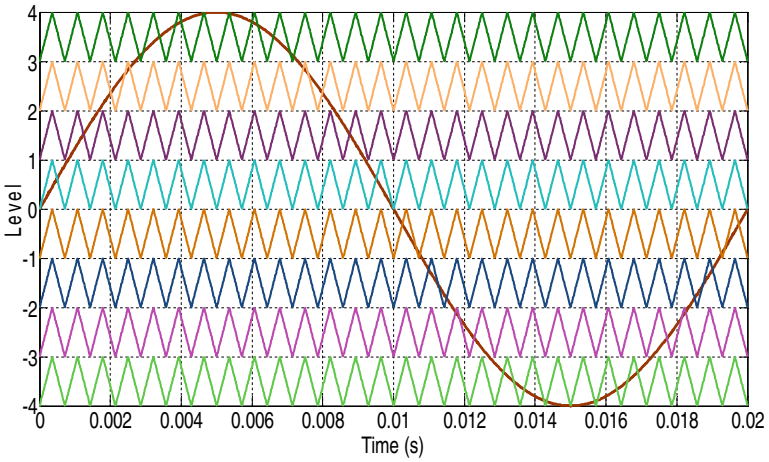

Fig. 4 Carriers and modulating signal at $M_a = 1$ Query ID="Q3" Text="Caption of Figs. 4 and 5 seems to be identical. Please check and correct if necessary." Query ID="Q4" Text="Caption of Figs. 4 and 6 seems to be identical. Please check and correct if necessary."

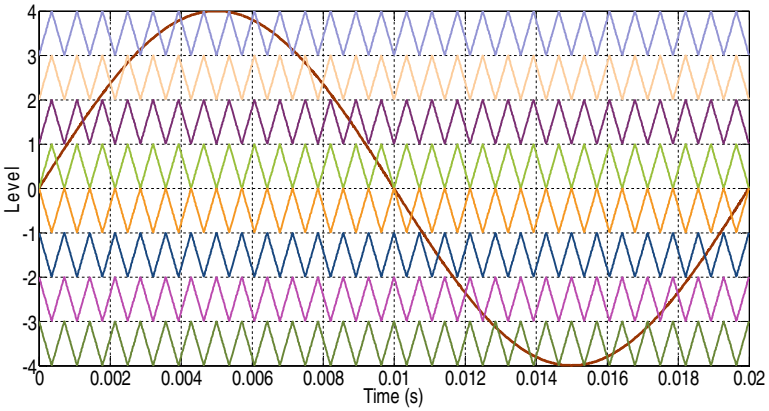

Fig. 5 Carriers and modulating signal at $M_a = 1$ Query ID="Q5" Text="Caption of Figs. 5 and 6 seems to be identical. Please check and correct if necessary." Query ID="Q6" Text="Caption of Figs. 5 and 7 seems to be identical. Please check and correct if necessary."

5 Simulation Results

The proposed nine-level asymmetrical MLI is simulated in MATLAB/Simulink R2013b. Parameters used for the proposed nine-level MLI during the simulation process are load ($R = 10\ \Omega$) and sources ($V_{1\_} V_2 = 100$ V and $V_3 = 200$ V). The frequency of the reference wave is 50 Hz and the frequency of the carrier wave is 1.4 kHz. For calculation of total harmonic distortion, modulation index (M_a) is

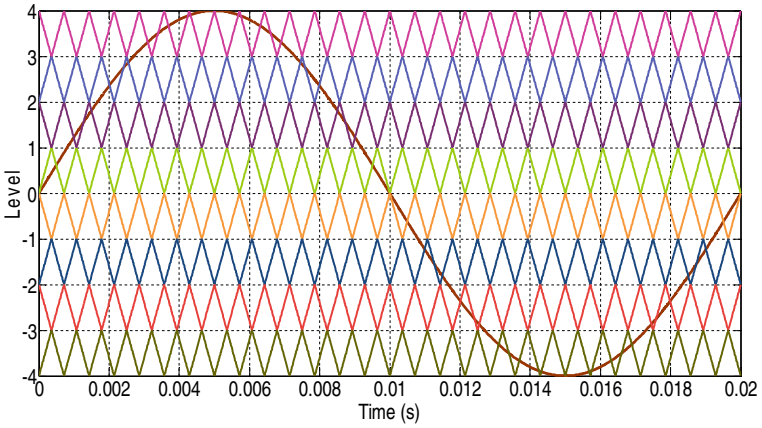

Fig. 6 Carriers and modulating signal at $M_a = 1$ Query ID="Q7" Text="Caption of Figs. 6 and 7 seems to be identical. Please check and correct if necessary."

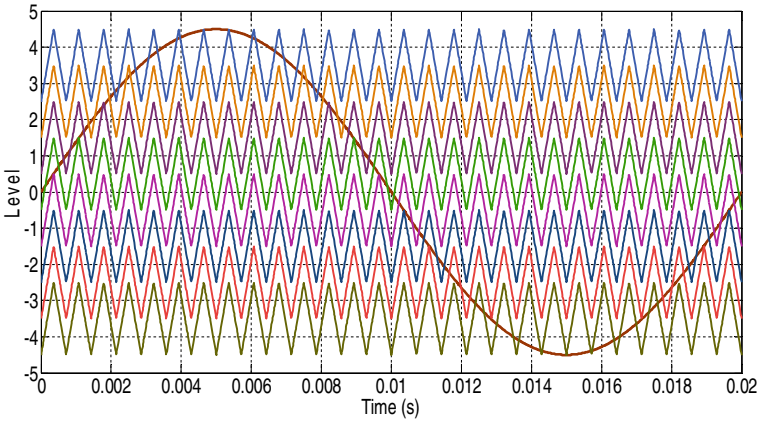

Fig. 7 Carriers and modulating signal at $M_a = 1$

a variable but frequency modulation (M_f) is 28. The output result of the proposed nine-level asymmetrical MLI using the POD-PWM technique is shown in Fig. 8. Total harmonic distortion (THD) with corresponding PWM techniques is shown in Figs. 9, 10, 11 and 12 and the comparison has been shown in Table 1.

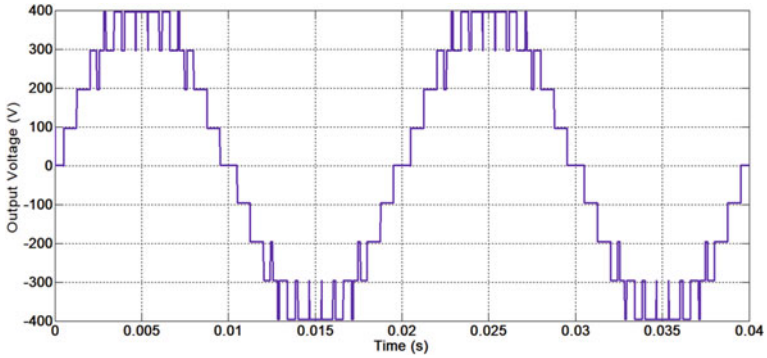

Fig. 8 Output wave of nine-level asymmetrical MLI

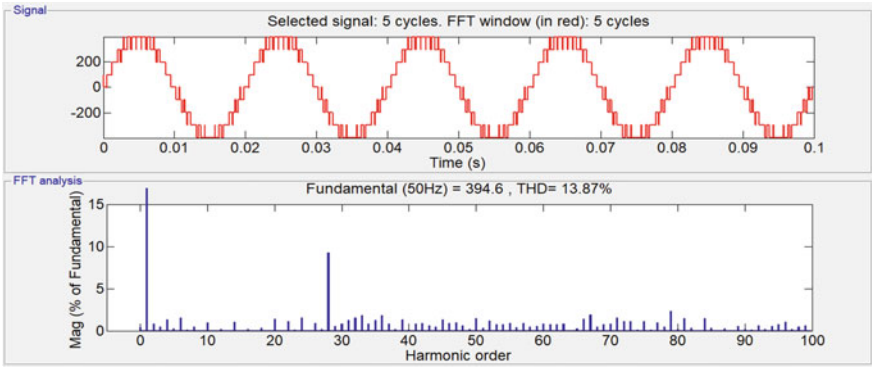

Fig. 9 THD of nine-level asymmetrical MLI PD-PWM

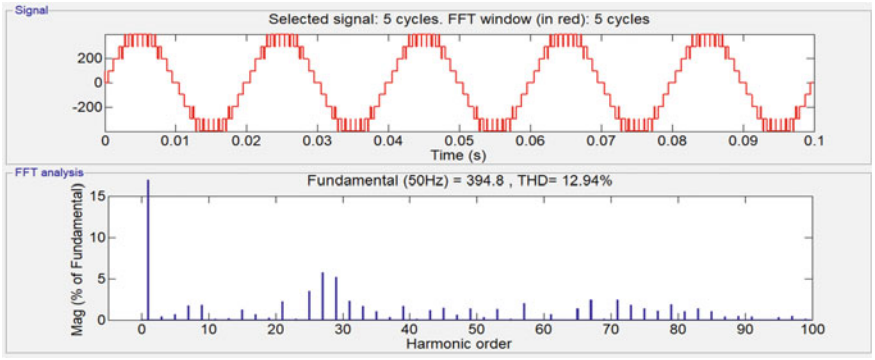

Fig. 10 THD of nine-level asymmetrical MLI POD-PWM

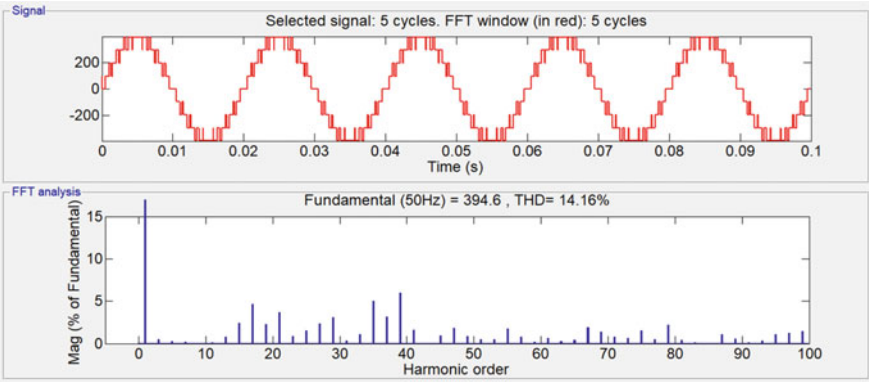

Fig. 11 THD of nine-level asymmetrical MLI APOD-PWM

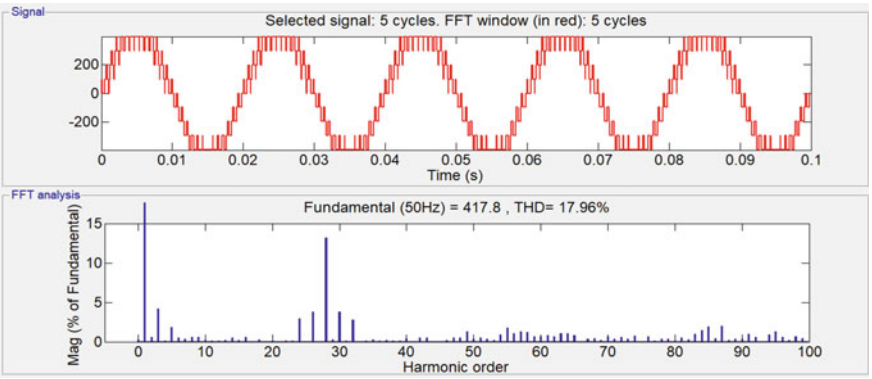

Fig. 12 THD of nine-level asymmetrical MLI CO-PWM

Table 1 Comparative study of THD analysis between different PWM techniques for proposed nine-level asymmetrical MLI

Modulation Index	PWM techniques			
	PD	POD	APOD	CO
1	13.87	12.94	14.16	17.96
0.95	15.51	14.59	16.32	19.70
0.90	16.87	16.11	16.61	21.03
0.85	17.37	16.96	16.79	22.66
0.80	16.97	16.44	15.14	24.30

Table 2 Comparative study of required components between conventional and proposed nine-level asymmetrical MLI

MLI components	Cascaded H-Bridge	Flying capacitor	Diode clamped	Proposed topology
Switching devices	16	16	16	8
Clamping diodes	–	–	56	–
DC split capacitor	–	8	8	–
Clamping capacitor	–	28	–	–
DC sources	4	1	1	3
Total	20	53	81	11

6 Conclusion

This paper proposed a topology of MLI having low switch count, lower losses, lower cost, better efficiency and smaller size, etc. in comparison to traditional inverter topology. So, a nearly sinusoidal output voltage waveform can be obtained by increasing the lower number of switches per voltage level using the proposed inverter topology. For the proposed nine-level inverter topology, THD is 12.94% at output waveform using POD-PWM technique having modulation index ($M_a = 1$). It is clearly observed from Table 2 that it requires a smaller number of switches to produce the same output voltage in comparison to other inverter topologies. It can be used as motor drives for induction motor, shunt active filters and power factor compensators, etc.

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Study of Filters for Improving the Output of Cascaded Seven-Level Inverter

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Abstract Poor quality is one of the prime problems in the electrical system. In recent times, high power demand and good quality of power are major concerns in an electrical system. In this paper, a conventional multilevel inverter topology is proposed and to design the LC filter and LCL filter that attenuate the ripple in the output waveform of the proposed MLI topology. The proposed topology used symmetrical configuration, i.e., the dc-link voltage is the same for each H-bridge cell. The performance of MLI is calculated by THD parameter, and the results of the proposed topology with LC, LCL circuit, and normal circuit are compared along with PD, POD and APOD-PWM techniques, followed by over and under modulation index.

Keywords Multilevel inverter · THD · PWM · Filter · Cascade H-Bridge

1 Introduction

A multilevel inverter is the most popular power converter device used for high power and high voltage applications [1]. The application based on renewable energy is more popular nowadays and power quality is a big challenge. The multilevel inverter is used in renewable power applications as its input is connected to the renewable energy source and its output to the grid. All the converters are nonlinear devices, so they create harmonics, and these harmonics degrade the quality of output power. To eliminate this problem the filter circuit is used at the load side. The selection

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of the filter is also a big challenge to attenuate particular harmonics. In this paper, two passive filter circuits, LC circuit and LCL circuit, are used, and the performance of these two filter circuits on a seven-level cascade H-Bridge PWM inverter was compared. The performance is measured in terms of total harmonic distortion factor.

2 Proposed Topology

The proposed topology is a conventional cascade H-Bridge seven-level inverter. It has an isolated DC voltage supply for each cell. In a seven-level topology, three H-bridge cells require and three separate DC voltage sources [2] are needed. If the DC voltage source has equal magnitude the configuration is known as symmetric configuration, and if these DC voltage sources have unequal magnitude then the configuration is known as asymmetric configuration. Table 1 shows the switches sequence to obtain voltage levels of the proposed topology. For +3 V level switch sequence 1, 3, 5, 7, 9, 11 is ON and the remaining switches are off. For +2 V level switch sequence 1, 3, 5, 7, 9 and 10 is ON. For +1 V level switch sequence 1, 3, 5, 6, 9 and 10 is ON. For +1 V level switch sequence 1, 3, 5, 6, 9, 10 is ON. For 0 V level switch sequence 1, 2, 5, 6, 9, 10 is ON. For −1 V level switch sequence 2, 4, 7, 8, 11, 12 is ON. For − 2 V level switch sequence 2, 4, 6, 8, 11, 12 is ON. For −3 V level switch sequence 2, 4, 6, 8, 10, 12 is ON. Switch configuration is chosen in such a way that stress on the switch remains low. So here use the redundancy method to select the switch to achieve the particular voltage level.

The proposed topology is suitable for high voltage and high power applications [3]. The advantage of the proposed topology is that it does not require any clamping diode and capacitor, so the required component in the proposed topology is less than the other two-diode clamped and flying capacitor topology [4, 5] (Fig. 1).

Table 1 Switching sequence of the proposed topology

Level	Magnitude	Switch configuration											
		1	2	3	4	5	6	7	8	9	10	11	12
1	+3 Level	ON		ON		ON		ON		ON		ON	
2	+2 Level	ON		ON		ON		ON		ON	ON		
3	+1 Level	ON		ON		ON	ON			ON	ON		
4	0 Level	ON	ON			ON	ON			ON	ON		
5	−1 Level		ON		ON			ON	ON			ON	ON
6	−2 Level		ON		ON		ON		ON			ON	ON
7	−3 Level		ON		ON		ON		ON		ON		ON

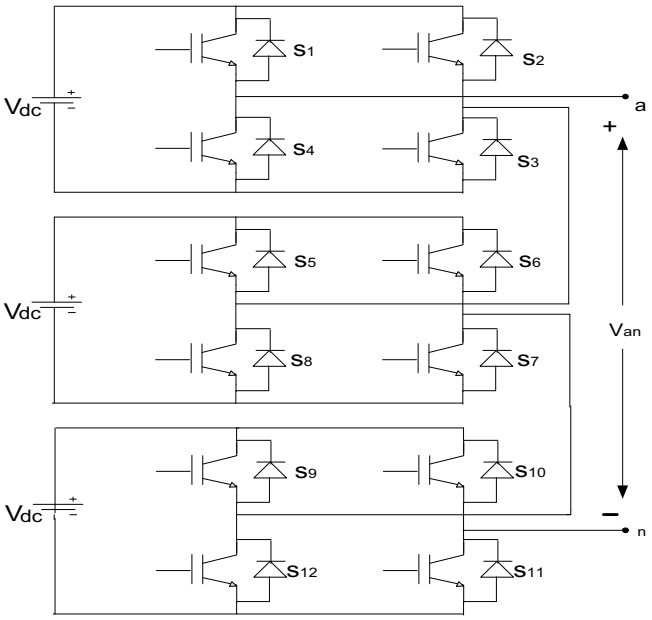


Fig. 1 Proposed topology circuit diagram

3 PWM Techniques in the Proposed Topology

The objective of PWM is to control inverter output and reduce the harmonics in the output waveform [6]. In this technique the pulses are generated according to output voltage level and this is done by comparing two waveforms. In this one waveform is a reference waveform of fundamental frequency and the other is a carrier waveform of high frequency [7], [8]. The frequency of carrier waveform is very high compared to reference waveform [9]. In this paper for the proposed topology the level-shifted PWM technique is used as given below. The proposed topology is a seven-level topology, so here the reference signal is a sinusoidal waveform of 50 Hz frequency and the number of carrier waveforms is 6 and each has 2 kHz frequency.

3.1 PDPWM

All carrier waveforms have the same magnitude and same frequency and have zero-phase shifting to adjacent waveform [10]. Figure 2 shows the configuration of PDPWM.

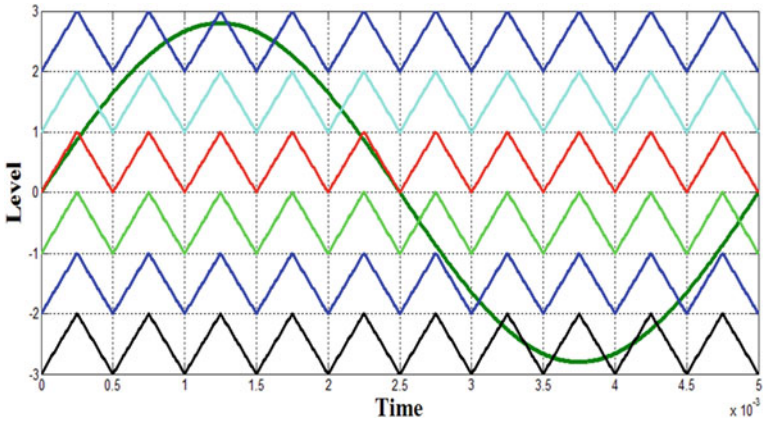


Fig.2 Reference and carrier waveform arrangement for PDPWM

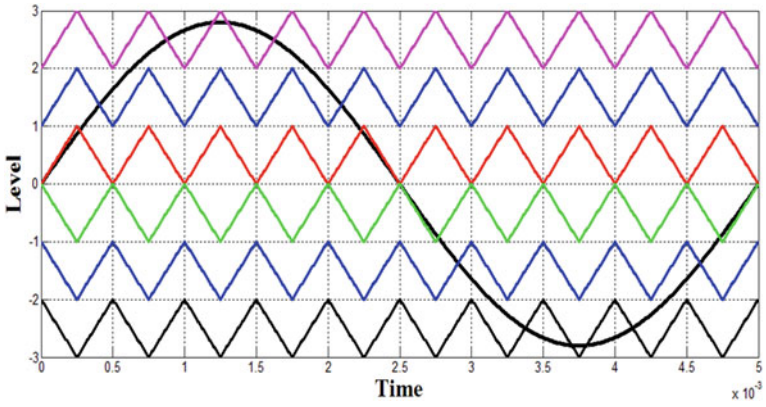


Fig.3 Reference and carrier waveform arrangement for PODPWM

3.2 PODPWM

All the carrier waveforms have the same magnitude and same frequency but the positive carrier and negative carrier groups have 180° phase shift. Figure 3 shows the PODPWM configuration.

3.3 APODPWM

All carrier waveforms have equal magnitude and frequency but adjacent carriers have 180° phase shift to each other. Figure 4 shows the APODPWM configuration.

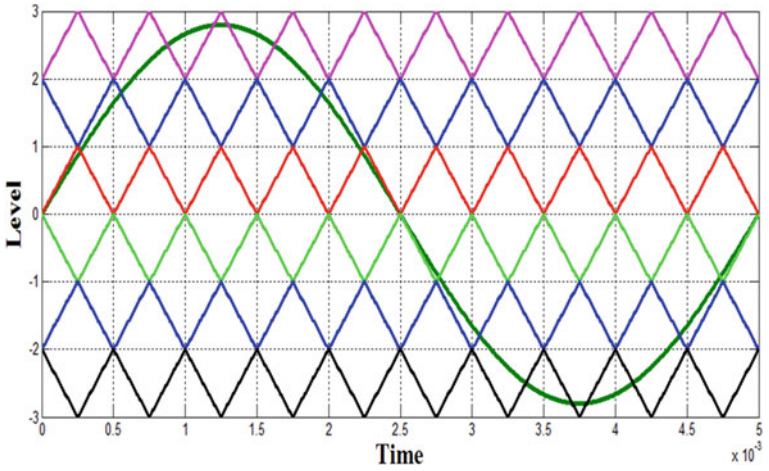
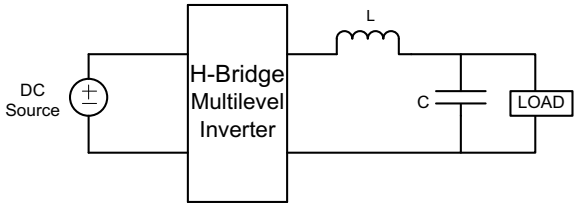


Fig. 4 Reference and carrier waveform arrangement for APODPWM

4 Passive Filter Circuit

In this paper, to improve the quality of voltage at the load side passive filter circuit is used. Passive filter circuits are of different types as single L with load, which gives less distorted output current to load. The combination of L and C has a different combination which provides the attenuation to harmonics [11]. In this paper two configurations of passive filter circuit are used, one is LCL filter circuit and the second is LC filter circuit. The LC circuit is a low pass filter circuit and it is able to attenuate the lower order harmonics in the output waveform. It is a second-order filter circuit giving −40 dB/decade attenuation and LCL circuit as high-pass filter circuit and a third-order filter circuit that gives −60 dB/decade attenuation. The elements L and C are considered lumped. The arrangement of the LC and LCL filter circuits is shown in Figs. 5 and 6.

Fig. 5 LC filter arrangement



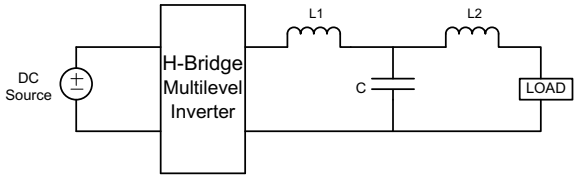


Fig. 6 LCL filter arrangement

5 Simulation Result

The simulation result for the proposed topology is derived from MATLAB Simulink 2010b software. The parameters used to simulate the results are DC input voltage is 10 V, reference waveform frequency is 50 Hz, carrier waveform frequency is 2 kHz, loads are resistive in nature and have the value of 10 Ω; filter circuit has L = 10 mH, C = 1 microfarad, L1 = 10 mH and L2 = 0.5 mH. The result simulated with over, under and unity modulation index with respect to level-shifted PWM techniques for LC, LCL filter circuit and with a normal circuit of the proposed topology (Figs. 7, 8, 9, 10, 11 and 12).

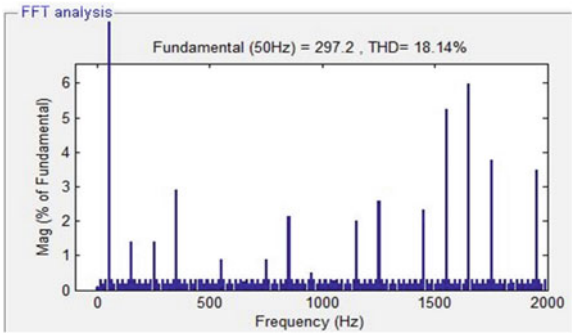


Fig. 7 THD of APOD with Ma = 1.0 (without filter circuit)

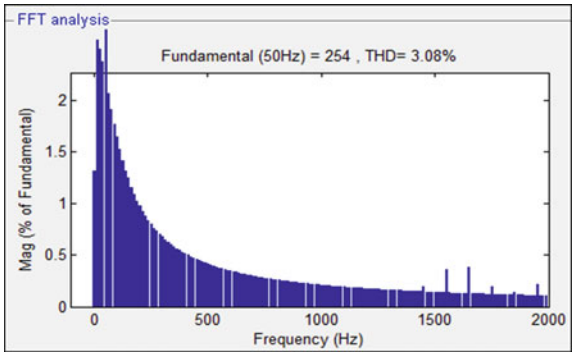


Fig. 8 THD of APOD with Ma = 1.0 (with LC filter circuit)

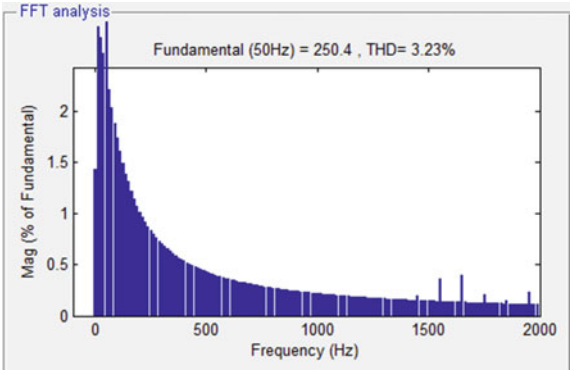


Fig. 9 THD of APOD with Ma = 1.0 (with LCL filter circuit)

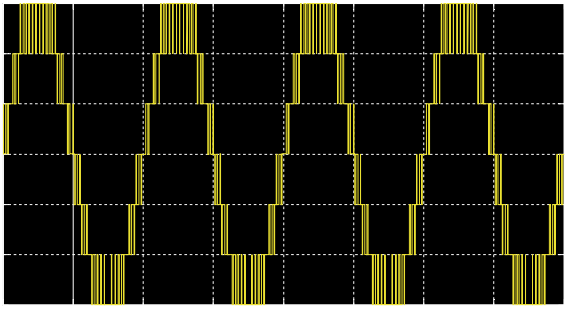


Fig. 10 Output waveform of without filter circuit

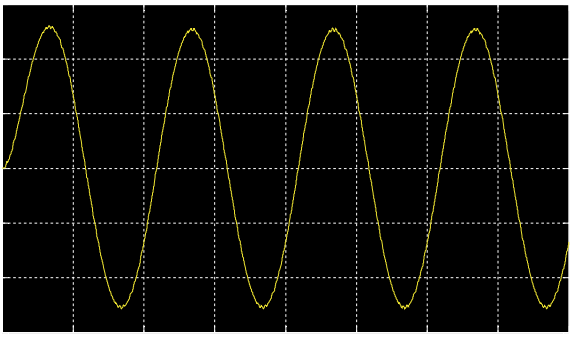


Fig. 11 Output waveform of LC filter circuit

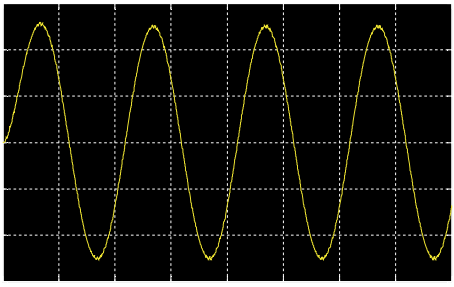


Fig. 12 Output voltage waveform of LCL filter circuit

6 Conclusion

The comparative study of total harmonic distortion analysis for the proposed topology with passive filter and normal circuit is presented in this paper. With the use of a filter circuit, the output waveform has less harmonic component, which improves the quality of power. Table 2 shows the simulation result and made a comparison between the normal circuit, LC filter circuit and LCL filter circuit. Figures 13, 14 and 15 show the comparison graph for over, unity and under modulation index, which shows the % total harmonic distortion value in the proposed topology with passive filter circuit and normal circuit followed by level-shifted PWM techniques. The LCL filter sometimes causes steady-state and transient problems due to resonance, hence the LC filter is widely used as it attenuates lower order harmonics which is more important in inverter application. The result obtained with the filter circuit is within the IEEE THD limit. This shows the usefulness of the filter circuit in the proposed topology.

Table 2 % THD result of the proposed topology

Modulation index (MI)		Without filter circuit			LCL filter circuit			LC filter circuit		
		PD	POD	APOD	PD	POD	APOD	PD	POD	APOD
Over modulation	**1.1**	17.05	16.88	17.05	3.52	3.61	3.68	3.42	3.50	3.58
Unity modulation	**1.0**	18.88	18.20	18.14	3.06	3.23	3.23	2.91	3.08	3.08
Under modulation	**0.9**	22.92	23.05	22.92	3.18	3.29	3.29	3.03	3.14	3.13

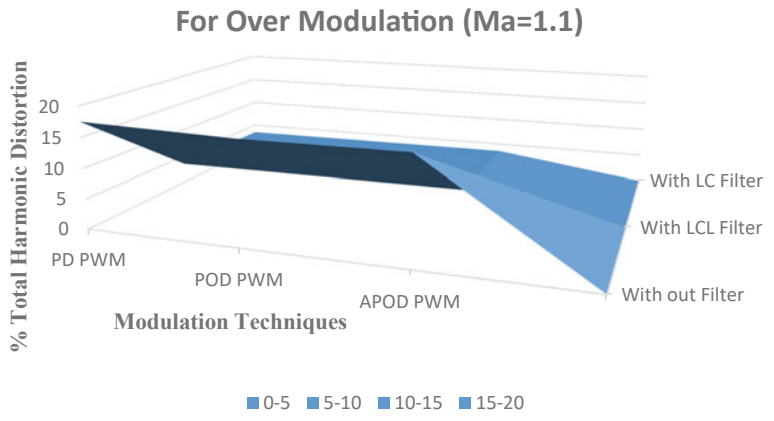


Fig. 13 Comparison graph for over modulation index

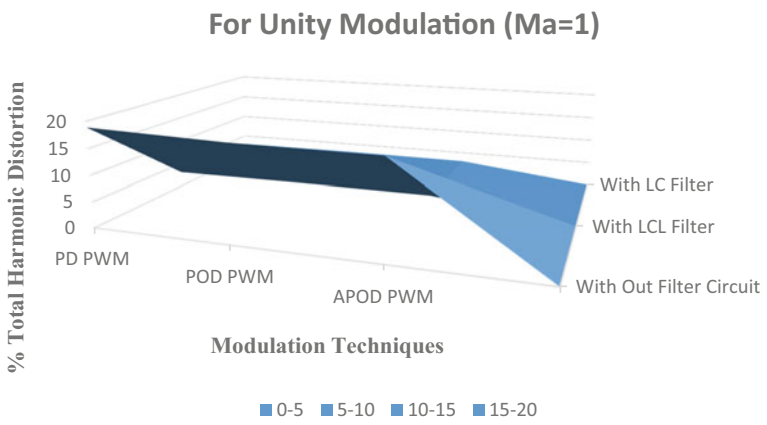


Fig. 14 Comparison graph for unity modulation index

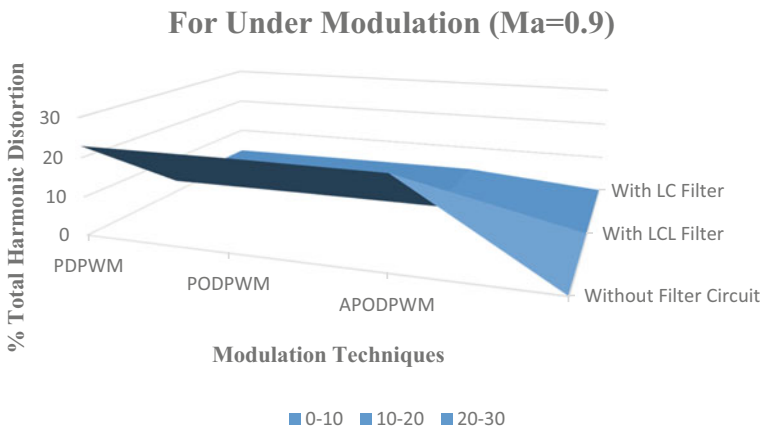


Fig. 15 Comparison graph for under modulation index

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A Review on Cloud Computing Architecture

Animesh Kumar and Sandip Dutta

Abstract Cloud technology is one of the most used technologies in the twenty-first century. More or less every organization and individual rely on the use of cloud computing techniques for their day-to-day work. In this paper, a discussion of all the selected architectures in cloud computing used by cloud service providers is done.

Keywords Cloud computing · Deployment · CORBA · EJB · Serverless computing

1 Introduction

In today's modern era of technological advancement, almost everyone is dependent on the use of information technology for the fulfillment of day-to-day work off recent. Cloud computing has rapidly gained momentum as a technology to be relied upon. It provides a user the benefit of accessing remote or virtual storage from the comfort of their fingertip. These services provided by cloud computing are well known to everyone interested in this field and do not need an introduction here. Although cloud computing is heavily used today, it has its open research problems. Among many such problems, resource allocation and security are two of the major problems in this field. Allocating resources to different jobs in a way that both the SLA and QoS are maintained is a challenging task in the cloud environment [1]. Often the cloud service provider tries to adopt a scheduling strategy such that their profit is maximized.

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2 Cloud Computing

Cloud computing provides the facility to use all the resources like storage device servers, networking, services on a "pay per use basis" [2]. It offers client heterogeneity, openness, scalability, transparency, concurrency, and round-the-clock availability.

2.1 Types of Cloud Computing

There are generally four types of cloud computing. These are mentioned below.

Private Cloud: These types of cloud are completely private in nature. Industries generally want to design their own data center to be only used within the company, purely private in nature. No one is allowed to access the cloud data via open access. Data are not to be shared outside the cloud system.

Public Cloud: This cloud is open to all public services. Cloud services are allowed to use on pay per basics. No need for companies to manage their own data center. Nearly all the maintenance is done by cloud service providers. For example, Amazon web services, Google cloud service, Alibaba cloud.

Hybrid Cloud: This cloud is a mixture of both public and private clouds. Sometimes there is a need to share some data or services to be hosted for public use from the private cloud. It helps the user to use the available resources efficiently.

Community Cloud: This type of cloud is specially designed to meet the specific requirement of industry, community, MNCs. It integrates the different cloud services and collectively shows them to the user. It may be managed by the cloud service provider or with the help of a third-party vendor. They share the same policy, security standard, and compliance.

3 Types of Cloud Services

There are generally three types of cloud computing.

Infrastructure as a Service (IaaS): In this type of cloud service, storage, networking, servers, computation, and other essential resources are provided by cloud service providers. Application, data, operating system, middleware, and its runtime are all managed by cloud users [3]; for example, Google photos, Facebook, Salesforce.

Platform as a Service (PaaS): Application and data users are managed by the client while networking, storage, server, virtualization, operating system, middleware, and runtime are all managed by cloud service providers [4]. It also provides the platform

to test, develop, and arrange applications as per specific requirements. For example, Windows Azure, AWS Elastic Beanstalk.

Software as a Service (SaaS): In this type of cloud all the facilities are provided by a cloud service provider. Application, data, networking, middleware, runtime, virtualization, operating system server, storage are all managed by cloud service providers [5]. For example, Dropbox, Google workspace.

4 Cloud Computing Architecture

Cloud computing is purely based on the concept of distributed computing. Distributed system interlinked the systems and appears the user as a single system. They communicate and coordinate their work bypassing the message among themselves. The most popular is client–server architecture. Clients are connected through a server either by an intranet or by the internet. Servers control the client system.

5 Cloud Computing Deployment Models

Mainly there are three types of cloud deployment models.

Traditional Deployment: In a traditional deployment, hardware forms the core layer and operating system embedded on hardware. The service application is installed on the operating system.

Virtualized Deployment: In virtualized deployment apart from the hardware, operating system, the hypervisor is also added. A hypervisor is located above the operating system. A virtual machine, operating system, bin along service application are also there in virtualized deployment, as shown in the Fig. 1.

Container Deployment: Container deployment has recently been introduced in cloud computing. Hardware, operating system, container, bin, application all are deployed in container deployment (Fig. 2).

6 Technologies Used in Cloud Architecture

- Common Object Request Broker Architecture (CORBA)
- Enterprise Java Beans
- Serverless Technology in Cloud

Common Object Request Broker Architecture (CORBA): It provides the facility for users to work in both cross-platform and cross-language among distributed

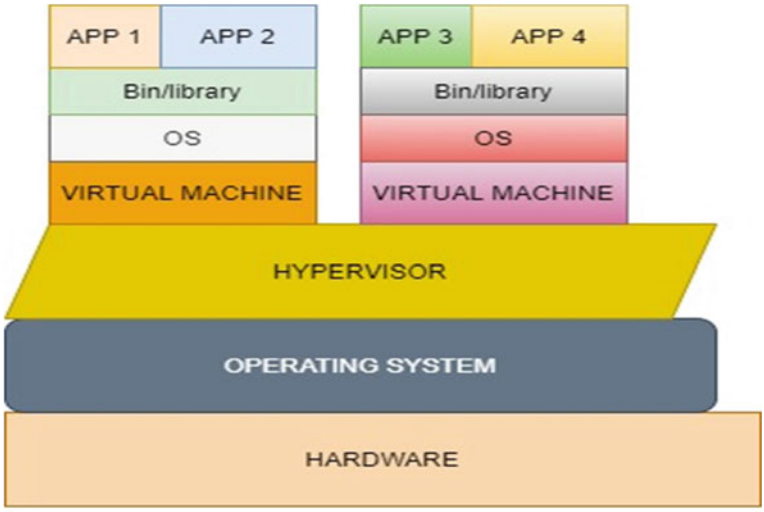

Fig. 1 Virtualized deployment

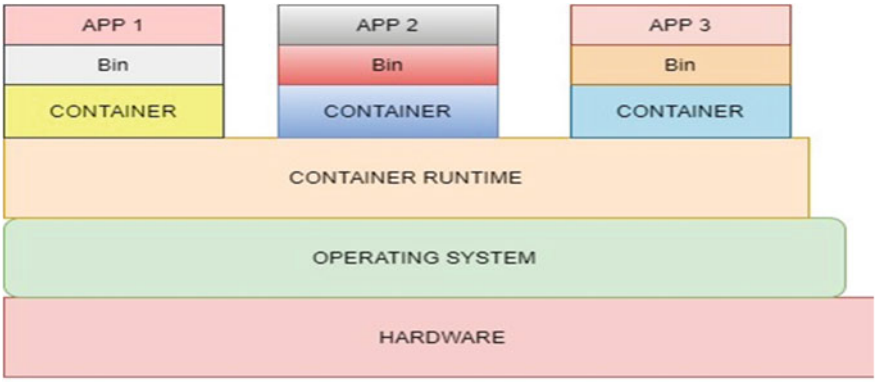

Fig. 2 Container deployment

systems. These are mostly used on an industry level. Object request broker forms the core of CORBA architecture (Fig. 3).

Enterprise Java Beans: EJB was developed by Sun Microsystem. It provides better security and scalability in distributed systems. Life cycle management and object pooling are its additional features (Fig. 4).

Serverless Computing: It is a model where a cloud service provider dynamically manages the computing resources of the server. The consumers have to pay only for the actual time and actual volume of resources used by them. No need to pay for the rest of the time. This model is successfully adopted by AWS lambda (Fig. 5).

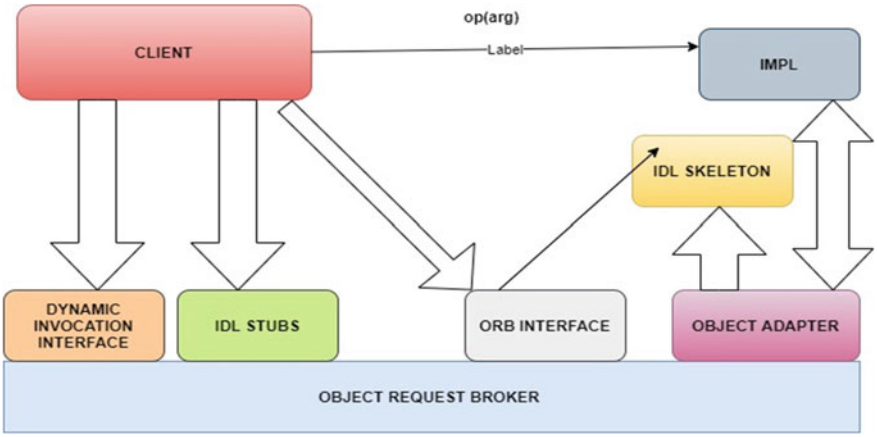

Fig. 3 CORBA

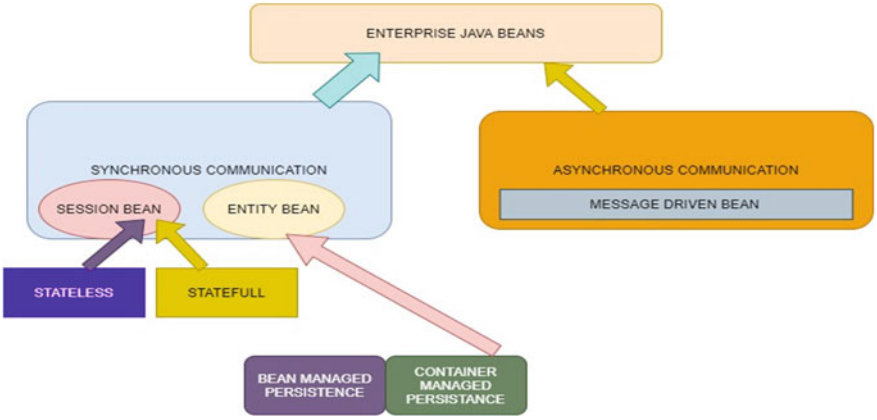

Fig. 4 Enterprise resource beans

7 Conclusion

In this paper, a detailed survey was done to review all architectural aspects of cloud computing. The architectural review was done on the basics of types of cloud, deployment models in cloud computing by cloud service providers. Based on cost analysis, serverless computing is the best among all available architectures.

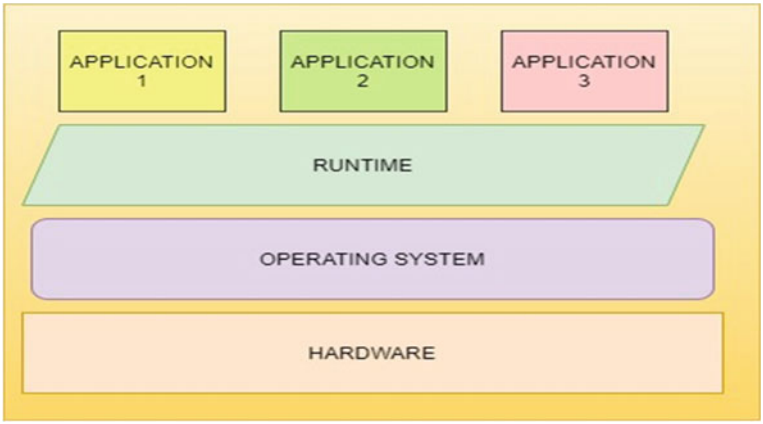

Fig. 5 Sharing resources in serverless computing

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Self-Cleaning System for Solar Powered Home and Street Lights

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Abstract The paper present the self-cleaning system for solar-powered home and street lights, in which it is designed and built the robot which is used to clean the surface of the photovoltaic panel. A wiper is connected with the robot, which removes the dust particles from the surface of the photovoltaic panel. This robot moves in forward and backward directions by changing the polarity of DC motors. An Arduino UNO microcontroller is connected to the circuit box, which receives the signal from the computer. This Arduino UNO microcontroller is connected with the motor driver, which drives the DC motors in forward and backward directions. The communication of signal from computer to Arduino is done by the bluetooth module. One water motor is also connected parallel to the circuit box in the pole; the water is sprayed on the solar panel in the form of water drop at the time of it required specially when the robot is in the working mode.

Keywords Solar panel · Robot · Arduino · Water · Aluminium frame

1 Introduction

Energy plays an important role in our present daily life. As the population and demand of electronic marker is increasing, the energy consumption is also increasing. For fullfilling the consumer's demand the power generation station is running at their peak, and the world fossil fuel is decreasing that will be depleted in few 100 years. For solving this problem, India has used 23.51% of renewable energy in production of electricity in 2019, in which 2% of solar energy is used in production of electricity [1–3]. About 365 days in a year, India has 300 days clear and sunny days, which is good for installation of solar plant in a country. But the problem of solar panels is they

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Table 1 Dust effect on solar panel

Dust sample type	Weight (g)	Power loss (%)
Red soil	25	59.31
Brick powder	25	58.37
Coal ash	25	42.05
Limestone	25	46.62
Silica sand	25	48.03
Sand	25	55.00

require a proper cleaning on a daily basis or after a particular period of time, and as we all know in Indian environment we get different types of dust particles, and these dust particles will cover the surface of the solar panels, so it cannot absorb the proper sunlight, which decreases the efficiency of solar panels. So, there is a need of solar panel cleaning system, to increase the solar panel's efficiency by cleaning the dust particles from the surface glass of PV panel [4–6]. The efficiency of monocrystalline, polycrystalline solar panel is (14–18%) and (12–14%), respectively, and the thin film solar panel have the lowest cell efficiency as compared to both of these solar panels, is (5–6%). There are several environmental and natural factors, which decrease the efficiency of solar panels like soil, snow, etc. In different places, we get different types of dust particles like red soil, cement, brick powder, ash, limestone, silica. sand, soil, harmattan dust, etc., out of them ash, limestone, silica sand and soil have greater effect on the solar panel [7–10]. Table 1 indicates the experiment of different types of dust we apply on the solar panel to decrease the efficiency of solar panel.

2 System Design

The design of the self-cleaning solar-powered home and street lights system consists of various components and each component have their own functions. These components are used for cleaning the surface glass of the PV panel. The system is designed in two parts (1) Mechanical setup, (2) Control system. The components are listed below with their function, significance and their location in the system.

2.1 Mechanical Setup

In the mechanical setup, several components are participating like Aluminium frame, robot and water spray system, which are shown in Fig. 1.

A. Aluminium frame

We take aluminium to make the frame, which is located outside the solar panel in which the robot moves. We take aluminium frame due to its lighter in weight and

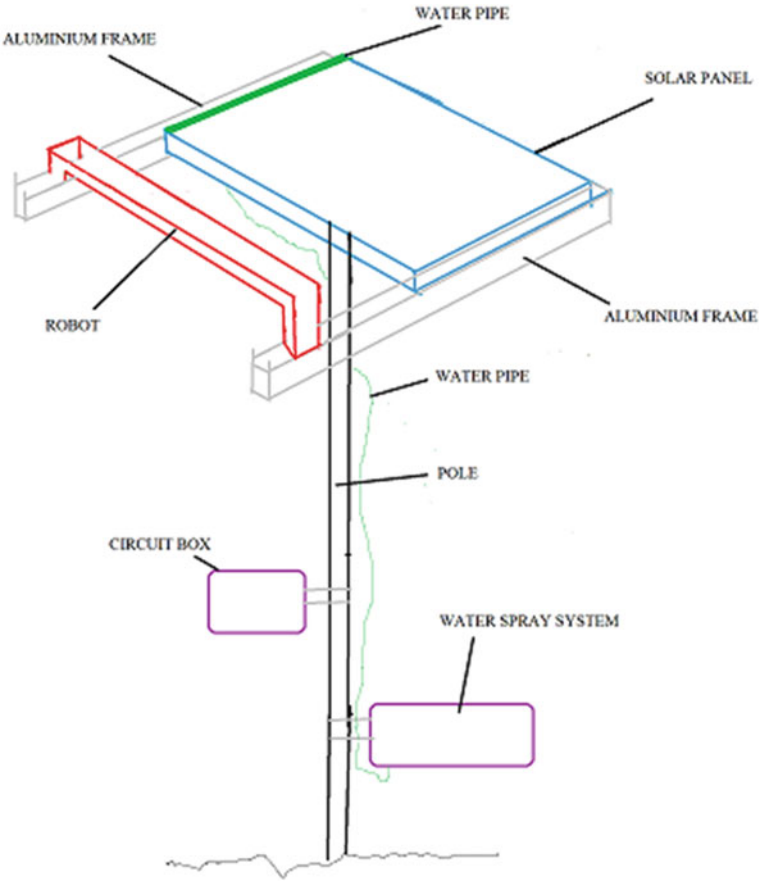
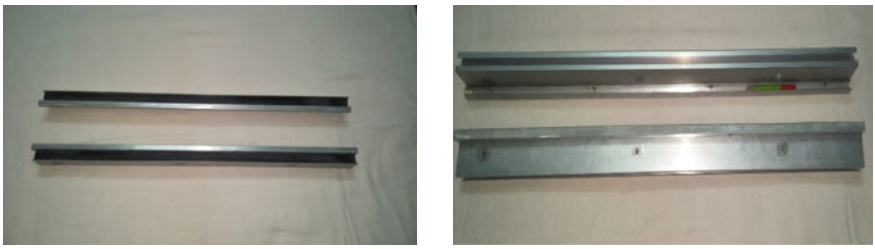


Fig. 1 Actual position of each components in system

corrosion less properties. This frame is situated horizontally to the solar panel; the use of aluminium frame is to provide a path to the robot in which it can move forward and backward directions. For this framework we use different types of aluminium channel, each channel has different dimensions. We divided these channels into two parts (1) Rolling channel, (2) Support channel. Table 2 shows the proper dimension of channels (Figs. 2 and 3).

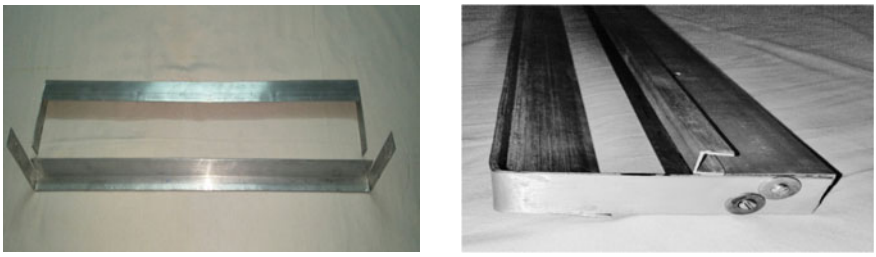
Table 2 Dimensions of rolling and support channel

Dimensions	Rolling channel	Support channel
Length	30 inches	30.5 inches
Width	1 inch	1.5 inches
Height	2 inches	2.5 inches



(a) (b)

Fig. 2 Rolling channel



(a) (b)

Fig. 3 Support channel

B. Robot

For cleaning the dust particles from the surface glass of the PV system, the robot moves in forward and backward directions on the surface of solar panel. The robot is made up of aluminium channel, in which the two DC motor is connected at the sides of the aluminium channel, in the aluminium channel the door wiper is attached with the help of nuts. The dimensions of the robot and door wiper are given in Table 3a; Table 3b presents a DC motor ratings which we occupy by testing the DC motor speed in laboratory (Figs. 4 and 5).

C. Water spray system

For the water spray system, we take a car water sprayer which works by receiving the signal from the microcontroller which is used in the circuit box. The command

Table 3a Dimensions of robot and door wiper

Dimensions	Robot	Door wiper
Length	22 inches	21 inches
Width	1.5 inches	
Height	1 inch	

Table 3b DC motor ratings

DC motor ratings	Voltage (V)	Current (A)	RPM
1	6	0.15	42
2	8	0.17	57.3
3	9	0.18	62
4	10	0.19	71.8
5	12	0.20	86.0

Fig. 4 Robot

Fig. 5 Final picture of aluminium framework with robot

Table 4 Specifications of water spray motor

Dimensions and ratings	Water spray motor
Dimension	35 × 72.5 mm
Rated voltage	12v
Rated flow rate	2.6LPM, 44.2psi
Max flow rate	4.9LPM, 20.8psi
Max pressure	57.0psi
Weight	98 g

Fig. 6 Water spray system

of microcontroller is given by the user. Table 4 represents the specification of motor and water tank capacity is 2.5 L, which is filled manually (Fig. 6).

3 Control System

A. Arduino UNO driving DC Motor using L293D H-bridge motor driver

As we see in the block diagram, a small DC motor is driven by Arduino UNO using L293D h-bridge motor driver IC. The motor upward and downward motion is controlled by motor driver L293D and Arduino UNO. Microcontrollers are operating with very small currents. The current at their output pins is may be in microamperes, thus with that current electrical motors are not operating. The DC motor used for cleaning the solar panel is operating at nearly 100–250 mA continuous current but microcontroller and Arduino are operating with 20 mA to 40 mA current. Thus with this amount of current motor driver and motor are unable to operate. So it's clear that to operate the DC motor we require external source. For that transistor or MOSFET-based drive is the best solution to drive the motor clock and antilock wise direction. To control the motor we are using H-bridge L293D motor drive IC. This IC is compact in size and easy to handle. This IC requires VCC voltage to operate. First they are 5 V and 12 V. With this drive IC we can connect two motors at a time (Fig. 7).

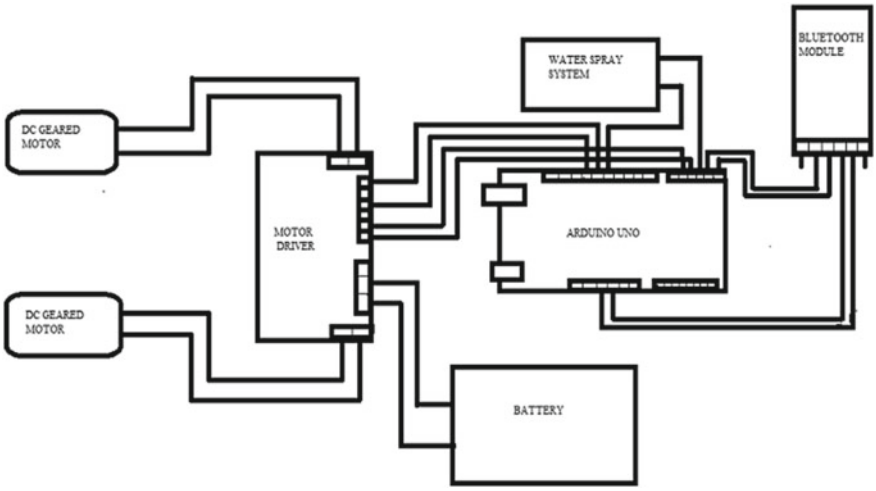


Fig. 7 Block diagram of control system

B. DC motor speed and direction control using Arduino by Bluetooth module

In this designed system, DC motor control is implemented by using hc-06 Bluetooth device by the mobile application. Each time when the mobile application is opened and the start button is pressed, the Arduino UNO will receive the signal. This way the designed system is very effective to operate. When the ON signal match, then the code written inside those functions of Arduino will be executed and the motors will start moving the robot. The connection of the Bluetooth module hc-06 with Arduino should be performed like this. The HC-06 VCC pin is connected to Arduino supply (5 V), Ground pin of HC-06 is connected to ground pin of the Arduino, Transmitter of the HC-06 to Receiver pin of Arduino, Receiver pin of HC-06 to Transmitter pin.

Now coming to the control of the motors, by typing '1' in the android application left side motor rotates in forward direction. By typing '2' the right side motor rotates in forward direction. By typing '3' both the motors will rotate in forward direction and for the backward type '4'. Finally to stop the motors send a command '0' (zero).

C. Horizontal Rail with Horizontal Brush

By keeping the cleaning brush horizontally to the solar panel surface, we could design a horizontal rail design which is depicted in Fig. 8. Although this design looks more difficult it can brush off dust more effortlessly by moving the motors clock and anti-clock direction off the solar panel.

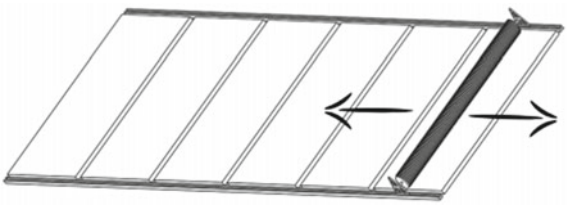


Fig. 8 Design of horizontal brush

4 Testing and Analysis

To analyze the performance of the robot for cleaning the surface of the solar street light during the impact of dust, we analyzed two results.

A. Robot working result

By making Pin#7 HIGH and Pin# eight LOW, this sign is going to the L293d Pin#2 and seven which made our motor to run in clock or anti-clock clever route relying on your configuration. Motor stays in this situation for four seconds then the country of the pins changes. Now each of the pins are at LOW method 0 which make the motor to prevent and motor stops for three seconds, this step may be very essential due to the fact now we need to extrade the route and if we extrade it with none put off, then it can be risky for our circuit and motor driver. while the motor rotates it generates a lower back EMF (electro reason force) in it and while it stops this EMF transmits lower back out to the circuit, which may be harmful. That's why we stopped the motor for three seconds. Then once more we rotate the motor however this time in the contrary route, through making Pin# eight HIGH and seven LOW. Motor now rotates in contrary route for four seconds. After it once more a put off and motor stops. After all of those steps, the loop characteristic repeats and the circuit carry out the identical steps from the start. Figure 9 shows the simulation of the motor in proteus software and the clockwise and anti-clockwise rotations are shown in Figs. 10 and 11.

B. Solar panel cleaning

The data of solar panel is collected in three stages. (1) Normal condition, (2) Dust impact, (3) After cleaning. The data are collected by applying the dust on the surface glass of the photovoltaic, to see how the dust affects on the solar panel. Table 5 presents the measurements taken, before and after the dust particles are applied on the surface of solar panel and what result should we receive after cleaning the solar panel. Figure 12 shows the solar panel under dust condition.

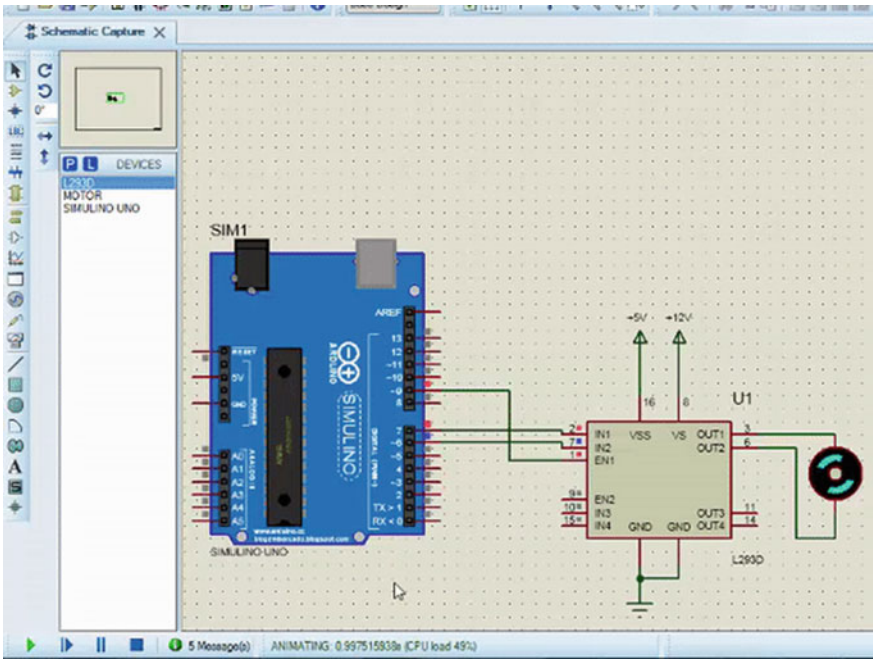


Fig. 9 Simulation of DC motor

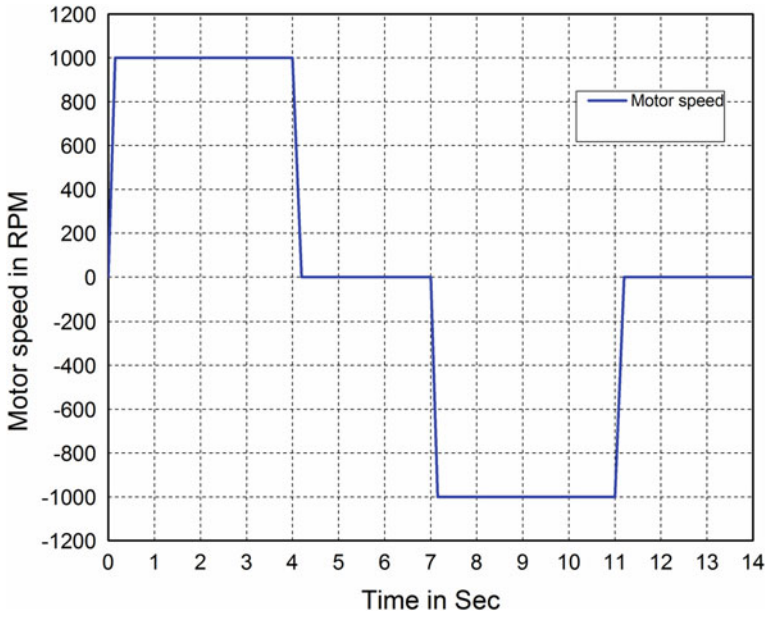


Fig. 10 Speed/time graph

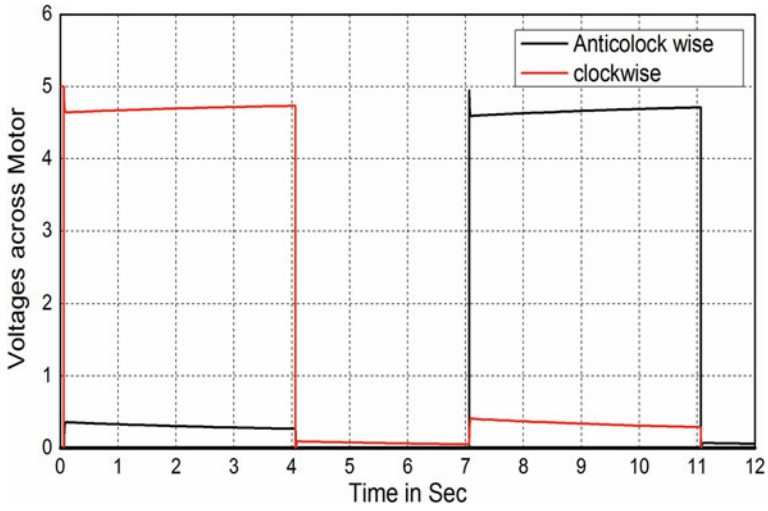


Fig. 11 Voltage/time graph

Table 5 Result and analysis

Measurements	Normal condition	Dust impact	After cleaning
Voltage (V)	22	13.2	22
Current (A)	2	1.5	1.9
Power (W)	45	20	40
Power loss %	2–3	10–15	3–5

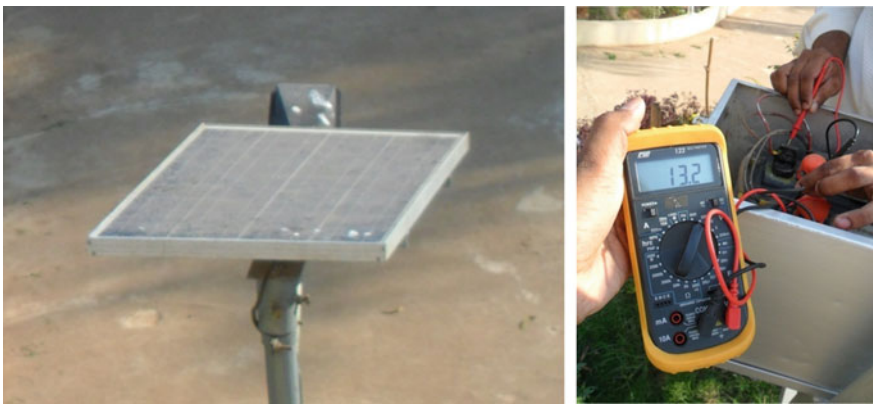


Fig. 12 Solar panel under test condition

5 Conclusion

For this paper, some experiments are done on robot by applying the different voltages to check the robot performance or speed on the solar panel. The tests are performing on clean solar panel and as well as dirty solar panel. For the dirty solar panel, we sprinkle the dust particles on the surface glass of photovoltaic panel. The mass and volume of the dust particles used in the experiment are specified as 25 g in weight.

The motive of sprinkling the dust particles on the surface glass of the photovoltaic panel is to check the capability of the self-cleaning system to remove dust particles for the surface of solar that help in regaining the efficiency of solar panel. After applying the dust on solar surface, we get 13% of power loss in the solar panel, when we apply water and clean the solar surface by robot, the percentage of power loss in solar panel decreases by 10%.

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A Design of Fork-Shaped Wearable Printed Antenna for Wireless Applications

Saraansh Srivastava, Stuti Srivastava, Amit Beliya, Ratnesh Tiwari, Anurag Saxena, and Vinod Kumar Singh

Abstract The research paper proposed a compact textile printed slot antenna with jeans material used as a substrate and copper tape is used for the patch and ground plane. The impedance bandwidth of 43.53% ranging from 4.04 GHz to 6.288 GHz was experimentally measured for the proposed antenna. The return loss of −18 dB at 4.12 GHz and −30 dB at 5.656 GHz is seen for the antenna and in the useful band, a comparatively stable radiation pattern is observed. Having compact size, the antenna shall widely be used in WiMax (5.25–5.85 GHz), WLAN (5.14–5.35 GHz) and C-band (4–8 GHz) applications. Simulation for the designed antenna was done using the Computer Simulation Technology (CST) studio suite 3D electromagnetic software.

Keywords CST software · Flexible printed antenna · Microstrip printed antenna · Textile substrate · Gain · Return loss · Directivity · Far-field

1 Introduction

Humans have faced continuous challenge when it comes to communicate between two far points. Initially by using smoke signalling techniques, then by telegraph sending and eventually the current ongoing wireless technology using electromagnetic signals. This evolving methodology has shown fruitful results in terms of quality to deliver various content either analog or digital. Wireless handheld devices are the most suitable examples of such innovation [1–5].

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In wireless communication, the antennas play a crucial role where the focus is on the low-profile, small size and multiband. The complex design of antennas is constantly evolving, with major reasons being market pressure, requirement and safety regulations. Current demands want antennas capable enough of radiating power to the limit in free-space conditions by keeping the power radiated towards the humans to be minimum. Wearable and flexible electronics technology are the two most recognized trends in today's world. The number of wearable devices currently available in the market including activity trackers, smart glasses, helmets and smartwatches seems to be growing exponentially. The wearable and flexible electronics technologies aim at creating a bond in everyday activities to maximize the quality of life [6–10].

Compared to other wireless networks, Body Area Networks have unique properties, one of which is the limitation of electromagnetic radiation due to its proximity to the human body. The equipment used in the Body Area Network has limited energy due to its compactness and small size. Under the concept of intelligent clothing, antennas and radio frequency systems are integrated into clothing so that the wearer does not notice the existence of these subsystems due to their small size and compactness. The effects of the human body on the operation of short-range antennas have been studied in detail, including the specific absorption rate (SAR) of short-range antennas used in cell phones [11–14]. The main area of application for sensors and antennas worn on the body today is in medical technology. For UHF and VHF bands, in particular, the military and military have long been investigating the possible uses of flexible and concealed portable antennas for communication purposes. The main goal is to achieve and provide a flexible, efficient, multifunctional multiband and hidden antenna system to provide reliability and security to soldiers. Wearable antennas cannot be placed in those places where they will be more prone to bend especially in places like sleeves because the resonance length of antennas can be changed; especially in the case of narrow band antenna [15–19].

2 Structure of Proposed Flexible Antenna

According to the design considerations for the patch antenna, the Jeans fabric which has low permittivity ($\varepsilon_r = 1.7$) has been utilized as a substrate. Jeans substrate also possess uniform electrical properties with a wide range of frequency. The patch dimension is 47.24×53.75 mm^2 and the ground dimension is 53.24×59.75 mm^2 using the transmission line model (Table 1).

Table 1 Dimensions of antenna design

Parameters	Value
f_o	2.4 GHz
ε_r	1.7
h	1 mm
Wg	59.75 mm
Lg	53.24 mm
L	47.24 mm
W	53.75 mm

3 Result and Discussion

The Fork-shaped design on the flexible textile patch antenna is shown in Fig. 1. The substrate thickness is calculated to be $h = 1$ mm (operating frequency (f_o) = 2.4 GHz). Figure 2 shows the simulated Reflection coefficient graph at 2.4 GHz. The proposed antenna designed on Jeans fabric substrate is found to achieve bandwidth of 43.53% which is from 4.04 GHz to 6.288 GHz. Figure 3 represents the VSWR vs. Freq. graph of proposed flexible textile printed antenna which is equal to 1.29 at 4.12 GHz and 1.07 at 5.656 GHz, respectively (Figs. 4, 5, and 6). Figure 6a–c show the 3D radiation pattern which is obtained from CST. The radiation pattern is usually presented in polar coordinates along with a dB scale. The proposed antenna has greater gain and improved radiation efficiency.

These were the basic parameters which were measured for the proposed fork-shaped flexible printed antenna having jeans material as the substrate where ground plane was partial by reducing its width. As a conclusion for the above analysis, the

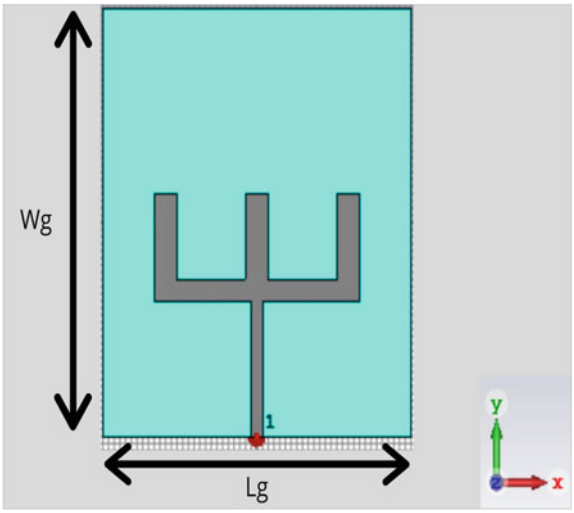

Fig. 1 Geometry of the proposed antenna

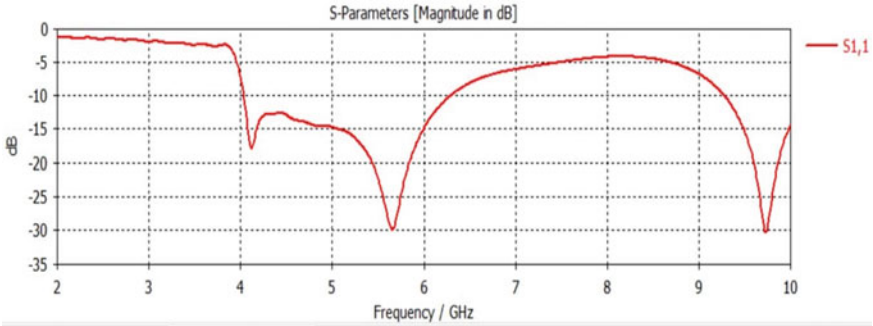

Fig. 2 Reflection coefficient of Flexible textile antenna

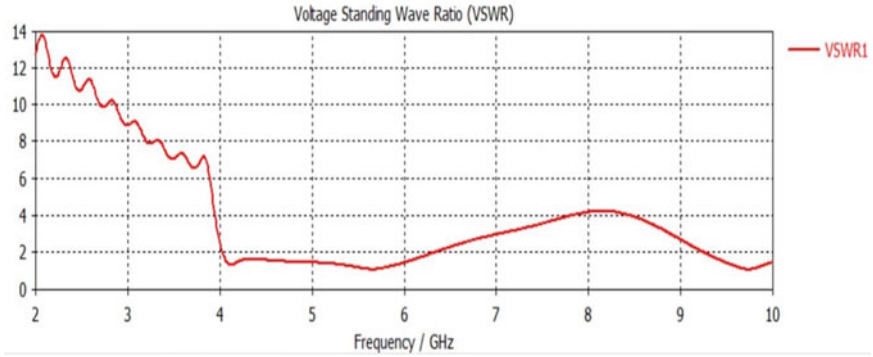

Fig. 3 VSWR of flexible textile printed antenna

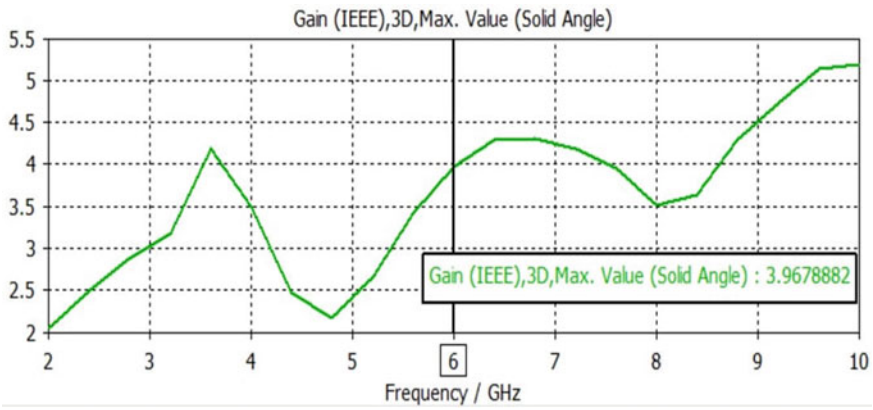

Fig. 4 Gain of Flexible textile printed antenna

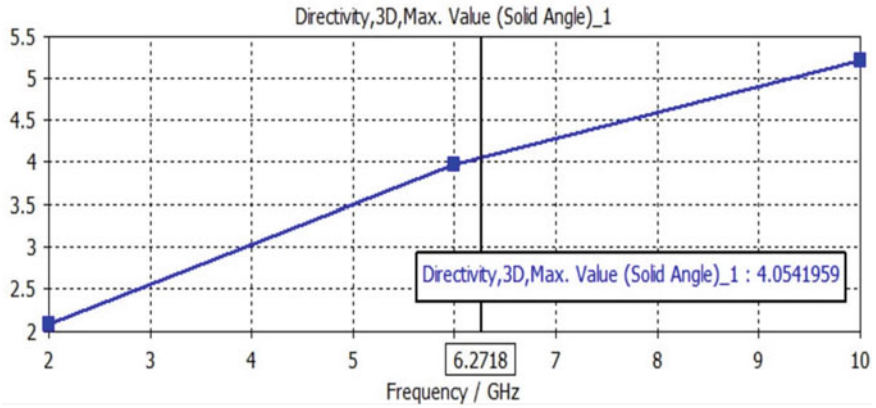

Fig. 5 Directivity of Flexible textile printed antenna

bandwidth is 43.53%. There were two resonant frequencies with return loss less than −10 dB, i.e. −18 dB at 4.12 GHz and –30 dB at 5.656 GHz and VSWR was found accurate between 1 and 2, i.e. 1.29 at 4.12 GHz and 1.07 at 5.656 GHz (Fig. 7).

4 Applications

The frequency range obtained from the proposed fork-shaped flexible textile printed antenna has multiple applications which are listed below.

1. WLAN, HIPERLAN and IEEE802.11a (5.152 GHz –5.35 GHz)
2. WiMax Upper band (5.25 GHz–5.85 GHz)
3. Automatic Toll collections (5 GHz–6 GHz)
4. The frequency range also falls under the C-band which can have various applications like satellite communication transmission, Cordless telephones, Wi-Fi devices and also including surveillance and weather radar systems.
5. The chance of improvement also exists in the proposed work. So, we can overcome the disadvantages of the patch antennas by using several other techniques by which we can get higher bandwidth and the maximum directivity.

5 Future Scope

The scope of improvement always exists in the proposed work. Many techniques can be applied in future using this antenna in order to achieve wideband frequency range and reduce the size of microstrip antenna. Improvement for impedance matching at resonant frequency along with increasing the gain above 6 dBi for better directivity and radiation intensity shall be taken up as future scope.

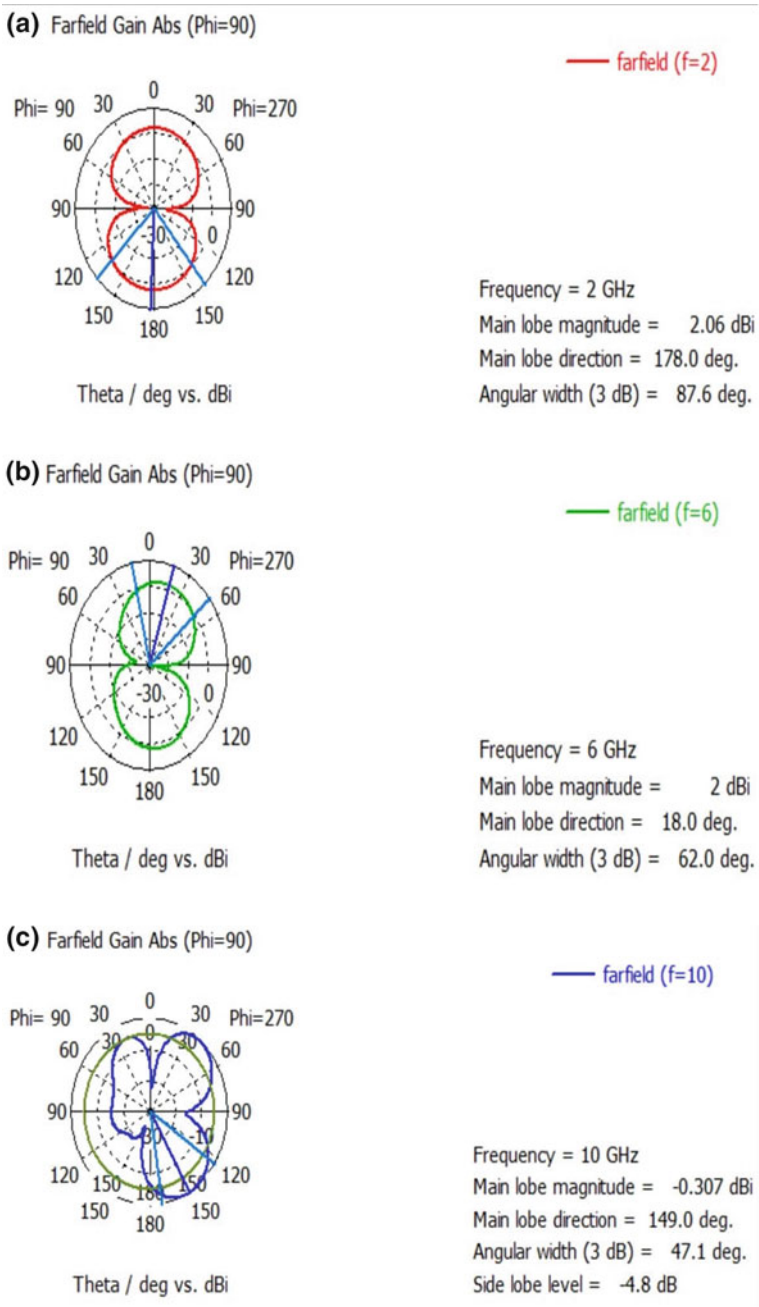

Fig. 6 **a** Farfield Gain Pattern for Antenna at 2 GHz. **b** Farfield Gain Pattern for Antenna at 6 GHz. **c** Farfield Gain Pattern for Antenna at 10 GHz

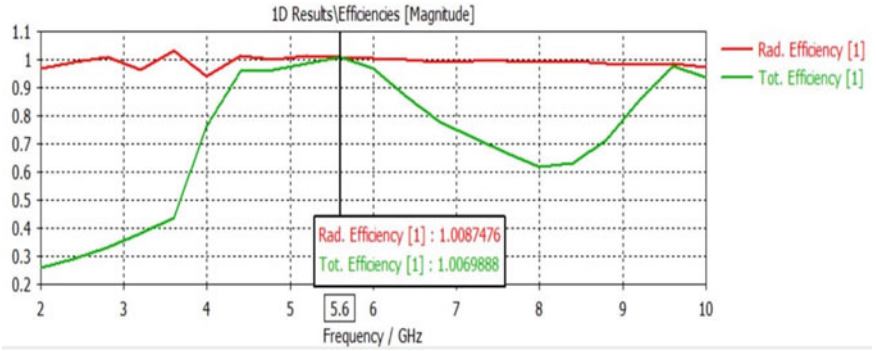

Fig. 7 Efficiency versus frequency pattern of the proposed flexible textile printed antenna

6 Conclusion

In the field of wireless communication, the antennas have a crucial role to play by focusing on the low-profile, small size and supporting multiband in an antenna system. In the proposed thesis work, the fork-shaped flexible textile printed antenna is designed which is from 4.04 GHz to 6.288 GHz. Here, the good return loss, gain and directivity were achieved. The proposed work finds the space in various applications such as WLAN, HIPERLAN, WiMax upper band, Automatic toll collection and C Band.

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Component-Wise Scrutiny of Existing Rule-Based Punjabi Grammar System and Implication for Accuracy Determination

Vikas Verma and S. K. Sharma

Abstract The use of Computational Linguistics (CL) to process Natural Languages (NL) is an important domain of Natural Language Processing (NLP). Fewer grammar checkers are available implicitly for Indian literary languages despite listed twenty two languages as per eighth schedule of Indian Constitution. Traditionally, "linguistic units"—token of a sentence in literary context are grouped together according to a set of predefined rules which can be stated as "Grammar" and hence directs research to a Grammar checker which performs the task of detecting and correcting grammatical errors in the text. This paper categorically explores existing Rule-based Punjabi Grammar System by providing a framework for quantitatively measuring the effect of each component and thus overall implication of the grammar checker using precision and recall as parameters for accuracy criteria and digs out Morphological Analyzer and POS Tagger as the faulty components generating false-alarms and errors to the tune of 58.13% and 26.74%, respectively. Based on these detections, further research can be carried out for developing a model to overcome these ambiguities using Machine Learning techniques.

Keywords Computational linguistics · Natural language processing · Grammar checking · Punjabi grammar checker · Grammatical errors

1 Introduction

During communiqué, "Language" acts as a model for transferring information through a standardized approach called its grammar. A Grammar Checker used in arena of Machine Learning integrates an application of Artificial Intelligence with Computational Linguistic. The generalized functionality can be depicted in Fig. 1.

Though heaps of research is carried out in Grammar Check particularly for English and Foreign languages yet fewer research is carried out for various Indian languages like Punjabi. Statistics reveal that there are 6,900 spoken languages throughout the world. Punjabi language falls under the top ten languages with 120 million total

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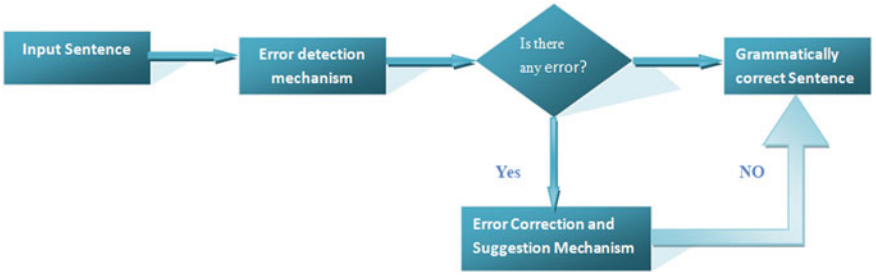

Fig. 1 Diagram for grammar checker—functionality

speakers out of which 109 million are native speakers whereas Mandarin is the top spoken language and English occupies fourth rank in the list. The tyranny of the situation is that on the internet, English reserves the lion's share of 26.8%, Chinese occupies 24.2%, Spanish maintains 7.8%, whereas all other languages contribute meager 26.4%. This drift is sufficient motivation for the research community to contribute in this sphere. Also, the Punjabi language finds its linkage to Indo–Aryan languages family generally referred to as Indic Languages and is morphologically rich language.

Grammar checking systems are mostly an integral part of specific word processors. For instance, in English language, by default characteristic is imbibed in Microsoft Office and for Punjabi, such functionality is provided in AKHAR (a software exclusively designed for literary purpose). Contribution in the development of Urdu Grammar Checker was done by [1]. In Bangla, it was done by [2] by developing a Bangla Grammar Checker, Punjabi Grammar Checker was propounded by [3] and in Hindi, contribution was extended for checking grammar by [4].

Rule-based [5], statistical (data-driven) [6], and hybrid-based [7] grammar checking methodologies exist. Rule-based categorization is used frequently viz-a-viz, other techniques are used in grammar checking. In this technique, corpus is considered for framing rules as in case of if–then-else rules and given sentence is inputted for checking the accuracy of designed grammar checker. Highlighting aspect of this technique is that such rules are crafted easily and can be modified as and when required. Another motivation for using this feature is that programming is not requisite and a linguistic person can aid the process of rule creation. Additionally, details of the error, if any, are provided easily. Last but not the least, such rules are capable enough to handle basic candid features of specific languages without any major modifications required to entertain input sentence. History of such rule-based systems revolve around languages like Dutch [8], Slavic [9], English [10–13], Punjabi [14], Swedish [15–20], German [21], Korean [22], Danish [23], French [24, 25], Portuguese [26], Persian [27], Afan Oromo [28], Chinese [29], Malay [30].

In statistical grammar checker, annotated corpus is being used and implemented which is obtained from different journals, magazines, or documents. Rules for this system are manually generated. Correctness of a sentence is validated through a thumb rule. A given sentence is passed through a rule to check its correctness.

On success, it is processed against a grammar checker with the help of corpus. On successful pass, the sentence is termed as grammatically correct otherwise it is flagged as a grammatical error. In case of supervised learning, from the given sample, rules are framed as production rules and are used to check the accuracy of the given sentence. The latter technique is infested with a drawback as it is very difficult to perform the task of detecting and recognizing an error in sentence or system.

An alternative approach consists of an Hybrid implementation which comprises Rule-Based and Statistical Grammar Checking which result in a more robust environment and having higher efficiency.

This paper has been organized into the following segments: Segment 2 presents literary aspects of computational linguistics and existing rule-based Punjabi Grammar Checker. Segment 3 presents the critical analysis and shortcomings of existing techniques in light of various sentences procured from standardized organizations and corpus like CDAC, TDIL, Language Newspapers, Texts, etc. Segment 4 presents a novice model to critically justify an advanced Punjabi Grammar checker. Finally, Segment 5 brings our paper to a close and suggests some areas for future investigation.

2 Existing Punjabi Grammar

An interesting aspect of prevailing Grammar Checker is that it follows purely Rule-based philosophy and has no correlation with Statistical approach for computation task, i.e., exhausted hand-crafted rules are followed. These rules can be easily edited and we can add new rules also, further already existing rules can be deleted as and when required based on the concept of production rules written by a linguistic expert without any specific intervention by the programmer.

In the current system, for evaluating correctness of a sentence, Input is given to the Grammar checker, which in turn identifies the end of a sentence with the help of punctuation and breaks down input into unit form, i.e., tokenization and detection of phrases is done here [31].

In preliminary phase, data pre-processing is done. Pre-processing checks for the presence of phrases and tokenizes the sentence into individual words. Once, this process is completed, the checker performs activities like Morphological Analysis (MA), Part-of-Speech (POS) tagging, Error Detection, and Correction. This rule-based approach analyzes the language at Morphological and Syntactical levels. The Morphological Analyzer analyzes each input word and grammatical information is assigned as part-of-speech tags. The suggestions generated for detecting grammatical errors use root word of a particular word along with a full form lexicon. The Part-of-Speech Tagger and Phrase Chunker again follows Rule-Based approach. Phrase Chunker helps in grouping based on predefined phrase chunking rules. Henceforth, at sentence level, rules are applied to check grammatical errors. Excerpt from the system is narrated as follows:

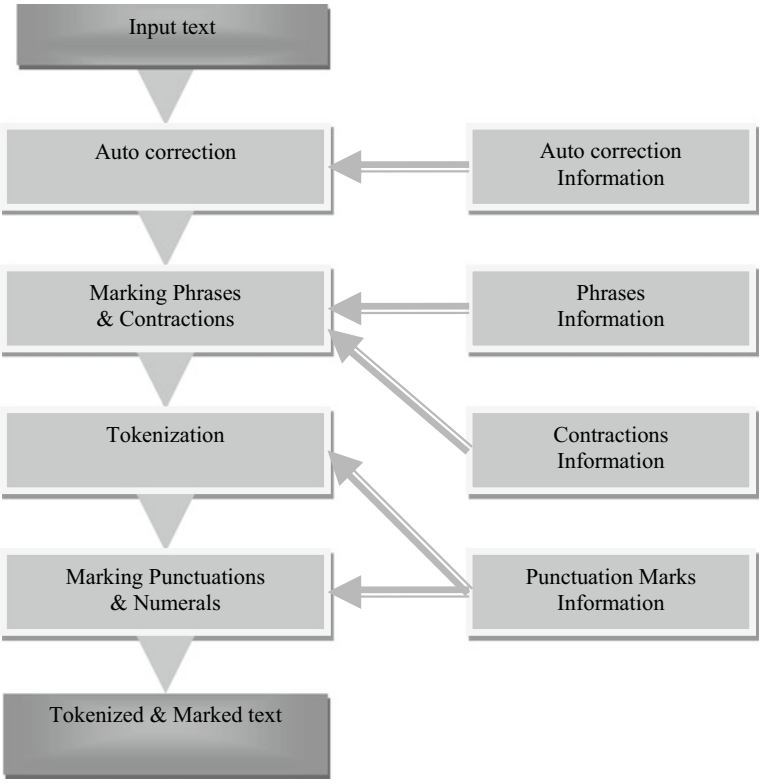

Fig. 2 Pre-processing system design

2.1 Pre-Processing Phase

In the preliminary phase, a Punjabi text is given as input which helps in tokenization, identification of punctuation symbols, detection of contractions, identification of colloquial and phrases, if any. Basically, this phase prepares the input text for next phase, i.e., for morphological analysis as shown in Fig. 2.

2.2 Morphological Analyzer

With the help of full form lexicon concept, possible tags of all words (from the given extract) are assigned. Certain classes like noun, adjective, pronoun, verb, adverb, conjunction, interjection, postposition, ordinals, cardinals, etc., (twenty two in total) are used for classification as per Punjabi grammar. Adjectives are categorized into inflected and uninflected. Similarly, pronoun is classified as personal, interrogative,

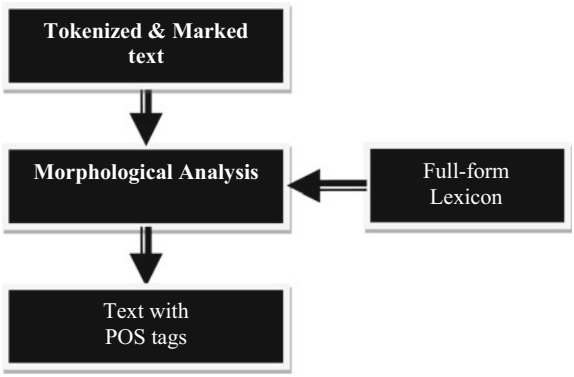

Fig. 3 Morphological analyzer flow diagram

demonstrative, relative, reflexive, and indefinite; verb is classified as main verb, auxiliary verb, and operator verb, respectively. Additionally, details like number, gender, tense, etc., are added depending on the word class. It's worthwhile to mention here that lexicon used for this analyzer is based on full-form, i.e., all common words from literature are stored with their respective root and relevant grammatical information as shown in Fig. 3.

2.3 POS Tagger

In case of disambiguation, i.e., assigning multiple tag to a single word, a Rule-Based POS tagger (parts of speech) has been used to remove this anomaly. Current system uses 600 plus tag sets. Word-specific tags are additionally used. In addition to this, some tags are also there. For instance a notation, NMSD means a noun that is masculine, singular, and direct. In the absence of any statistical corpus used, existing system uses only rule-based phenomenon. The rules are followed in sequential order as shown in Fig. 4.

2.4 Phrase Chunker

Based upon certain phrase chunking rules, grouping of texts is done into various phrases. A rule-based protocol is followed here. Different tag sets are used for different cases—like direct or indirect. Polarity of a sentence, i.e., meaning of a sentence is also considered for framing such rules as shown in Fig. 5.

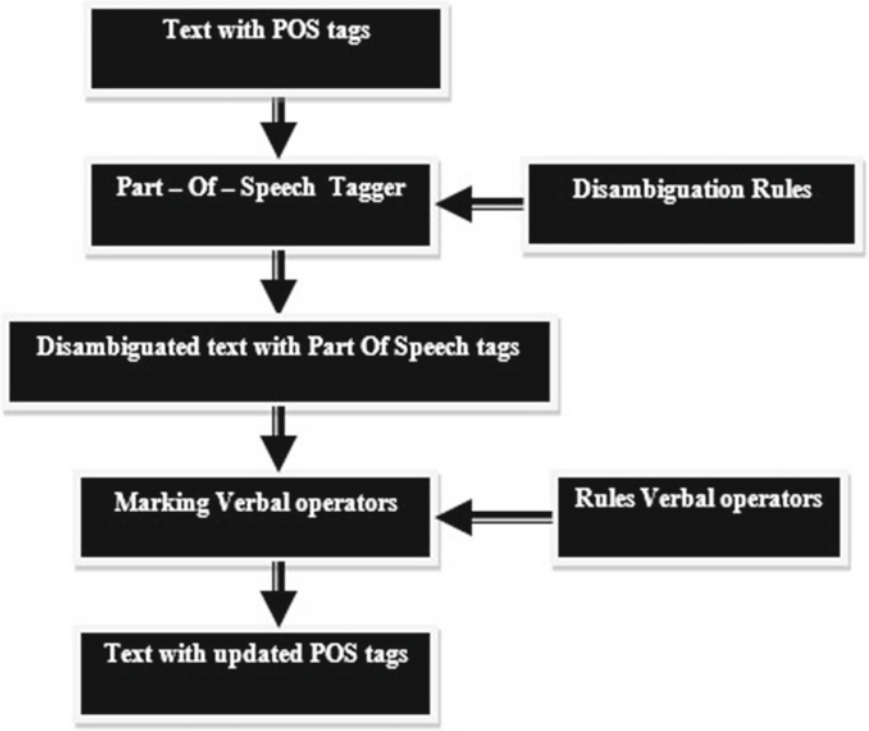

Fig. 4 POS Tagger flow diagram

3 Error Checker and Corrections

In this phase, rules keeping into consideration grammatical errors in phrases and sentence level agreement are implemented. Relevant corrections are suggested on the basis of contextual information on occurrence of error, if any. Subsequently in Grammar Checking phase, error detection rules (rule based) are used to detect potential errors and corrections are provided to resolve such errors.

The concept is summarized as shown in Fig. 6.

4 Critical Analysis and Shortcomings

Existing Punjabi Grammar checker detects grammatical mistakes only for simple sentences and lacks support for compound and complex sentences and raises false alarms. It does not have any component for unknown word guessing. Further, it has a limited domain for certain words that affect its precision and recall. Moreover, Spell checking is not available. Also, the structure lacks support for other languages of

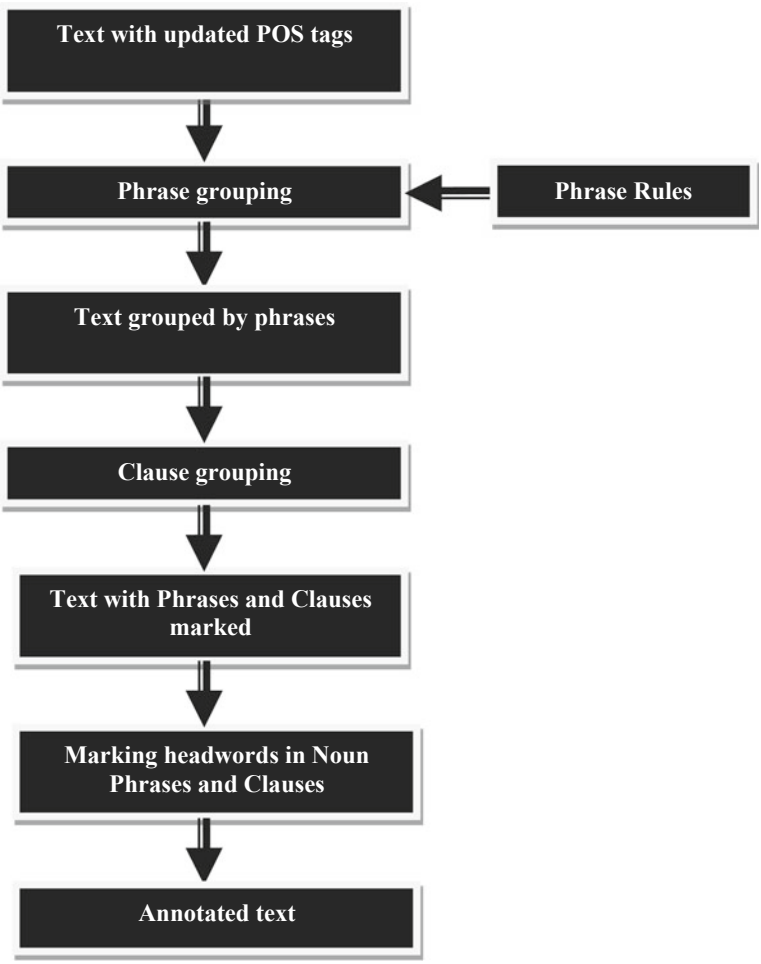

Fig. 5 Phrase chunker flow diagram

Modern Indo-Aryan family, like Hindi, Bengali, etc. [32]. The distinct features of such languages are highlighted in the following Table 1.

Similar theories were put forwarded for other languages including European ones [35–39]. Existing Punjabi Grammar Checker system is processed against sufficient number of sentences (seventy five in total) collected from a standardized repository (as stated earlier) and the results were disappointing. Chosen sentences are processed at the listed URLs:

a. http://punjabi.aglsoft.com/
b. http://pgc.learnpunjabi.org/

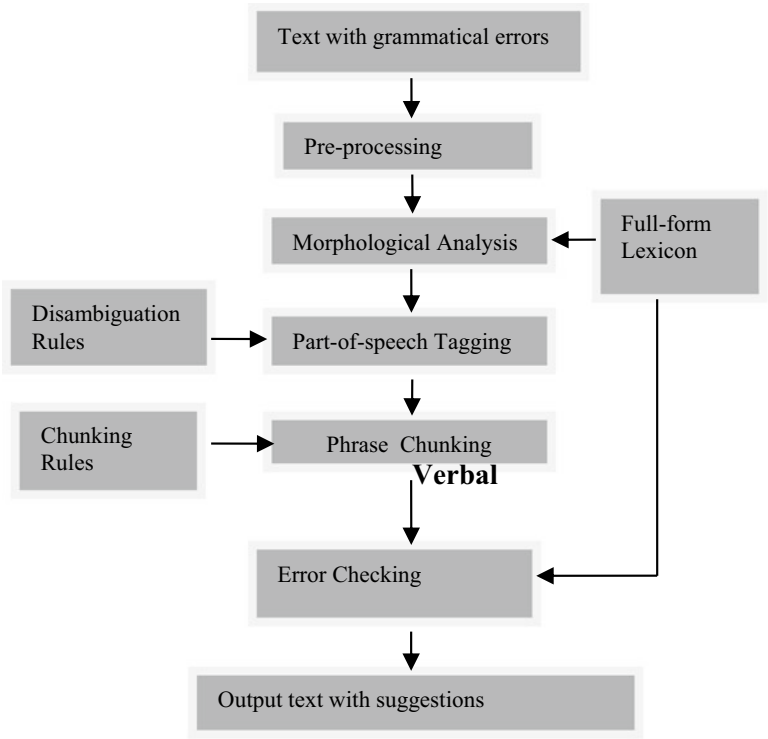

Fig. 6 Model of existing Punjabi grammar checker

Table 1 Analysis of Indo-Aryan languages

Language	Methodology adopted for checking grammar	Characteristics	Evaluation features	Shortcomings
Hindi [4]	Rule-Based	Rich in inflection	Optimal result	Not suitable for Compound and Complex Sentence
Nepali [33]	Rule-Based	Language primitives are shared by Bangla and Hindi	Providing information about errors in simple sentences	Not suitable for Complex and Compound sentences
Urdu [34]	Rule-Based	Formulates S–O-V agreement	Provides error correction by checking structure and grammar	Lacks disambiguation due to Morphology and POS
Bangla [2]	Data-Driven-Based	Formulates agreement of Word	Provides better result	Not suitable for Compound sentences

The analysis report comprises the count of total number of errors (including false alarm) creeping from individual phases of the Grammar Checker and helps us in visualizing the inefficiency of individual components of the Grammar Checker [40–43]. The report is projected through the listed Table 2.

The component-wise reasons for such errors /issues may be accounted for listed factors:

a. In context of a Punjabi sentence, modifiers must collaborate with the noun and modify with respect to gender, number, and case.
b. In Noun-Adjective agreement, Noun needs to be changed sometimes and not only adjective. In current rule, adjective is always changed.
c. POS was not able to remove ambiguity and acted in contrary to its defined assignment and followed the same result of MA.
d. Whenever a word is encountered whose root is not traced, "unknown" tag is assigned.

Table 2 Analysis of Punjabi sentences

Existing grammar checker component	Total number of contributing errors	Percentage contribution	Interpretation (Grammatically correct/incorrect/false alarm)
Morphological Analyzer (MA)	44	58.13	Problem in morph due to an unknown word
Part-of-speech Tagger (POS)	20	26.74	Ambiguity of words is not removed
Phrase Chunker (PC)	5	6.67	In Noun-Adjective agreement, Noun needs to be changed sometimes and not only adjective. In current rule, adjective is always changed
Error Checker (EC)	12	16	Problem in Grammar Component although all previous components were fine and thus Logically Incorrect interpretation
MA and POS	21	28	POS was not able to remove ambiguity and same result of MA is followed
POS and EC	5	6.67	Logically Incorrect interpretation. POS was not able to remove ambiguity

5 Proposed Framework for Punjabi Grammar Checker

All listed shortcomings as stated above may be overcome by using hybrid technique by combining grammar rules with machine learning technique [44]. Till now hybrid approach has not been used for development of Punjabi grammatical error detection because of unavailability of standard Punjabi corpus to be used for machine learning [45]. Two step approach may be followed for the same.

a. Step One

The working of each component of Existing Rule-based System is studied through the listed flow of steps.

As shown in Fig. 7, once an incorrect Punjabi sentence will be given as input, efficiency would be calculated phase-wise, i.e., efficiency would be calculated after MA, Tagging, Chunking, Error Detecting, and Error Correcting, respectively, for analysis so as to evaluate accuracy of each component.

b. Step Two

The components that are responsible for false alarm are identified, and a proposed algorithm to improve these components is followed using two phases. For evaluating a component accountable for false alarm situation, 2-phase process would be followed.

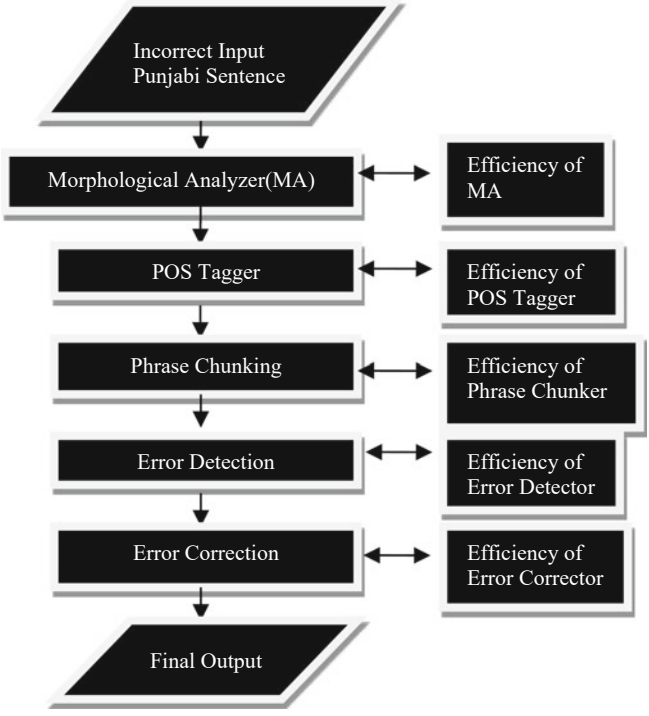

Fig. 7 Proposed model for measuring accuracy

In phase 1, Grammar Checker will perform preliminary check with the help of certain rules. An incorrect sentence would be made to pass through phase II. In phase II, output from phase I would pass through each component (step) to check whether the said component is faulty or not. A particular component is faulty, if the output from that component is incorrect; otherwise, the output will be made to pass through the next step and so on. The step-by-step approach is described in Fig. 8.

6 Results and Discussions

Onto a repository of corpus collected from various standard texts, authorized resource centers like TDIL, etc., as discussed above, we were able to identify Morphological Analyzer as the component contributing maximum in generation of errors, false alarms followed by POS Tagger. The percentage contribution of these were 58.13% and 26.74%, respectively, on individual basis and combined error percentage is 28. Hence, paving a way for further research in this area as these being the important and preliminary steps in overall procedure would be helpful for checking grammatical errors with much accuracy once rectified.

7 Conclusion and Future Work

Our paper has categorically analyzed the accuracy of each component of existing rule-based Punjabi Grammar Checker. The effect of each component is analyzed as it has an implication on the overall accuracy of the system. The parameters for measuring the same were taken as Recall and Precision. This paper also proposes a "Fault Determination System" with an aim of evaluating the "Faulty Component" by following a two-phase approach and concludes with providing the facts and results that Morphological Analyzer and POS Tagger were the faulty components generating false alarms and errors to the tune of 58.13% and 26.74% respectively.

Based on these detections, further research can be carried out for developing a model to overcome these ambiguities using Machine Learning techniques by inculcating a "Hybrid" mechanism. Such "Hybrid" framework may be used for other morphologically rich Indian languages like Oriya, Sanskrit, Hindi, Bengali, etc., and can be further extended for various Natural Language Processing (NLP) tasks associated with Punjabi and other languages.

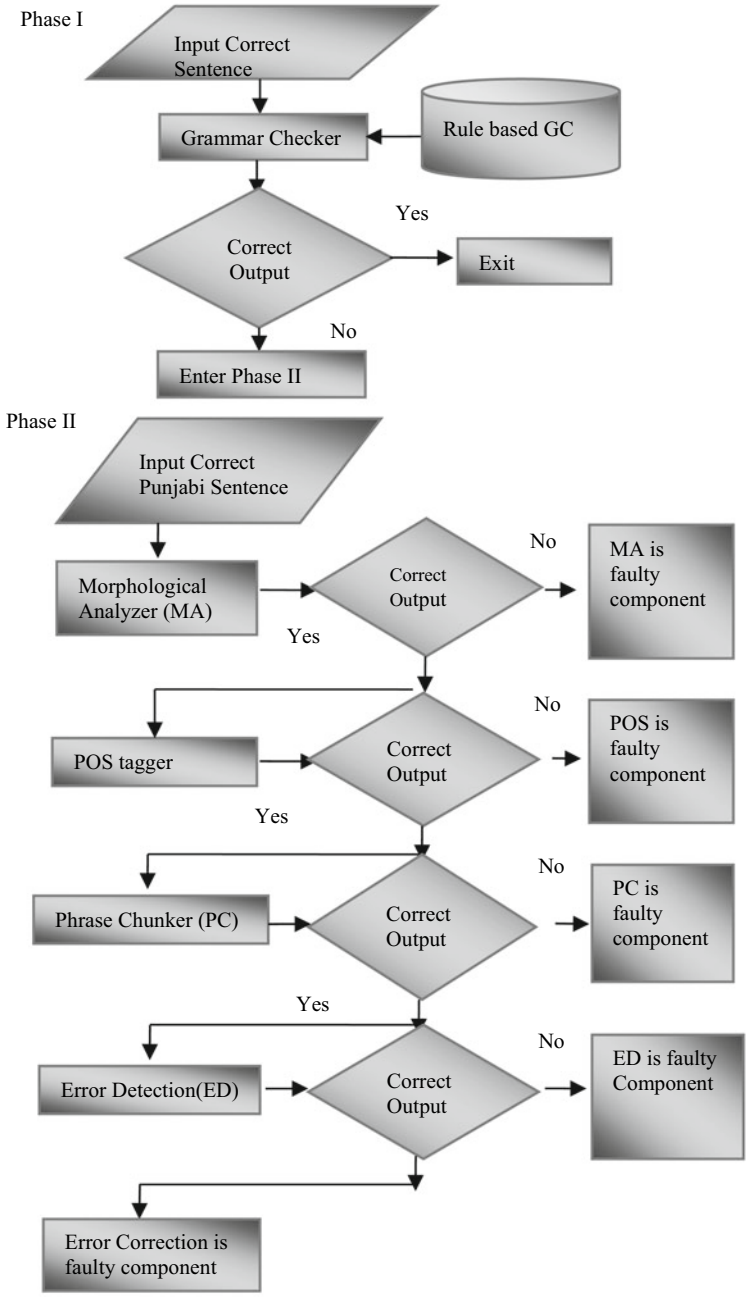

Fig. 8 Proposed model for evaluating faulty component

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Role of Innovation in Education and Development

Simarjeet Kaur

Abstract Role of innovation in Education and development is very important as it stimulates teachers and taught to explore new ideas, research hidden facts and to investigate new tools to find out something hidden. Innovation emphasis variety of ways of finding out the solution to different problems. In the field of education, it facilitates and impels the students to creatively think and analyze something and to unravel multiplex problems. There is a great scope and need of innovation in education and development. Its role in Innovation in education is often a rather intangible concept and may mean various things to different people. However, there are very real and tangible benefits of innovation in education.

Keywords Innovation · Education · Development · Technology · Empowering innovation

1 Introduction

The process of altering an existing situation by introducing something latest is called Innovation. There have been several changes in the way education has been planned and delivered in various regions of the world throughout the years, introducing something new. Technology is a major driver of change in today's world, and it may also contribute to a major change in educational design and delivery. As per the utilization of today's technical breakthroughs, as well as the implementation of innovative educational programmes, there are enormous opportunities for bigger and wider-spread transformation. The biggest challenge on the way is to make sure that the current innovation improves the educational opportunities for all those sections of people who are deprived of taking these services all around the world [1–3].

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2 What is Innovation in Education?

All things considered, various people would have various reactions to this inquiry.

While some may think, that when the world is changing why individuals actually educate and learn in a manner that was developed many years or even hundreds of years. Others may say 'Development in schooling includes consistent changes and coordinated effort with others or having a unique educational plan and instructing system'. Furthermore, somebody might think 'Development is more with regards to innovation'. Or then again it is beyond what that, it's with regards to how we can utilize innovation to engage understudies and persuade them to become deep rooted students [4, 5].

Despite the fact that, it very well may be hard to characterize development in schooling in a solitary way, however it is certain that it has a vital spot in instruction. Advancement is critical for the steady turn of events, development, and improvement of the most common way of conferring and getting information.

3 Learner-Centered Innovation for Educators

Now the question arises: How might innovation and technology help to overcome the challenges to education that exist in many parts of the developing world, such as access and mobility? Innovation has been proved as a boon for those where people were deprived of taking education and most of them do not have education opportunities due to lack of education institutes. But the versatile technologies like smartphones, E-books, Podcasts, low cost computers, and cell phone access have opened the doors of providing educational opportunities for the deprived community of people [6, 7].

4 Demand-Driven Innovation Approach

In order to establish good results focus should be on achievement of educational and development goals and not on popularization of technical gadgets. Students are seen to acquire this technical competency at a rapid speed. Whether it is hardware, software, and any other ICT tool students have been considered as the masters of these. Can education system be able to incorporate this into program design and deliver it to the students to improve education for the learners? Can teachers and institutes have greater intently in shaping their instructional layout and shipping with the technology to which inexperienced persons have everyday access?

Increasingly, innovation in training at faculty is extra than only a buzzword. It is rapidly turning into a manner of gaining knowledge of and coaching for each college students and instructors, respectively. Upheaval in training stimulates higher

education learners and faculties to investigate, examine, and utilize all of the gear to find something new [8, 9].

Innovation includes a one-of-a-kind manner of searching at troubles and fixing them. It accelerates the mind of youth and impels them to think something new to get a solution to complicated problems. Innovation does now no longer simply imply using era or new inventions, alive though those can make a contribution to innovation. Innovation includes a brand new manner of wondering; thereby supporting college students to expand their creativity and trouble-fixing skills.

Innovation in schooling may be a as a substitute intangible idea and may suggest various things to special people. However, there are very actual and tangible blessings of innovation in schooling. Innovation cannot be examined or graded, however it could be inculcated and constructed up in students. In this surrounding of high-stakes testing, it could be distinctly hard to introduce innovation and creativity with inside the classroom. However, right here are 8 special approaches that instructors can introduce innovation with inside the classrooms [10].

1. Give kids a provocation that is both genuine and exciting to solve: There is no such thing as a project that fits all kids. This implies that the work assigned to the student should be flexible enough and according to the specific interest of the students. It also means that teachers must be aware of their pupils' passions. Authenticity entails using genuine tools to solve problems that don't have answers printed on them
2. Give pupils the fundamentals but keep it brief: You'll need to educate them some basic facts and knowledge before they can begin working on their projects. The amount of information needed for the class, however, will be less than you might think.
3. Encourage learners to workout independent research: Students will receive the great majority of the material they require through their own independent study if the project design is clear and consistent. This research can make use of Wikipedia, social sites message boards, documentation for programming languages, coding, and other resources.
4. Encourage scholars to use challenging equipment to entire their duties by using encouraging them to do so. Tickle, Scratch, Makey, and different comparable programmes are samples of these tools. To use these applied sciences on a day-by-day basis, each instructors and college students should come to be acquainted with them.
5. Verify that the students have grasped the concepts: Teachers must keep track of what pupils are struggling with in a classroom that focuses on highly personalized assignments. When college students fighting with an problem and are in a position to resolve it, they are mastering at their best. They are extra susceptible to supply up if they turn out to be pissed off or confused. Teachers should keep a close eye on what their students are doing.
6. Guarantee that understudies discover creative employments of ordinary articles: Most individuals see just a solitary use for an item. This is called Functional Fixedness. Understudies can be instructed to see past this and can likewise figure

out how to design electric changes from the garments pins or assemble robot middle out of a soft drink bottle. This will assist understudies with utilizing their imaginative muscles and think past the standard employments of regular items.

7. Affirm that understudies know what they actually need to learn: In request to improve and tackle issues successfully, understudies need to comprehend not just what they definitely know and what they actually need to learn. Instructors should assemble their tasks so understudies can list the things they comprehend about their undertaking, just as the things they need to see better.
8. Try not to grade understudies on advancement and innovativeness: Grades function admirably when there is one right response for a particular issue. For projects that accentuate development and inventiveness there is nobody reply. Assuming you need understudies to claim an issue and discover a really unique answer for it, you can't spur them with a grade.

Development in education encourages students and teachers to research, examine, and use all available tools to discover something truly novel. Advancement entails seeing things from a different viewpoint and addressing them. It also advances education by requiring students to use a higher degree of intuition to deal with challenging problems.

5 Staying Informed Concerning Technological Change

"Despite the fact that innovation ought not drive our educating, innovation drives change"

Today, instructors have the test of observing changes in advancements, deciding whether they apply to students living in reality, and looking for approaches to utilize advances to supplement and support educational strategies and practices [11].

Who will teach the instructors? How could instructors stay up to date with mechanical headways that help developments and upgrades in educational plan and conveyance? What can establishments, governments, and global associations do to assist instructors with dominating new advancements and devices for setting out and working with instructive open doors?

6 Challenges, Opportunities, and Barriers

Given the difficulties of lacking quantities of instructors being prepared, educators leaving the calling, and to couple of homerooms in non-industrial nations, would technology be able to empower more individuals to get to schooling? Will the up and coming age of minimal expense PCs make it possible for additional understudies in non-industrial nations to approach this innovation? It isn't the innovation, yet the potential it accommodates access, effectiveness, and improved learning openings.

PCs better empower students to get to training through ODL. Students can utilize Internet innovation to speak with different understudies or educators across a city or all throughout the planet. Educators and understudies can get to data through virtual libraries and the World Wide Web, and use programming to dominate specialized just as scholarly abilities.

Here are a few inquiries to contemplate in applying development to empower admittance to training:

- What cycles are expected to give power and broadband admittance to every instructive foundation (for example, schools, universities, colleges);
- What cycles are expected to give broadband admittance to every deep-rooted student (grown-ups who can pay sensible rates for access);
- What options do organizations have in case they are probably not going to be associated with a dependable power administration within a reasonable time-frame;
- What options are there for presenting PCs or expanding their numbers in schools and establishments of higher learning; and
- In case PCs are to be introduced in foundations, what cycles are in progress to guarantee full preparation and support for instructors and students to viably incorporate these into the educating, learning, and school the board measures?
- What are the developments in instruction that can assist with meeting the three-billion individuals challenge?

The chances are huge, yet there are likewise innovative restrictions in many pieces of non-industrial nations. Hindrances to mechanical developments for supporting schooling incorporate deficient media communications transmission capacity, absence of prepared care staff, and the expense and the accessibility of straightforward phones, PDAs, PCs, and power.

The chances are gigantic; however, there are likewise mechanical constraints in many pieces of agricultural nations. Hindrances to mechanical advancements for supporting schooling incorporate insufficient media communications data transfer capacity, absence of prepared care staff, and the expense and the accessibility of straightforward phones, cells, PCs, and power.

7 Advancement for Education for Development

The take a look at of closing the steady broadening hole between people who area unit well to do and therefore the poor may rest with the readiness of the schooling native space to examine coaching in step with another purpose of reading and to develop. This may incorporate utilizing cheap and open innovations to grow admittance to instruction. It would likewise need alternative ingenious cycle or administration techniques that do not depend upon innovation. It would need a modification in center to focus on instructive and making ready comes to regulate all the additional intimately with what people distinguish as their most earnest wants. Giving schooling in

new and flighty manners issimply oneamong numerous arrangements; however it's through advancement that we will address the difficulties of more developed efficiencies, lower prices, increasing availableness, and higher progress in accomplishing improvement objectives through instruction

8 Examples of Innovation in Education

Development comprises discovering higher strategies of undertaking something and higher techniques to take a gander at problems. E School News shares the tale of understudies building reusing receptacles to help supportability. The understudies didn't just form receptacles.

They recognized issues with the waste administration program, explored arrangements and made a publicizing intend to advance their answer with assistance from different spaces of the school, like mechanical technology and broadcasting.

The use of undertaking-based learning is one more methodology for prodding development and inventive reasoning. Rather than chipping away at a solitary undertaking in a numerical class, project-based learning joins various disciplines in a single task. It advances dynamic and more profound learning. It joins every one of the disciplines: composing, math, social investigations, science, and workmanship. In doing this, understudies thoroughly consider all that it takes to assemble a city or country. They find out with regard to their present government and networks by standing out them from the ideal society they make [12, 13].

9 Empowering Innovation in Schools

School pioneers need to try not to order development. "Strategy ought to set out open doors and impetuses for people to plan unique and better learning encounters, yet not need it," Lars Esdal composes.

Rather than simply displaying ABCs and 123s, improvement goes previous the nuts and bolts via becoming a member of an assortment of disciplines to concoct some different result. Information on the rudiments is a establishing stage. Understudies use records and thoughts to find out preparations with the aid of investigating till they music down the most becoming replies.

How might school pioneers figure out how to fuse advancement and innovation without ordering it? A few colleges offer seminars on advancement in their online MS Ed. in Educational Leadership programs as a component of the central subjects. Similarly as task put together learning centers with respect to the entire youngster by consolidating disciplines, "Inventive School Leadership" shows understudies how to execute frameworks that lead to advancement [14, 15].

10 Conclusion

Educational improvements are perceived as a method or technique of instructional interest that diverge drastically from installed exercise and is utilized to boom the extent of performance in a aggressive habitat. Educational improvements consist of pedagogical inventions, clinical and methodological innovation, and academic and machinery innovation. It is substantiated that the schooling marketplace is one of the maximum essential factors of the countrywide innovation system. Higher schooling establishments which have selected an innovation-primarily-based totally improvement, end up aggressive leaders at the schooling marketplace. The formation of the latest kinds of schooling and using best controlling mechanisms at every academic group will deliver the possibility to create unmarried academic space, that's capable of meeting the desires of society in exceptional schooling with precise possibilities of clients inside the academic marketplace. The predominant additives of the innovation improvement of better schooling establishments are determined.

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A Study of Smart Grid Application and Impact of Renewable Resources When Integrated with Smart Grid

Deepa Kumari and Ashish Sharma

Abstract The article focuses on the design and implementation of a Smart Grid that utilizes renewable energy sources. Various renewable sources, such as mini-hydropower plants, solar power plants, and wind power plants, are integrated into the smart grid's designed scheme. The current trend of renewable energy resources becoming a larger part of the electricity supply mix has increased the demands on the power system for supply quality. The addition of distributed generating units to the electricity system has posed new planning and operational problems A major priority for future power generation has been to use RER due to the energy crisis. We discuss the benefits, complexity, challenges, and potential solutions for renewable energy deployment in the SG context. Our research also looks at how RERs may be effectively integrated into an energy market with higher generating capacity, better power quality, and more dependability. This paper also looked at the issues surrounding renewable energy integration in SG. A thorough SG model with integrated renewable energy is also given. Furthermore, this paper gives a viewpoint on SG in terms of development, economic progress, and implementation obstacles.

Keywords Smart grid · Energy storage · Distributed generation · Renewable energy resource (RER) · Integration · Control strategies

1 Introduction

Expansion of urban populations and the changing nature of urban governing concepts have both contributed to the desire for integrated and interoperable technologies that facilitate smart functioning of complex systems in cities. The creation of information and communication technology (ICT) and data services can provide many new

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Table 1 Defines the percentage of world primary energy demand from 2002 to 2030 [3]

Energy sources	2002	2010	2020	2030
Coal (%)	23	23	22	22
Oil (%)	36	35	35	35
Gas (%)	21	22	24	25
Nuclear (%)	7	6	5	5
Hydro (%)	2	2	2	2
Biomass and waste (%)	11	10	10	10
Others renewable (%)	0.53	0.83	1.12	1.55

services in a city, particularly in the developing world, resulting in a more productive, ecologically aware, and technological solution. Electricity and communication networks, which are critical for supplying urban services, are becoming more and more important. For higher-level services to function, the functionality, interoperability, and resilience of these networks are critical. Although utilities are being forced to upgrade and adapt their existing business scopes, methodologies, and system capabilities due to rapidly changing consumer behavior and technological development, several trends (such as distributed generation and electric vehicles) are significant. Due to the energy crisis, renewable energy capacity is of great interest today in future power generation [1]. The current energy crisis is leading to an increased interest in the future power generation capacity of renewable energy resources [2].

Between 2002 and 2030, fossil fuels generated the bulk of global primary energy consumption, compared to alternative renewable energy sources, which are less regarded as power generation sources as shown in Table 1. This results in a significant increase in CO2 emissions, causing severe ecological damage [4]. Renewable energy technologies as a cost-effective way to generate electricity in the future without emitting greenhouse gases [5]. The integration of renewable energy resources into smart grids is the focus of several current studies [6–8]. They discuss the advantages and disadvantages of renewable energy supplies as they are incorporated into an intelligent grid system [1]. Consequently, this article describes the effects of renewable energy on the smart grid.

Harvesting energy from renewable resources, on the other hand, necessitates an valuable and sophisticated smart grid system [9]. Discussing more, smart grid can more effectively address difficulties including generated and raw energy losses, transmission losses, load optimization, and equal load distribution. Furthermore, distributed generation (DG) technologies help to manage demand and supply [10]. By increasing generation capacity through the introduction of RERs, the gap between supply and demand is reduced [11]. In the conventional power system, generating electricity faster than the rate of RERs can't be achieved within a short period of time. The following are the main benefits of renewable energy resources.

(a) less operating costs in different areas, (b) habitat for wildlife, (c) nature abundant, and (d) minimal maintenance cost is required [12]. Long-standing energy crises can be overcome with RERs. Maintaining energy growth should consider extending

existing resources and expanding exploration [13]. We are motivated by the following to conduct this research: (a) A look at the main challenges and possible solutions to integrating renewable energy into the grid and (b) The technology minimizes the negative effects on the environment and reduces load on the non-renewable grid as well as usage of fossil fuels. Power generation, power distribution, and electricity pricing are proving to be inefficient under the traditional power grid [14, 15]. In spite of that, the demand for power is growing rapidly, with an increase of twice as much by 2050.

The benefits offered by SG are numerous, including the following

(a) Efficient performance, (b) Reduced cost for consumption, (c) Empowering consumers, (d) Easy-to-usetwo way system, (e) Communications infrastructure based on advanced technologies, and (f) intelligent control. There are frequent fluctuations in renewable energy, which introduces uncertainty to the system due to climate change [16]. An hour-by-hour forecast of the weather is the best solution to the issues outlined above [17]. Superconducting DC transmission lines can eliminate conversion losses in a DC-DC system. Briefly, the proposed study has the following major contribution: An overview of RER SG is provided, and its benefits are detailed. The barriers and challenges that must be overcome to move from a conventional power grid to a SG-based power grid are also reviewed in detail. In this work, we present comprehensive information on RERs technology as well as relevant factors that need to be evaluated in the context of SG integration, including how to evaluate RERs as assets. RER integration within SG is discussed in terms of its potential benefits and associated challenges. Furthermore, the integration of RERs within SG is also discussed from a financial and benefit perspective.

2 Smart Cities and Energy Applications

Controlling electricity flow is the function of SG. As SG is self-aware, it can adapt to changes in the network environment by automatically reconfiguring its settings based on the current conditions. As a matter of fact, at least in current times, the SG is only a solution to penetrate the conventional system with RERs. High-speed data acquisition and measurement have emerged with the introduction of new systems; SG will be able to operate in the future such as the one shown in Fig. 1. As SG is resilient and prognosis-focused, they are able to achieve high levels of success [12]. The SG is a conventional electricity distribution system that incorporates computer networking and intelligence [18]. Technology developed by SG includes automation as well. Power grids provide a variety of benefits through the concept of SG. It is important to deal with scheduling uncertainties, energy transfers between regions, reducing RERs, optimizing demand, distributing electric power, and forecasting to respond to emergencies. SG will benefit consumers by providing an interactive grid that facilitates the interaction with load management. This interface also provides the users with authentic and real-time pricing information and enables them to decide based on information.

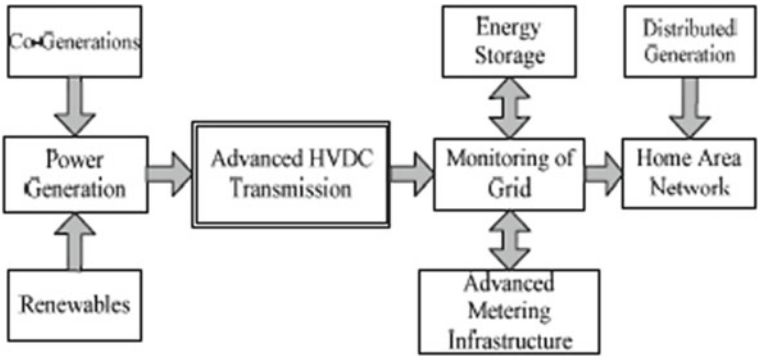

Fig. 1 Schematic of the smart grid [4]

2.1 Smart Grid Benefits

As a result of SG, the following benefits occur:

(a) Metering using smart technology, (b) Renewable energy resources accommodation, (c) effectiveness, (d) encouraging, (e) possibilistic, (f) customer-centric, (g) strong, and (h) environment friendly, below we discuss each of them.

2.1.1 Smart Metering

The ability to exchange information on tariffs and power consumption in real-time is a unique feature of smart grid that makes use of communication systems.

2.1.2 Efficient

Increased end-user demand and the ability of the system to adapt without adding extra infrastructure.

We can use energy from any fuel source, including solar and wind, to the same extent that we can use natural gas and coal.

2.1.3 Quality-Focused

With no spikes, voltage drops, interruptions, or disturbances, we provide stable power.

2.1.4 Opportunistic

By leveraging plug-and-play novelty, it creates new markets and opportunities and capitalizes on them wherever and whenever appropriate.

2.1.5 Resilient

Decentralized power systems become more resilient to cyberattacks, severe faults, and disturbances as they are strengthened with SG security protocols.

2.1.6 Barriers

Even though SG's viability is widely acknowledged, its implementation may take half a decade or more. Following is a list of factors contributing to the concept's unimplementation for over a decade:

2.1.7 Human Resource Development

There is no way to train the present staff to utilize and deploy the new technology. It will take time for the skills of the personnel to be developed, and a short-term solution may be needed in order to address the new requirement.

2.1.8 Financial Implications

It takes a lot of capital and operating expenses to replace an existing infrastructure with a new one. The government of developing countries offers incentives and rate-based funds to fund projects. Developing countries with a complex operating system do not see its expansion and modification as straightforward.

2.1.9 Project Planning

In order to ensure minimal disruption and to avoid disasters, it will take some time to implement SG as it replaces an existing operating system.

2.1.10 Legal and Regulatory

Regulation and legal organizations already in place can accommodate SG technology's benefits and costs. Before the deployment of the project, these issues need to be addressed properly.

2.1.11 Technical Issues

Defective analysis and unclear communication lead to different technical risks. SG technology and products have not been tested enough in the global marketplace due to its infancy, and there are no global solutions available that address SG technology and products.

2.1.12 Operations and Maintenance

The operation and maintenance of SG equipment will be different. It will also affect how current maintenance is implemented, making it easier to provide better components with better information and data.

2.1.13 Security and Privacy

The system has become increasingly dependent on technology. It will be possible to optimize the system with the collected information and data.

3 Grid Integration of Renewable Energy Resources

Our need for electrical energy is expected to rise in the future due to energy security, climate change, and sources of renewable energy. There are both dangers and opportunities associated with renewable energy. A system and its electrical characteristics will be much more challenging to run and regulate if there are more renewable sources linked to the grid. To improve urban energy supply and demand, the grid needs to make greater use of RERs. RERs and energy storage will continue to be used by the residential, commercial, and industrial sectors, despite their higher initial costs. They are influenced by factors such as independent power generation, sustainability, dependability, security, and power quality.

A smart grid can help reduce operating costs and increase efficiency on a wide range of levels. Smart grid technologies are, however, a benefit in that they enable an electricity network to feature high levels of renewable resources. Various types and scales of RER exist. There is geothermal energy, biomass energy, wind electricity, and hydro energy. However, when RERs are embedded in traditional power grids on a large scale, their benefits are greatly enhanced [18]. However, when RERs are embedded in traditional power grids on a large scale, their benefits are greatly enhanced [18]. As a result of SG approaches, renewable resources such as wind, solar, and geothermal can penetrate more readily. RERs penetrate SG in several ways as shown in Fig. 2. These are the characteristics of renewables derived from SGs.

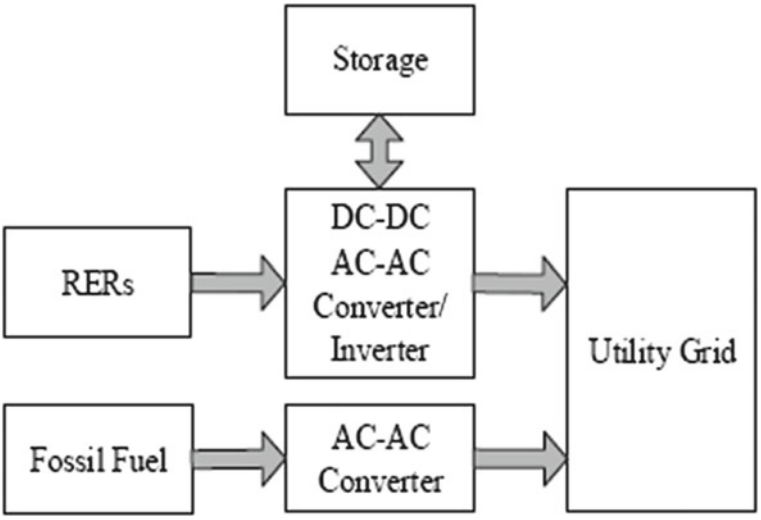

Fig. 2 Integration of renewable energies into the grid [19]

(1) Energy demand and supply are stabilized through SG technology. Various technologies can assist in this process. Distributed storage devices, advanced sensors, software to control markets, market signals, and information structures can all be utilized.
(2) Automated SG technology uses feedback on distributed storage and demand to enhance the integration of RE generation hosting and allow for better and more cost-effective utilization.
(3) RER penetration is restricted by the implementation of SG technologies.
(4) A grid operator can coordinate the system and control it based on grid characteristics by applying SG technology relative to RE.
(5) Software programs and converters and inverter devices are used to communicate, SGs provide diverse management and distribution mechanisms for RE.

For the SG, model evaluations of technologies and resources for renewable energy such as biomass, solar, wind, and fuel cells are necessary, as well as control evaluations of their penetration levels and effect on innovation and upgradation. Biological resources are non-RE resources because they cannot be replicated at comparable scales. Nuclear energy, Coal, petroleum, gas, and oil are among the major non-RE sources of energy. A safe and reliable energy supply is largely responsible for financial growth, computerization, and modernization. There is a constant increase in power demand. There is an urgent need for energy right now around the world. Power demands are met by using fossil fuels as primary energy sources. Hazardous gases are mainly emitted by fossil fuels. According to the CO2 distribution in 2013, oil accounted for 33% of the emissions, gas flares made up 0.6%, coal accounted for 43%, cement made up 5.3%, and gas accounted for 18% [19].

A. *RERs Taxonomy*

Energy is derived primarily from the sun. With all the other renewable energy sources like Sun-dependent energy sources, such as wind and hydro, humanity can be supplied with energy for almost a billion years. As predicted, at this point liquid water will not be possible on Earth due to the earth's increasing temperature [18]. Figure 3 shows how the potential sources of electricity from renewable sources are further categorized.

In the context of smart grids, integrated renewable energy resources refer to the process by which power is transferred from renewable energy to various network technologies [20]. Figure 1 illustrates the basic architecture of an AC grid that integrates renewable energy [20].

Figure 4 illustrates the design of the overall system:

- Solar and wind power plants (renewable energy sources) can be inputs into the AC grid.
- Substations: AC power from the plants is considered as a distribution type of power.

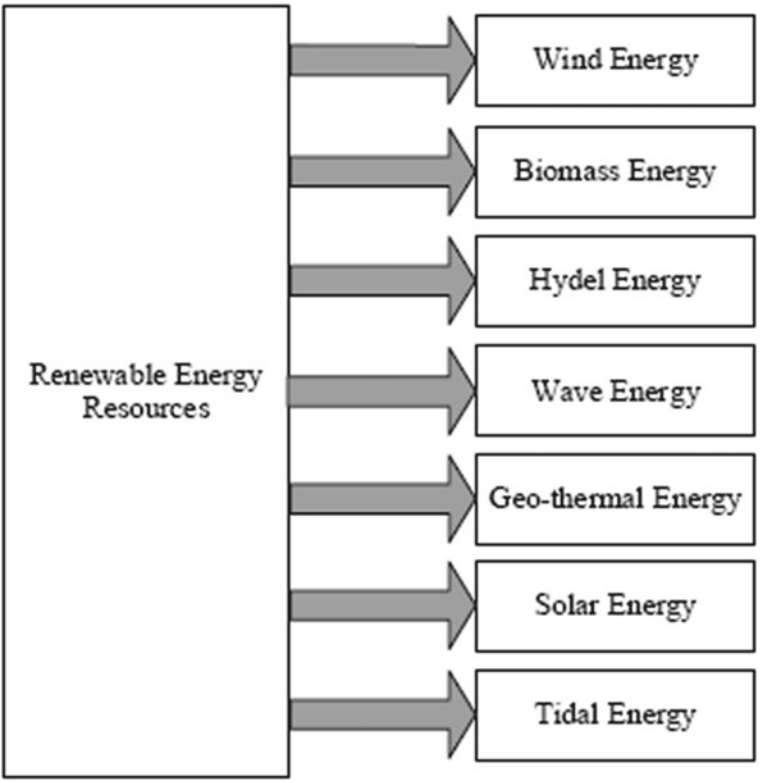

Fig. 3 Types of RER

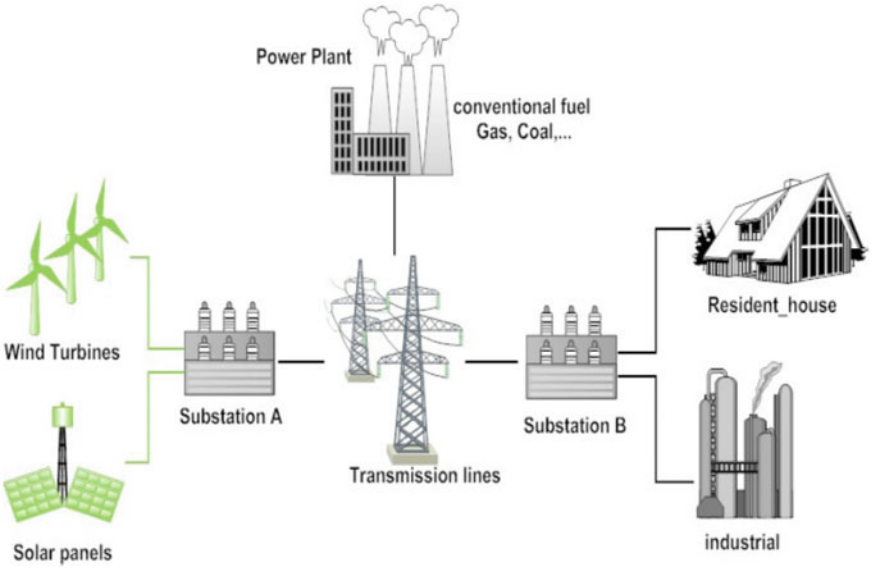

Fig. 4 AC grids designed to integrate renewable energy

- Transmission lines: The AC power they deliver to the distribution system is either high voltage or low voltage.

Integrating RE into conventional power plants is meant to reduce the environmental impact of conventional power plants [21]. The SG [22] maintains this reduction properly. Also, by developing a method of interconnecting renewable energy supplies with the main grid, grid operators can develop a more efficient system [23].

Integrated renewable energy sources require a control system, as shown in Fig. 5, that is capable of many different functions at the standalone application level:

- Communicate between the various components of the system and maintain information.
- Renewable energy output can be adjusted.
- Create the signals that will signal the damp loads and the storage subsystems in operation.
- Overcharging must be avoided and storage must be operated within the prescribed limits.

Renewable energy sources can provide a number of benefits. That is why their introduction into smart grids is becoming a very hot topic of research [24, 25]. Furthermore, the literature shows that the integration of renewable energy resources into smart grid presents a set of benefits and challenges:

A renewable energy resources are advantageous in a grid system, and they can be summarized as follows:

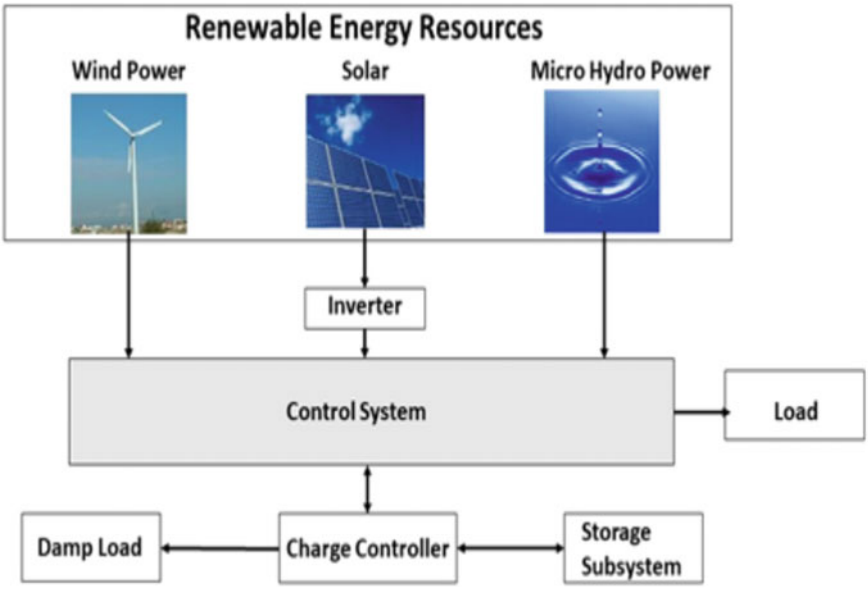

Fig. 5 An integrated system for generating renewable energy

- Positive environmental aspects include the following: The addition of renewable energy sources to the grid system makes fossil-fuel power plants produce less electricity and, thus, reduce CO_2 emissions.
- Social benefit: The ability to sell excess energy to utilities when many people isolate their own energy source is one of the benefits of isolating one's own energy source.
- Economic benefit: Jobs are created as a result of integrated renewable energy.

4 Challenging Issues of Renewable Sources Within SG

Grid stability, power quality, and load on the network are threatened by the inclusion of DG. Controlling DG appropriately can solve the problems mentioned above [21]. Achieving an extra-efficient power grid will require an advanced grid with communication technologies and controlled services.

Comparative analysis of renewables and non-RE resources.

	Renewable	Non-renewable
Availability	1. Sun, wind, geothermal, and ocean energy are available in ample amount 2. Available everywhere 3.no cost 4. Reusable	1. Area specific 2. Limit restriction 3. Cannot be used more than once 4. Destine to expire one day
Environmental effect	1. Less CO_2 emission 2. No environmental harm 3. Clean energy production	1. Huge amount of toxic gas discharge 2. Causes great damage to environment 3. After production environmental effects are very dangerous to humans
Economical effect	1. Low-cost production makes it more economical 2. Employment development	1. Plant Set up is less expensive than production 2. High raw fuel charges 3. High transportation charges
Advantages	1. Environmentally friendly 2. More Economical 3. Stabilized energy prices	1. Quite easy to use 2. Market value is more 3. Cost effective
Disadvantages	1. More capital cost 2. Huge area required for set up 3. Large quantity generation is difficult	1. Fuel price hike is very frequent 2. Great environmental hazards 3. Acid rain

Issues associated with RER integration.

(1) Harmonics

The main cause of harmonics in power systems is the operation of power electronics. As a result of deploying power electronics devices in greater quantities, voltage surges have occurred. Because of DG systems equipped with converters and inverters, such as wind and solar power, the transmission grid can face a high harmonic level. Standards must account for voltage harmonics and nonlinear behavior if they are to properly assess harmonics.

(2) Transients

Lightening as well as connecting and disconnecting generation from the grid are the leading causes of transients. Additionally, if huge flows of current are allowed, transients can result. It is possible to regulate such currents to a certain extent by designing generators in a prudent manner. Power supply stability can be weakened by transients tripping overvoltage protection devices.

(3) Forecasting

Forecasting accurately solar and wind energy production can reduce grid integration costs and ease the challenges of operating a grid with renewable energy

resources. There is a lot of research being done in the field of wind energy forecasting. An un-stationary stochastic process produces wind power. There are two major approaches to tackling this problem:

(a) Wind farm output is predicted using a practical approach that combines wind farm physical model and data collection from weather predictions
(b) There are many methods of matching patterns, such as statistical forecasting, fuzzy systems, neural networks, and ARMA, etc., combined with weather prediction methods to forecast the output of a wind farm are some of the techniques that are used.

(4) Power Grid Stability

Wind power penetration level exceeding 15% constitutes a serious systemic problem, especially in island-based power systems. When several integrated power generation sources are integrated, analyzing system performance and stability can be a serious and difficult task. The overall impact of fluctuation in RE production on frequency and voltage is determined by

(a) A generation control system that is automated, (b) load forecasting, (c) Response to transient frequency changes, and (d) Responses to adaptation.

5 Conclusion and Future Work

SG systems could be a useful method of meeting future energy requirements as they are highly efficient and effective. In addition to providing significant benefits to the environment, SG can also conserve non-renewable resources. As a result of its immense benefits, RER's integration within SG is extremely important. Among the top concerns that need to be addressed are renewable energy's highly variable nature, uncertainty, and intermittency. A significant challenge and an exciting research area is the integration of RERs into the conventional grid. Control methodologies will be needed for many of these issues. As well as SG basics and renewables, we present some specific problems caused by the uncertain, volatile nature of REERs. Making energy resources efficient, reliable, and affordable is a daunting task. Indirectly and directly, RE sources can have an impact on the environment and the economy. Energy security could be improved with RERs power generation inside SG. Politicians must encourage RERs as a means of ensuring non-carbon and sustainable energy. Service providers are experiencing a major shift with SG. The effective and efficient penetration of renewables within SG will require different approaches in order to reap maximum benefits. Utilities need strategies to handle this disruptive technological shift. For SG technologies to become able to contribute to new business processes and penetrate renewable energy resources, technology needs to be upgraded.

A number of benefits and challenges are outlined in this article regarding renewable energy integration in smart grids. Suitable control strategies, such as converter and grid controls, are essential to an efficient renewable energy integration. Integrated RERs systems-dependent power production is the future goal of this work.

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Validation of Adaptive Neuro-Fuzzy Technique for Performance Analysis of Induction Machine

Ashish Sharma and Rinku Garg

Abstract Self-excited induction generator plays a vital role these days for generating power in remote areas. This generator can also run in parallel with a conventional generator to deliver uninterrupted power. Starting from manual calculation to soft computing techniques, various researches are carried out to analyze the performance of this machine. Software techniques play an important role in this analysis as with the help of this, one can analyze the value of unknown parameters magnetizing reactance which is necessary for building up the voltage of self-excited induction generator. In this work, emphasis is given to validate the results already proved with the Adaptive Neuro-fuzzy Technique with another two induction machines. Validation proves that this technique is acceptable.

Keywords SEIG · Fuzzy logic · Induction generator · Magnetizing reactance

1 Introduction

An induction generator is widely used in remote areas for delivering power. This generator works in isolated mode and can work in parallel with conventional synchronous generator [1]. The main advantage of this generator is its robust construction. This generator works when the velocity of the induction motor is increased above its synchronous speed, Induction generator works in saturated region. So, excitation is required for this generator. For starting this generator, minimum capacitance is required. The attached capacitor provides the minimum reactive power which is the need for starting the induction generator at any load [2]. For this generator to start, enough voltage is induced at the terminals of the generator. This decided the excitation method for this machine, after this one can decide generator is ready to deliver power for which mode of operation, i.e., self-driven mode or

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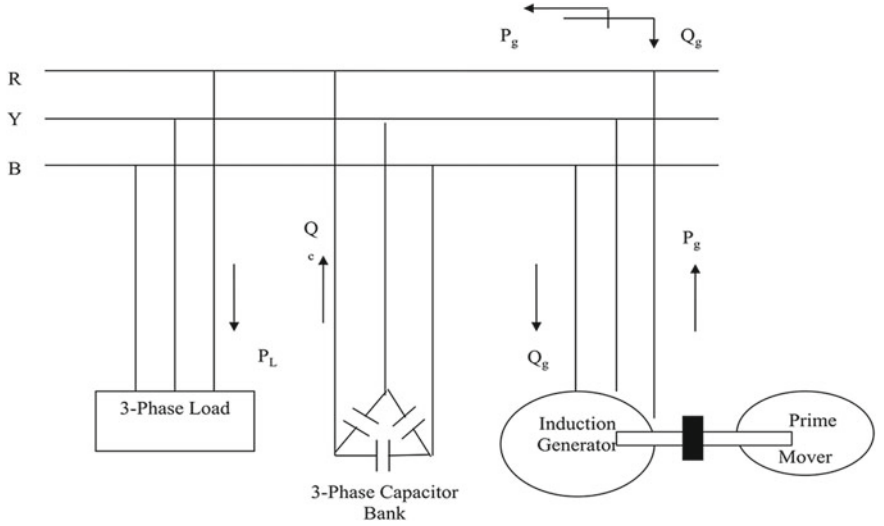

Fig. 1 SEIG schematic diagram

Grid connected mode [3]. It is seen that this generator with a constant value of excitation capacitance gives rise to a lot of dissimilarity among capacitor banks [4–6]. Therefore, extra and variable capacitance is needed. Otherwise, voltage regulation also increases.

$$P_L = P_g$$
$$Q_L = Q_C - Q_g$$

In self-excited induction generators, it is observed that at various speeds and different loading conditions, the capacitor which is fixed will not provide enough quantity of reactive power. Due to large voltage regulations, even the average value of the capacitor is not helpful. Less amount of capacitance does not permit the generator to upsurge voltage and the large valued capacitor can cause transients in the line [7]. There are various challenges in the determination of saturated magnetizing per unit reactance and per unit generated frequency of SEIG under varying conditions of speed, load, and other terminal conditions [8–10]. Determination of air gap voltage corresponding to desired X_m for varying conditions of speed and load. Purpose of the minimum value of capacitance is to regulate the air gap voltage also at different loading conditions.

2 Analytical Approach of Induction Generator

Figure 1 represents the equivalent circuit model of induction generators. This circuit is used by various researchers for doing research on these generators. Various

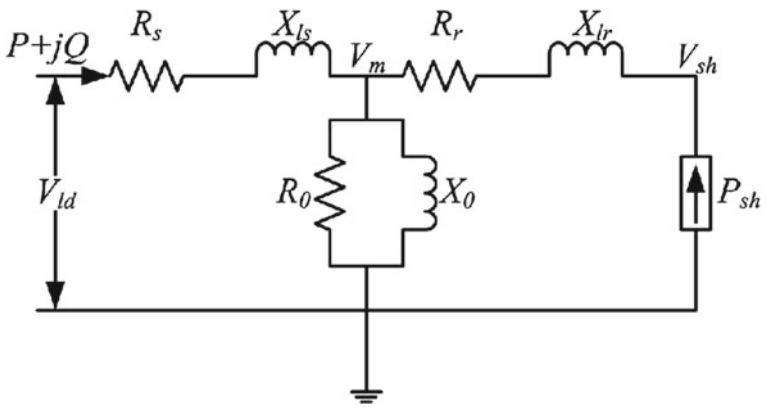

Fig. 2 Equivalent circuit of induction generator

techniques such as nodal admittance method and impedance method are used by researchers. In the circuit, R_r and R_s are rotor resistance and stator resistance, respectively [11–13]. P and Q are real and reactive power. R_0 and X_0 are the no-load resistance loss and magnetizing reactance, respectively. V_{ld} and P_{sh} are voltage input and real power delivered by the load. When we solve this equivalent circuit, it is seen that two non-linear equations are generated. These equations are solved by the Newton-Raphson method by various researches to get the value to magnetizing reactance and generated frequency. The values of finding magnetizing reactance are necessary to analyze the performance of the induction generator, since the induction generator works in a saturated region. But in doing, these mathematical calculations there is a chance of mistake and it is very time-consuming also. Moreover, to judge the performance of different generators there is need of soft computing techniques [14] (Fig. 2).

3 Adaptive Neuro-Fuzzy Technique

The study of various tools for the solution of complex electrical circuits using ANN and Fuzzy logic in MATLAB along with an exhaustive literature survey to ascertain the implementation of artificial intelligence technique for performance evaluation of SEIG is considered in this work. In the ANFIS technique, all parameters are trained as per ANN in MATLAB. After that, the fis file is made. For both the machines under consideration, seven parameters are taken as input and two parameters are taken as output. These parameters are rotor resistance, stator resistance, stator reactance, rotor reactance, speed, load, and capacitive reactance [15]. The output parameters are magnetizing reactance and generated frequency. All parameters of the induction generator are mapped as per rules. Experimentaion is done using fuzzy logic rules, which is a very simple rule-based technique. These rules tally with linguistic variable

Table 1 Range of machine parameter

Range of machine parameters (P.U.)		Range of terminal variables (P.U.)	
Rotor resistance	0.03–0.15	Load impedance	0.70–1.25
Stator resistance	0.03–0.15	Power factor	0–1
Rotor reactance	0.05–0.16	Speed	0.85–1.25
Stator reactance	0.05–0.16	Excitation capacitance	0.80–1.20
Core loss branch	30–40 Ω		

which involve easy logical operation and relatively easy programming. Range of all parameters for making the algorithm is taken due consideration for the maximum and minimum values of all parameters. Table 1 shows the range of all the parameters. The ranges are selected in such a way that these ranges are fitted to all the machines [16, 17]. Various data is studied before coming to a conclusion for selecting the range—approximately twenty machines' data of different ratings are studied and collected. All the machines are taken from Punjab state electricity Board, Bhatinda office and from Vardman Yarn and Thread Limited, Hoshiarpur. It is found that the range of all the machines falls within the range decided in the research. All values are taken in per unit by selecting the base value of the machine placed in Giani Zail Singh College of Engineering and Technology, Bhatinda (Figs. 3 and 4).

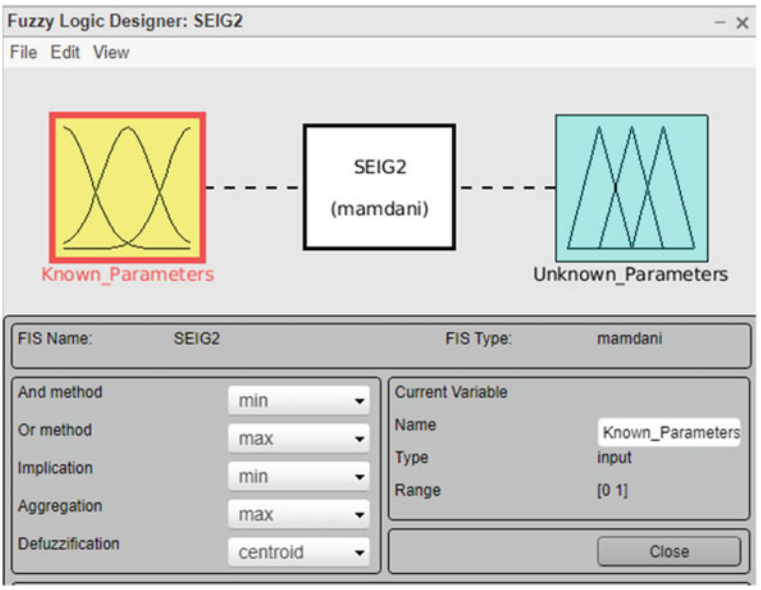

Fig. 3 Fuzzy logic controller

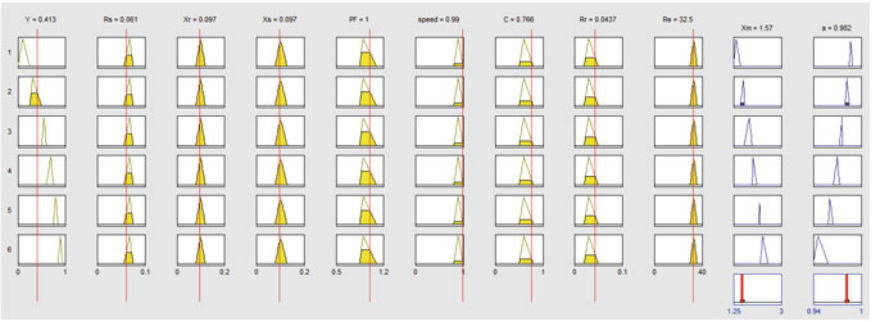

Fig. 4 Neuro-fuzzy rules

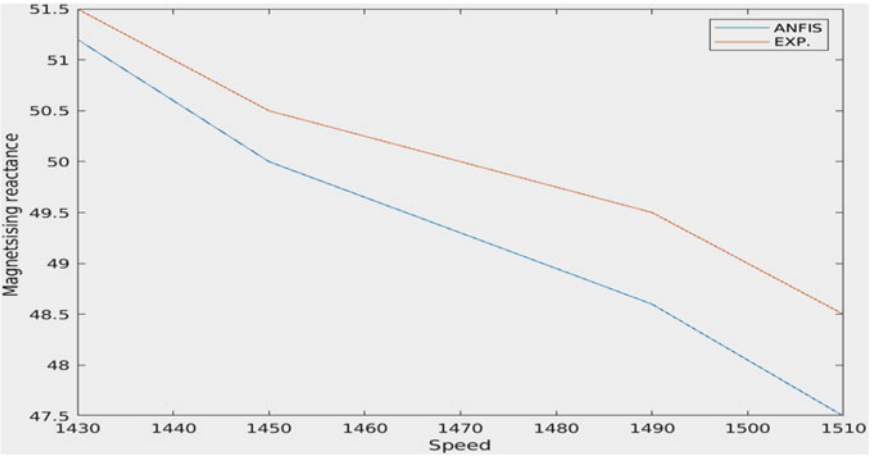

Fig. 5 Comparison of results for validation at two different machines

4 Comparison of Results with Different Machines

See Figs. 5, 6, 7, 8, 9 and Tables 2, 3.

5 Conclusion

It is seen from the graphical analysis that as the speed increases, the magnetizing reactance decreases and as the load increases the magnetizing increases. The terminal voltage and air gap voltage increase with the increases in speed and terminal voltage and air gap voltage decreases increase in load. Moreover, the validation shows that the software ANFIS also gives almost the same results. The same technique can

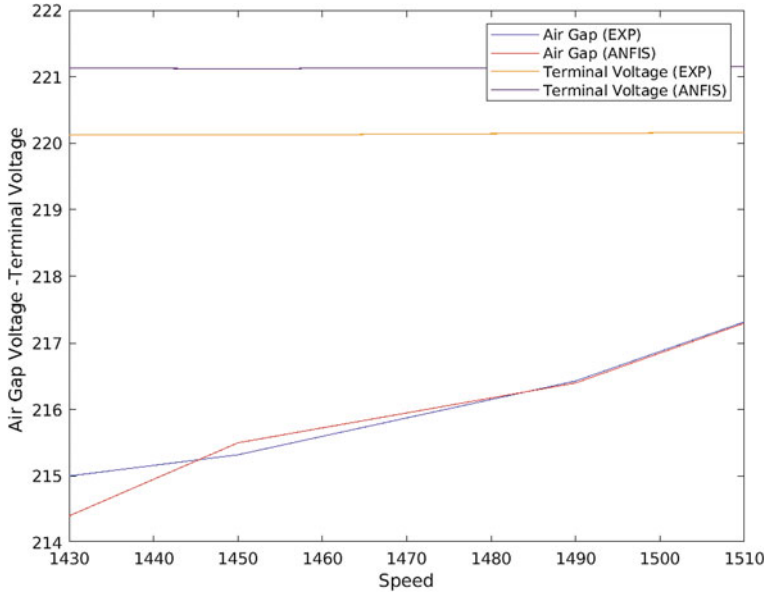

Fig. 6 Comparison of results for validation at two different machines

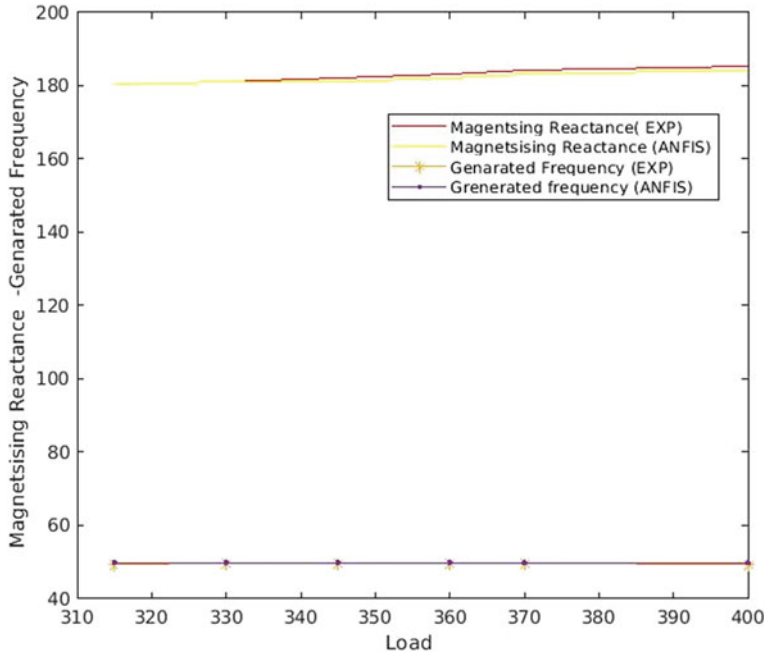

Fig. 7 Comparison of results for validation at two different machines

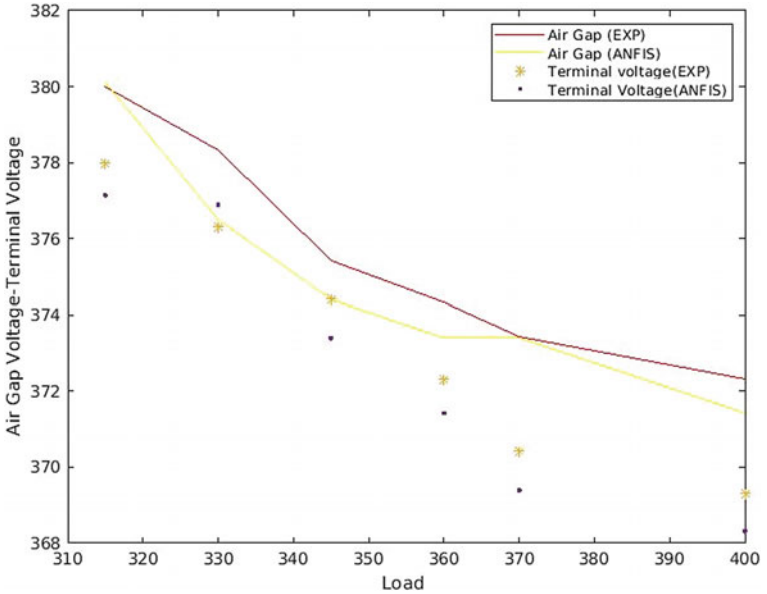

Fig. 8 Comparison of results for validation at two different machines

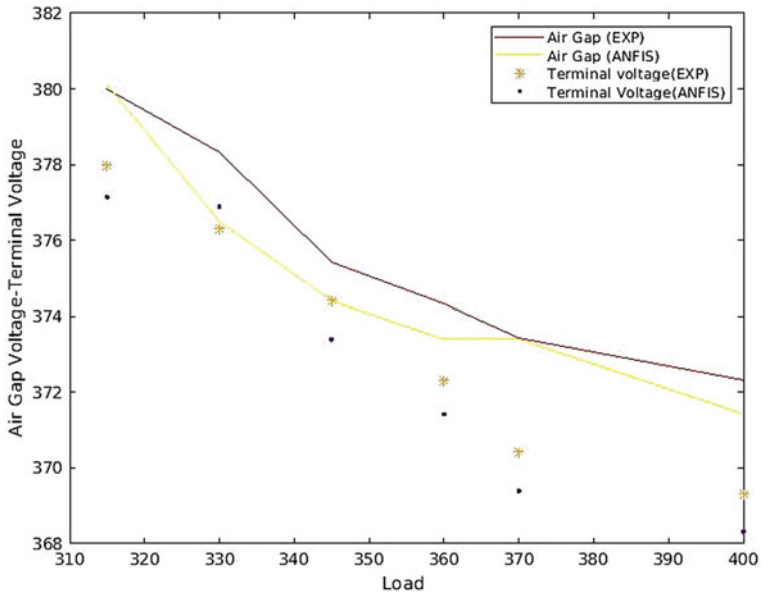

Fig. 9 Comparison of results for validation at two different machines

Table 2 Comparison of ANFIS with experiment variable for SEIG1

Speed (rpm)		1430	1450	1490	1510
Magnetizing reactance (Ω)	Experimental result	51.2	50	48.6	47.5
	ANFIS result	51.5	50.5	49.5	48.5
Generated frequency (Hz)	Experimental result	49.74	49.94	49.96	49.92
	ANFIS result	49.8	49.87	49.86	49.86
Air gap voltage (V)	Experimental result	215	215.32	216.43	217.32
	ANFIS result	214	215.51	216.4	217.42
Terminal voltage (V)	Experimental result	220.12	220.14	220.15	22.16
	ANFIS result	221.13	221.12	221.14	221.15

Table 3 Comparison of ANFIS with experiment variable for SEIG2

Load (Ω)		315	330	345	360	370	400
Magnetizing reactance (Ω)	Experimental result	180.2	181.2	182.2	183.2	184.2	185.2
	ANFIS result	180.2	181.2	181.2	182.2	183.2	184.2
Generated frequency (Hz)	Experimental result	49.45	49.75	48.67	49.78	49.75	49.45
	ANFIS result	49.85	49.87	49.86	49.86	49.86	49.85
Air gap voltage (V)	Experimental result	380	378.32	375.43	374.32	373.43	372.32
	ANFIS result	380.14	376.51	374.4	373.42	373.4	371.42
Terminaloltage (V)	Experimental result	378	376.32	374.43	372.32	370.43	369.32
	ANFIS result	377.14	376.89	373.4	371.42	369.4	369.42

be used to analyze the unknown parameters for any machine. For more verification of this technique, the parameters can be checked on other machines also. With this technique, one can analyze the performance of any induction generator of ant size and shape. This technique is helpful to install the induction generators at isolated places even at the field without experimentation.

Appendix

Parameters of Machine used for Validation of results.

SEIG1: 3 KW, 230 V, 8.6 A, 50 Hz, 1500 rpm, and 4 poles; SEIG2: 1 KW, 380 V, 1.9 A, 50 Hz, 1500 rpm, and 4 poles.

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Human Resource Practices and Employee Performance in Indian IT Industry: An Empirical Study of Selected IT Companies

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Abstract Human resource practices plays a huge role in the long-term survival of organizations. Organizations have started to realize the importance of innovative human resource practices for employees as well as organizational well-being. The IT sector of India has always been the torch-bearer of creative and innovative thinking. Therefore, the present study aims to explore the relationship between selected human resource practices and the performance of employees in the selected IT giants of India. Descriptive and inferential statistics have been used to analyze the data collected from 375 participants. The study found that human resource practices especially contemporary practices and compensation have a significant impact on in-role and extra-role performance of the employees.

Keywords Human resource practices · Contemporary human resource practices · In-role employee performance · Extra-role performance · Indian IT companies

1 Introduction

Human Resource Management is critical in IT companies because the industry is more people-intensive. In the IT industry, the people cost is more than capital cost. Edwin Flippo defined HRM as "planning, organizing, directing and controlling of procurement, development, compensation, integration, maintenance and separation of human resources to the end that individual, organizational and social objectives are achieved". The people-intensive organizations spare a great deal of effort and money on managing human resources. Employees in this industry have a higher switching tendency than any other industry in the service sector. The average attrition of the Indian IT industry is 15%, which is higher than the global average of 11.2%. To retain talented employees, managers need to employ practices, which affect the behavioral outcomes of employees and eventually their performance.

The best employers are aware that to be competitive in the industry, they need to have resources, which are rare, valuable and inimitable. The resources of the

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organizations in terms of material, machinery and money can be duplicated but competitors cannot imitate the human resources. Therefore, the best organizations in the industry maintain uniform and effective HR policies and practices to motivate and develop their employees and ensure their optimum utilization in achieving the corporate goals.

In order to achieve organizational objectives and goals, the organizations thrive on high employee performance and productivity. In addition, if the employees do not have any intention to leave in near future, it means that they are happy with the work they have been assigned and they are satisfied with the environment of the organization.

2 Review of Literature

The organizations can gain a competitive advantage by implementing HR functions, Schuler and MacMillan [1]. Singh [2] explored HRM practices in selected private sector organizations in India and reported a significant difference between the HR practices adopted by the organizations which can be attributed to specific requirements of different organizations. On the other hand, Ishrat and Habib [3] found that Indian MNCs and foreign MNCs have developed innovative and contemporary practices, viz. e-HRM and green HRM to cope with the external environmental changes. Adopting innovative practices such as management restructuring programs, performance ethics programs and differential reward systems are crucial to retaining key employees. Indian MNCs have developed innovative culture-building practices, while foreign MNCs were more concerned with cost and performance aspects of the employees, Jain et al. [4]. HR professionals of high-performing organizations have adopted innovative practices in terms of green recruitment, 360-degree feedback, variable compensation, more perks instead of cash and outbound training. While providing training to their employees, IT firms emphasize both technical and behavioral aspects of the job and the formal performance appraisals form the basis of training and development. These firms use internal and external sources of recruitment, and performance appraisal is done after completion of very project and at regular time intervals, Kumar and Prasad [5].

Reference [6] identified that Chinese manufacturing firms mainly rely on internal sources of recruitment and resort to external sources only when it is absolutely necessary. The organizations also rely heavily on on-site training for their employees, and off-site training methods are used for their further enhancement of knowledge and education. Reference [7] explored the human resource practices in a Japanese firm in Morocco and reported the existence of social incentives, including religious holidays and free transportation, in the compensation package offered to employees. There is also the presence of employee empowerment practices and investment in knowledge and education of employees to scale in the hierarchy of the organization. The authors concluded the high level of employee loyalty and commitment as drivers of human

resource practices through alignment between values and beliefs of employees and organization.

The human resource practices adopted by an organization significantly affect its operational and intangible performance, Ahmad and Schroder [8]. Reference [9] identified the impact of high-commitment human resource practices on employee service behavior and found that human resource management serves as a link between employee productivity and organizational goals, thus affecting employee service behavior. The study further indicated that high commitment practices lead to the building of trust between employees and management, which in turn affects the in-role service behavior of employees leading to cooperative and sincere employees.

Reference [10] found a strong relation between job satisfaction and organizational citizenship behavior and further indicated that organizational citizenship behavior significantly affects the performance of employees, however, compensation and training are the two strong predictors of employee performance [11–14]. Institutions with trained and involved employees receiving competitive compensation have a higher level of employee performance. HR functions in collaboration with organizational outcomes positively affect the performance of employees, Nyameh et al. [15].

3 Materials and Methods

The study's purpose is to explore the relationship and subsequent impact of HR practices on employee performance in the Indian IT industry. The data was collected from 375 respondents using a self-structured questionnaire containing statements for human resource functions and employee performance of the employees. The reliability and validity of the scale were also calculated which came out to be at appropriate levels.

4 Results

Table 1 presents the inter-correlations among the scores of eight constructs.

The highest correlation (0.907) was found between training and development and performance appraisal as training needs are identified based on performance appraisal of employees and vice versa.

The inter-correlations between human resource practices and dimensions of employee performance range from 0.761 to 0.831. The highest correlation was found between contemporary human resource practices and in-role performance as 0.831, and the lowest correlation was found between contemporary human resource practices and extra-role performance as 0.761.

There is a high correlation between in-role performance and selected human resource practices indicating that selecting the right candidate, with the required

Table 1 Mean, standard error and inter-correlations between human resource practices and employee performance

S. no.	Variables	HRP	R&S	T&D	PA	CS	CHRP	In-role	Extra-role
1	HRP	1	0.851**	0.821**	0.829**	0.842**	0.842**	0.819**	0.785**
2	R&S		1	0.878**	0.874**	0.891**	0.838**	0.805**	0.776**
3	T&D			1	0.907**	0.874**	0.863**	0.816**	0.810**
4	PA				1	0.905**	0.879**	0.815**	0.773**
5	CS					1	0.874**	0.811**	0.767**
6	CHRP						1	0.831**	0.761**
7	In-role							1	0.852**
8	Extra-role								1
	Mean	27.34	23.76	17.03	20.25	23.84	27.69	30.35	22.99
	Standard error of mean	0.50	0.46	0.34	0.41	0.48	0.53	0.50	0.46

Source Primary survey results
**Correlation is significant at 0.01 level (2-tailed)

competence, skills and abilities and the right service attitude, at the right time with the help of forecasting techniques and placing him/her on a job that is clearly defined with duties and responsibilities will have a positive impact on the in-role performance of the employee, and he/she will perform the duties as expected along with showing sincerity toward his/her work and cooperation toward others. Also, if the employees are provided with regular training and development to sharpen their skills and their compensation is based on competence and performance, they are likely to complete their assigned duties on time and fulfill their responsibilities as per the job description. Contemporary HR practices, viz., recreational facilities and work-life-balance also co-vary with in-role performance.

The correlation among human resource planning (0.785), recruitment and selection (0.776), training and development (0.810), performance appraisal (0.773), compensation system (0.767), contemporary human resource practices (0.761) and extra-role performance was also found significant indicating that selecting the right candidate for the right job at the right time with adequate training to perform tasks assigned and providing him/her with performance-based compensation leads to an employee being more constructive in the work. Such employees also go out of their way to help and encourage their colleagues to be more productive and help the organization in foreseeing the potential harmful problems.

Regression analysis has been used to predict employee performance based on HR Practices.

The 0.886 value of R as shown in Table 2 indicates a high correlation between employee performance and human resource practices.

Table 3 shows the ANOVA where the F-value for the significance of multiple R equals 225.007, which is significant at 0.01 level.

Table 2 Model summary

Model	R	R square	Adjusted R square	Std. error of the estimate
1	0.886	0.786	0.782	8.40908

Predictors: (Constant), HR practices

Table 3 ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig
1	Regression	95,465.273	6	15,910.879	225.007	0.000
	Residual	26,022.263	368	70.713		
	Total	121,487.536	374			

[a]Predictors: (Constant), HR practices
[b]Dependent variable: employee performance

Table 4 shows regression coefficients that can be interpreted in the below equation:

$$Y = 8.263 + (0.555 \times 1) + (0.165 \times 2) + (0.820 \times 3) + (0.092 \times 4) + (0.079 \times 5) + (0.298 \times 6)$$

Table 4 depicts that human resource planning, training and development and contemporary HR practices contribute very high in employee performance as indicated by their t-values, $p < 0.05$ indicating that for every unit increase in human resource planning, employee performance increases by 0.555. Similarly, for every unit increase in training and development, employee performance increases by 0.820

Table 4 Regression coefficients

Model	R		R square	Adjusted R square	Std. error of the estimate
1	0.886		0.786	0.782	8.40908
Model	*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Sig*
	B	*Std. error*	*Beta*		
(Constant)	8.263	1.322		6.248	0.000
HRP	0.555	0.096	0.301	5.767	**0.000**
RS	0.165	0.125	0.083	1.325	0.186
TD	0.820	0.175	0.304	4.693	**0.000**
PA	0.092	0.161	0.041	0.573	0.567
CS	0.079	0.131	0.041	0.605	0.545
CHRP	0.298	0.104	0.170	2.874	**0.004**

Dependent variable: employee performance

and for every unit increase in contemporary HR practices, employee performance increases by 0.298.

5 Discussion

The study finds that performance appraisal in the IT industry is based on all-round ratings of the employee using a 360-degree mechanism and BARS which usually serves as a basis of the training and development needs of the employee. The training to be provided to employees is need-based, the duration of which may extend from one week to one month. The employees are also provided feedback and counseling after the yearly appraisals. The organizations emphasize keeping their appraisals transparent and explicit which serves as a basis for the fair and just compensation to be provided to the employees. The compensation at these firms is based on merit and targets achieved, with added perks and benefits based on performance in projects handled. Similar findings have been reported by [16–18] where they reported that compensation systems are inter-related as one serves as the basis for other if the organization is fair and transparent in its policy. This also leads to a higher level of employee performance and other outcomes.

Training and development, human resource planning and contemporary HR practices are identified as strong predictors of employee performance indicating that if the right candidate is selected at the right time whose attitude, ethics and values match with that of the organization, provided with proper training with respect to the behavioral and technical aspects of the job and provided with just and fair merit-based compensation, then the level of his/her in-role performance and extra-role performance will be higher.

Research also reports a strong correlation between contemporary HR practices and employee performance dimensions indicating that organizations that take care of the well-being of their employees by use of innovative practices, viz., recreational facilities, social gatherings and flexible work hours, will have a higher level of extra-role performance leading to employees being goal-oriented, cooperative to their supervisors and taking active participation in volunteering activities. This finding is specific to the study as previous researches have only identified the existence of contemporary HR practices as part of the HR function, not the causal relationship of the same with other variables.

6 Conclusion

The industry's top firms have made their mark in the world by providing affordable and quality products to their clients.

To acquire the right person at the right time and at the right position is a must for firms to be successful in their business. The traditional HR practices along with

contemporary methods can help the organization in its objectives. This has led to a high level of employee performance especially in terms of employees taking an active part in volunteer activities for the organization and being supportive to colleagues. These employees make constructive suggestions for the benefit of the organization and achieve their targets on time.

The present research suggests that service organizations should adopt such practices, which leads to high involvement of their employees and increased level of performance.

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Detection of Stress with Deep Learning and Health Parameters Monitoring Using Raspberry Pi

Sujata S. Chiwande, Ashutosh Bagade, Sakshi Deshmukh, and Sushma Nagdeote

Abstract Now in day-to-day life, every individual faces some sort of stress due to workload, school, or form their lifestyle. Stress is an unwanted portion of life that is seen in people. As stress can have some positive effects, but it has adverse effects on your health if it is for a long time. Therefore, it is crucial to detect a person's stress, as it can lead one to depression. It is observed that stress leads to worse health situations. It is also found that stress can affect health by increasing heart rate, decrease in oxygen level of the body, and increase in weight. It can lead to obesity. Regular change in BMI also indicates that a person is stressed. Stress is threatening mankind's well-being. Due to stress, body releases a hormone that speeds up your heart rate and breathing. In the detection of stress, facial expressions have a pivotal spot. The proposed system will detect stress based on three stress-related facial expressions sad, angry, and fear. The proposed work in this paper is to make individuals aware of their physical condition. The aim of this paper is to detect stress by using deep learning concepts and health parameters monitoring such as heart rate, oxygen level, and BMI using Raspberry pi. And the measured results of the different persons with the proposed system and the existing system are given in the table.

Keywords Deep learning · Facial expression · Heart rate · Oxygen level · BMI

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1 Introduction

Nowadays, stress is one of the main reasons that affect many lives. It is an emotional state where a person is trying to cope with life, by facing difficulties such as financial problems, workload, peer pressure, etc. Stress can also affect one's thinking ability and physical health. It is seen that stress has a great

influence on heart-related problems. It can accelerate heart rate or blood pressure, and also it can create breathing problems. In the new study, the theory is explored that if stress is not eased down, then it can boost anxiety and lead to depression. So, it is very essential to have concern over the acknowledgment of stress before it is too late and can create adverse effects on well-being of humans. Thus, for this, we have come up with a system that is deep learning-based stress detection using facial expressions and health parameters monitoring. For the recognition of emotions, facial expressions play a crucial role. Facial expressions can help to identify people, to recognize the emotional state of a person, or in non-verbal communication. Therefore, automatic systems often use facial expressions as it gives information on emotion state of a person. In this, the proposed framework detects stress by stress-related emotions such as fear, sadness, and angry. It categorizes if a person is stressed or not stress by basic emotional states: angry, disgust, happiness, sad, surprise, and neutral. For capturing the frontal view of a person, a camera is used. Firstly, the face of the person sitting in front of the camera system is captured. Haar cascade algorithm is used to detect face from the captured image. The system then extracts features from the image and classifies them into expressions into six categories: angry, disgust, happiness, sad, surprise, and neutral. Here for the classification of images, the Keras Model, a deep learning algorithm is used. Stress temporarily raises blood pressure, which increases heart rate and lows down oxygen level in the blood. It also affects the overall BMI of a person. Therefore, these are the parameters that are taken into consideration. And a prototype is developed where these three parameters are calculated and their result is implemented on Raspberry pi.

2 Literature Review

Depending upon the analysis of facial expression, a stress detection system is developed. By analyzing facial expressions and capturing real-time videos, emotional status of a person is detected. Based on image processing and deep learning concept, this system is developed. Python framework Theano is used, in this stress is predicted through the position of the eyebrow from its mean position. The one who is working on a computer for a longer duration, it is necessary to monitor his emotional status for his safety [1]. Paper [2] demonstrates a faster R-CNN for facial expression detection in order to overcome the problem of low function of the data processed in the traditional feature extraction methods, and do not have complex features. For faster

discovery, R-CNN uses a region proposal network to create a high-quality and accurate region proposals. The softmax classifier and a linear regression layer is used to classify the facial expressions and the project, the boundaries of the sample. The results of the experiment showed that the proposed procedure provides better absorption efficiency [3]. The motive of this research is to detect seven basic emotional facial expressions using a k-NN classifier and MLP neural network. On the basis of this, the proposed model is generated, the Kinect device records particular 121 points in the face. These points on the face are organized in a characteristic position, for example, eyebrows, nose, corners of the mouth, bones of cheeks, etc. Paper [4] detects stress using different machine learning and image processing methods. Stress in a person predicted by the symptoms calculated by observing, analyzing the stress levels in a person, and providing solutions and remedies for the person to recover is the main objective. When the user is logged image is captured automatically and is used to predict the stress of the user based on the mechanism of image processing and standard conversions. Then by using machine learning algorithms, the system will analyze the stress levels [5]. In this paper, stress is detected by the deep learning method and by IoT. The developed prototype predicts whether the person is stressed or not based on the fluctuations in his/her heart rate. To know the heart rate, a pulse sensor is used. CNN algorithm is used to classify images automatically. It will train the classifier on labeled images and from them, features will be extracted. By observing the features of the newly provided image and comparing it with this learned information, the image will be classified. In paper [6], it is discussed that many times stress led to depression. For the better mental health of a student's problems such as fear, stress, anxiety cannot be neglected. A system is trained such that it will capture the face videos of students or person, then extracts facial gestures/expressions and by the gestures sign of stress will be detected. SVM classifier can classify features of a sad face which is the same features as that of the depressed or stressed face. For face detection and feature extraction, the system uses various image processing methods. These features are then classified as depressed or no depressed. The system will be trained with features of depression. Then using a web camera videos will be captured [7]. This paper author discussed that stress has many different symptoms for every individual, but a decrease in the temperature of hands is common for most individuals. Here, the proposed system is a case-based system that is utilized in a standard phase to detect a collection of primary parameters and hypotheses which can be used for taking a decision which in turn helpful for clinicians [8]. This system is been proposed for the real-time recognition of emotions, here in this paper they have suggested a procedure which will include Haar cascade, which will be used for the extraction of several features using Active shape Model (ASM) and Adaboost classifier for classification of emotions like surprise, happiness, disgust, neutral, and anger. This implemented using Raspberry Pi II with a mean precision of 94% is achieved in real time [9]. In this, they have proposed a model which is a real-time recognition that detects the mood of a person, and different algorithms and deep learning methods are used. They have created application software that recognizes the expression of humans in real time using powerful packages in python. For real-time image processing, TensorFlow, Keras, OpenCV, Matplotlib are some of the

libraries used by this model. In this paper [10], technique of dual-feature fusion is proposed. The framework created will be based on the features (local and global features) that are used to build the projected framework robust to change in obstruction, noise, and illumination. The images are divided into blocks, the extracted the feature from salient face regions and then for better representation combined with texture and orientation features. To get the discriminative features, "Feature selection process" is used where the features which are unessential will be eliminated. The decrease in feature vector length also decreases; the main advantage which makes proposed system satisfactory for the real time is the time complexity [11]. According to the research of this paper, evidence showed that stress contributes to heart diseases. Also, stress leads to various other responses including heartbeat, blood pressure, and also decreased heart rate inconsistency. In this study, they examined the relationships among stress, blood pressure, heart rate variability. In this paper, N. Jaymon used CNN architecture such as Inception and Exception to train the model on Fer2013 and their accuracies are compared. This paper highlights the future trends of this model which can be used to improve gaming experience, detecting potential threat in security systems, and detecting the emotions of stakeholder giving online interviews [12]. Energy Parameter is very well defined and can be analyzed from paper [13].

3 Methodology

The main objective of the proposed system is to design real-time stress detection from the facial expressions and health parameters measurement. By taking images from camera, the software detects if the person is in stress or not. The system recognizes the facial expressions describing emotions like anger, disgust, happy, surprise, sad, and neutral from the facial images taken by the webcam. To recognize expressions, we have used the Keras Model through OpenCV python frame work. Further steps involve calculation of health parameters such as oxygen level, BMI, and heart rate. For measuring oxygen level, MAX30100 is used. A pulse oximeter measures the oxygen level, or the oxygen saturation in the blood. The BMI (Body Mass index) is a value calculated from the height and weight of its body; the interfacing diagram is shown in Fig. 3. We will segregate this in two parts, calculation of body mass and of height. Height is measured by ultrasonic sensor and mass is measured by load cell with amplifier unit HX711 (Figs. 1 and 2).

The model then predicts if that person is stressed or not using captured images and by measured health parameters. It is implemented on Raspberry pi 3 model B.

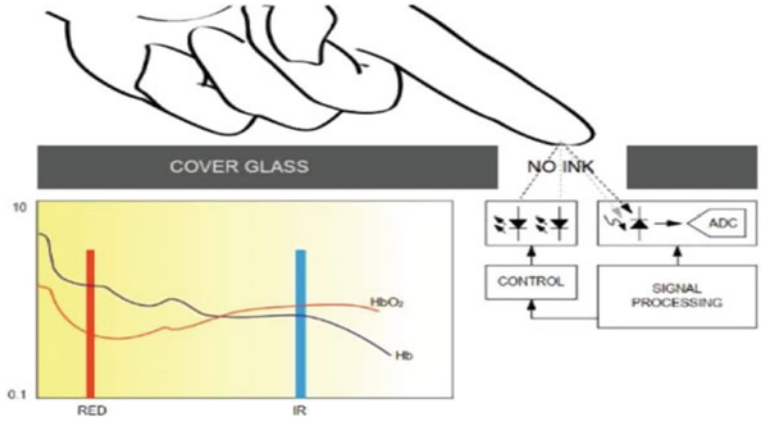

Fig. 1 Interfacing MAX 30,100

Fig. 2 MAX 30,100

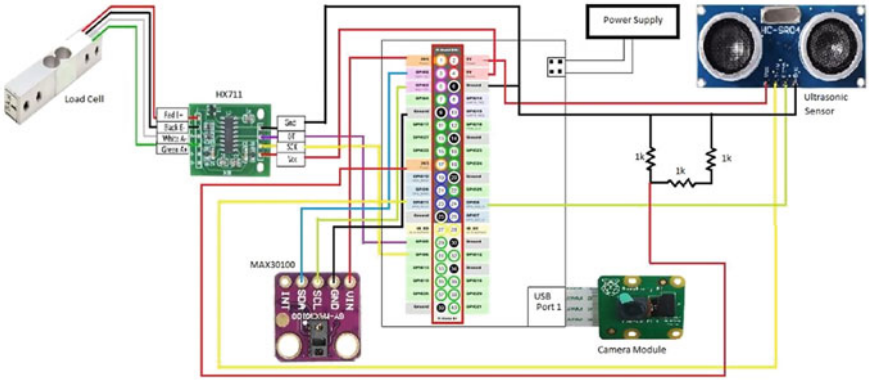

Fig. 3 Circuit diagram for hardware interfacing

4 Work Done

This paper presents a working prototype device to detect human stress to a measuring human stress level. This paper deals with the development of software- and hardware-based prototype devices. This system will aim on detecting stress based on the facial expressions and emotions of human sitting in front of it. And it will find various health parameters like heartbeat, level of oxygen, and BMI. Figure 4 shows the hardware implementation of the system.

4.1 Facial Expression Detection

Some facial expressions represent stress. Thus, detection of facial emotions plays vital role in stress detection. With the help of expressions, we can predict if person is stressed or not. So to recognize facial expressions of person sitting in front of system, we have used a Keras model through OpenCV python framework. We have used Haar Cascade-frontal face library which is a inbuilt emotion classifier under Keras model application of OpenCV. This classifier is a machine learning-based function which is pretrained model. This model is then used to identify objects in other videos or images. The objective was to detect six facial expressions which were Angry, Disgust, Sad, Happy, Surprise, and Neutral. Firstly, the image was captured by camera. Here, for capturing purpose, we have used pi-camera module. Then the captured image was transformed into grayscale image. The reason of converting RGB image into grayscale was that the grayscale channel was easy to process and was computationally

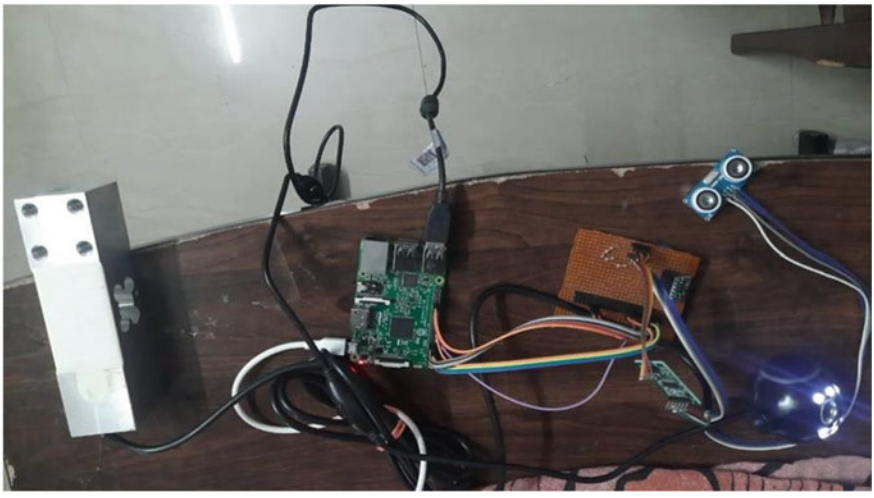

Fig. 4 Hardware Implementation of the proposed system

less intensive as it contains only one channel black-white. The dimensions of captured image were very large, so for better output, we scaled down the image. To locate exact facial expressions features in face, we used detectMultiScale. This function returns four parameters: width, height, x-coordinate, and y-coordinate. Based on these four values, a rectangle will be formed around detected feature along with the name of expression which is detected by the model. The result of this task can help in only prediction of stress but it is not possible to detect stress only on the basis of facial expression detection. So for the accurate result, we calculated two more parameters—oxygen rate and heartbeat rate.

4.2 Oxygen and Heart Rate Measurement:

Oxygen and Heart rate measurement is one of the important parameters in finding whether the person is in stress or not. This can be found with the help of MAX30100 Sensor as shown in Fig. 2. Here, we have used MAX30100 as an integrated pulse oximetry and heartbeat monitor sensor for measurement. It consists of red and infrared LED , photo detector, optimized optics, and the signal will processed by less noisy analog signal unit. The MAX30100 works on the range of 1.8–3.3V power supply. It can be powered through software with negligible standby current and permitting the power supply unit to stay connected for all times. It works on the principal that, when we place our fingertip in the sensor, a small ray of light passes through our blood through the finger and measuring the amount of oxygen.

It can be done by measuring changes in light absorption in oxygenated or deoxygenated blood, and the rate of oxygen available for the determination of the heart rate when the heart is pumping the blood to the amount of oxygen-rich blood is increased, and when the heart relaxes, the volume of oxygen-rich blood drops. In this way, you can find out what is the body by the heart. Normal SPO2 value is usually ranging from 95 to 100%. Values below 90% are considered as low, and indicate the need for additional requirement of oxygen. A normal beats of heart should be **60–100 beats/min**, but it can vary from every time.

4.3 BMI Measurement

BMI is not directly connected to stress, it's just parameter to check health. It is often seen that a high BMI mean a stressed person; but it's just a theory, there is no proof of it. Here, we have used this parameter just to keep check that whether the person is fit or not. BMI cannot be used as a diagnostic tool, it's just a medium of suitable for use in the identification of potential problems due to the weight of this. A person is in grave danger, when they have a high BMI. These measurements will enable physicians to recommend you to the various health risks associated with obesity. For example, the measurement of skin folds, a person, a fitness center, and a dietician is

able to decide a person's diet and the other is a human health screening. BMI stands for Body Mass Index. The calculation of BMI can be calculated using this formula, BMI = [(weight in kg/height in m^2)]. People who are overweight and obese have a large risk of many diseases such as high blood pressure, high LDL cholesterol, and low HDL cholesterol levels, diabetes, plaque in the arteries of the heart, heart attack, stroke, diseases of the gall bladder, infections, issues, and breast cancer. The equipment that are used in this system are load cell to measure the weight and an ultrasonic sensor. An ultrasonic sensor is used to measure the height. A person's weight is measured in Kg or pounds. The elevation has been calculated in meters and is in size however, for a BMI of use of the height in meters. The weight is measured by a load cell; the physical energy is converted into an electrical signal and sent to the Raspberry pi model 3b. The height will be measured with an ultrasonic sensor as shown in Fig. 6, the light is reflected when it hits an object, and a signal is sent to the Raspberry pi. The main advantage of this device is in this generation and the control in of body weight and maintains a healthy lifestyle. Currently, BMI is commonly used to classify underweight, overweight, and obesity. It is calculated by dividing weight in kilograms by their height in meters, and then to divide the answer, again, because of their height (Fig. 5).

Body Mass Index = Body Weight (kg)/(Height in meter)^2 For instance: BMI = 77kg/(1.59 m)^2 = 77/2.528 = 30.457

This ratio is then compared to an index chart (Fig. 1), to check status of BMI.

Fig. 5 Load cell

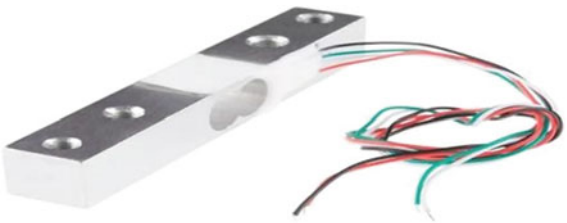

Fig. 6 Ultrasonic sensor

5 Result and Conclusion

In the above results as shown in Fig. 7, we can see different facial emotions have been detected like Neutral, Sad, Angry, Happy, Fear, etc. Calculating this results is one of the important factors that will contribute to health monitoring. After processing the facial expression like happy, sad, angry, disgust, surprise, fear, and getting various health parameters like pulse rate, oxygen rate and BMI of the person, stress is detected when the facial expression recorded as angry or sad, or pulse rate greater than 90 and oxygen level less than 95. As we have discussed, the overall implementation is done on Raspberry pi 3 model B. In short, the overall outcome can be explained by the following statement (Figs. 8 and 9):

Fig. 7 Showing the result for the detection of emotion for different facial expressions

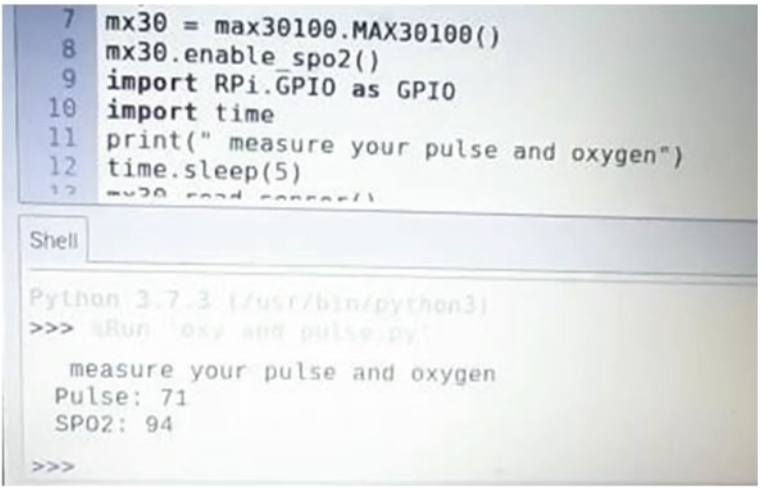

Fig. 8 Results showing pulse rate and oxygen

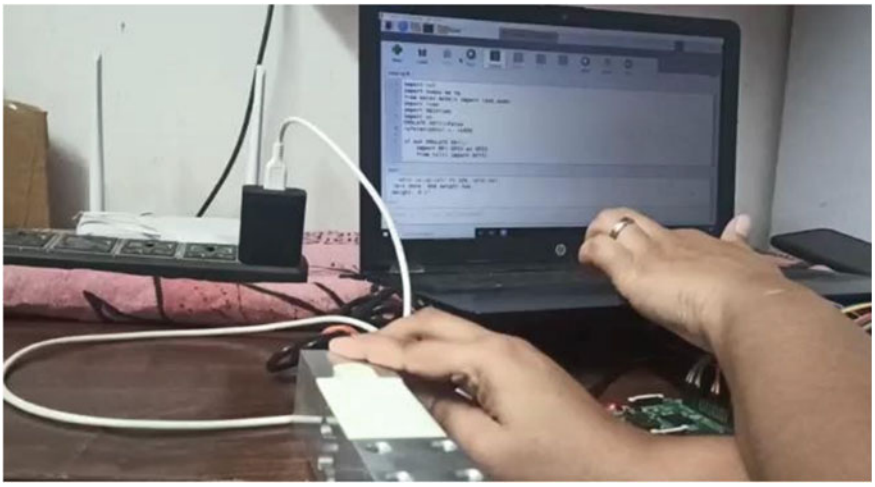

Fig. 9 Body mass index representation

If ((oxy && heart rate level == beyond normal range) && emotion == one of stress emotion)

{

Print(″The person is stressed and immediately need to consult a doctor″;)

}

Here, we have tried to generate a detector which can detect stress on the basis of the overall analysis of various facial gestures and variety of health parameters. We have compared our device with the standard device present in the market and comparative analysis result is given in the Tables 1 and 2 for the number of individuals. At the moment, even with all our technological advances, there are no low-cost reliable solution available for detecting stress. Even though there are a lot of mobile apps related to health, there isn't a single app in order to accurately measure stress levels. Our work makes the use of previously reported stress, and markers for the determination of the degree of stress, with the help of the equipment, and the relatively high level of accuracy (Table 3).

Table 1 Pulse-rate chart

Object	Sex	Age group	Heartbeat measured by developed system	Manually heartbeat measurement	Error%
Object I	Male	22	85	84	1.04
Object II	Male	22	84	82	2.38
Object III	Male	20	78	78	0
Object IV	Male	22	90	87	3.333
Object V	Male	32	100	102	2
Object VI	Female	22	76	77	1.32
Object VII	Female	40	104	103	0.96
Object VIII	Female	20	68	66	1.47
Object IX	Female	22	72	71	1.38
Object X	Female	22	84	85	1.19

Table 2 Oxygen rate chart

Object	Sex	Age	Oxygen level measurement by developed system	Market oximeter	Error%
Object 1	Male	22	96	97	1.04
Object 2	Male	22	95	96	1.05
Object 3	Male	20	98	97	1.02
Object 4	Male	22	99	98	1.02
Object 5	Male	32	97	98	1.02
Object 6	Female	22	98	99	1.05
Object 7	Female	40	98	98	0
Object 8	Female	20	99	99	0
Object 9	Female	22	99	99	0
Object 10	Female	23	97	96	1.04

Table 3 BMI index chart

Type	BMI (range in kg/m^2)
Critically slimness	<16
Average slimness	16–17
Low slimness	17–18.5
Regular	18.5–25
Weighty	25–30
Overweight Type I	30–35
Overweight Type II	35–40
Overweight Type III	>40

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Energy-Efficient Automated Guided Vehicle for Warehouse Management System

Minal Keote, Tanmay Choudhari, Tanmay Alone, and Ashar Ahmad

Abstract The automation business has grown at a breakneck pace, breathing new life into an otherwise dormant industry. The use of robots has lowered human workload and freed up the workforce from boring, non-creative professions, allowing them to focus on more gratifying tasks. This project's purpose is to develop a bot that will be employed in storage and retrieval systems. Instead of carrying the individual components in the shelf, the robot's goal is to translate long shelves in storage buildings to new locations. A lead screw mechanism will be used to lift the shelf in its principal function. The key issues were evenly dispersing the load distribution over the chassis to achieve maximum stability and restricting the robot to shelf weight ratio to an optimal level. Design and analysis of the bot were carried out using FUSION 360 software. The second objective of this project is to develop a GUI for placing order and logistics management. It is done on VISUAL STUDIO 2019 software.

Keywords Automation industry · OpenCV · FUSION 360 · Visual studio 2019 · Lead screw mechanism · Data matrix · PID (proportional integral derivative) · BFS algorithm

1 Introduction

Now every emerging goods and service company requires a warehouse to store their products. Every individual product is different in the sense of size, structure and manner. So, it becomes very important to store such products in an effective way so that they can be accessed easily and, in a hassle-free way. Traditional distribution centres, such as those used by Amazon and Staples, rely on an army of employees trekking miles every day to pick products off shelves and place them in boxes. This procedure is costly, inefficient and prone to errors. The pick–pack procedure would be vastly more efficient and time-saving if e-commerce distributors could bring shelves to people rather than people to shelves.

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So, basically our aim is to develop industry based autonomous bot or automated vehicle which picks the object in warehouse and follows the white line on black track to reach the delivery station. This will save most of the time and the system will become fast and efficient. Now, our second objective is to develop a GUI which shows the logistics of data. From this interface, a user can select an order and then the bot will bring that shelf in which the order is kept.

2 Literature Review

Paper [1] presents the line follower bot which gives information about how to drive a robot on a white or black track. Also it represents about the PID (proportional, integral and derivative) method of control system with which we can make the robot follow line with minimum error. From [2], the Warehouse management paper gives information about how to implement an automated robot for an effective warehouse management system and also presents various algorithms and techniques of navigation, path planning and rearranging of goods using robot in the warehouse. Paper [3] is related with the computer vision (QR code) paper, the information about how to use computer vision for localization and the navigation of the robot. We know how to implement computer vision navigation and localization using QR code and how to make robot collision free using LRF (laser range finder).

In [4], Raspberry pi applications paper we got to know how to use Raspberry pi. How to configure it and to work with it. Raspberry pi is a very useful and strong microprocessor which can be used for various projects. We also got to know how to use raspberry pi for image processing which is one of the main elements of proposed system. From [5–7], the OpenCV paper we got to know how to use OpenCV libraries for our system. How to access them and how to work with OpenCV libraries. Opencv libraries provide a wide range of modules that can be easily accessed and manipulated according to the project's needs. Such as for the need of capturing stills of QR code in the path, we require packages of OpenCV and also to extract and process information within it.

3 Methodology

The heart of the project is the design of the automated vehicle, i.e. bot. The system is divided into two parts. First part is the delivery bot which transports the shelf in the warehouse. Second part is the GUI which is used for monitoring the logistics of the warehouse and giving command to the bot. Figure 1 shows the flowchart of client side GUI. The main components used in bot are:

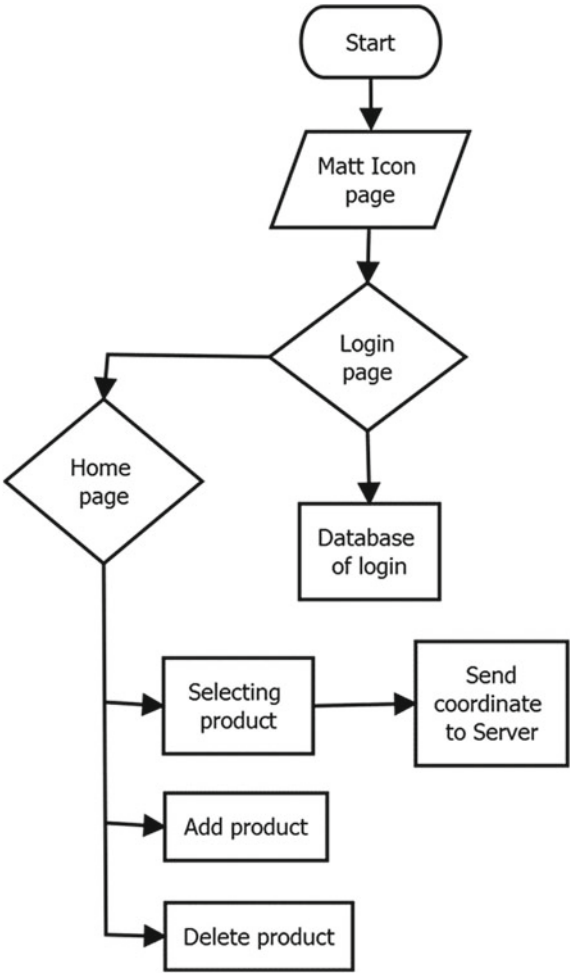

Fig. 1 Flow chart of the client side GUI

- Raspberry pi 4B-2gb RAM
- Arduino Mega 2560
- QTRA Sensors
- Camera Module
- HMC5883L Magnetometer Module
- Johnson DC-geared Motor
- Monster Motor Driver IC VNH3ASP30Module
- NEMA-17 Stepper Motor 4.2 kg-cm
- A4988 Stepper Motor Driver
- 150 mm Lead Screw
- Linear Bearing LMK8LUU 8 mm
- Li-ion LG Battery 18,650.

.

The GUI (Graphical User Interface) and the autonomous bot are connected wirelessly with each other with the help of Socket programming. The GUI is also connected with the MySQL Database where all the information regarding the products and the users is stored. The information regarding products is stored in the products table, while the information regarding the users is stored in the user the table. First, the user has to login into the GUI by entering his username and password. When the user press login button these credentials are then compared with the data inside the user table in the database. If the credentials are matched the user goes to the next page else a message box is shown that the username and the password are not correct. Onto the next page, the user has to give the IP address of the device with which the connection is to be established and in this project this device is the autonomous bot and as mentioned above this connection is made with the help of socket programming with autonomous bot being the server and the GUI as client.

In the scope of this system, the user refers to receiving agent at the receiving station in the warehouse. When the receiving agent at the receiving station selects a particular product from GUI by pressing the order button, the location of the shelf/inventory (in which the product is placed) is fetched from the product table of the database and sent to the autonomous bot. In the autonomous bot, there are two main processing systems; one is the microprocessor Raspberry Pi and the other one is the microcontroller Arduino Mega. The server program runs in the Raspberry pi and this server program receives the location of inventory/shelf from the GUI which is the client. Flowchart of raspberry pi as server is shown in Fig. 2. All the decisions of the autonomous bot are made in this server program in the raspberry pi, while all the action performed by the bot are controlled by the Arduino Mega as shown in Fig. 3. The communication between the Raspberry pi and the Arduino mega is established with the help of serial communication. The whole task done by bot can be categorized into three cycles.

1. Cycle 1: In this cycle, the bot goes from its current location to the location where the desired inventory is present and lifts it (destination).
2. Cycle 2: In this cycle, the bot goes from the destination to the receiving station where receiving agent takes product from the inventory.
3. Cycle 3: In this cycle, the bot goes from receiving station to the destination to restore the inventory.

In cycle 1, the server program receives the location from client which is given to the BFS path finding algorithm. When the location is received the camera in the bot is turned ON and the QR code beneath the bot is read. This QR code gives the location where the bot is currently present. Now the server program gives command to the Arduino to read orientation of the bot with the help of the magnetometer sensor. This information, i.e. QR code reading and magnetometer reading along with the location of inventory are given to the BFS algorithm which calculates the path from the current position of the of the bot to the location of inventory and gives a path in the form of string containing direction like {L, R, S, L} (L: left, R: right, S: straight).Now

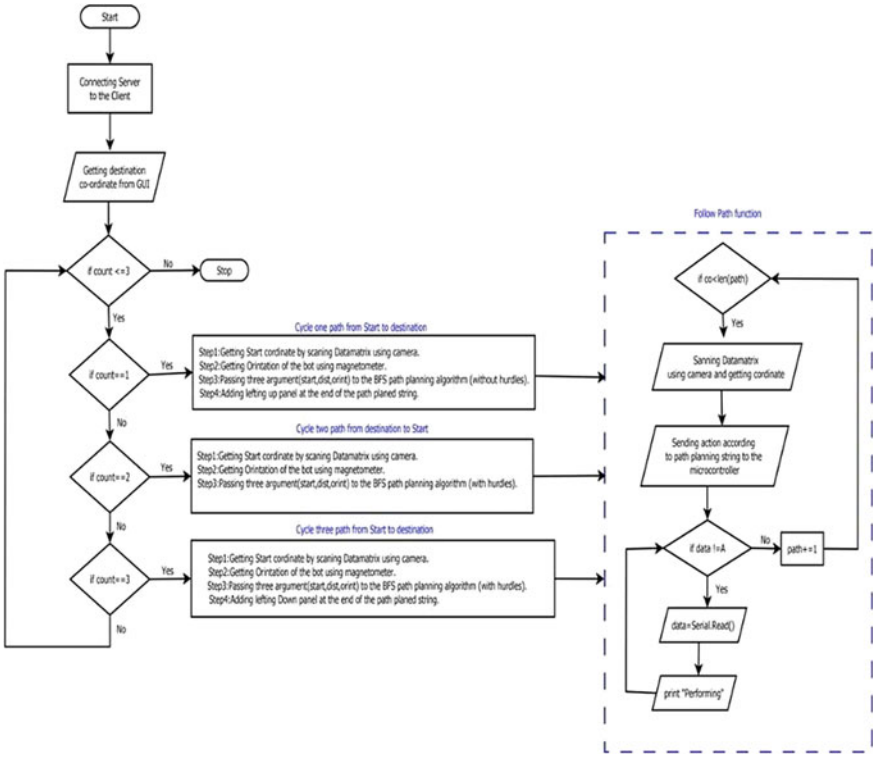

Fig. 2 Flow chart of the raspberry pi as server

this string is given to the Arduino which performs the direction in the string at each intersection and between two intersection it makes the bot to follow the line and this is how the bot reaches the destination and as the bot reaches the destination the server program commands the bot to lift the inventory. Now cycle 2 starts in which again the desired location (in this cycle receiving station) and current location of the bot is given to the BFS algorithm a] which gives calculated path and this is again given to Arduino which makes the bot to reach the receiving station. At the receiving station, the receiving agent takes the product and after its work gives command from GUI to restore it into inventory. Now here cycle 3 starts. Again, same thing is done that is desired location (in this cycle location of inventory) and bot's current location is given to the bot and again with the same procedure bot takes inventory to its original location and restores it.

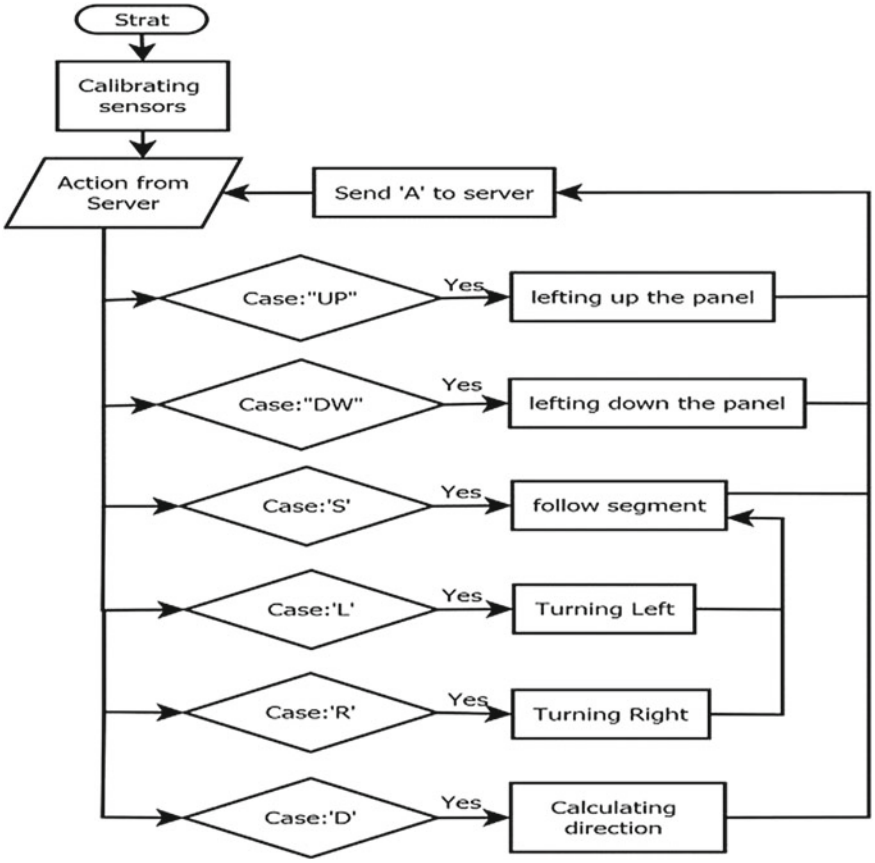

Fig. 3 Flow chart of the Arduino control

4 System Design

The heart of the project is the system's design, which should ensure that it is error-free once installed. The system design consists of two parts, namely the base of the bot and the lifting system. The base of the bot contains the components QTRA, magnetometer, driving motor drivers, Arduino mega, Raspberry pi, camera and other small electronics components such as led, switches and buzzer, while the lifting system consist of the stepper motor, stepper motor driver and the lead screw and nut. The general representation of the system design is shown in the Fig. 4, i.e. Block diagram of power supply unit is shown in Fig. 5.

First, we have made 3D model of the actual bot on the fusion 360 software as shown in the Fig. 6. Front view of final model and Top view of final model can be viewed from Figs. 7 and 8.

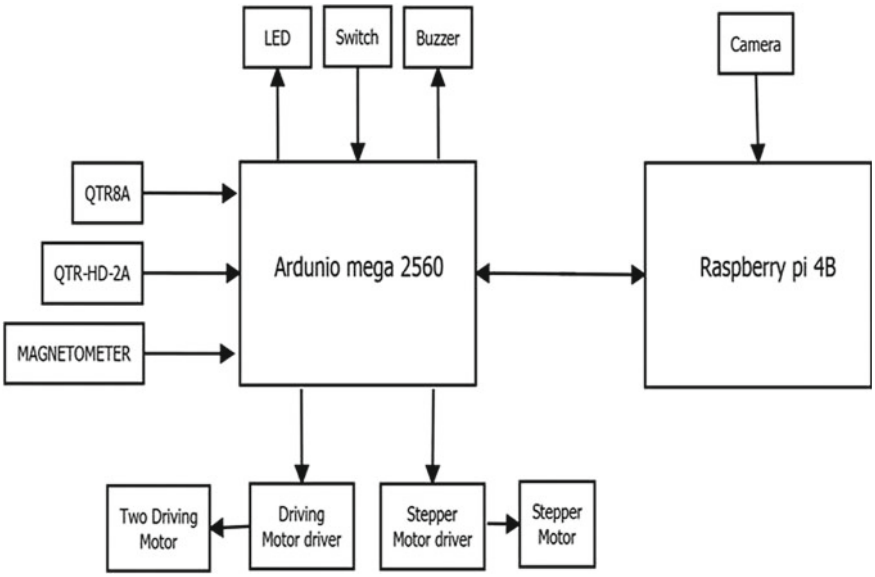

Fig. 4 Block diagram of the hardware system

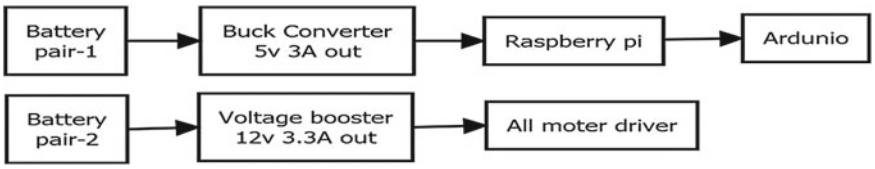

Fig. 5 Block diagram of power supply unit

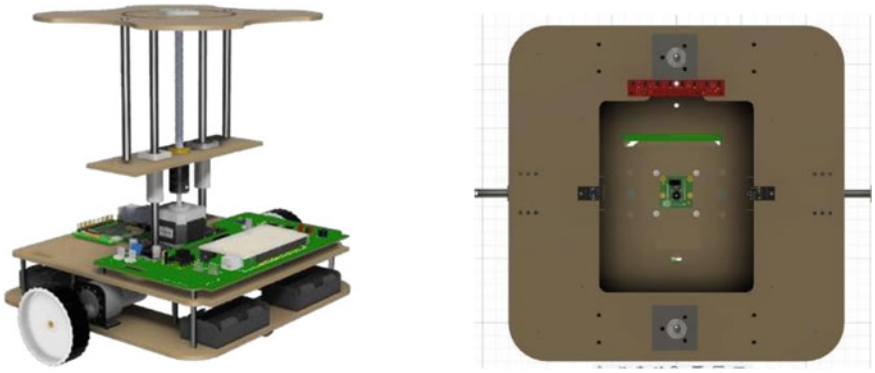

Fig. 6 3D models

Fig. 7 Front view of final model

5 Result and Discussion

At first, GUI program is started and below shows the results.

Before entering further, on the second page (Fig. 9) of GUI, we have to enter the login details. Every client has their username and password shown in Fig. 10 to gain access and this data is stored in the database. Only admin has the access to add or delete product from the database client can only place order.

On the next page, we get the list of products that are available in the warehouse displayed in Fig. 11 every product has its location and shelf number stored in the database. Client can pick product and place order then automatically shelf coordinates are sent to the server through the Wi-Fi network

At this stage, shelf coordinates are sent to the server. This coordinate acts as the destination coordinates. Now, bot has to analyse its current position in the path of matrix for which it calibrates itself to identify the path of black background with white lines, then turns on the camera and flash light to scan the data matrix below it. That data matrix is the current location of the bot. It also takes note of in which direction the bot is facing shown in Figs. 12 and 13. This parameter helps in finding the shortest path from current location to the destination location.

Fig. 8 Top view of final model

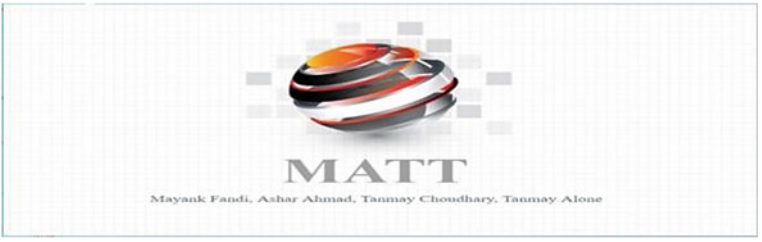

Fig. 9 Starting page of GUI

In this way, bot delivered shelf to the client who gave command shown in Fig. 14. Client will pick up the order and then restore the shelf to its original location and will be ready for next command of order to collect

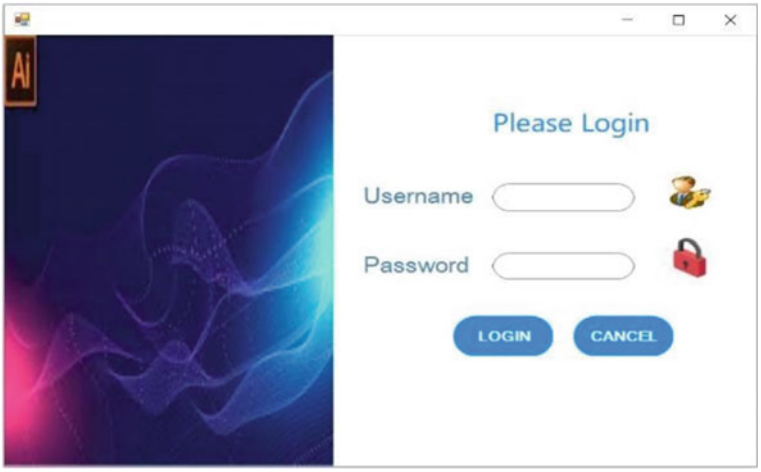

Fig. 10 Login page of GUI

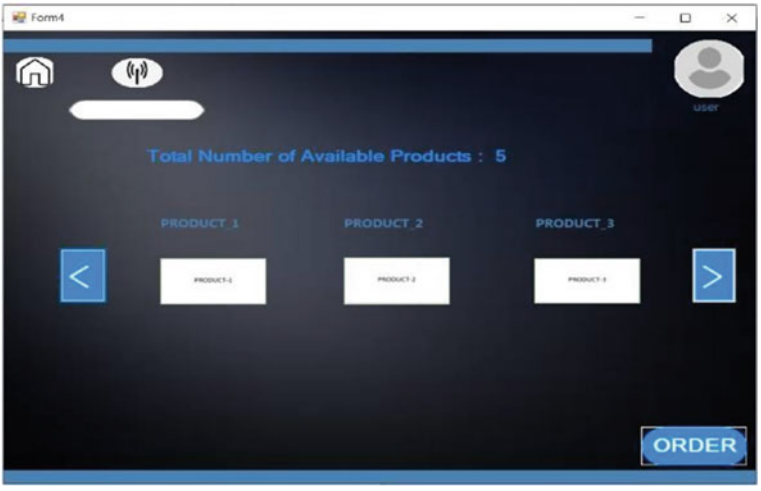

Fig. 11 Order page of GUI

6 Conclusion

With the use of automation and software engineering, the goal of engineering is to improve the quality of life and make daily and industrial activities easier. The proposed system is a contribution in this line. The problems encountered in a conventional warehouse management system are not only solved but the quality and the speed of the processes can also be improved with the help this system. The logistics

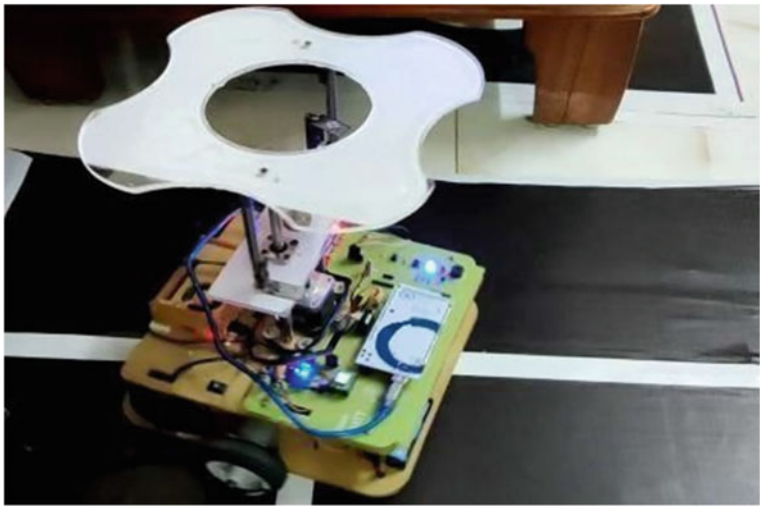

Fig. 12 Bot is in calibrating position

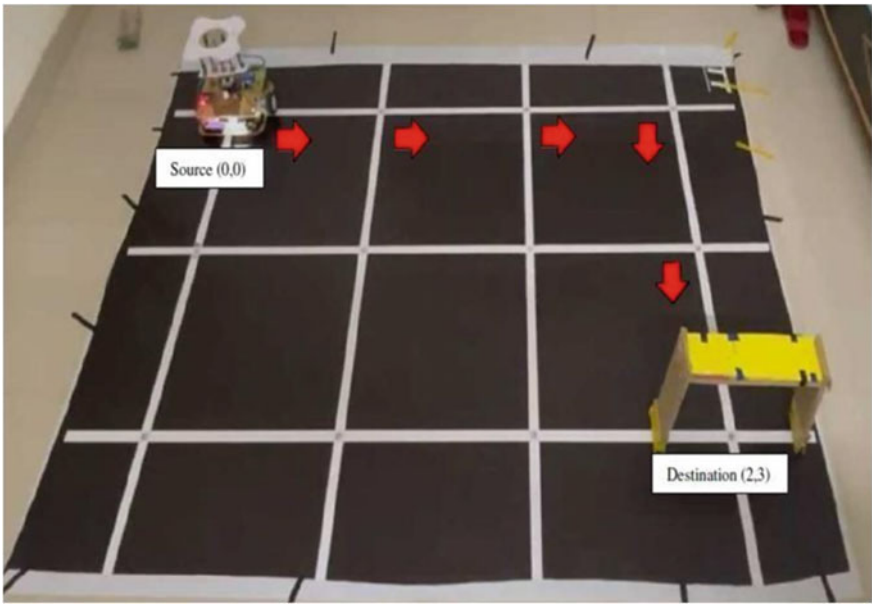

Fig. 13 Bot going to pick shelf

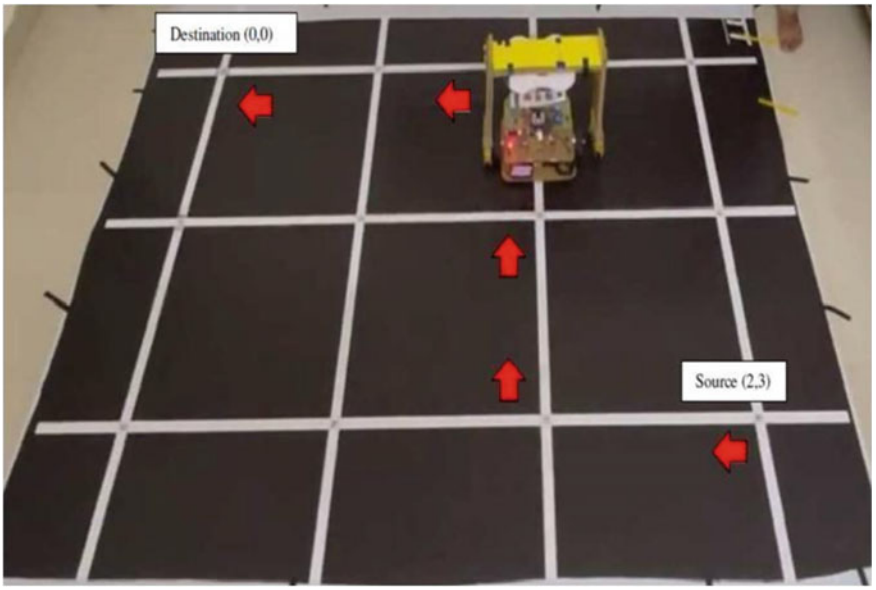

Fig. 14 Bot going back

and the maintenance of the product data can be made reliable and the process of insertion and retrieval of the information can also be made easy with this system.

This has given us a platform to act and tackle the problem by utilizing technology to its full potential and skill set. An attempt has been made by realizing the space that exists and a fully automated and efficient receiver system has been developed which is to be installed in customer premises.

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A Crow Search Algorithm-Based Machine Learning Model for Heart Disease and Cervical Cancer Diagnosis

Ali Aloss, Barnali Sahu, Hasan Deeb, and Debahuti Mishra

Abstract Both heart disease and cancer are the major causes of death in the world. As diagnosing it early helps us from the risk of it occurring, but the high costs are a major hurdle. Feature selection is one of the important techniques that can be used to improve the classification process and to reduce the cost of diagnosis by relying on a specific set of features instead of using all features, in addition to identifying those features that play the largest role in the classification improvement process for each of cervical cancer and heart disease by using heart failure clinical records and risk factors of Cervical Cancer datasets. Five machine learning algorithms were used for classification and then the Crow Search Algorithm (CSA) was used for feature selection to improve the performance of the model. SVM act as a good classification algorithm to predict both heart disease and cervical cancer. The proposed method shows 75% accuracy for cardiac patients and 97% accuracy for cervical cancer patients.

Keywords Feature selection · Crow search algorithm · Classification methods · Medical data

1 Introduction

The human heart is the most important organ in the human body. Heart disease is a major cause of death around the world. A statistic conducted in the United States of America showed that more than 610,100 deaths occur each year due to heart failure. On the other hand, cervical cancer is one of the most common cancers in women that affects the cervical cells. The main cause of cervical cancer is the human papillomavirus (HPV) which is a sexually transmitted infection. Fortunately, the early detection associates with high survival rate. Moreover, the prevention of

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cervical cancers possible by screening tests like Pap smear and HPV test. Medical data analysis has become one of the priorities of researchers and machine learning scientists, where machine learning techniques have helped improving the reality of the data analysis process and made great achievements in this field. Machine learning allows us to build models that associate a broad range of variables with a disease. Often medical data contains a lack of data in addition to unimportant data, which causes an obstacle in the work of machine learning systems and thus obtaining less accuracy and more time in the analysis process [1]. To face these challenges, feature selection is one of the most important technologies that are being relied upon at the present time. With the increase in data dimensions and containing large amounts of data, this posed a challenge to machine learning systems, which led to the deterioration of their performance. Feature selection is one of the important branches in the field of machine learning that has been focused on to reduce the dimensions of data. This technique relies on selecting a set of interrelated and related features from the sum of the original features, according to specific criteria. This usually leads to improving the performance of the used classifiers and reducing the computational cost of the system. Feature selection is an important focus in the process of improving classifiers, but with the increase in the size of databases, this requires more effort from machine learning systems in the process of improvement, as it faces new problems and therefore it is necessary to find new approaches of feature selection [2]. Crow Search algorithm (CSA) is one of these approaches which can use for feature selection. CSA is a metaheuristic algorithm proposed by Askar Zadeh in 2016 is the CSA [3], it relies upon on analyzing the smart behaviors of crows, through the potential of crows to conceal their food in protected locations and chase them to other crows to obtain their food. It has been applied successfully to different science and engineering fields of optimization. Therefore, in the current work, we have applied the CSA for medical diagnosis and it showing significant results for medical data. Section 3 offers a discussion of the data collection as well as the categorization algorithms utilized in the model. The experimental results and comparison of results are presented in Sect. 4, followed by the conclusion and future work section.

2 Literature Review

In this section, we'll look at some of the work that's been done on applying classification and feature selection approaches to predict heart disease and cervical cancer. In 2017, Seyedamin conducted a research study on the use of various machine learning techniques and their application to a dataset related to heart disease using SVM classifier. To enhance the accuracy of the classifier, the filling, boosting and stacking techniques were used. The technique used showed an accuracy of 84.15% [1]. Gene sequencing unit is one of the effective models proposed by A. Ghoneimto predict cervical cancer. It was applied to two types of data, one of which is private, obtained from a Chinese hospital based on 472 questionnaires, and the other is public, which includes 32 traits and 858 examples, from a hospital in Venezuela. It showed good

Table 1 Characteristics of 2 datasets of heart disease and cervical cancer

Datasets	No. of instances	Number of attributes	Missing values
Heart failure clinical records dataset [5]	299	13	No
Risk factors cervical cancer [6]	858	36	Yes

results in the process of predicting cervical cancer, with the possibility of developing it in the future [2]. The CSA method has been useful in the field of medical data feature selection. Leandro used an improved CSA for feature selection and applied it on Breast Cancer dataset where the method demonstrates good results with few numbers of selected features in terms of classification precision and computational cost [4].

3 Materials and Methods

3.1 Dataset Description

In this study, two different datasets have been used to predict each of heart disease and cervical cancer. The datasets are collected from the UCI Machine Learning Repository. The first one used to predict heart disease which consist of 13 attributes where the predictable attribute is referred to "Death Event" and rest of 12 refer as input attributes. The dataset was collected at the Faisalabad Institute of Cardiology and at the Allied Hospital in Faisalabad (Punjab, Pakistan). The second dataset used to predict cervical cancer by selecting the best features that assured diagnosing it at an early stage where the predictable attribute is referred to "Biopsy". "The dataset was collected at 'Hospital Universitario de Caracas' in Caracas, Venezuela". The dataset comprises demographic information, habits, and historic medical records of 858 patients (Table 1).

3.2 Crow Search Algorithm for Feature Selection

The Crow search algorithm is a newly developed algorithm that imitates the social intelligence of crows and their way of collecting food. It is a metaheuristic algorithm inspired by crows' intelligent behaviors. Crows are among the wisest creatures in the world as shown in the mirror test. There are numerous bits of proof indicating crows' astuteness. Crows can recollect faces, trade data with one another, take the nourishment, and get it far from others by concealing the assortment of food sources [3].

Let us presume that a d-dimensional environment exists, and this environment has N number of crows, the position of crow i at iteration (iter) represent by the vector $x^{i,iter} = \left[x_1^{i,iter}, x_2^{i,iter}, \ldots, x_d^{i,iter}\right]$. The crows have a good memory which make it able to remember the hiding place of its food, $m^{i,th}$ represents the position of the hiding place of crow i at iteration (iter), suppose crow j needs to update its position to a new position and let it be at iteration (iter) and on the same iteration crow i decide to track crow j to discover its hiding place, two cases can occur here, in first case crow j does not notice crow i when crow j follows crow j, As a consequence, crow i will locate the hiding place of crow j, and as per Eq. (1), the new location of crow i will be changed as follows:

$$x^{i,iter+1} = x^{i,iter} + ri * fl^{i,iter} * (m^{j,iter} - x^{i,iter}) \tag{1}$$

ri: is a random number with uniform distribution between 0 and 1, $fl^{i,iter}$ represents the flight length of crow i at iteration iter.

In the second case, the crow j notices that crow i is pursuing him and will discover his food's hiding place as a result, to guard his hideout from being stolen, crow j deceives crow i by changing its location to other location in the exploration area. Figure 1 depicts the characteristics of the crow flight length (fl) on search process.

States 1 and 2 can be represented as per Eq. (2) as follows:

$$x^{i,iter+1} = \begin{cases} x^{i,iter} + ri * fl^{i,iter} * \left(m^{j,iter} - x^{i,iter}\right) & rj \geq AP^{j,iter} \\ m^{i,iter} otherwise \end{cases} \tag{2}$$

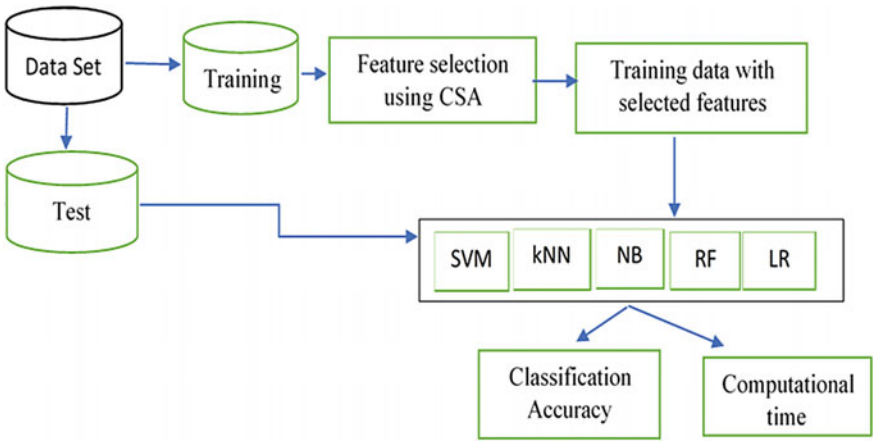

Fig. 1 Schematic representation of proposed model

In the current work, the crow search algorithm has been used for selection of most relevant features for the classification of heart disease and cervical cancer data. The applied technique shows improvement in the classification accuracy.

3.3 Classification Techniques Revisited

A brief description of the various machine learning algorithms employed in this study is provided in this section.

Support Vector Machine (SVM): In classification problems that contain a large number of data, SVM is one of the good techniques that can be relied upon to solve these problems. This classifier helps multi-domain applications in their work, especially in a big data environment. Types of support vector classifiers can be divided based on kernel functions into four types: Linear, non-linear, sigmoid, and polynomial. SVM is increasingly being used especially in the field of biological applications. In a previous study, decision trees, SVM, and Naive Bayes algorithms were used to classify diabetes and cancer where SWM showed the highest accuracy and effectiveness in the classification process [7].

Naïve Bayes: Naïve Bayes, it is not a single algorithm but a group of classification algorithms that share the same principles in their work and are based on Bayes theory, and it assumes that each pair of features classified are independent of each other. In a study that has been done on a dataset taken from UCI to predict heart disease, Naïve Bayes demonstrated high performance and accuracy in the prediction process [8].

Neural Network: A neural network or artificial neural network is inspired by the work of a biological neural network located in the brain or nervous system. These networks have been widely used in machine learning applications in addition to their ability to perform classification tasks as well. The information processing system within these networks contains a large number of synapses and neurons that are closely interconnected with each other in a way that allows the passage of messages within them that solve a specific problem. In a previous study, artificial neural networks were used to study their effectiveness in diagnosing diseases on the data of acute hepatitis disease taken from the machine learning store. The classification process showed an accuracy of 99% [9].

K-Nearest Neighbor (KNN): kNN is a simple classifier with no parametric classification method. Despite its simplicity, this classifier is very effective in many classification situations. Choosing the value of k plays a major role in the success of the classification process so as to ensure the best performance. There are many ways to choose an appropriate value for k. One of the simplest of these methods is to implement the algorithm using different values of k and then choose the best value for it based on the results. The researchers suggested looking at multiple sets of k-nearest neighbors, rather than just one set of k-nearest neighbors, to loosen the dependence on k-value entirely. In a previous study, KNN algorithm with particle

swarm optimization (PSO) was used to detect heart disease, and it showed high classification accuracy [10].

Random Forest algorithm: Random Forest is a set of non-uniform decision trees. If there are a large number of input variables, i.e., hundreds or thousands, and a large number of training data in the dataset, it can be used as a good classifier. This classifier consists of many decision trees and class outputs that represent the class's output pattern by individual trees. Random Forest was applied to ten datasets for different diseases, and it showed promising results in terms of the accuracy of the classification process [11].

3.4 Proposed Model

In the first phase of the current work, the datasets are partitioned into training and test sets. CSA is applied to select the most optimal features for classification. The reduced dataset is used for training the different classifiers individually and validated with the test data. Random forests, SVM, KNN, Naive Bayes, and Neural Network classifiers were employed in this study to determine the efficacy of the specified features using CSA. The classification accuracies are compared to the accuracies of non-feature-selection classifiers. The time spent computing after and before feature selection is measured and compared. Figure 1 depicts the flow of the proposed classification model that employs CSA for feature selection.

4 Experimental Results and Discussion

Our findings were tested in the Python environment on a PC with Windows 10 and 4 GB of RAM. We know that the accuracy of the model is affected by preprocessing, the dataset utilized, and the analysis tools employed, but the goal of this study is to demonstrate the importance of selecting features over using all features in enhancing the accuracy of the proposed model. To extract the features and apply them to the dataset, we initially utilized five different classifiers without employing CSA. The accuracy, sensitivity, specificity, F1-score, and computing time of each classifier are shown in Tables 2 and 3. The experimental results reveal that Random Forest is the best of the utilized classifiers, with a 75% accuracy rate and a computational time of 2 ms for the heart disease dataset and a 94% accuracy rate and a computational time of 2 ms for the Cervical Cancer dataset.

To improve the performance of the used classifiers for both datasets, we used feature selection using CSA with the aim of extracting the most important features and relying the classifiers in their work on these features. Parameters of CSA are set as follows: AP = 0.2, Fl = 2, N = 20, and iteration max = 200.

Table 2 Experimental results without using CSA for feature selection over heart disease dataset

Algorithm	Accuracy	Specificity	Sensitivity	F1-score	Computational time (ms)	#No. of features
Random forest	0.756	0.864	0.548	0.607	2	11
SVM	0.656	0.801	0.425	0.521	5	11
Naive bayes	0.711	0.881	0.387	0.480	3	11
Logistic regression	0.733	0.932	0.355	0.478	19	11
KNN	0.633	0.763	0.387	0.421	4	11

Table 3 Experimental results without using CSA for feature selection over Cervical Cancer dataset

Algorithm	Accuracy	Specificity	Sensitivity	F1-score	Computational time (ms)	# No. of features
Random forest	0.946	0.970	0.667	0.667	2	33
SVM	0.919	0.996	0.429	0.581	11	33
Naive bayes	0.905	0.864	0.805	0.645	8	33
Logistic regression	0.938	0.983	0.429	0.529	33	33
KNN	0.919	0.954	0.856	0.545	14	33

The outcomes of classifiers after performing feature selection using CSA to both the heart disease and cervical cancer datasets are shown in Tables 4 and 5. Table 4 shows that the CSA algorithm has significantly improved the classification process for all of the classifiers used. The accuracy of the Random Forest algorithm has increased to 76.7% based on seven features (age, anaemia, diabetes, serum sodium, smoking, platelets, and high blood pressure), while the accuracy of SVM has increased to 75.6% based on four features (age, anaemia, diabetes, serum sodium, smoking, platelets, and high blood pressure) (anemia, platelets, smoking, time). For Naïve Bayes algorithm,

Table 4 Results using CSA for feature selection over failure heart disease dataset

Algorithm	Accuracy	Specificity	Sensitivity	F1-score	Computational time (ms)	# No. of features
Random forest	0.767	0.864	0.581	0.632	1	7
SVM	0.756	0.966	0.355	0.500	4	4
Naive bayes	0.742	0.864	0.548	0.607	3	6
Logistic regression	0.756	0.966	0.355	0.500	15	4
KNN	0.752	0.915	0.452	0.560	4	7

Table 5 Results using CSA for feature selection over risk factors for cervical cancer dataset

Algorithm	Accuracy	Specificity	Sensitivity	F1-score	Computational time (ms)	#No. of features
Random forest	0.961	0.979	0.762	0.762	2	16
SVM	0.977	0.987	0.857	0.857	4	10
Naive bayes	0.950	0.954	0.905	0.745	5	13
Logistic regression	0.965	0.992	0.667	0.757	17	15
KNN	0.95	0.996	0.429	0.581	11	12

the accuracy has increased to 74.2%, using six features, which are (age, anemia, diabetes, serum sodium, smoking, platelets). For Logistic regression algorithm, the accuracy has increased to 75.6%, using four features, which are (anemia, diabetes, smoking, platelets) and for KNN algorithm the accuracy has increased to 75.2%, using seven features, which are (age, anemia, diabetes, serum sodium, smoking, platelets, high blood pressure).

To better study the effectiveness of CSA, it was applied to another dataset for cervical cancer diagnosis, which have a larger number of features and more instances. From the result of Table 5**,** we can notice that SVM can be considered as the best classifier with accuracy of 97% and ten features during 4 ms computational time.

5 Conclusion

It is known that the analysis techniques, pre-processing, and the data used are among the basic factors for evaluating the accuracy of the model. In this study, the use of feature selection has shown an effective role in improving the performance of classifiers' work compared to the use of full features in dataset. This study shows that SVM can be used as a good classification algorithm to predict both heart disease and cervical cancer, with an accuracy of 75% for cardiac patients and an accuracy of 97% for cervical cancer. Despite the good results that CSA showed and its use as a feature selection algorithm, it still suffers from low convergence and falling into local optima. One of the solutions that can be proposed in my next work to improve this algorithm is to use logistic chaotic map to update the positions of the crows instead of using arbitrary variables.

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COVIHunt: An Intelligent CNN-Based COVID-19 Detection Using CXR Imaging

Abhinandan Roul, Abhilash Pati, and Manoranjan Parhi

Abstract Recently, the individuals are under lockdown and limited mobility due to the random spreading of the COVID-19, i.e., coronavirus disease - 2019, worldwide as well as pandemic declared by the World Health Organization (WHO). RT-PCR, i.e., reverse transcriptase-polymerase chain reaction, tests that can detect the RNA from nasopharyngeal swabs have become the norm to allow people to travel within the nation and also to international destinations. This test is people-intensive, i.e., it involves a person collecting the sample, needs transportation with strict precautionary measures, and a lab technician to perform the test which may take up to 2 days to get the results. There is a lot of inconvenience to the people due to this process. Alternatively, X-Ray images have been used primarily by physicians to detect COVID-19 and its severity. Detection of COVID-19 through X-Ray can act as a safe, faster, and alternative method to RT-PCR tests. This method uses a Convolutional Neural Network (CNN) to classify the X-Ray scans into two categories, i.e., COVID-19 positive and negative. In this paper, a novel method named COVIHunt: an intelligent CNN-based COVID-19 detection technique using CXR imaging, is proposed for binary classification. From experiments, it is observed that the proposed work outperforms in comparison with other existing techniques.

Keywords Deep learning (DL) · Convolution neural network (CNN) · COVID-19 · Binary classification · CXR imaging

1 Introduction

COVID-19 originated from Wuhan, PRC, in November 2019 is a highly contagious disease caused by SARS-CoV-2. It spreads so quickly that it had to be declared a pandemic by WHO. The fatal disease is characterized by fever, cough, breathing issues, and loss of taste and smell [1, 2]. The pandemic has impacted the lives of all people across the earth. Now, social distancing, face masks, and having a hand

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sanitizer is recommended by all government organizations. Although these act as a temporary preventive measure, still people get infected by COVID-19.

Being a novel coronavirus, most citizens aren't immune to it. The vaccination drive is at its peak to help develop immunity against this deadly disease. As of March 2021, the COVID-19 infection rate is on a constant rise in India. The government has made the RT-PCR test mandatory to enter into certain states and educational institutions are shut down once again. Keeping the current situation in mind, new ways to trace COVID-19 patients must be developed for better management. It is proposed to use CXR imaging (Chest X-Rays) to detect infected patients and quarantine them [3]. Here, it is focused on PA (Posteroanterior) view of the lungs in X-Ray scans CXR imaging is cheap, readily available, and easy to administer. Furthermore, CXR images expose the patient to very low radiation of 0.1 mSv making it a safer alternative to CT scans or MRI. As an already available method in various regions, it can act as an effective method to collect data for detection. To diagnose patients on CXR images requires professionals with years of experience. As there's a shortage of such specialists and the patients are increasing exponentially, it is proposed to automate the detection system using machine learning and image processing technique [4–6].

In this paper, a novel method named COVIHunt: an intelligent CNN-based COVID-19 detection technique using CXR imaging, is proposed for binary classification. This method would reduce the workload on doctors and would enable them to focus on more critical aspects such as patient treatment and care. X-Rays being fast and scan being readily available, can act as an effective method for detection.

The **key contributions** of this research work can be stated as follows:

- A unique model is developed which can help to detect COVID-19 disease with the aid of CXR imaging.
- It has a significant improvement in accuracy for COVID-19 category detection.
- The application of various image augmentation techniques on the dataset helps to improve diversity in the training set which results in better generalization.

The remaining of this work can be organized as Sect. 2 for the works done related to this study. This study employed materials and methods are discussed in Sect. 3. Section 4 is for the discussion of the introduced model. The results obtained from various experiments along with a comparison study of existing related works are discussed under Sect. 5. Section 6 discusses the conclusions and future aspects of the research.

2 Related Work

Ismael and Sengur [7] have proposed a method to detect COVID-19 based on chest X-rays using deep learning techniques. CNN models such as VGG16, ResNet101, and ResNet50, and for classification, SVM classifiers with diverse kernel functions such as Linear, Cubic, and Gaussian were used for feature extraction, concerning the accuracy, sensitivity, specificity, F1-score, and AUC as evaluative measures on the

open-source dataset with 180 COVID-19 samples and 200 Normal cases. The authors claimed to have achieved an accuracy of 95.79% using ResNet50 features+SVM with a sensitivity of 94%, specificity of 97.78%, F1-score of 95.92%, and AUC of 0.9987.

Wang et al. [3] suggested COVID-Net a deep-CNN (DCNN) method to detect COVID-19 from CXR images using projection–expansion–projection–extension (PEPX) design which decreases computational complexity, concerning accuracy and sensitivity as evaluative measures on the COVIDx dataset with 13,975 CXR images and thereby claiming to have an overall accuracy of 93.3% with a 91% sensitivity on COVID-19 class and 94% sensitivity on non-COVID-19 class.

Rahaman et al. [8] have proposed a methodology for COVID-19 diagnosis by automatic CAD system utilizing deep transfer learning with application of VGG, Xception, ResNetV1, ResNetV2, MobileNet, DenseNet, and Inception networks as pre-trained base layers concerning the accuracy, precision, recall, and F1-score as evaluation metrics on the dataset by J. P. Cohen. The authors have achieved an accuracy of 89.3% using VGG19 with an average precision of 90%, recall of 89%, and F1-score of 90%.

Heidari et al. [9] have proposed a technique to detect COVID-19 using image pre-processing techniques which includes histogram equalization algorithm (HE), bilateral low pass filter coupled with a CNN model concerning the accuracy, sensitivity, specificity as evaluative measures on a dataset acquired from various public repositories having 8474 CXR images. The authors have claimed to have received an accuracy of 94.5%, sensitivity of 98.4%, and specificity of 98%.

Jain et al. [10] have proposed a methodology to classify COVID-19 infections through the use of DL methods such as InceptionV3, Xception, and ResNeXt models concerning the precision, recall, and F1-score as evaluation metrics on the dataset by Prashant Patel on Kaggle thereby claiming accuracy of 93% with a precision, recall and F1-score of 91%, 89%, and 90% on normal class and 97%, 78%, and 95%, respectively, on COVID-19 class.

3 Materials and Methods

3.1 Dataset Used

Open-source data has been used in this research [11]. The collected dataset was then processed to clear irrelevant images and keep only PA views of the X-Ray. The PA view of COVID-19-infected and normal lungs are depicted in Figs. 1 and 2, respectively. Furthermore, a dataset containing healthy lungs was also collected for our model to recognize healthy lungs. Then the data was segregated into two classes, one containing an equal number of images for X-rays of COVID-19-positive patients and the other containing the healthy patients' images. In the pre-processed dataset, there are 466 COVID-19 samples and 474 healthy lung samples in training data. In the validation set, 39 samples of infected patients' X-Ray images and 40 samples of

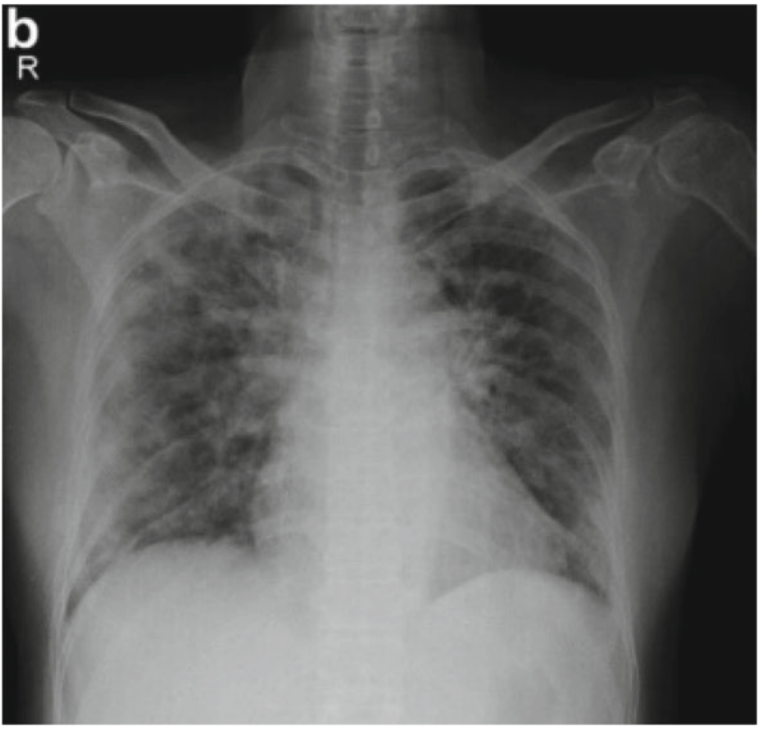

Fig. 1 PA view of COVID-19-infected lungs

healthy patients of the normal image are kept. Finally, the test set has 20 samples of each class.

3.2 Convolution Neural Network (CNN)

A CNN is a DL method is employed in general while image-related researches carried out. In short, known as ConvNets, they are primarily used for image classification problems [12]. The convolutional layer takes an input image extracts some features and passes them to the next layer. The filters in the CNNs can detect patterns. They learn the local patterns such as edges, lines, textures, shapes, etc. The deeper they go, the more intricate patterns, they observe. In ConvNets, the neurons are arranged in three dimensions, i.e., width, height, and depth.

The convolutional layer performs the most computational task. The parameters consist of specific learnable filters, image matrix, kernel size, padding, and strides. Each filter is small and convolves over the whole image to detect features. With each passage through a layer, the image becomes abstracted to a feature map. The hyperparameters that control the output volume are depth, stride, and zero-padding.

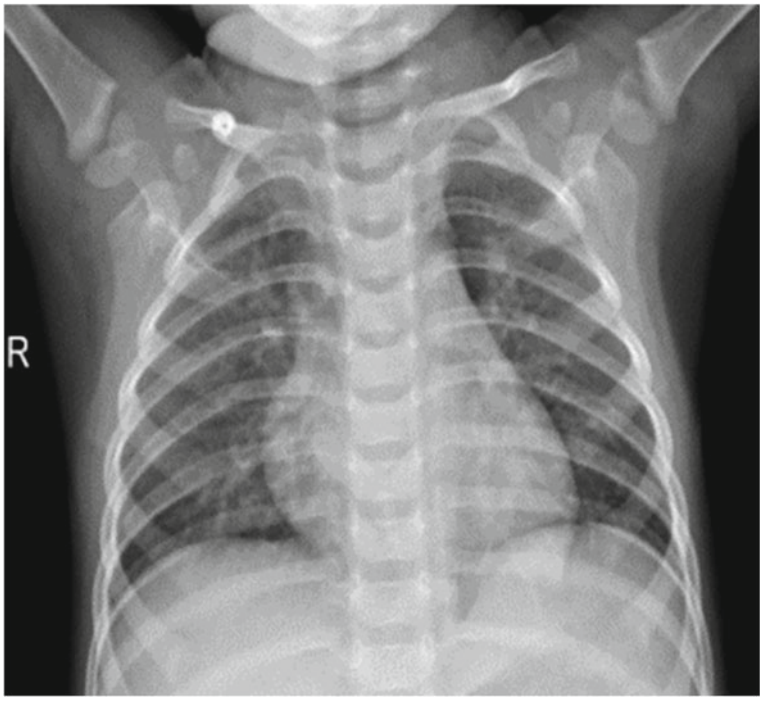

Fig. 2 PA view of COVID-19 normal lungs

3.3 Max Pooling

Max Pooling operation is generally added to the CNNs after each convolutional layer. It helps to decrease the dimensions of the images with each successive iteration. It generally preserves the information in a large image file but with reduced data storage. The Max Pooling technique employed in this research work is depicted in Fig. 3. Strides determine the number of pixels required by the filter to move as it slides across the image.

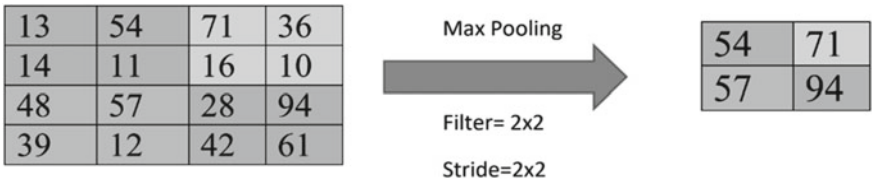

Fig. 3 The max pooling technique

3.4 Activation Function

In this research, for all the inner layers ReLU (Rectified Linear Technique) is used as the activation function, which can be defined as:

$$y = max(0, x) \tag{1}$$

It is a linear function that will produce the output directly if it is greater than zero else, it outputs zero. In other words, it preserves the output values of positive inputs and maximizes the negative input values to zero. The benefits of ReLU are that it prevents the problem of vanishing gradient, enables the model to train faster, computationally inexpensive, and produces accurate results. The sigmoid function is a very popular activation function having a sigmoid curve. The output is always scaled to a value between 0 and 1 and can be defined as:

$$S(x) = \frac{1}{1 + e^{-x}} \tag{2}$$

3.5 Regularization Technique

This technique makes slight modifications to the learning algorithm such that the model performs well in real-life data. A problem of overfitting arises if the model is not generalized. In this work, dropout layers are used to deactivate neurons in several layers to avert the network from learning the training data too well [13]. The sensitivity to specific weights of neurons is reduced, which enhances the capability of the network to generalize well.

3.6 Fully Connected Layer

All outputs from the previous layer are linked to each neuron in the following layer in this layer. Each setting in this layer has a significant influence on class prediction. The activation function uses the output of the final completely connected layer to calculate the prediction score for each class.

3.7 Image Augmentation Techniques

Due to the limited availability of COVID-19 X-ray scans, image augmentation is used to generate more data during training to increase diversity in the training set.

This method helps to replicate some real-world features which happen naturally while data collection. The images are subjected to shearing, rotation, and zooming [14]. Shearing means to transform the image along a horizontal or vertical axis with a magnitude rate. Rotation is the process by which the image is rotated by certain degrees along its axes. Zoom augmentation means focusing on specific parts of the image particularly and add pixels to the image data. Horizontal and vertical flip augmentation help to change the orientation of the image by reversing complete rows and columns of pixels of the image.

4 Proposed Model

The proposed model is a shallow-CNN with three Convolutional layers. The input image is rescaled to size 300 × 300 to allow for faster processing and better GPU memory management. The first convolutional layer uses ReLU to activate 32 filters with a kernel size of 3 × 3. After that, another convolutional layer with 64 filters and ReLU as an activation function is added. To decrease the dimensionality of pictures from the preceding output layer, we use the Max Pooling layer. A dropout layer follows the third convolutional layer, which consists of 128 filters with a kernel size of 3 × 3. To make it a 1D array, the model is flattened. After flattening, a completely linked layer of 64 units is followed by a dense layer of 128 units, which is triggered by the sigmoid function and precedes a 1-unit output layer. A binary cross-entropy loss method is employed to build the model, defined as

$$L = \frac{1}{Os} + \sum_{i=1}^{Os} \left(y_i . \log \hat{y}_i + (1 - \hat{y}_i) . \log(1 - \hat{y}_i) \right) \tag{3}$$

where "L" is for Loss and "Os" is for Output Size.

The intention of selecting the BCE function is since our model has two output classes. This model uses Adam optimizer due to the unparalleled benefits of ADAM (Adaptive Moment Estimation). Adam has the benefits of AdaGrad and RMSProp to handle noisy and sparse gradients [15]. Being computationally efficient and requiring less memory space, it is easy to implement. The model has 18,976,129 trainable parameters. The model was trained over 15 epochs with 24 steps per epoch. In the experimental run, the training is stopped at the seventh epoch as the desired training accuracy was achieved, any further training might result in overfitting. The block diagram of the proposed work, COVIHunt is shown in Fig. 4. Table 1 represents the architecture of the network.

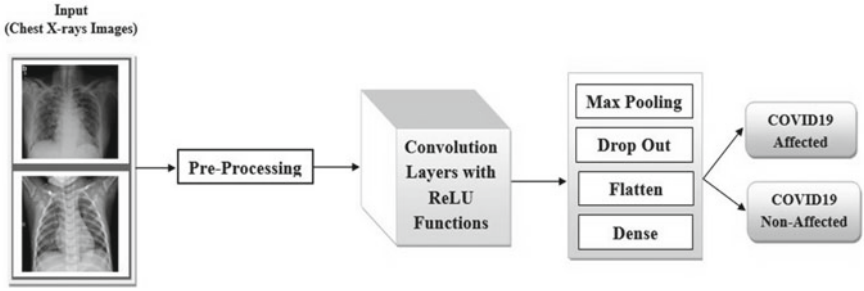

Fig. 4 Block diagram of the proposed model

Table 1 The architecture of the network

Layer type	Output shape	Param#
Conv2d	(298, 298, 32)	896
Activation	(298, 298, 32)	0
Conv2d	(296, 296, 64)	18,496
Activation	(296, 296, 64)	0
Max pooling	(148, 148, 64)	0
Dropout	(148, 148, 64)	0
Conv2d	(146, 146, 128)	73,856
Activation	(146, 146, 128)	0
Max pooling	(48, 48, 128)	0
Dropout	(48, 48, 128)	0
Flatten	(294,912)	0
Dense	(64)	18,874,432
Dense	(128)	8320
Dense	(1)	129
Activation	(1)	0
Total params: 18,976,129 Trainable params: 18,976,129 Non-trainable params: 0		

5 Results and Discussion

The CNN architecture which was created from scratch performed well on the given dataset. The training accuracy is found to be 97.4% with a loss of 0.091. Figures 5 and 6 illustrate the model accuracy as a function of the number of epochs, as well as the reduction in loss as the number of epochs increases for both training and validation data.

Figures 7, 8, 9, and 10 depict the channels in intermediate activation. The initial layer acts as an edge detector collection. All information in the image is retained by

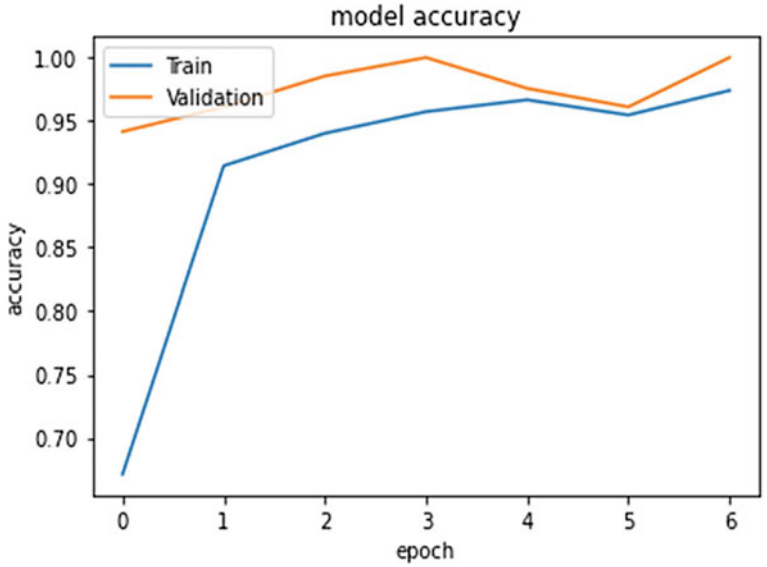

Fig. 5 Accuracy of training and validation data

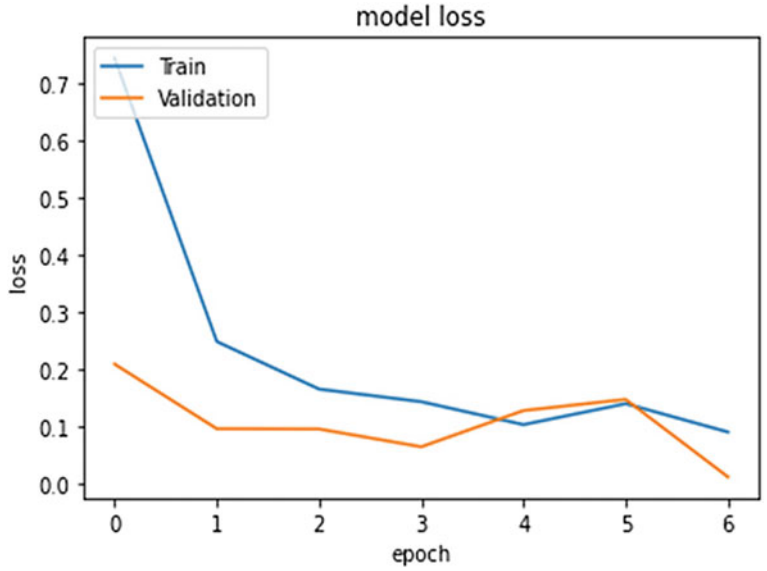

Fig. 6 Loss of training and validation data

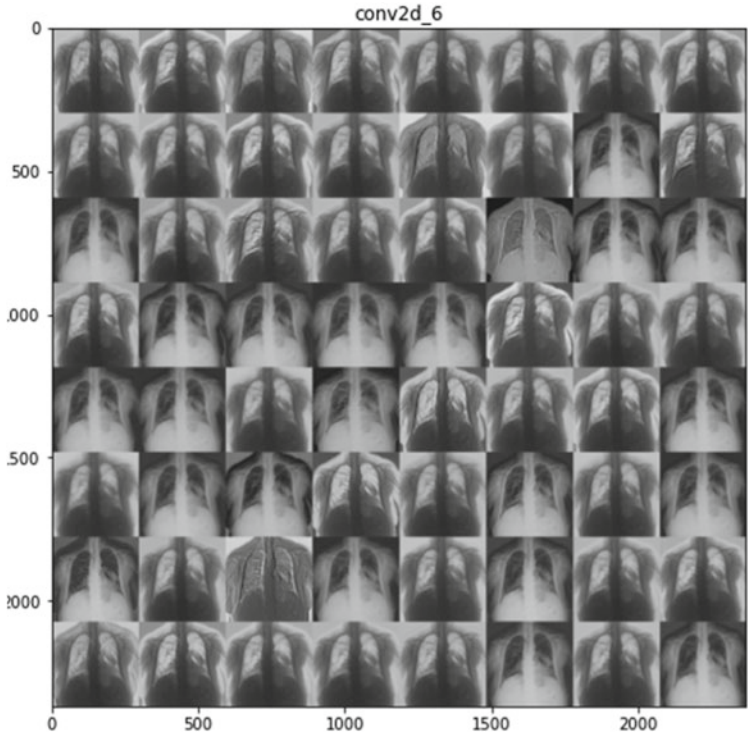

Fig. 7 Convo2D layer

the CNN layers. As the network goes deeper the activations become less visually interpretable. The information about the image's visual components diminishes as the layer depth increases, but more information about the image's class is stored. With an increase in depth layers, the sparsity of activation increases, i.e., in the prior layers, all filters become activated by input image, but in later layers, more filters are left blank.

It is found the precision is 95% for the COVID-19 class which shows that the predictions of the model are accurate and reliable, which is depicted in Table 2. It never predicts a non-infected patient as having COVID-19 which can be known from the 100% precision of normal class. A higher precision helps us to know that the number of false negatives is low. The recall is a measurement of false negatives against true positives. This means there are lesser chances of having a negative report on the prediction of a person having COVID-19. The F1-score is a metric that is used to balance Precision and recall. In our experiment, it is found that the F1-score for the COVID-19 positive class is 98% and for the negative class (not infected) is 97%. The support metric of COVID-19 and normal patients shows that the class is balanced with 20 samples of COVID-19 and 20 samples of normal patients' data. A

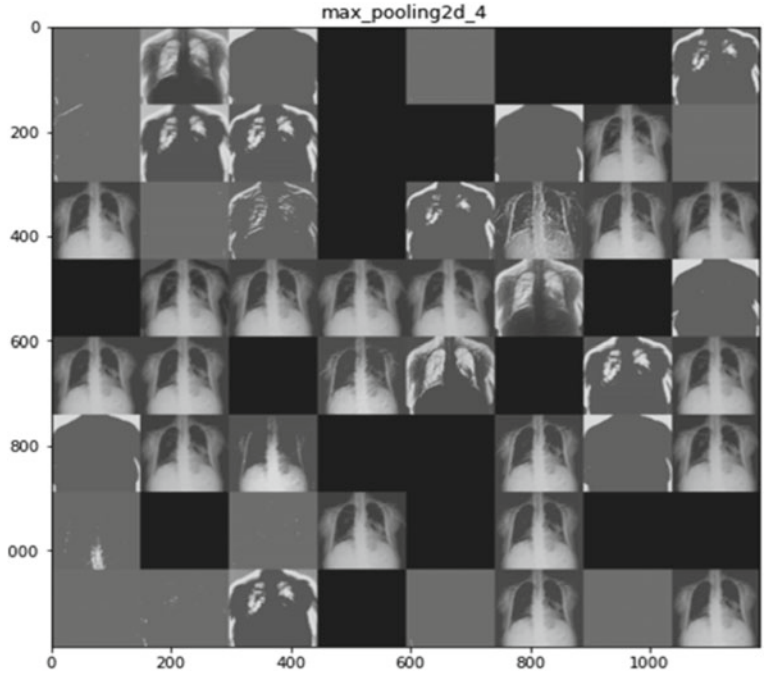

Fig. 8 Max pooling layer

comparison of this proposed work, COVIHunt, with some related existing works is stated in Table 3.

The proposed model, COVIHunt, has some advantages as well as disadvantages, can be stated as:

Advantages:

- The model will help to classify and get instant results of people being infected.
- It is faster, cheap, and efficient.
- It will act as an alternative method to conduct tests where rapid testing kits or the RT-PCR method is infeasible.

Disadvantages:

- The model might result in false negatives due to improper imaging.
- Early stage infections might not get detected.
- It is required to get more data to guarantee clinical accuracy.

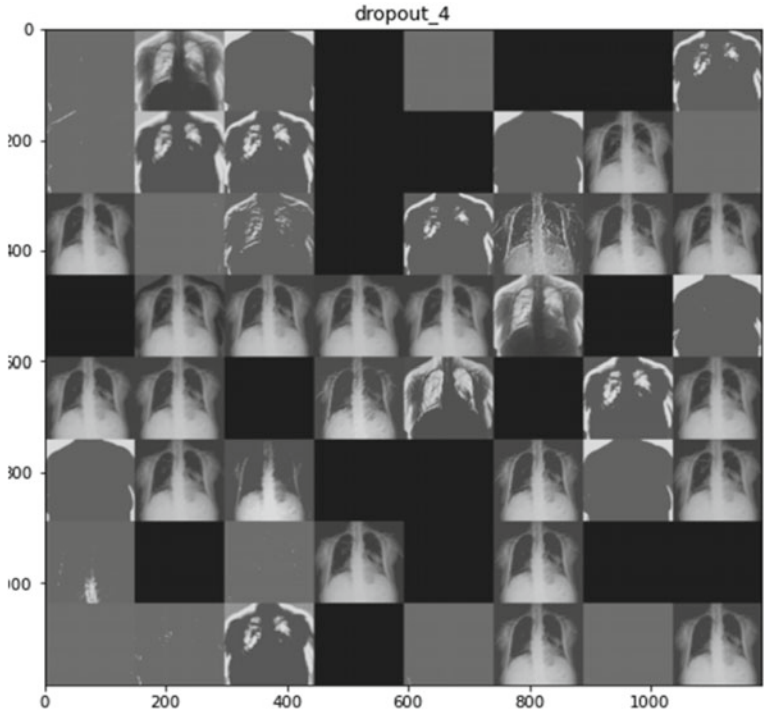

Fig. 9 First dropout layer

6 Conclusion and Future Scope

In this research, a deep learning-based image classification technique termed as COVIHunt has been proposed to identify COVID-19-infected patients. The accuracy of the dataset is found to be 97.5% which is reliable. Keeping in mind the current situation of the pandemic, this method will help in faster diagnosis and quick quarantine decisions. Being a novel method, it needs further fine-tuning to get better at real-life data and act as a tool with clinical accuracy. Deployment of this tool will help to collect data from numerous patients which will act as a database for future work related to lungs ailment. In the future, it is planned to take the age, gender, and demographic information of a person to get better classification results.

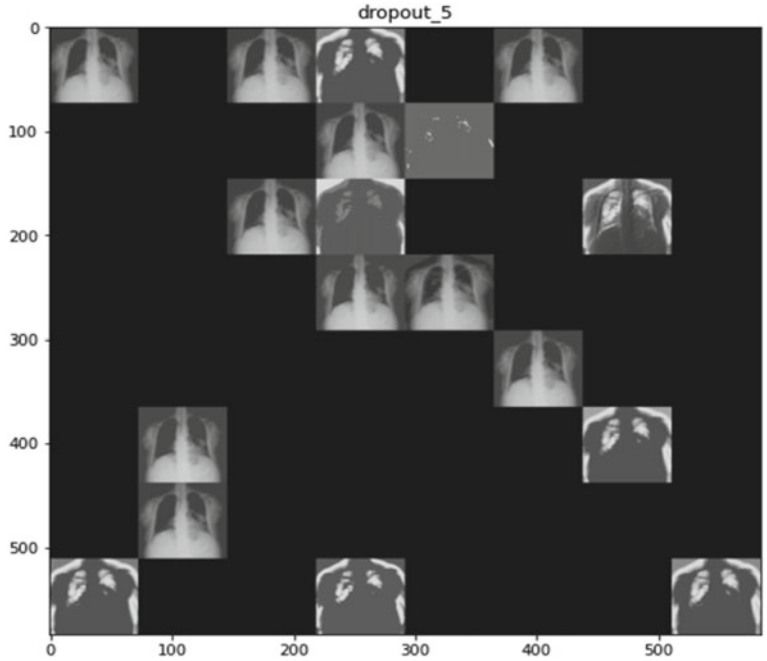

Fig. 10 Second dropout layer

Table 2 The results obtained using COVIHunt

	Accuracy	Precision	Recall	F1-score	Support
COVID-19	0.99	0.95	0.99	0.98	20
Normal	0.95	0.99	0.95	0.97	20
Weighted avg	0.975	0.98	0.97	0.975	40

Table 3 Comparison of COVIHunt with other existing models

Work	Method(s) used	Dataset(s) used		Findings			
				Accuracy (%)	Precision (%)	Recall (%)	F1-score (%)
Ismael and Sengur [7]	CNN models such as VGG16, ResNet101, and ResNet50, and for classification, SVM classifiers	An open-source dataset with 180 COVID-19 samples and 200 Normal samples		95.79	96	94	95.92
Wang et al. [3]	DCNN with PEPX design	COVIDx dataset with 13,975CXR images		93.3	98.9	91 (COVID-19) 94 (normal)	-
Rahaman et al. [8]	Image enhancement methods such as CLAHE, HE, BCET with CNNs	COVQU-20 dataset with 18,479 CXR images	Gamma correction	96.29	96.28	96.29	96.28
			Segmented Lungs	95.11	94.55	94.56	94.55
Heidari et al. [9]	Histogram equalization algorithm (HE), bilateral low pass filter coupled with a CNN model	Data was collected from public repositories having 8474 images with 416 confirmed COVID-19 cases		94.5	-	98.4	-
Jain et al. [10]	Deep learning models such as InceptionV3, Xception, and ResNeXt	Prashant Patel, Chest X-ray data on Kaggle	Normal	93	91	89	90
			COVID-19		97	78	95
Proposed work	CNN (3 Conv2d layers) for binary classification	940 CXR images with 466 COVID-19		97.5	98	97	97.5

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Application of Machine Learning Techniques for Information Extraction from Airline Tweet Data

Tanisha Paul, Somiya Ranjan, Neha Sarkar, and Sarada Prasanna Pati

Abstract Sentimental data analysis is a way of determining the sentiments shared through text. Today, the social media is a powerful platform to share the sentiments which can be in the form of reviews, opinions, etc. Twitter is such a social media platform where we can share our opinions, thoughts, or any reviews about any product, events, or services. For commercial service providers, it is important to identify the attitudes in the sentiments to improve their services. For this purpose, where these tweets need to be analyzed, the sentimental data analysis has made this task easier. This paper throws light on two different classifiers used to build two different models to classify the airline sentiments into positive, negative, and neutral classes The process starts with data collection followed by the pre-processing the data to remove those words which are irrelevant to identify the tone of the sentiments. Pre-processing includes data segmentation, tokenization, stop word removal, lemmatization, and stemming. The next step is to apply classifiers to classify the tweets. We used two classifiers: Support Vector Machine (SVM) and Artificial Neural Network (ANN). Finally, using the confusion matrix obtained, accuracy, specificity, and sensitivity are calculated. These measures are used to compare the performance of the classifiers which proves the efficiency of the SVM-based classier over the ANN-based classifiers in classifying the tweets.

Keywords Sentimental data · Airline tweets · SVM · ANN · Classification

1 Introduction

Sentimental data analysis is an application of Natural Language Processing (NLP). Information Extraction uses NLP techniques to retrieve important texts from documents automatically [1]. Sentimental data analysis is a process of analyzing the sentiments of people shared through text. Today, there are lots of platform present online where people share their sentiments. One such platform is Twitter.

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Twitter is a microblogging platform where people share their opinions or reviews on any subject in the form of tweets [2]. They are generally short messages which has length up to 140 [3]. They can also have links to resources. Airlines also require to understand the feelings of their customers about their services. Sentimental data analysis plays an important role to help airlines to monitor their customers' needs.

It's important is for the companies, service providers to know the sentiments of the public to improve their services. Similarly, airlines also need to know what their customers think or feel about their services. What motivates us to work on this project is that the airlines should be provided with comprehensive views regarding their customer's sentiments. This would help them to provide the customer the possible services in less time keeping in mind about their convenience. This is our objective also.

This paper throws light on two different classifiers used to build two different models to classify the airline sentiments into positive, negative, and neutral classes. It also concentrates on the steps applied to prepare the data before using them to train and test the model. At last, the results compare the models' performance.

2 Literature Study

Twitter has become one of the popular social media platforms where public is found to be very active. People post their opinions, give reviews on any subject in the form of sentiments. That is why it has become an area of interest for many researchers to analyze the sentiments by applying different machine learning techniques.

Many researches have proved that ANN gives the best results [4]. Another research was conducted where recurrent neural network and recursive neural network were applied. The problems which were observed led the author to invent another technique recurrent convolution neural network [4]. ANN approach used in a work showed its efficient performance in handling huge datasets of sentiments [5]. In one more work, it is stated that in one of the works, SVM was performed on two datasets: Twitter and IMDB review and comparison were conducted for each one of the datasets [6]. Another work categorizes sentiments into positive and negative classes using Naïve Bayes, SVM, and Maximum Entropy (MaxEnt) Classifier, reveals that the performance of SVM is better than the other two [7]. One existing algorithm is MaxEnt which uses encoding to convert features which are labeled to vector [8]. This algorithm is best for dependent features which are related to one another. But, for sentimental data analysis, there should be events which are identified uniquely.

3 Proposed System

This work is based on Airline tweets dataset which consists of the sentiments shared by passengers regarding the services provided by airlines. The data is divided into three classes: positive, negative, and neutral.

The data collected consists of 14,641 samples and 15 attributes. Among these many samples, 16% belongs to positive class, 21% belongs to neutral class, and 63% belongs to negative class. The data is separated into features and labels. As labels, we use the airline_sentiment feature which lists the sentiments of customers. After that, the data is sent for pre-processing so that the important data is retrieved. Then the data is converted into a matrix of numbers with the help of *TfIdf* vectorization. Then we move towards to split the data into training and testing set in the ratio of 8:2.

3.1 Methodologies

The proposed system is based on two different and popular classifiers: SVM and ANN. The airline tweets are worked upon by these classifiers. There are 14,641 samples and 15 attributes. Among these many samples, 16% belongs to positive class, 21% belongs to neutral class, and 63% belongs to negative class. These two classifiers are chosen because they can work well with the independent features. The data is needed to be pre-processed so that the insignificant ones can be removed or the words can be converted to such forms which makes them relevant to search. It is better to convert these data into a matrix of numbers. These numbers give the scoring to the words which again helps to know the relevancy of the desired text. As we need data to train the model and data to test it, we split the same pre-processed and vectorized data into training and testing set. Then apply classification on the training and testing data. Certain measures like accuracy, specificity, and sensitivity are calculated with the help of the confusion matrix. We compare the performance of the models based on these measures.

Dataset. The csv file of the data is collected from Kaggle which is known as "Twitter US Airline Sentiment." It contains CrowdFlower's released tweets [9]. The number of tweets and features is 14641 and 15, respectively. The features include tweet id, sentiment, sentiment confidence score, negative reason, negative reason confidence, airline, sentiment gold, name, retweet count, tweet text, tweet coordinates, time of tweet, date of tweet, tweet location, and user time zone. The sentiments are categorized into positive, negative, and neutral classes.

Pre-processing. Pre-processing is used to increase the efficiency of the working system and reduces the size of the data [10]. It includes processes such as stop-word removal, tokenization, stemming, and lemmatization.

Tf-Idf Vectorization. Tf-Idf contains the terms Tf and Idf which are term frequency and inverse document frequency, respectively. It calculates the score of a term which is required to know the relevancy of the word as per the need. Tf counts the frequency of terms and Idf gives weightage to these terms. Idf helps in identifying the terms which are insignificant to search. Tf-Idf converts text into matrix of vectors [11].

Split. The data is split into training and testing set in the ratio of 8:2.

Classification. Classification using Machine Learning (ML) techniques predicts under which classes the given data falls. We have used two classifiers in our work, SVM and ANN.

SVM is a supervised machine learning classification algorithm. In our project, we used Simple SVM, which is usually suggested for text classification as a large portion of these sorts of characterization issues are linearly separable.

ANN is a famous classification technique used for the prediction of numeric as well as categorical data. It is also a supervised algorithm. Generally, ANN has an architecture of three layers: input layer, hidden layer, and output layer [12]. There can be more than one hidden layer. There is one activation function in the output layer. In our work, the hidden layer size is 100 and the activation function is ReLU.

The two different models of SVM and ANN are trained with the training data and output is predicted for the testing data (Fig. 1).

4 Results

In our work, we focused on three measures which we calculate with the help of confusion matrix elements: accuracy, specificity, and sensitivity. Accuracy tells us how much the model can make accurate predictions; specificity is the measure of true negative rate and sensitivity is the measure of true positive rate.

$$\begin{aligned} \text{Accuracy} &= (\text{TN} + \text{TP})/(\text{TN} + \text{TP} + \text{FN} + \text{FP}) \\ \text{Specificity} &= (\text{TN}/\text{TN} + \text{FP}) \\ \text{Sensitivity} &= (\text{TP}/\text{TP} + \text{FN}) \end{aligned}$$

where TP is true positive, TN is true negative, FP is false positive, and FN is false negative. According to our observations, the results for both the classifier models are given in Tables 1 and 2.

As it is evident in the tables, for the test data in case of SVM, the accuracy is 0.85 and. for that of ANN, we get 0.83. The specificity for SVM is 0.85 and, for ANN, it is 0.84. The sensitivity for SVM is 0.80 and, for ANN, it is 0.66. From the results, we can say that SVM outperforms ANN. The sensitivity of ANN is also bit low; it happens in some cases.

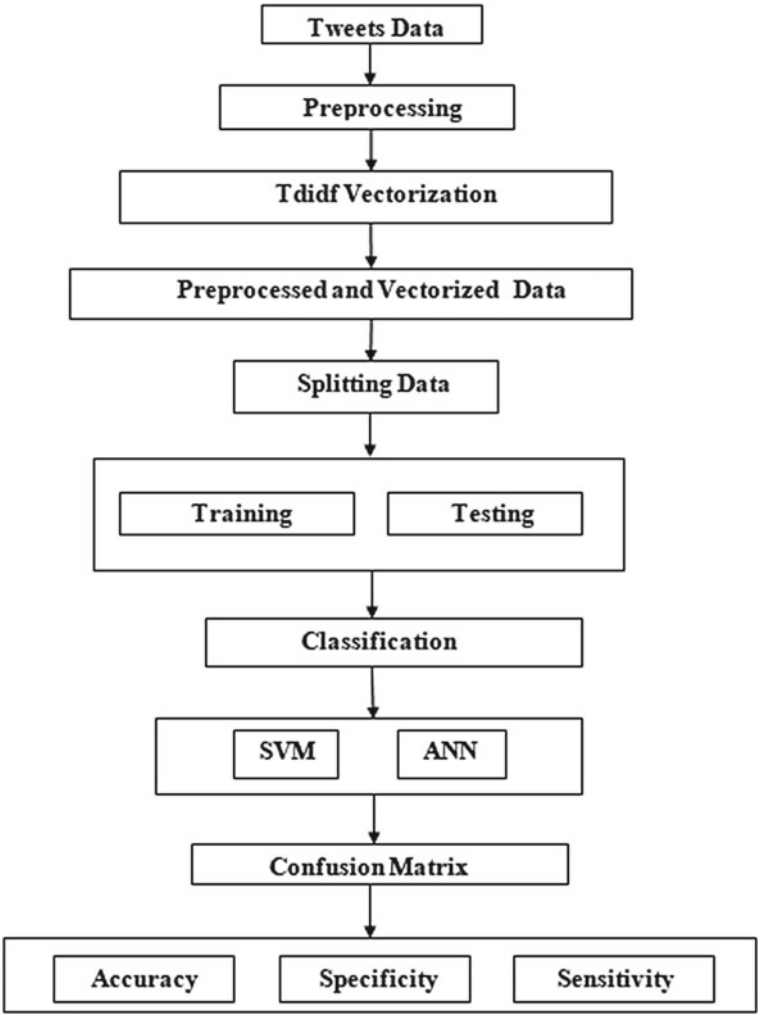

Fig. 1 Flow diagram

Table 1 Performance for SVM classifier

SVM classifier	Accuracy	Specificity	Sensitivity
Testing	0.90	0.92	0.84
Training	0.85	0.85	0.80

Table 2 Performance for ANN classifier

ANN classifier	Accuracy	Specificity	Sensitivity
Testing	0.99	0.99	0.98
Training	0.83	0.84	0.66

5 Conclusion

Sentimental data analysis have now become a popular approach to understand the desires of public through their opinions. It is not only cost-effective but also an easier way to determine the emotions or feelings of public behind any matter. Here, we worked on the public's sentiments for the airlines twitter data. This work proved how much twitter sentiment analysis is effective with the help of machine learning techniques like SVM and ANN. Pre-processing and vectorization helps in increasing efficiency of the whole process. SVM-based classifier showed better classification performance over ANN. We can still try out sentimental data analysis with many other classification or clustering techniques.

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Hate and Offensive Language Identification from Social Media: A Machine Learning Approach

Manswini Swain, Manish Biswal, Priya Raj, Abhinav Kumar, and Debahuti Mishra

Abstract Social media has evolved into a valuable tool for disseminating information while also ensuring that everyone on the site has complete freedom of expression. This ability of social media to openly express oneself to the world has resulted in major issues such as hate speech, cyberbullying, aggression, and general profanity, all of which harm society's well-being. It's critical to pay attention to these issues as it has a significant impact on an individual's life and, in some situations, be suicidal, negatively impacting the victim's mental health. Our key aim is that our approach will automate and quicken the detection of offensive content that has been posted, making it easier to take appropriate steps and moderate these offenses. In this work, we have implemented several popular machine learning classifiers with character N-gram TF-IDF features. Along with this, we have also proposed dense neural network (DNN) and convolutional neural network (CNN) models for the identification of hate speech. In the case of DNN, character N-gram TF-IDF features wherein CNN, word embedding features are used. In the extensive experiments, we found AdaBoost classifiers performed best with the weighted F1-score of 0.86 in the identification of hate speech.

Keywords Classification · Abusive language · Hate speech · CNN · Machine learning · Deep learning

1 Introduction

People have more freedom to express themselves and post anonymously in diverse formats such as blogs and social media sites like Twitter and Facebook as a result of the widespread use of the internet. Social media creates a lot of data and has given

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individuals new ways to express themselves online, resulting in the emergence of a positive exchange of ideas while also contributing to the spread of hate speech [1, 2]. The use of hate speech, as well as a surge in cyberbullying and cyberterrorism, creates difficulties for a better society. Because of the ubiquity of hate speech materials on the internet and social media, detecting hate speech is a critical component of social media anti-bullying legislation. Hate speech and other rude and horrible things on the internet pose a threat to society. Many countries prohibit hate speech on social media if it is directed at a specific group or is intended to incite criminal activity. Hate speech can be removed from many internet venues, including YouTube, Facebook, and Twitter because it creates opinions or anything else that harms society.

The worsening unfavorable scenario on the internet has created a significant demand for these social media platforms to identify obnoxious content and take appropriate action, which can be done manually by a human pacifier, but it is both practically absurd and time-consuming due to the volume of information generated by various social media platforms, as a result, there is a requirement to automate this procedure. Although harmful social media material comes in a variety of formats, including audio, video, picture, and text is the most common. Several works [1–8] have been reported by many researchers, who utilized textual social media information to detect hate and abusive text. Kumari and Singh [4] proposeda CNN model to detect hate speech, harsh language, and vulgarity in English and Hindi tweets. Mishra and Pal [5] developed an attention-based bidirectional LSTM network to recognize hate, offensiveness, and profanity in English, Hindi, and German tweets. Mujadia et al. [6] built an ensemble-based model that comprised a support vector machine, a random forest, and Adaboost classifiers to detect hate content in English, Hindi, and German tweets.

In most of the previous works, either word-level N-gram features or word embedding features were used by the researchers to build a machine learning-based model to identify hate and offensive content from social media. In this work, we are exploring the usability of character N-gram features with the classical machine learning models such as (i) SVM, (ii) Naïve Bayes, (iii) Logistic Regression, (iv) Decision Tree, (v) KNN, (vi) Gradient Boosting, (vii) Random Forest, and (viii) AdaBoost for hate and offensive tweet identification. Along with this, we have also proposed dense neural network (DNN)- and CNN-based models for hate and offensive tweet identification.

The remaining parts are arranged as follows: Sect. 2 lists related works for hate speech detection, Sect. 3 discusses the proposed methodology in detail, Sect. 4 lists the results of the implemented models, Sect. 5 discusses the outcome, and Sect. 6 concludes the paper with future directions.

2 Related Works

Hate and offensive language detection from social media have recently piqued the interest of numerous researchers, leading to the development of an automated system that can efficiently identify hate and offensive language from social media [2–6].

Kumari and Singh [4] developed a CNN model to detect hate speech, harsh language, and vulgarity in English and Hindi tweets. Mishra and Pal [5] developed an attention-based bidirectional LSTM network to recognize hate, offensiveness, and profanity in English, Hindi, and German tweets. Mujadia et al. [6] built an ensemble-based model that comprised a support vector machine, a random forest, and Adaboost classifiers to detect hate content in English, Hindi, and German tweets. Kumar et al. [1] presented a machine learning-based approach for detecting hate speech in Dravidian social media messages. They found that character-level features performed better than word-level features when it came to detecting hate content. Mishra et al. [2] used deep learning-based models like CNN and LSTMs to identify hate content in English, Hindi, and German social media comments. Saumya et al. [8] used a variety of conventional machine and deep learning algorithms to identify hate speech in Dravidian social media posts. They found that character N-gram features performed better with conventional machine learning classifiers than sophisticated deep learning models. Kumar et al. [9] proposed a fine-tuned BERT model for detecting hate and offensive social media content.

Kumari et al. [2] developed a CNN-based unified multi-modal approach to detect cyberbullying by combining textual and imagery features of social media posts. Kumari et al. [10] proposed a multi-modal system by optimizing textual and imagery features using a genetic algorithm to identify cyberbullying. Samghabadi et al. [11] utilized ensemble learning using a feature set of word N-grams, character N-grams, word embedding, and emotion. They discovered that using a combination of words and character N-gram features outperformed using a single feature. Srivastava et al. [6] employed a capsule network to detect online social aggression and toxicity in Facebook comments.

In most of the previous works, researchers used either deep learning-based models or traditional machine learning models. Kumar et al. [1] and Saumya et al. [8] found that the use of character-level features greatly improves the detection of hate and offensive content in Dravidian social media posts. In accordance with prior studies, we investigate the usefulness of various combinations of character-level N-gram features with the traditional machine learning and dense neural network models for detecting hate and offensive content in English social media postings.

3 Methodology

The suggested technique is thoroughly discussed in this section. Figure 1 depicts the overall flow diagram for hate and offensive tweet identification. This section starts with the data description, and then it discusses the proposed models. We used the HASOC 2020 (English) benchmark dataset [12] to carry out our experimentations. Each tweet in the dataset is labeled as offensive (HOF) or not-offensive (NOT). The overall data statistic used in this study can be seen in Table 1.

We experimented with eight different conventional classifiers such as (i) Support Vector Machine (SVM), (ii) Naïve Bayes (NB), (iii) Logistic Regression (LR), (iv)

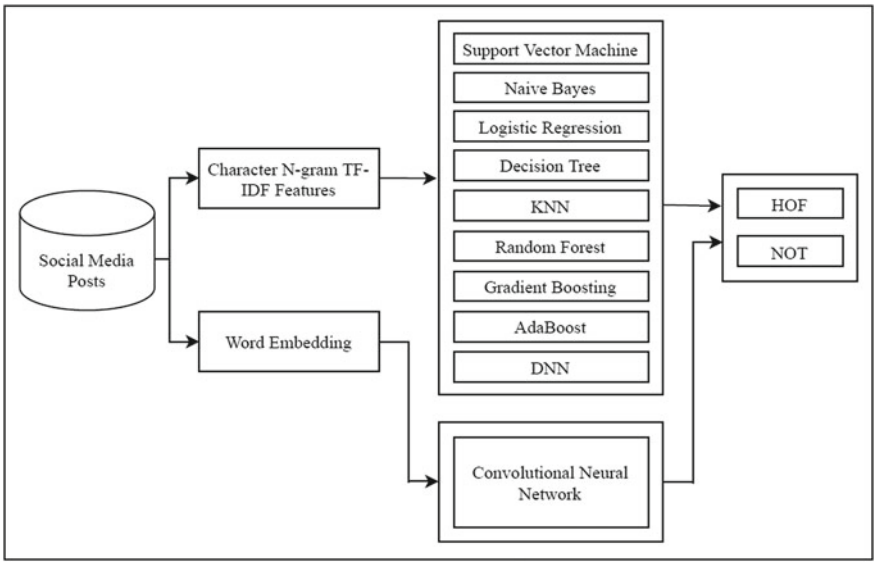

Fig. 1 Overall flow diagram for hate and offensive tweet identification

Table 1 The overall data statistic employed in the validation of the proposed system

Class	Training	Testing
Not offensive (NOT)	1,852	391
Hate and offensive (HOF)	1,856	423
Total	3,708	814

Decision Tree (DT), (v) K-Nearest Neighbor (KNN), (vi) Gradient Boosting (GB), (vii) Random Forest (RF), and (viii) Adaptive Boosting (AB). Along with these conventional machine learning classifiers, we also implemented two different deep learning-based models (i) Dense Neural Network (DNN), and (ii) Convolutional Neural Network (CNN).

We employed character N-gram TF-IDF features in conventional machine learning classifiers and the DNN model. In the case of CNN, we used a 100-dimensional word embedding vector to represent each word of the tweet. In our case, we fixed the maximum word length for a tweet to 30 words. As in our dataset, we found most of the tweets were have less than 30 words, due to this we chose the maximum length of 30 words for the experiments. It means we curtailed out the words of the tweets that have more than 30 words and padded for the tweet having less than 30 words. It means a tweet matrix with a (30×100) dimension is passed through the CNN network to extract features from the tweets to classify them into HOF and NOT classes. A convolutional neural network is a multi-layered neural network with a unique design that is used to recognize complex data features. We implemented one layered convolutional neural network with 128 filters of 3-Gram

to extract features from the text and then this feature is passed through Max Pooling operation and the activation function to get the feature map and this feature map is then used by the dense layer to classify tweets into hate and not-hate classes. For all conventional machine learning models, the default parameters are used as defined in the Sklearn python library.

4 Results

This section list the results of all the implemented models for hate speech detection. Precision, recall, and F1-score are used to evaluate the proposed model's performance. The precison, recall, and F1-score for the hate class can be calculated using Eqs. (1), (2). and (3), respectively.

- **Precision**: The proportion of correctly predicted hate comments to total predicted hate comments is termed as precision. The precision for hate class can be calculated by Eq. (1):

$$\text{Precision (Hate)} = \frac{\text{Number of accuractely predicted hate comments}}{\text{Total number of predicted hate comments}} \tag{1}$$

- **Recall**: The ratio of accurately predicted hate comments to the total number of hate comments in the dataset is termed as recall. The recall for hate class can be calculated by Eq. (2):

$$\text{Recall (Hate)} = \frac{\text{Number of accuractely predicted hate comments}}{\text{Total number of hate comments in the dataset}} \tag{2}$$

- **F1-Score**: It is the harmonic mean of precison and recall. The F1-score for the hate class can be calculated using Eq. (3):

$$\text{F1} - \text{score (Hate)} = \frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \tag{3}$$

Similarly, for the non-hate class, precision, recall, and F1-score can be computed using Eqs. (1), (2), and (3), respectively.

We started extensive experiments with different combinations of character N-gram features with all the conventional machine learning and DNN models. We found the best performance with (1–6)-gram character TF-IDF features. The results for each of the models are listed in Table 2. Along with this, we have also implemented one layered CNN with 128 filters of 3-Gram to extract features from the text and then this feature is passed through Max Pooling operation and the activation function to get the feature map and this feature map is then used by the dense layer to classify comments into hate and not-hate classes. The bar graph for the performance comparison of each classifier in terms of weighted F1-score is plotted in Fig. 2. The AdaBoost and

Table 2 Results for the different machine and deep learning models

Classifiers	Class	Precision	Recall	F1-score
Support vector machine	HOF	0.94	0.74	0.83
	NOT	0.77	0.95	0.85
	Weighted avg.	0.86	0.84	0.84
Naïve Bayes	HOF	0.76	0.81	0.79
	NOT	0.78	0.73	0.75
	Weighted avg.	0.77	0.77	0.77
Logistic regression	HOF	0.92	0.74	0.82
	NOT	0.77	0.93	0.84
	Weighted avg.	0.85	0.83	0.83
Decision tree	HOF	0.83	0.80	0.81
	NOT	0.79	0.83	0.81
	Weighted avg.	0.81	0.81	0.81
KNN	HOF	0.78	0.69	0.73
	NOT	0.70	0.79	0.74
	Weighted avg.	0.74	0.73	0.73
Gradient boosting	HOF	0.94	0.78	0.85
	NOT	0.80	0.95	0.87
	Weighted avg.	0.87	0.86	0.86
Random Forest	HOF	0.93	0.77	0.84
	NOT	0.79	0.94	0.86
	Weighted avg.	0.86	0.85	0.85
AdaBoost	HOF	0.94	0.79	0.86
	NOT	0.81	0.94	0.87
	Weighted avg.	0.87	0.86	0.86
DNN	HOF	0.84	0.74	0.79
	NOT	0.75	0.85	0.80
	Weighted avg.	0.80	0.79	0.79
CNN	HOF	0.83	0.79	0.81
	NOT	0.79	0.81	0.80
	Weighted avg.	0.81	0.81	0.81

Gradient Boosting classifiers performed better than the other implemented models by achieving a weighted F1-score of 0.86, as shown in Table 2. However, for the hate class, the AdaBoost classifier performed better than the Gradient Boosting classifier with a recall of 0.79.

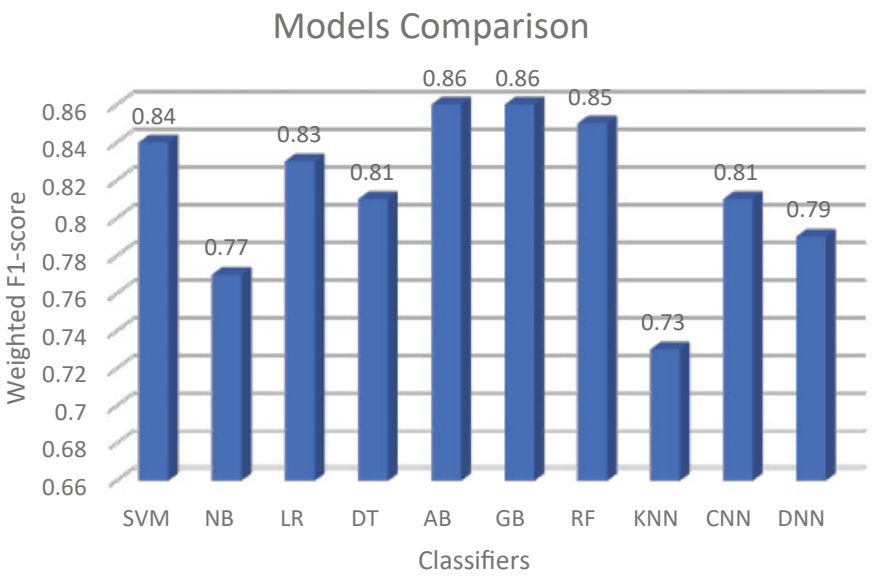

Fig. 2 Classifier's performance comparison for the hate speech detection

5 Discussion

The challenge of detecting abusive language on social media platforms is a critical one that is growing rapidly. As a result, we focus on employing machine learning techniques to give a solution for normalizing these insulting or abusive posts. The main contribution of this work is to explore several traditional machine and deep learning models in identifying hate and offensive content from social media. In extensive experiments with the different combinations of word-level and character-level N-gram TF-IDF features, we found that the use of character N-gram features was performed better in the identification of hate and offensive social media posts. Social media posts generally contain several grammatical mistakes, spelling mistakes, and people generally use nonstandard abbreviations in their posts. This can be one of the possible reasons that the character-level N-gram features performed better in comparison to word-level features. To identify hate and offensive content, the current system can be deployed on top of any social networking site. This can provide safer platform for social media users to communicate with other users.

6 Conclusion

The ability of social media to openly express oneself to the world has resulted in serious concerns such as hate speech, cyberbullying, aggression, and general profanity, all of which harm society's well-being. In this work, we conducted a detailed comparison of several feature extraction methodologies, machine learning, and deep learning models and found that the Adaptive boost classifier and Gradient boosting have the precision, recall, and weighted average F1-score of 0.86. In the extensive experiments, we found that the use of character-level N-gram features performed better in comparison to the one layered CNN model where word embedding vector was used. The future works include merging machine learning and deep learning models to construct a powerful ensemble model that can improve on the existing findings. In the future, a proper parameter tunning can also be performed with the proposed CNN-based model to improve the performance for efficiently identifying hate and offensive content from social media.

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Maximum Likelihood Estimation for Bangla–Odia Word Alignment

Bishwa Ranjan Das, Dilip Singh, Prakash Chandra Bhoi, and Debahuti Mishra

Abstract In this paper, the mathematical function Maximum Likelihood Estimation (MLE) used to measure Bangla–Odia word alignment performance is used to provide better results and good accuracy. This MLE technique helps to find out the maximum likelihood probability value with the collaboration of the 'argmax function' that follows the mapping between two or more words of source and target language sentences. The lexical relationship among the words between two parallel sentences knows after calculating some mathematical values and those values indicate which word of the source language (SL) is aligned with which word of the target language (TL). Find MLE or MAP, the maximum a posterior parameter in the probability model, which depends on the unobserved latent model or hidden variables. Keeping all these issues in mind, it is described the nature of lexical problems that arise at the time of analyzing bilingual translated texts between Bangla (source language) and Odia (target language). The basic challenges lie in the identification of the single word units of the source text which are converted to multiword units in the target text and vice versa. The experimentally, there are thousands of parallel sentences are taken as training set and out of these sentences only hundreds of parallel sentence pairs are considered for test data. The accuracy of the proposed model is giving better performance as compared to other model and the accuracy which is more than expectation.

Keywords Expectation · Maximization · Probability · Alignment · Divergence · Odia · Bangla

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1 Introduction

Word alignment is the process of identifying or mapping the exact and corresponding word between two parallel corpora. It is one of the translation relationships of the words between two or more parallel sentences. Somehow, a word is translated by a single word or multiple words called word divergence. In the given parallel sentences, to find the corresponding relationship among words that may be one-to-one, one-to-many, and many-to-many of source and target sentences remains the main task of word alignment. Alignment of source language phrases with corresponding target language phrases or groups of words is the solution of phrase-based translation. If the phrases of the supply sentence are not able to discover their suitable translation withinside the goal language, clearly, they're assigned null. The movement of translated words in the source sentence to their appropriate position in the target sentence is also done in word alignment. In the case of bilingual machine translation, the word reordering may be a necessity and word alignment helps in achieving it. There are multiple factors for word alignment, i.e., Named entities, Transliteration similarities, Local word grouping, nearest aligned neighbors and dictionary lookup. The various challenges of achieving word alignment include ambiguity, word order, word sense, idioms, and pronoun resolution can be solved by mathematical operation and some conceptual concept of linguistics. In Word alignment, handling the 'Word divergence' or 'lexical divergence' problem is the main issue and challenging task here though it is not solved by many more algorithms till now it is only possible through a bilingual dictionary or called lexical database that is experimentally examined and tested only mathematically. Problems of word divergence or lexical divergence are normally addressed at the phrase level using bilingual dictionaries or lexical databases.

In the information of phrase alignment, the use of numerous the use of techniques inclusive of hybrid approach which plays nearby phrase grouping on Hindi sentences and makes use of different techniques which includes dictionary lookup, transliteration similarity, anticipated English phrases and nearest aligned neighbors. The probability values between small and large pair of sentences are discussed thoroughly [1]. The various issues, problems, and challenges are described very briefly here. Different types of approaches are also described thoroughly [2]. Most of the challenges are faced and solved very carefully using Expectation Maximization algorithm and using statistical technique, the whole concept is described very prominently with good accuracy. Most of the problems and issues are solved here [3]. In this paper, the various mapping techniques one-to-one, many-to-one are solved for Bangla–Odia lexical divergence problem [4]. In this paper, for estimating the parameters of those models given a hard and fast of pairs of sentences which can be translations of each other is defined through a sequence of five statistical models of the interpretation system and algorithms [5]. English–Hindi parallel words of the sentences are mapping using word dictionary [6]. Automatic word alignment has been done using different approaches like boundary detection approach, minimum distance function, and dictionary look up [7]. Compound word spitting is the most important part of machine translation which breaks the whole word into different meaning of the word.

Different approaches and their advantages and disadvantages are elaborated systematically as well as discussed, the challenges faced during translation of one language to another [8]. In this paper, a new probabilistic version is supplied for phrase alignment wherein phrase alignments are related to linguistically encouraged alignment sorts. A novel undertaking of joint prediction of phrase alignment and alignment sorts is being proposed and applied novel semi-supervised gaining knowledge of set of rules for this undertaking [9]. The algorithm illustrated with examples: pooling information from more than one noisy source and turning into an aggregate density [10]. A collection of five statistical version of translation method is defined and algorithms are given for estimating the parameters of those models additionally proven a fixed of pairs of sentences which are translation of each other and is described an idea of phrase-by-phrase alignment among such pairs of sentences [11]. This book provides a comprehensive and clear introduction to the most prominent techniques employed in the field of statistical machine translation [12]. Semantic relationship can be used to improve the word alignment, in addition to the lexical and syntactic feature that are typically used [13].

2 Estimation of Maximum Likelihood

MLE is a way that discover values for the parameters of a version. The parameter values are determined such that they maximize the probability that the method defined via way of means of the version produced the information have been really observe.

Maximum likelihood estimation is a technique of calculating the parameters of a possibility distribution technique via way of means of maximizing the possibility price the usage of argmax characteristic in order that the assumed statistical model, the discovered facts is maximum probable. The price withinside the parameter area that maximizes the chance characteristic is referred to as the most chance estimate. The good judgment of most chance is each intuitive and bendy to calculate the most price amongst all chance's values. Now it is mostly dominate the all maximization functions.

3 Word Alignment with Methodology

This paper presents to learn and implement conditional probability model between Bangla and Odia sentence, denoted as $P_\theta(B|O)$. If the alignment of the sentences is observed before, then only estimate the P(B|O) that means to find the MLE value by taking some sentence pairs as an example. The subscript θ represents set of parameters having a dataset D of n sentences pairs, D = {(B1, O1), (B2, O2), (B3, O3), ..., (Bn, On)}, where each subscript n indexes a different pair and it represents number of sentence pairs that means (B1, O1) is one pair, (B2, O2) is another pair and so on. The model is fully trained to predict the

existence of the missing word alignment. These are many ways to define P(B|O). Suppose a Bangla sentence B is represented by an array of I, (B1, B2, B3, ...BI) and an Odia sentence O is represented by an array of J, (O1, O2, O3, ..., OJ). The Bangla–Odia word can be represented as an array of length I, is (a1, a2, a3, . . . ai) where a1, a2, a3, . . . ai one–one alignment variables are. An alignment variable ai takes a value in the range [0, J]. If ai = 0 means j value is also 0 because ai = j, that means Bi is not aligned to any word Odia word called null alignment. Consider the sentence pair Bangla–Odia as an example. But in this particular example there is no null value exist. It may be arise in other pair of sentences in the whole corpus.

Bangla sentence

রবিবার\N_NNP মায়চা\N_NNP গ্রামে\N_NN কৃষক\N_NN সংঘর্ষ\N_NNP সমিতি\N_NNP পঞ্চায়েত\N_NN করে\V_VM_VNF ২৫\QT_QTC অক্টোবর\N_NNP থেকে\PSP নির্মাণ\V_VM_VNF কার্য\N_NN বন্ধ\N_NN করার\V_VM_VNF সিদ্ধান্ত\N_NN নিয়েছে\V_VM_VF ।\RD_PUNC

Transliteration. Rabibar Mayacha grame krushak sangharsh samite panchayate kobe 25 Octobar theke nirman karjya band korar sidhant niechhe.

Odia sentence

ରବିବାର\N_NNP ଦିନ\N_NN ମାୟାଚା\N_NNP ଗ୍ରାମରେ\N_NN କୃଷକ\N_NN ସଂଘର୍ଷ\N_NN ସମିତି\N_NN ପଞ୍ଚାୟତ\N_NN ବସାଇ\V_VM_VNF ୨୫\QT_QTC ଅକ୍ଟୋବରରୁ\N_NNP ନିର୍ମାଣ\N_NN କାର୍ଯ୍ୟ\N_NN ବନ୍ଦ\N_NNV କରାଇବାକୁ\V_VM_VINF ନିଷ୍ପତ୍ତି\N_NN ନେଇଛି\V_VM_VF ।\RD_PUNC

Transliteration. Rabibar dino mayacha gramare krushaka sangharsha samiti panchayata basai 25 Octobarru nirmana karjya band karaibaku nispatti neichhi.

The Bangla sentence is a length of 17 and the Odia sentence length is also 17. The Bangla sentence length indicates as I and so on the Odia sentence length indicates as J. The words of both the sentences are indexed like B1, B2, B3, . . . , BI and O1, O2, O3, ..., OJ. The value of an alignment array 'a' will be {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17}. These are all j values. It is being assumed that the probabilistic model automatically create the Odia sentence from Bangla using a normal method. First of all, the size of Odia sentence I is chosen as per the probability distribution P(I|J), i.e., P(17|17). Since the P(I|J) can be written mathematically as P(1, 2, 3, ...I|1, 2, 3, . . . J) i.e., P (length of source language followed by target language). Then each Bangla word position aligns to an Odia word (or null) according to the valid sentence alignment of the standard corpus (ILCI) is P(ai = j|J). Finally, each Bangla word Bi is translated according to the probability distribution function on the aligned Odia word, P(Bi|O_{a_i}). So, for this alignment, all probability values are multiplied likewise P (Rabibar dino|Rabibar),

P(Mayachal|Mayacha), P(grama|grame), and so on. The joint probability value of the Bangla sentence and its alignment conditioned, both are calculated on the Odia sentence is simply the product of all these probabilities [15].

$$\mathrm{P}(B, a|O) = \mathrm{P}(\mathrm{I}|\mathrm{J}) \prod_{i=1}^{I} \mathrm{P}(a_i|\mathrm{J}).\mathrm{P}\left(B_i|O_{a_i}\right) \tag{1}$$

It is basically two values, P(I|J), for all pairs of sentence lengths I and J, and P(B|O) for all pairs of co-occurring Bangla and Odia words B and O.

$$\forall_{O,B} P(B|O) \in [0, 1] \tag{2}$$

$$\forall_O \sum_B P(B|O) = 1 \tag{3}$$

4 Use of Maximum Likelihood Estimation

To observe the alignment, just taking care of the P(B|O) and estimate the approximate value through maximum likelihood estimation (MLE). At first, the alignment of the sentence has been discussed properly before then start doing the word alignment between Bangla and Odia. But there is no such type of situation occurs in Bangla–Odia as it shows in French to English translation. For Example, most of the word of French is aligned with the English word many times but this type of situation also arises in Bangla–Odia sentence pairs. From the understanding point of view, an MLE function is introduced here to calculate the probability of the given parameters. Here is showing one example how P(B|O) is calculated,

$$\begin{aligned}
&\theta_1 = \mathrm{P}(\text{krushaka}|\text{krushakder}) \\
&= \frac{\text{count(krushaka, krushakder)}}{\text{count(krushaka, krushakder), P(krushakamananka, krushakder), P(krushamanankara, krushader)}} \\
&= 1/(1+2+1) = {}^1\!/_4 = 0.25
\end{aligned} \tag{4}$$

$$\begin{aligned}
&\theta_2 = \mathrm{P}(\text{krushaka}|\text{krushakder}) \\
&= \frac{\text{count(krushakamananka, krushakder)}}{\text{count(krushakamananka krushakder), P(krushaka, krushakder), P(krushamanankara, krushader)}} \\
&= 2/(1+1+2) = 2/4 = {}^1\!/_2 = 0.5
\end{aligned} \tag{5}$$

$$\begin{aligned}
&\theta_3 = \mathrm{P}(\text{krushaka}|\text{krushakder}) \\
&= \frac{\text{count(krushaka, krushakder)}}{\text{count(krushaka, krushakder), P(krushakamananka, krushakder), P(krushamanankara, krushader)}} \\
&= 1/(1+2+1) = {}^1\!/_4 = 0.25
\end{aligned} \tag{6}$$

From these three equations [14], the Bangla word "krushakder" is aligned with different Odia words many times with different probability values. The matter is which value should be chosen for consideration. Sometimes it's depended on highest probability value as find out by MLE here. But three parameters θ_1, θ_2, and θ_3 have different values of different alignments. If the highest value is considered, i.e., 0.5(Eq. 4) for P(krushakal|Krushakder) not always satisfied for all cases, only satisfied for that particular semantic sense of the sentence. So, MLE is not always good at all for all cases to find the exact values.

$$\prod_{n=1}^{N} P_\theta\left(B^{(n)}, a^{(n)} | O^{(n)}\right) = \prod_{n=1}^{N} P(I^{(n)} | J^{(n)}) \prod_{i=1}^{I^{(n)}} P(a_i^{(n)} | J^{(n)} . P(B_i^{(n)} | O_{a_i}^{(n)}) \quad (7)$$

Here, N is number of sentences, the source length language Bangla is I, the target language Odia length is J, i is the alignment index, and a_i is the alignment.

Now data is observed, and the parameters are estimated, finally need a probability function to find the highest value as our data(value) is highly probable under this model.

$$\hat{\theta} = \underset{\theta}{argmax} \prod_{i=1}^{N} P_\theta(B^{(n)}, a^{(n)} \big| O^{(n)}) \quad (8)$$

In Eq. (4), where $\hat{\theta}$ it searches the highest probability value of word alignment by argmax function for each and every word in a sentence. It is basically a searching problem from an infinite number of possible sentences in the case of machine translation. Only one sentence is selected from different possible sentences after translation in agreement with the corpus. For this case, though the search problem is trivial, because the solution for $\hat{\theta}$ when the data described by model is fully observed. An algorithm is developed to learn θ from our hypothetical aligned data actually initiates the strategy or model which is described here. The data is scanned and observing the alignments and counting them (means aligned data) for each Bangla–Odia word pair. To calculate the probabilities values (aligned word pair Bangla–Odia), all counts (means probability values) are normalized by the number of times that is observed the corresponding Bangla word participating in any alignment. This implies an algorithm which is described here.

Algorithm

Step 1. Initialize all counts to 0

Step 2. For each n value between 1 to N

Step 3. For each i value between 1 to I

Step 4. For each j value between 1 to J

Step 5. Compare $a_i = j$ upto n i.e. i value

Step 6. Count $[(B_i, O_j)] + +$

Step 7. Count $[O_j] + +$

Step 8. For each (B_i, O_j) value in count do

Step 9. $P(B|O) = \text{Count}(B,O)/\text{Count}(O)$

This algorithm implements over all pairs of the word in each to collect count, a computation that's quadratic in sentence length. This is not strictly necessary: it could have just looped over the alignment variable to collect the counts, which is linear. However, thinking about the algorithm as one that examines all pairs of a word will be useful when it is moving to the case of unobserved alignments, which turns out to be an extension of this algorithm. Here, two formulae are used to calculate alignment probabilities after some iteration.

A Bangla sentence $B = b_1, b_2, b_3 \ldots b_i$ and translated into an Odia sentence $O = o_1, o_2, o_3 \ldots o_j$. Among all possible Odia sentences, one is looked for the highest probability $P(B|O)$. Using Bayes' rule it may be written as follows:

$$P(O|B) = P(O)P(B|O)/P(B) \tag{9}$$

As the denominator is independent of O, finding the most probable translation e^* will lead to the noisy channel model for statistical machine translation.

$$e^* = \text{argmax } P(O|B) \tag{10}$$

$$= \text{argmax} P(O)(P(B|O) \tag{11}$$

where $P(B|O)$ is the translation model and $P(O)$ is referred to as the language model. In most of the cases, many-to-one and one-to-many world alignment is purely based on phrase-based translation, there is no other way to do translation when word divergence is seen in word alignment. A bilingual Bangla–Odia lexicon is developed as per the corpus based on the agriculture domain for mapping the words and translated very smoothly by one-to-one, one-to-many, and many-to-many.

5 Result and Discussion

In the bilingual dictionary based on the agriculture (Corpus collected from TDIL, Govt. of India) domain, a small handful of sentences (approximately five thousand), around fifty thousand words stored in a well-formatted and scientific manner for easy access with observed alignments. All observed alignments are trained and it produces a good estimate of θ as mentioned in Eq. (8). If we think as much as data, to get good estimates. It contains a one-to-one word, many-to-one, and many-to-one word correspondence. First of all, connections (as one-to-one mapping) are equally

likely. After one iteration the model learns that the connection is made between most similar words from two parallel sentences by finding the probability value between 0 and 1. After another iteration, it becomes clear that a connection between previous similar words is more likely as the probability value of the current word. So, bigram and trigram are the best method to find the probability of the sentence along with the alignment among the words. All probability values are calculated using a bigram with MLE and argmax function in the form of a table/matrix. All probabilities values calculated by MLE with argmax function is not sufficient for the finding to exact alignment two parallel sentences Bangla–Odia. Taking more than thousands of parallel sentences, the accuracy is not so satisfactory by experimentally done. So further, it will be tested by Expectation Maximization (EM) algorithm to get the good accuracy value for proposed system. So here a better probability distribution is being progressed. This percentage value can be further enhanced by using EM algorithm in near future. But here the accuracy is calculated manually using the mathematically formula Precision, Recall, and F-Score measure to reach near the threshold value around more than 80%.

6 Conclusion and Future Work

When a translation is occurred from one language to another, first of all, if a parallel corpus is properly aligned in sentence level, then word by word is easily done by machine. Most of the problem is raised like one-to-many and many-to-one alignment which are solved by bilingual dictionary and phrase-based translation. A bilingual dictionary is made one-to-one, one-to-many, and many-to-one correspondence (Bangla–Odia) between two languages is created. Sometimes phrased-level translation is a more appropriate solution for word divergence occurrences. The MLE function is used for finding the most suitable word pair between two languages (Bangla–Odia) from where the highest probability value is taken. It also helps to translate word by word, phrase wise and finding the appropriate position of the word of the target language with good accuracy. Time complexity is one of the major factors when data is huge for word alignment as well as machine translation. So, care should be taken to obtain a better result; to optimize this, is a challenging task. Space complexity not be reduced as our data or corpus is huge, space should be increased for this as memory is concern, otherwise, any research work based on NLP or Data Science will be superficial.

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Performance Analysis of Video Streaming Methods

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Abstract Due to the proliferation of smart devices with high-speed data communication, video streaming is evolving as the most dominating application on the Internet. Upcoming requirements of 5G wireless include Quality of Experience (QoE) for streaming and other multimedia applications. Recently, HTTP adaptive streaming (HAS) solution has gained popularity for streaming applications. However, many challenges still need to be addressed, in order to adapt HAS for upcoming 5G wireless networks. In this paper, we explore video. In day-to-day life, we consume enormous number of videos across various platforms, so knowing the main mechanism behind the technology should be an essential part in figuring out various difficulties that could be faced if various components are not fitted properly. The main objective of this work is to compare the best algorithms(s) or codecs available for video streaming. The primary aim is to test the efficiency of well-known algorithms (MPEG, H.264) that are being currently used.

Keywords Streaming · H.264 · MPEG-DASH · Encoding · Video

1 Introduction

In our today's world, we know how video streaming and video sharing platforms plays a very significant role. It acts as a source for learning new things to provide a channelized entertainment. It's hard to believe a common man has accesses to such massive resources, all this has become due to these giant tech platforms. Today in this free world any person can share his/her views and perspective regarding any matter without hesitation. And video sharing/ streaming platforms play a vital role in this. For a average human it's easier to understand a idea or through a video rather than a written document, its saves time and gives better clarity. The most currently used codecs used by large streaming websites like Netflix, Amazon, and video uploading platforms like YouTube of Google use H.264, VP9 (it's open source) and these codecs

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are widely used today and have gradually replaced older ones like mp4 and AAC [1]. Apart from mainstream video encoding codecs there are many smaller ones like mp4 family of codecs, H.263, FEVC, MPEG4, 3GP, etc.

Initially, in the beginning, the websites were of simple design and layout. In this age of 5G and fiber, high-speed internet connection could easily watch and upload high-quality videos from anywhere in the globe. Traditionally, streaming is a continuous transmission of audio and/or video files form a source to destination. The source destination pair is a client–server model. Just like other data, the data of video is broken down in little packets. The small packets contain little part of files, and the video decoder/player on client-side interprets them. In simple terms, the YouTube video you watch or the Netflix series you binge are example of video streaming [2]. The media is transmitted to your device from the servers through your internet connection. Traditionally, files used to be downloaded and stored in the device then the user can gain accesses to it. The downside of such method is one has to wait for the completion of the process and a copy of it get stored into local drive. Basically, it very time consuming. So how these huge platforms work so efficiently stands a chance to be explored and gather a clear understanding by focusing on micro details [3].

HTTP (Hypertext Transfer Protocol) live Streaming or HLS. HTTP live streaming also known as (HLS) is used the most for streaming protocols around the world. This is widely used for video hosting and lives streaming [3]. This technique of video streaming work by breaking files of the video into tiny HTTP files then delivering it by HTTP protocol. The receiver device downloads these HTTP files and plays them as video. HTTP is the application layer protocol for transferring information between receiver and sender devices connected to the network [4]. Data transfer on HTTP is based on the old requests and response method. Almost all HTTP messages are either a request or a response to a request.

One of the primary advantages of HLS streaming is, every internet connected devices support the HTTP, making it very simple to implement. Another advantage of HLS is that the video quality can be increased or decreased depending on the internet speed so that the video can be played without interruption. This feature is known as “adaptive bitrate streaming”. The slow internet connection can hamper the video form starting [5]. HLS was developed by Apple and for the Apple products, but now it’s used in large range of devices [6].

1.1 Video Encoding

The encoding of video is necessary to help efficient transmission of data from one place to another. The receiving device on which a user is viewing the file use the decoding process while the sending device encodes the data. Publicly used standards are available in order to support diverse of devices and every one can interpret the universally encoded data. Captured video are kept as segments on server with different frame to support adaptive streaming. Streaming protocols like HLS

or MPEG-DASH breaks videos into smaller segments [7]. After that, the video is encoded using available standards for video encoding like H.264, H.265.

Basically, the streaming process compresses the video thus, redundant information are reduced. Using the content delivery network (CDN) the encoded videos are sent to the client machine. For compressing and decompressing data a codec is used so that it can be easily delivered and received by different applications. Codecs may use lossy compression or lossless compression to encode. In lossy compression, some parts of the video may be dropped keeping the essential data. Lossless compression retains original quality of the video file by copying every segment of data exactly. However, both lossless compression have their pros and cons. Smaller file sizes and lower video quality is handled by lossy compression; the lossless is used for better quality video.

2 Existing Works

Due to revolution in the smartphone industry the data consumption has increased significantly in recent days. Recent forecast shows the video traffic controls 80% of it. In near future, the rise of 5G will take the bar way further. So, video compression will play a very vital role in fulfilling such promises. Baig et al. [6] states that the advancement of standard compression ratio are growing exponentially which is additionally supported the evolvement of artificial intelligence. He majorly concentrated on developing the next-generation codecs which can work more efficiently than the current generation. Video Streaming over wireless network medium. Since the wide implementation of 5G the focus towards wireless transmission of video has changed in a drastic manner. Streaming of video through wireless network has wide range of application in today's society. But the unpredictable network barriers create large hindrance in ground-level implementation. The papers written by Zhu and Girod mainly provide solution of how we can remove these barriers. Their work revolves around improving the cross-layer design for allocating resources. There has been numerous comparison of streaming process. We have tried to capture the data saved in wireless network by MPEG and H.264.

3 Video Encoding Algorithms

Any client-side browser (application) can use a codec to compress and decompress the data irrespective of the device hardware.

Dynamic Adaptive Streaming over HTTP (DASH)also known as MPEG-DASH is a popular streaming method. Using this process client can start playing a video before the buffer is fully loaded. Another similar process called HTTP Live Streaming (HLS). HLS breaks video into chunks with small sizes. The chinks are encoded into different quality levels so that the video can be sent according to network conditions.

Streaming process: The video file is broken into smaller pieces which are of different length. After this, the broken pieces is encoded with the help of any available standard encoder. As the user starts watching the video, the encoded file are transferred into the client system. In maximum cases, a CDN comes into action to help distribute and help the stream more efficiently [8]. When the receiver plays the video the encoded video segments gets decoded and video get played in the client device. The best part is the video decoder reduces the quality of stream when there is a hindrance in the network.

In today's generation, H.264 most widely used video codecs. Having feature such as advance video encoding makes it stand out in the crowd.

3.1 Performance Metrics

The Peak Signal-To-Noise Ratio (PSNR) is commonly used objective video quality method. PSNR is calculated as

$$PSNR = 10 \log_{10} \frac{L^2}{MSE} \tag{1}$$

where L represents the range of pixels which is dynamic and mean squared error is noted as *MSE*. To calculate *MSE*, equation can be used.

$$MSE = \frac{1}{n} \sum_{i=1}^{N} x_i - y_i \tag{2}$$

N the number of pixels of the received frame/video,
x_i the number of pixel of the source frame/video
y_i pixel from compressed frame/video

4 Experimental Results and Discussions

We have implemented MPEG and H.264 in MATLAB software considering different network condition with packet loss rate 0.03% [9, 10]. We have used real player and with few n real video parameters. MPEG-DASH and H.264 were evaluated in different condition and average values are presented in results given below. Different bitrate levels used with video resolutions are 240p, 360p, 480p, 720p, and 1080p, respectively, with the bitrates.

Figure 1 shows the amount of noise in the signal through every bitrate that is used. This graph shows that for every bitrate more noise is there in signal of MPEG-DASH as compared to H.264. For higher bitrate, H.264 performs better than MPEG.

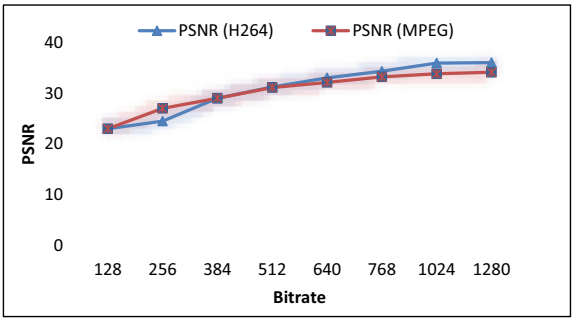

Fig. 1 Comparison of PSNR value

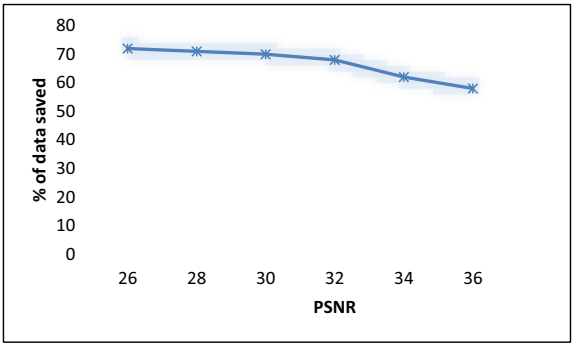

Fig. 2 Data saving by H.264 in wireless network as compared to MPEG

Figure 2 shows that more data is saved by H.264 in comparison to the MPEG. This also proves that H.264 is more efficient then MPEG.

5 Conclusion and Future Scope

In this work, we have studied MPEG-DASH and H.264 and realized that H.264 is more efficient and faster than MPEG-DASH which has been outdated by this new encoder. This also has been proved by the commercialization of H.264 by various large video hosting sites like Netflix and Amazon Prime because unlike MPEG-DASH, H.264 is very fast encoder without any downsides. H.264 also saves lot of data in case of lossy wireless networks. In future, we shall try to implement this work with highly loss wireless channels and check the quality of experience.

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Intelligent Blockchain Services for Smart City Economy Using Emotion Analysis

G. Nagarajan, R. I. Minu, Samarjeet Borah, and Debahuti Mishra

Abstract Universally large amount of initiation was taken up by different governments to make their countries prime cities as Smart cities. The major component of Smart cities is Internet of Things (IoT) devices and sensor data. When comes to financial data transmission in those smart cities it required a high security and privacy-oriented IoT infrastructure. To support such robust infrastructure, blockchain is one of the best solutions. While processing the IoT sensor data, if an Artificial Intelligent (AI)-based processing and analysis were used, it will provide a semantic digital data analysis. In this paper, a concept has been introduced for semantic data extraction and data pattern analysis using intelligent emotion extraction. This framework provides a highly secured economic services for smart cities.

Keywords Smart city · Blockchain · Sharing economy · Internet of Things (IoT) · Smart contract

1 Introduction

The continuing progress in information technology have breakthrough traditional personal communication helped industry to be highlighted of data-driven basic headship. Throughout the outlook at Internet of Things (IoT) accept an important role of registering substructure thus designing a Cyber-Physical System (CPS). Blockchain can strengthen different modern implementation, for instance, producing, correlate,

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production, and services. IoT expects to improve activity proficiency and generation throughput, decrease the machine personal time, and upgrade item quality. Specifically, IoT has the accompanying highlights: (1) redistribution of blockchain subsets, (2) assorted variety of gadgets and schemes, (3) heterogeneity of IoT information, and (4) organize intricacy. Every one of them bring about the difficulties including heterogeneity of IoT framework, poor interoperability, asset imperatives of IoT gadgets, protection, and security vulnerabilities. The existence of IoT developments gains the conquering of above challenge of IoT. With the decentralized agreement, blockchains can empower an exchange to happen and be approved in a commonly questioned appropriated framework without the intercession of the confided in outsider. Dissimilar to occupant exchange the executive's frameworks where the incorporated office needs to approve the exchange, blockchains can accomplish the decentralized approval of exchanges, along these lines incredibly sparing the expense and relieving the exhibition bottleneck at the focal office. Additionally, every exchange spared in blockchains is basically unchanging since every hub in the system keeps all the submitted exchanges in the blockchain. In the meantime, cryptographic systems, (i.e., deviated encryption calculations, computerized mark, and hash capacities) ensure the uprightness of information obstructs in the blockchains. Along these lines, the blockchains can guarantee non-denial of exchanges. What's more, every exchange in blockchains is recognizable to each client with the appended memorable timestamp.

IoT for virtual bodily frameworks, decentralized data stockpiling figuring thru cloudlets, and blockchain-based decentralized safety empower the arrangement of putting mindful, custom designed, and canny sharing economy administrations to a big clever town swarm. Cutting aspect clever cities areas will confront the take a look at of the combination of those headways wherein a sizeable degree of information may be created by means of the mass institution and IoT gadgets frequently. These information need to be processed, dealt with, and reacted to in a safe and subjective manner. After the innovation of www, the difficult improvements that have contacted pretty lots every part of the processing space include the presentation of decentralized records exchanges making use of blockchain, IoT, and device insight at the versatile edge. Every considered one of them cooperate to offer clever town sharing economic system arrangements wherein factors play out a trade in a total decentralized manner with no middle confided in birthday celebration. At the supply facet, people can provide matters along with brief-time period rentals in their idle vehicles, or spare rooms of their apartments or homes.

Sharing economy can use various elements of the proposed research [5]. With regards to transportation [6] administrations, blockchain can store the driver and vehicle profile with the historical backdrop of upkeep, mishap [7], move, and different kinds of changeless information Furthermore, it can likewise interface the partners of vehicle by a common chain, giving assistance [10] via vehicle splitting the financial situation. Blockchain, and medicinal IoT can possibly interconnect every one of the networks of enthusiasm of specially appointed well-being-based sharing economy online networking administrations. Being instance, they will permit the Voltaic Well-being Record (EHR), Electronic Medicinal Record (EMR), client outline, medical

coverage description, singular therapeutic trial antiquity, subtleties of visits to various emergency clinics, and contour of doctors and medical clinics to be spared in a regionalize and certain vault. Particular serious issues looked by the allocating providence is the one of a kind character the executives and confirmation of every partner in a protected and unknown manner. Blockchain affords an encouraging arrangement through giving sealed character the board; approval of IoT gadget profiles and other computerized marks, accordingly permitting worldwide personality for sharing economy situations. Blockchain's brilliant agreements can robotize self-executing understandings that were to a great extent hypothetical before the presentation of bockchain [14].

These arrangements will guarantee an adaptable enormous information age, imparting after isolated spectra, consolidate or disseminate in a bright town. Be that as it may, information preparing and occasion identification in various situations are an overwhelming assignment as the measure of information is at an enormously huge scale. Breaking down aforesaid a complete magnitude of information and deciding the marvels of premium boundary and threat are conceivable because of the headway in fast exchange ability as an overlay over existing blockchain systems, subjective registering capacities with Artificial Intelligent (AI), with the help of equivalence AI, profound training, and different sorts of information science progressions.

2 Related Work

Loper et al. [1] presently, there was enormous enthusiasm for the not unusual economic device packages, in which humans can adapt their things. The sharing financial gadget has encountered rushes of hyper excitement, but it still cannot appear to reach at its maximum ability. The big majority of the route of movement of ranges, as an example, AirBNB and uber count on an interest as middle human beings among clients and personal belongings. The blockchain is expressed to furnish a basis with the possibility to type out absolutely decentralized markets.

Pautasso et al. [2]. An ongoing discourse paper through IBM precise that blockchains can in all likelihood make a "sharing economic gadget 2.0" through decentralizing agree with, Lundy et al. [3]. Additionally, an amazing part of the scholarly writing recommends the blockchain innovation to defeat believe-associated problems and consequently to feature to the goals of one of the main difficulties of the dispensed markets and sharing economic machine bodily sports.

Beenest [4] is one startup that goals enhancing the residence-sharing financial system through killing the phrases of administration and expenses received by the added together specialists making use of the blockchain innovation. On this new model, the ones hosts with keep rooms or houses can straightforwardly interface with the customers seeking out agreement, without delegate charging or misusing its customer's facts. Slock. It is a version that had a few knowledge in blockchain and IoT packages to understand Szabo's vision of clever contracts implanted in IoT-empowered devices [6].

Helbiz [7] is a number one defender of this financial version for transportation by way of consolidating the automobile innovation. The technical fills in as a course for the administrations gave through Helbiz's foundation, consequently coping with exchanges among directors, owners, and outside expert co-ops. Typically, superior due to the fact the "blockchain rendition of uber," 'zooz' plans to manufacture an open-source, around the area, decentralized adventure-sharing tool, to assignment and alternate the constructed up non-public transpiration frameworks with big quantities of squandered void seats and payload area [8]. Arcade city [9] is each other decentralized ride-sharing help primarily based things. It interfaces up drivers and travelers and offers a trip in a similar way uber does. With the exception of those new businesses, a few plan technological information processes get the concept of the blockchain and flow the concept of middle man or woman loose degrees to capacity application settings.

For example, bogner [10] proposes an evidence of idea to reveal off how applications empower every day sharing. The creators built the sensible agreement on the smart agreement, which permits proprietors to sign on and lease devices without a confided in outsider association. Be that as it can, a blockchain-based totally framework spills safety facts of the protected gatherings because of its receptiveness to fashionable society, and a protection regarding approach is proposed to authorize understandings among owners and real clients of merchandise, Xu et al. [11].

Notheisen et al. [12] gift a decentralized sans believe change framework that permits clients to move genuine assets without a focal vault. Moreover, they propose to apply the changeless file to moderate the educational sided exchanges.

Rahman et al. [13] recommend a foundation for the internet of things empowered sharing economy in uber clever town communities. The proposed basis use the intellectual figuring and rancid-chain based totally decentralized records stockpiling for a big institution. Dorri et al. [14] gift a conveyed solution for make sure the safety of customers and to the safety of the automobile organic device. The proposed safety layout is famously appropriate for vehicle sharing administrations, which require a believed correspondence channel to change data together with the vicinity of the car, keys to open the car, and installment subtleties of the client.

Albeit amazing exertion antique directed, the winning examination exist initial issue assist allocating providence administrations with the guide as regards subjective figuring and taut blockchain and off chain hinge separate facts stockpiling as a giant group. Within powerful following section, we supply the condition phrasings along with essential statistics territories identified with the examination.

On the inventory aspect, humans can provide matters, as an instance, brief leases of their inactive vehicles, or more rooms in their condos or homes. At the interest facet, buyers can income through leasing products at decrease fee or with lower price-based totally overhead than shopping or leasing through a traditional provider.

The sharing financial system has made various open doors for clever towns areas concerning enhancing resource use and effectively lessening change charges. Enhancing the usage of advantages infers various nice results, for example, vitality sparing, and blockage diminishing. While sharing products and ventures in business facilities has a long record, and antiquated vis-à-vis sharing still happens in networks

throughout, internet center people might now be able to assist those exchanges and in shape market interest continuously on a huge scale.

The sharing economy is pushed by using empowering advancements of computerized network, which offer the established order of these traits as in it lets in promptness (Gori et al. 2015). Steady statistics and information assembled through human beings are critical to dealing with the wasteful usage of beneath-used assets and creating a metropolis "keen." citizens, items communities can interface up flawlessly by making use of commonplace advances to essentially improve information sharing with respect to the status and trade of inert assets. With advanced availability, people can hire save rooms and cellars, retain parking spots full, experience an inert motorcycle in the road, and take a mutual taxi with an extra atypical heading a comparable way.

3 Existing System

Haze processing framework is a developing engineering for giving registering, stockpiling, control, and systems administration abilities for acknowledging Internet-of-Things (IoT). In the haze figuring framework, the cell phones (MDs) can offload its information or computational costly errands to the haze hub inside its nearness, rather than far off cloud. Despite the fact that offloading can decrease vitality utilization at the MDs, it might likewise acquire a bigger execution delay including transmission time between the MDs and the mist/cloud servers, and pausing and execution time at the servers. Consequently, how to adjust the vitality utilization and defer execution is of research significance. Broad reproduction considers are directed to show the adequacy of the proposed plan and the better execution more than a few existed plans are watched.

4 Proposed Framework

Intellectual registering depends on the human perspectives, and it confers this knowledge to various electronic frameworks. Intellectual registering is made out of programmed AI systems that utilization information examination, design acknowledgment, and characteristic language handling to think like people. At the point when prepared, these frameworks don't need human support. The subjective motor is like incredible cerebrums that drive the circulated IoT gadgets. This new mind can look over tremendous information assets and assemble knowledge that is required for basic leadership and future activities. These psychological motors have amazing investigation capacity and information preparing competency that bestows mortal like knowledge attentive blockchain structures.

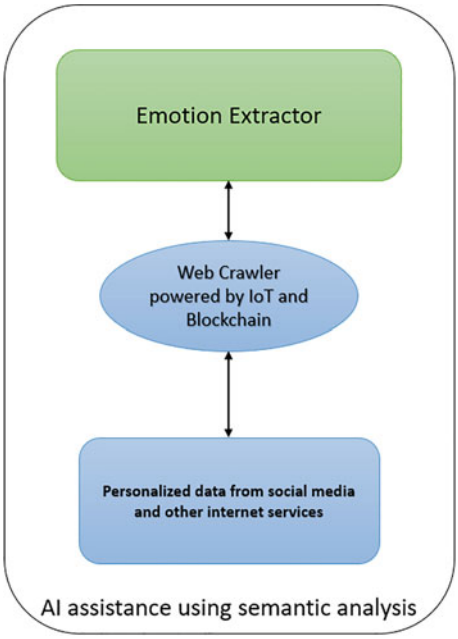

Fig. 1 Overview of the proposed system

Mechanized blockchain construct dispense scrimping benefits, the money-related exchanges and administrations are computerized and wisely oversaw by the subjective motor. The partners take an interest in confided in tasks where the understanding is examined by the psychological framework, and the commitments live prosecute naturally in the absence of an individual contribution. Corresponding elegant understanding or agreement is made out of immovable cipher, which manages supplementary comparable brilliant agreements. Such a framework can settle on astute choice, perform information investigation, and utilize Near-Field Correspondence (NFC), or area data for IoT gadgets during radiate inherent information to circulated apportion of blockchain records. Simulated intelligence operators are accessible to oversee such self-ruling frameworks with circulated IoT gadgets. Consequently, blockchain ground carve up parsimony administrations and AI operators model dealings by utilizing astute agreements (Fig. 1).

5 Result and Discussion

Toward clever cities groups to recognize the blockchain association. The dynamic of people being sans agree with in blockchain enterprise administrations relies upon on straightforwardness and protection in the administration connection amongst human and innovation. Blockchain innovation empowers individuals to get to the facts of every alternate they make, because it for all time facts trade records at every hub of the

blockchain. Due to the adjustment inside the accept as true with version of blockchain primarily based framework, the administration connection additives of human and affiliation totally sharing administrations has come to be democratized. In blockchain primarily based sharing administrations, accept as true with isn't always put in an individual, but as an alternative dispersed over the entire populace. The usage of focal experts is supplanted by a community of buddies as a shared gadget; nobody can singularly take activities within the hobby of the network. In such a democratized putting, governments can't control a political decision through pressuring human beings, and firms cannot singularly defy the pointers of the framework.

Computerization is totally sharing administrations is the most striking component of management connections institutions. In view of the highlights of being sans trust, blockchain innovation has empowered business exchanges with outsiders without the requirement confided in center person; within the period in-between, programming can computerize an outstanding a part of the alternate process, enabling authoritative vows to be carried out without human affiliation. The robotization of working collectively in blockchain-based totally commercial enterprise administrations has pulled in noteworthy enthusiasm for one-of-a-kind ventures.

Toward smart cities communities to comprehend the blockchain arrangement, we outline the highlights of the administration in Fig. 2 of blockchain-based sharing administrations. The dynamic of individuals being sans trust in blockchain business administrations depends on straightforwardness and security in the administration connection among human and innovation.

Figure 3, the creation of blocks has done properly with the respective insurance type of listing where all type of insurance credentials are stored to the database, where claiming process will be successful after the blockchain generation and report as shown in the figures below.

Here, the application is used to provide security for the credentials for the insurance claiming details. In this proposed work, we are add encryption key with

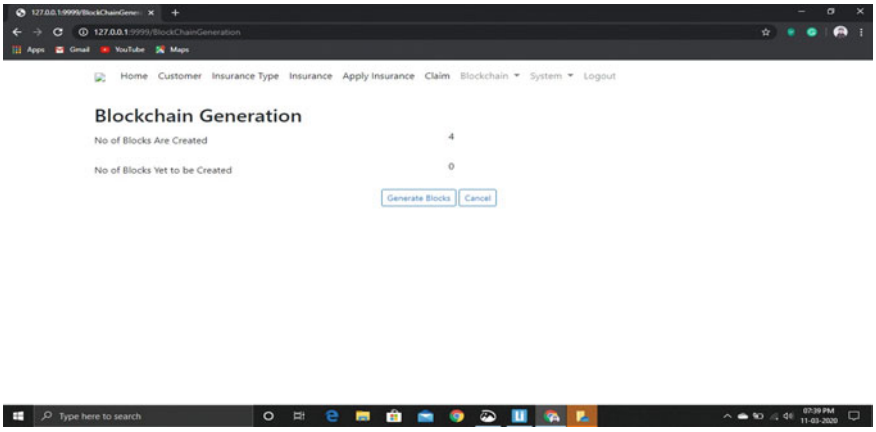

Fig. 2 Creation of blocks

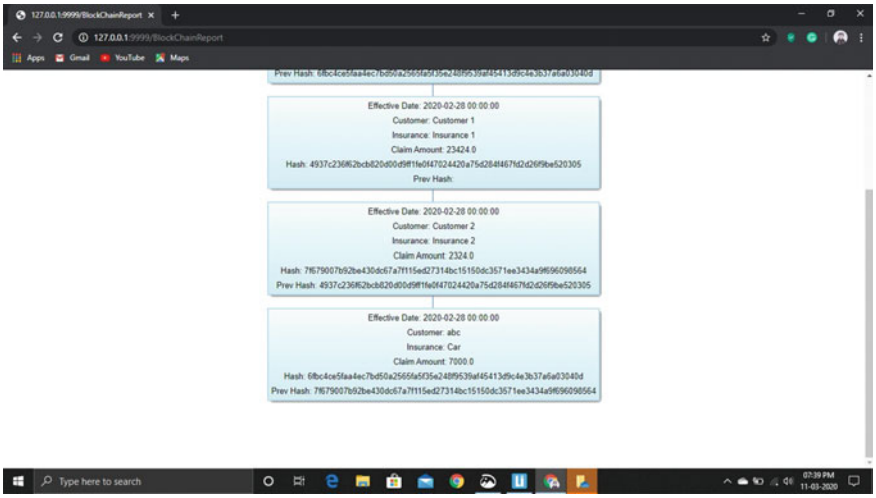

Fig. 3 Blocks generation

consensus algorithm of type proof of work which creates unique identity for the database. So, if any one tend to change the records which is not possible.

6 Conclusion

With the evolvement of IoT, the trouble of overseeing hub gadget additionally expanded. Particularly for cities communities, a system of different gadgets in a wide zone can cause numerous vulnerabilities because of the multifaceted nature of the system. Nonetheless, the city arranges, which is legitimately associated with the national and social foundation, requires a significant level of security because of its administration attributes. Along these lines, a shrewd city comprising of heterogeneous gadgets must be secure, guaranteeing uprightness, privacy, and information accessibility. Likewise, validation, inertness, flexibility, and auditability on hub gadgets ought to be considered. The basic purpose of system the executives is gadget the board. Every gadget ought to consistently be in a protected state and issues happening on every gadget ought to be accounted for right away. Brought together foundation based structures may not accomplish these objectives and inappropriate administration and refreshing of gadgets can bring about critical misfortunes to shrewd city, requiring convenient, secure, and ensured gadget refreshes.

This paper has proposed a blockchain-based gadget that can accomplish different security contemplations on the smart city. The proposed system utilizes private blockchain that reliably examines the respectability of the gadget and stores the outcomes gadget the executives. In this work, we possess advocate a measure niggard framework, use the blockchain and off-anchor structure concern pool unchanging

records. Administration help of our proffered AI framework, a group of people yet to come burgh can purvey digital somatic ration sparing benefits through IoT information. Beyond utilizing keen agreements, the system occur fusion spatial-fleeting administrations to a worldwide pitch without entailing a focal check leverage.

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Decision-Making in Fuzzy Environment

Suprava Devi, Mitali Madhusmita Nayak, and Srikanta Patnaik

Abstract Actual decision problems comprise contradictory systems of criteria, uncertainty and imprecise information. Multi-attribute decision analysis (MADA) is a commonly adopted decision technique, which enhances the value of decisions by constructing the process more clear, logical and competent. This paper discusses about the techniques applied for multi-attribute decision-making (MADM) in the environment where fuzziness is present. The rating of alternatives is assessed by the fuzzy multi-attribute decisions through the evaluation of weighted average aggregation methods. If the solutions of the rating are crisp then the ranking of alternatives can be simple. Therefore, this paper brings attention for finding crisp ratings for the alternatives by taking into consideration of the uncertain, imprecise and linguistic assessments that are provided by decision-makers (DMs).

Keywords Decision-making · Multi-attribute decision analysis · Multi-attribute decision-making · Weighting method · And rating alternatives

1 Introduction

Decision-making is possibly depicted as the psychological process bringing about the selection of a belief or a course of action from numerous probable alternative options, to achieve specific objectives or goals, which may be rational or irrational. Major of the decisions contain uncertainty, so the important feature of making valuable decision is to make availability of the capability to handle inexact and indistinct information, for example 'huge' profits, 'high' speed and 'low' price. Decision making procedure is a logical process, which is based on the decision-makers perception of values, preferences and beliefs [1]. All the decision-making process leads to

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a selection of final choice that may perhaps not the immediate action. As stated by Bellman and Zadeh [2], majority of the process of decision-making occurs in a situation where goals, constraints and outcomes of feasible actions are not known accurately.

One valuable decision model should manage unfinished, uncertain findings and information about various ideas, perspectives and beliefs. A decision model must involve methods for distinguishing, estimating and joining criteria or options for generating a conceptual model for making decisions and different types of calculations in fuzzy environments.

Theory of fuzzy set intends to address the uncertainty and the vagueness, which acknowledged extra attention. It progressively flourishes due to its inherent substantial significance and insightful theoretical base [3–7]. Based on fuzzy set theory different fields like the set of intuitionistic fuzzy [8] and set of hesitant fuzzy [9], continuously go up which brings varied tools to solve complex calculations in decision making. While human beings take decision, too complex data structures make the decision more complicated for finding actual assessments regarding the alternatives. To avoid these problems and to make a balance between the usefulness and briefness, fuzzy is a reasonable as well as better solution for modeling ambiguity in the process of decision making. That's why this paper concerns about decision-making under fuzzy environment.

According to Bellman and Zadeh [2] in fuzzy environment, the decision-making is aimed at a decision practice wherein objectives along with constraints, not essentially the entire system, which manages are fuzzy in character. This signifies that objectives and constraints comprises the courses of actions contains the limits that are not stated clearly.

Regarding the process of choosing the best option while making decision, numbers of theories are present for different kinds of issues related to decision-making like MCDM—multi-criteria decision-making, GDM—group decision making, etc. MCDM is a well-known method for contributing a standardized approach to support a variety of decision-making problems, which involves several criteria and actions [10]. The main purpose is to support the individuals who take decisions to attain every vital objective plus subjective principles of the issues by employing further clear, balanced and productive decision process [11, 12]. Every criterion of the decision-making process is habituated to compute any possible action quantitatively or qualitatively [13].

From MCDM, we are going to study about multi-attribute decision-making (MADM), which is a part of MCDM. The scope of this research is providing knowledge about the decision-making process in a fuzzy environment. This paper also describes the dominant elements of a decision-making process, common knowledge about uncertainty. It defines the methods of decision-making for problems regarding fuzzy multiple attributes. The core idea of this paper is the rating of alternatives, and, therefore, the weighted average aggregation method is explained in detail. This is possible by comparing with some examples. A straightforward ranking is followed where the maximum aid comprises by the best satisfactory alternatives.

2 Basic Idea of Decision-Making in Fuzzy Environment

In the universe of discourse X, a fuzzy number is a fuzzy subset that is considered together as normal and convex. The given Fig. 1 demonstrates that $\bar{n}$ is a fuzzy number in the universe of discourse X.

As stated by Turban [14], the process of decision-making involves selecting the best alternative among the courses of actions to obtain goal or goals. For illustration of a fuzzy constraint like the price of C must not be much larger than α where α is a specified constant. Likewise, fuzzy goal is referred as x must be in the locality of $\times 0$ where $\times 0$ is a constant. These words are examples of the basis of fuzziness. Within the scope of alternatives, goals along with constraints of fuzzy may be detailed thoroughly in the sets of fuzzy. The decision in fuzzy environment is considered as a meeting point of the specified constraints and goals, which is displayed in Fig. 2.

The decision having the highest priority is specified like a point within the area that belongs to the alternatives where the value of membership functions reaches its highest of a fuzzy decision process.

The decision-making process involves many entities, processes and uncertainty, which are required for the decision-making in a fuzzy environment. Only some are discussed below.

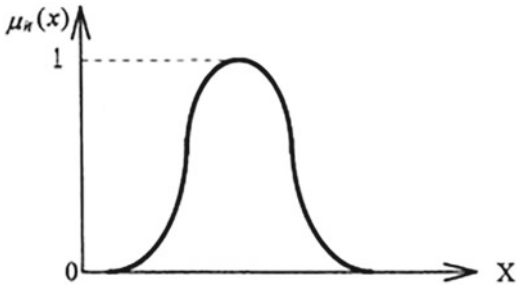

Fig. 1 Representation of Fuzzy number $\bar{n}$

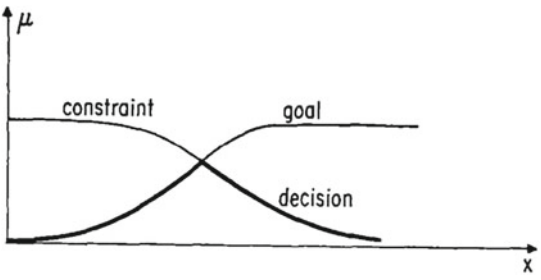

Fig. 2 A Fuzzy decision

2.1 Entities

Several entities are involved in the problems of decision-making, which includes:

Alternatives: These are sets of items, entities, actions, things of choice or approaches. Like a list of bike to be purchase.

Attributes: Every alternative possesses a set of features, which may correspond to the physical features such as weight or color.

Objectives: Gathering of attributes which are chosen by the person who take decision is considered as an objective or a goal. For purchasing a bike (objective) contain attributes like cost, speed and satisfaction [15].

Preferences: It denotes that a comparative significance of every attribute among all the attributes along with relative significance regarding the attribute occurrences.

The attributes, weights and objectives within the fuzzy environment are fuzzy sets, furthermore, attributes are regarded as linguistic elements of fuzzy. For example, the attribute 'price' consists of 'inexpensive', 'reasonable' and 'costly', the three fuzzy subsets.

2.2 Uncertainty

In fuzzy decision-making, three major types of uncertainty are encountered (a) incompleteness (presence of insufficient data), (b) fuzziness (difficulties in defining attributes, criteria etc.) and (c) illusion of validity (detection of erroneous outputs) [16].

As depicted, different categories of uncertainty may happen, and several techniques and hypothesis being recommended to resolve the issues within the dominion of decision-making. But the majority of assumptions that are intending for uncertainty for the process of decision-making include fuzzy set theories.

2.3 Fuzzy Decision-Making

In fuzzy settings when the process of decision-making is encountered, expressions like multi-objective, multi-attribute and multi-criteria are frequently utilized reciprocally. The following part describes the multiple attribute decision-making and also explains the different aspects of the concepts used.

3 Multi-Attribute Decision-Making

This method basically operates on the difficulty of selecting one alternative from amongst the group of alternatives that are described in respects of their corresponding attributes. This technique includes a particular goal, which perhaps of two distinct kinds. First one represents as the goal, choose an alternative from the scored set, which is based upon the worth and significance of the attributes for every alternative. Another kind of goal sets for categorizing the alternatives by employing different models or like actions. MADM is regarded as qualitative approach because of the presence of criteria subjectively. Both kinds of goals need knowledge regarding the preferences for representation of attribute and preferences of available attributes, and this type of evaluations of preferences is either given by the decision-maker or derived from former selections. Common formula for this is:

Suppose X1,X2,…,Xm, a set of alternatives being evaluated by the criteriaY1,Y2,…,Yn.

And Zij represents the rating of alternative Xi for the criteria Yj.

So function for the decision is:

A(Xi) = (AZi1, AZi2,…, AZin), here A denotes to aggregation.

The main purpose of MADM approach is to get top alternative, which possesses maximum satisfaction level towards all important goals or attributes. In case, alternative Xj found to be crisp, then no issue arises to get the top alternative, which acquires maximum support.

Several methods are used for evaluating the two important stages of multi-attribute decision-making. As mentioned by Mac Crimmon [17], the two methods can be categorized as: weighting methods and sequential elimination methods.

3.1 Weighting Methods

For multi-attribute decision problems, these methods are generally used. This method necessitates an alternative set along with prescribed attributes. Corresponding occurrences are considered for the attributes like, a procedure for gaining numerical or linguistic weights over attributes, the procedure for comparing the attribute values by getting the numeric or linguistic attribute values for weights, the requirement of the objective function intended for each alternative for aggregation of attribute values and preferences of a fuzzy number, and for selecting the top alternative ranking technique is applied. Decision-maker possesses three choices to get the highest preference, (a) gather the preferences from former choices, (b) to get the preferences proactively and added them against attributes, (c) the process of aggregation, which may include simple additive weighting technique or hierarchical additive weighting technique. The general algorithm meant for this method is weighted average rating,

$$D(A_i) = \frac{\sum_{j=1}^{n} w_j * r_{ij}}{\sum_{i=1}^{n} w_j} \quad (1)$$

where

A_i denotes to ith alternative,

w_j denotes to significance of jth criteria,

r_{ij} denotes to relative priority of jth criteria for ith alternative.

3.2 Techniques for Sequential Elimination

Such approaches are not as much required by the decision-maker because they don't necessitate inter-attribute preferences. The general features of these methods are: an accessible alternative set with identified attributes along with the values of each attribute, sequencing of these values. Moreover, one technique intended for comparisons of alternatives for elimination according to their attribute values. These methods are very less challenging as per the preferences of the decision-maker because this technique is significantly depending upon the method of subjective comparison of the decision-maker.

4 Multi-Attribute Approaches Based on Fuzzy

Common acceptance is multiple attribute issues comprise of a particular goal which is categorization of various alternatives along with choosing the best one amongst the alternatives set. Selection process is commonly accomplished by examining a general crisp set or fuzzy characteristics and to which different degrees of weights might be allocated. As an illustration, the purpose for selection of a vehicle fulfills particular criteria like cost, highest speed, etc. In addition, the decision-maker also mentions the preferences of the criteria just like the 'cost' criterion a lot more vital than the 'highest speed' criterion. Alternatives that are generally presented include real elements, activities, things or similar possibilities, for example to purchase a particular bike or to choose specific type of policies. So this article addresses the consequences of getting a rating correctly that depicts the criteria and the criteria preference, which are explained by the decision-maker.

4.1 Rating Alternatives

At this point, the course of decision-making expresses the issue of rating (classification), the alternatives developed on the respective value of the criteria (attributes). The ultimate answer to the technique in fuzzy multi-attribute decision-making is weighted average aggregation method. Most of the authors coping with this believe that criteria are fuzzy in nature whereas weights might fuzzy or crisp, such as the criteria inexpensive and costly, which are illustrated as fuzzy set persists as the attributes for purchasing a bike. Assuming that the bike expenses RS 70,000 so that the criterion 'inexpensive' degree of satisfaction becomes 0.9 and criterion 'costly' degree of satisfaction becomes 0.05.

5 Weighted Average Aggregation Method

This method is the best way of representing the conventional weighted average rating principle in fuzzy numerals. This is considered as the accurate logical process. In addition, Baas and Kwakernaak [18] too well distinguish the nonlinear programming result is alike to max–min result of Zadeh [2], which is the extension principle.

A common n-dimensional mapping function $y = f(x_1,x_2,\ldots,x_n)$ is taken by Baas and Kwakernaak [18], where $\times 1 \in X1,\ldots\ldots, xn \in Xn$; $y \in Y$ and A1 on X1, A2 on X2 etc. are the fuzzy numbers, which mapped against B on Y. The normalized form of the problem is

maximize $\mu B\ (y)$

subject to $\mu B\ (y) \leq \mu Ai\ (xi)$

where $i = 1,2,\ldots..n$ as well as $y = f\ (\times 1, \times 2,\ldots\ldots\ldots\ldots,xn)$

Considering the above functions $f(x_1,x_2,\ldots,x_n)$ and $\mu A_i(x_i)$ that are constantly differentiable, the highest point through the biggest membership function $\mu B(y)$ is attained while the given three circumstances are encountered:

(1) Derivatives $\mu A_i(x_i)$ and $fx_i(x_1,x_2,\ldots.x_n)$, where $i = 1,2,\ldots,n$;
(2) $\mu A1(\times 1) = \mu A2(\times 2) = \ldots\ldots\ldots\ldots = \mu An(xn)$; in addition to
(3) $\mu Ai\ (xi)/fxi\ (\times 1, \times 2,\ldots..,xn)$ contains similar value for $i = 1,2,\ldots.n$.

In comparison with (2), the mapping function $y = f\ (\times 1, \times 2, \ldots, xn)$ may be resolved for any xi in comparison with y, for example $xi = g(y)$. Then the result is $\mu B(y) = \mu A_i(x_i;x_i = g(y)) = \mu A(g(y))$.

For demonstration of the algorithm, the illustration specified by Baas and Kwakernaak [18] is improved. Suppose the alternative set $A = \{A1, A2\}$ being measured by the 'good' and 'fair' criteria. In addition to the weights are 'very important' and 'rather unimportant' are judged for the criteria. Following Figs. 3 and 4 describe the graphical representation of the linguistic variables of the criteria ratings and corresponding weights.

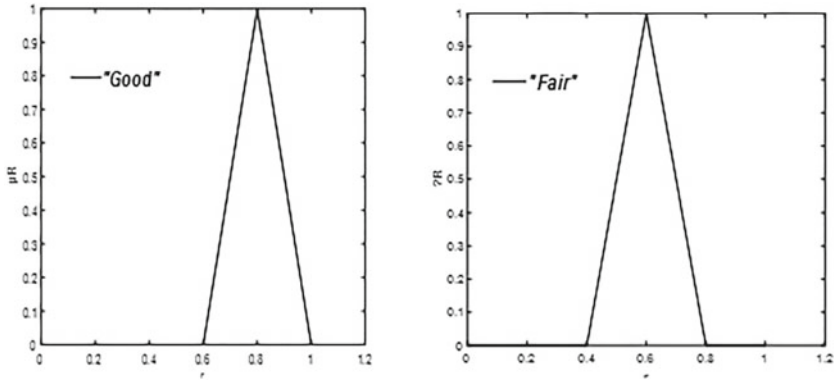

Fig. 3 The ratings 'good' and 'fair' membership functions

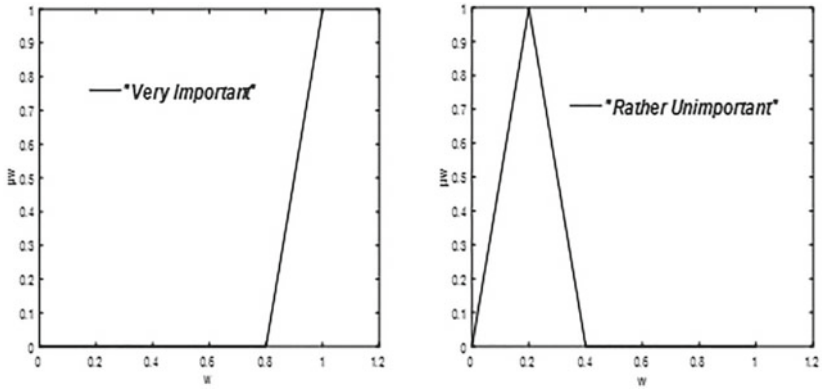

Fig. 4 The weights 'very important' and 'rather unimportant' membership functions

Suppose that the criterion × 1 is assigned with 'good' likewise × 2 is 'fair' and the weights w1 is 'very important' and w2 is 'rather unimportant', then the decision function weighted average can be evaluated by utilizing the membership names to communicate μname(xi), which is shown in Table 1.

$$D(A_1) = \frac{((\text{good} \times \text{very important}) + (\text{fair} \times \text{rather unimportant}))}{(\text{very important} + \text{rather unimportant})} \tag{2}$$

and

$$D(A_1) = \frac{((\text{fair} \times \text{very important}) + (\text{good} \times \text{rather unimportant}))}{(\text{very important} + \text{rather unimportant})} \tag{3}$$

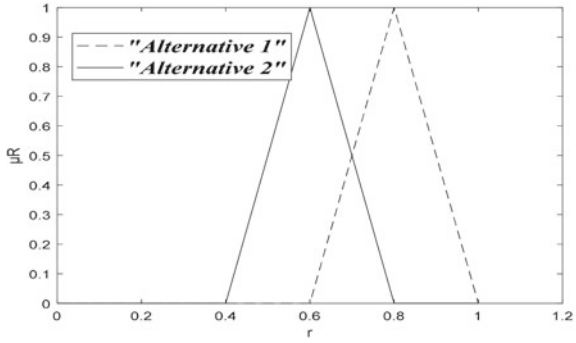

Fig. 5 Membership function of preference of alternative 1 over alternative 2

Table 1 Membership functions and their derivatives

Membership function	Derivatives $\frac{\delta b}{\delta a_i}$
$\mu(x_1) = \begin{cases} 5x_1 - 3 & 0.6 \le x_1 \le 0.8 \\ 5 - 5x_1 & 0.8 \le x_1 \le 1 \end{cases}$	$\frac{\delta\mu(x_1)}{\delta x_1} = \begin{cases} 5 \\ -5 \end{cases}$
$\mu(x_2) = \begin{cases} 5x_2 - 2 & 0.4 \le x_2 \le 0.6 \\ 4 - 5x_2 & 0.6 \le x_2 \le 0.8 \end{cases}$	$\frac{\delta\mu(x_2)}{\delta x_2} = \begin{cases} 5 \\ -5 \end{cases}$
$\mu(w_1) = \begin{cases} 5w_1 - 4 & 0.8 \le w_1 \le 1 \\ w_1 & w_1 = 1 \end{cases}$	$\frac{\delta\mu(w_1)}{\delta w_1} = \begin{cases} 5 \\ 1 \end{cases}$
$\mu(w_2) = \begin{cases} 5w_2 & 0 \le w_2 \le 0.2 \\ 2 - 5w_2 & 0.2 \le w_2 \le 0.4 \end{cases}$	$\frac{\delta\mu(w_2)}{\delta w_2} = \begin{cases} 5 \\ -5 \end{cases}$

The membership functions and corresponding derivatives are
For each fuzzy variable, the derivatives of weighted average function are given as

$$\frac{\delta y}{\delta x_1} = \frac{w_1}{w_1 + w_2} > 0$$

$$\frac{\delta y}{\delta x_2} = \frac{w_2}{w_1 + w_2} > 0$$

$$\frac{\delta y}{\delta w_1} = \frac{(x_1 - x_2)w_2}{(w_1 + w_2)^2} > 0 for x_1 > x_2$$

$$\frac{\delta y}{\delta w_2} = \frac{(x_2 - x_1)w_1}{(w_1 + w_2)^2} > 0 for x_2 > x_1$$

A fuzzy number F has the membership functions as,

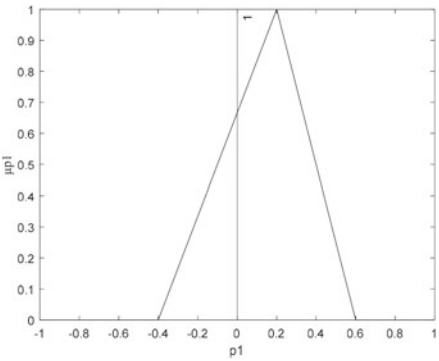

Fig. 6 Membership functions for final ratings

$$\mu_f(x) = \begin{cases} L\left(\frac{m-x}{e^L}\right), x \leq m, e^L \geq 0 \\ R\left(\frac{x-m}{e^R}\right), x \geq m, e^R \geq 0 \end{cases} \tag{4}$$

Here, x ∈ R and the left reference and right reference functions of the membership function indicate L() and R(), respectively. The mode is denoted as m, which is the most feasible value for the fuzzy number. The left and right spreads of the fuzzy number indicated as e^L and e^R, respectively, where e^L signifies the length from left endpoint to mode, whereas e^R shows the same distance from right endpoint to mode.

Therefore, the left-side (L) slopes as shown in Fig. 6 denoted to p1.

$$\mu L(x1) = \mu L(x2) = \mu L(w1) = \mu R(w2)$$

Whereas the right side (R) denoted to

$$\mu R(x1) = \mu R(x2) = \mu R(w1) = \mu L(w2)$$

By addressing the left and right with respect to ×1,

$$(X_{1L} = X_{2L})$$

$$5X_1 - 3 = 5X_2 - 2 \Rightarrow X_2 = X_1 - 1/5$$

$$(X_{1L} = w_{1L})$$

$$5X_1 - 3 = 5w_1 - 4 \Rightarrow w_1 = X_1 + 1/5$$

$$(X_{1L} = w_{2R})$$

$$5X_1 - 3 = 2 - 5w_2 \Rightarrow w_2 = 1 - X_1$$

$$(X_{1R} = X_{2R})$$

$$5 - 5X_1 = 4 - 5X_2 \Rightarrow X_2 = X_1 - 1/5$$

$$(X_{1R} = w_{1R})$$

$$5 - 5X_1 = w_1 \Rightarrow w_1 = 5 - 5X_1$$

$$(X_{1R} = w_{2L})$$

$$5 - 5X_1 = 5w_2 \Rightarrow w_2 = 1 - X_1$$

Lastly, for $\times 1$ intervals, the weighted average function can be evaluated as

$$y_L = \frac{x_1\left(x_1 + \frac{1}{5}\right) + \left(x_1 - \frac{1}{5}\right)(1 - x_1)}{\left(x_1 + \frac{1}{5} + 1 - x_1\right)} 0.6 \leq x_1 \leq 0.8$$

$$= \frac{7x_1 - 1}{6} \Rightarrow 0.533 \leq y_L \leq 0.767$$

$$y_R = \frac{x_1(5 - 5x_1) + \left(x_1 - \frac{1}{5}\right)(1 - x_1)}{(5 - 5x_1 + 1 - x_1)} 0.8 \leq x_1 \leq 1$$

$$= \frac{30x_1 - 1}{3o} \Rightarrow 0.767 \leq y_R \leq 0.9666$$

The solution provided here is for alternative 1 and the solution for alternative 2 is:

$$y_L = \frac{x_1\left(x_1 + \frac{1}{5}\right) + \left(x_1 - \frac{1}{5}\right)(1 - x_1)}{\left(x_1 + \frac{1}{5} + 1 - x_1\right)} 0.4 \leq x_1 \leq 0.6$$

$$= \frac{7x_1 - 1}{6} \Rightarrow 0.3 \leq y_L \leq 0.533$$

$$y_R = \frac{x_1(5 - 5x_1) + \left(x_1 - \frac{1}{5}\right)(1 - x_1)}{(5 - 5x_1 + 1 - x_1)} 0.6 \leq x_1 \leq 0.8$$

$$= \frac{30x_1 - 1}{3o} \Rightarrow 0.567 \leq y_R \leq 0.767$$

This is the solution for alternative 2. By comparing the membership functions for both the alternatives for the final ratings, it demonstrates that overall alternative

1 exhibits bigger rates compared to alternative 2. From this, we proved that, by evaluating the membership function that is provided in Table 1 we get that the degree of membership for alternative 1 from among the set of alternatives ranking higher of rate 1. But in the similar set, alternative 2 possesses lower degree of membership, i.e. 0.7.

The concluding results for both alternatives are shown in Figs. 5 and 6, which illustrates that commonly alternative 1 is favored over alternative 2 but not globally ideal. The fuzzy variables are used in this method along with weighted average rating method.

6 Conclusion

This article talks about the decision-making process by providing a solution to multi-attribute decision problems in a fuzzy environment. To achieve this, number of methods and fundamental concepts were recommended. As the attention is for the fuzzy multi-attribute issues, a thorough analysis is provided for key method, i.e. weighted average aggregation method for solving the problem of rating of alternatives in decision-making process. To sustain the importance of rating, this paper presents an innovative elicitation technique for assigning weights.

The decision-making in fuzzy environment may be facilitated by employing easier engagement of valuable schemes through efficient aggregation methods. So the ultimate outcomes attained by this kind of approach are crisp and also having substantial base for various alternatives. The highest support alternative is considered as the best one.

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Dealing with Imbalanced Data

Neelam Rout, Debahuti Mishra, Manas Kumar Mallick, and Pradeep Kumar Mallick

Abstract Class imbalance all around presents in real-world applications, which has brought more curiosity from different fields. While emphasising on accuracy for performance evaluation, studying from unbalanced data may produce unproductive outcomes. Cost-sensitive, sampling, ensemble approach and other hybrid methodologies have all been used in the past to address this imbalance problem. In machine learning, the ensemble approach is used to increase the accuracy of single base classifiers by aggregating numerous of them. To handle the issues due to imbalanced data, ensemble algorithms have to be formed specifically. Several performance assessing functions showed that the ensemble method outperformed the other techniques. In this article, different methods are described to handle imbalanced datasets with the special description of SMOTE with the ensemble method. The complexity of the ensemble model is defined. The clustering methods are also used to manage the issues due to imbalanced datasets.

Keywords Imbalanced data · Re-sampling techniques · Performance metric · Smote · Ensemble method · The complexity of ensemble · Clustering ensemble methods

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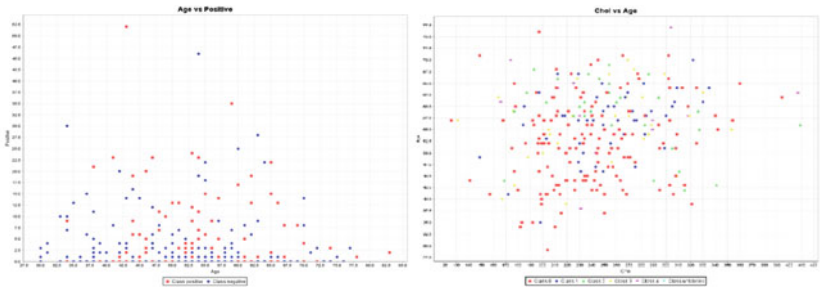
1 Introduction

Class imbalance data have occurred when "at least one of its classes is mostly outnumbered by the other classes". This class imbalance is difficult for most of the traditional learning algorithms, which are biased toward the majority classes and minority examples are misclassified. This problem has been thoroughly researched, and several ideas have been experimented. The solutions are the data (classifier independent) level and the algorithmic level [1]. The class imbalance issues have been addressed in a large number of real-life situations, like finding oil spills through satellite photos, software defect prediction, facial age estimation, detecting anomalies, detecting fraudulent credit card transactions, and image identification [2]. As a result, researchers have given more importance to data imbalance issues, and various conferences and workshops have been held.

Figure 1 is used to show the scattering plot of two and multi-class imbalanced datasets. The different ways to deal with the imbalanced data are changing the performance metric, change of algorithm, use of sampling techniques, ensemble method, etc. The versatile resampling techniques are used in the learning process to rebalance the sample zone for the unbalanced data to control the negative reaction of the misrepresented class distribution. Examples of resampling methods are over sampling, under sampling, and hybrid methods. The cost-sensitive learning approach assigns higher costs to majority class samples for misclassification of rare class samples. Ensemble-based classifiers, also known as multiple classifier systems, are used to improve the performance of a single classifier by combining numerous "base classifiers" that produce better results than each one separately. Examples are "bagging, boosting and a combination of bagging, and boosting (hybrid ensembles)". The ensemble models are categories as iterative and parallel based ensembles. Multi-class learning is difficult more complex than binary class. The solution for multi-class imbalanced data is decomposition techniques, i.e., "one-versus-one approach (OVO)" and "one-versus-all approach (OVA)" [3].



a. Two Class Imbalance Datasets **b.** Multi Class Imbalance Datasets

Fig. 1 Scattering plot of imbalanced datasets

Researcher can freely download imbalance data from UCI repository, Keel-dataset repository, and broad institute. The most common need metrics are accuracy and error rate. But accuracy is not worked on imbalanced datasets. The confusion matrix is used to carefully consider the quality of the "classifier". The performance evaluation metrics are F-measure, G-Means, Matthews correlation coefficient, AUC-ROC, and AUC-PR. Next parts are described in different methods like SMOTE, ensemble method to solve [4, 5] the issues due to imbalanced dataset.

2 Literature Review

In this paper [6], two unique "GIREnUS and GIREnOS" adaptive ensemble learning methods are offered for imbalanced data classification study. The proposed techniques divide an imbalanced data set into several sub-groups, each one creates a balanced data set with the help of the "oversampling" or "undersampling" scheme. A newly metric "GIR" is tried and depends upon the intra-class metre. To deduct bias and get good generalization, the methods are involved with "boosting" and "bagging" strategies. In this paper [7], predCar-Site is presented which an effective determinant for prediction. The succeeds of the experiments indicate that the proposed technology is very assuring and used to predict carbonylation positions. The predCar-Site has a noticeably more achievement rate than others. Additionally, the authors have proposed a user-approachable supplied and web server a line-by-line tutorial for the suitability of the research scientists. So, the desired results will get easily without the knowledge of the mathematical equations.

The goodness of "DNA microarray technology" makes it easy to examine cancer. Microarray gene expression data have hindrances like "class imbalance" and "high dimension" [8]. "Extreme learning machine (ELM)" has turned into one of the best classification algorithms for its speed learning and capable classification performance, and a "weighted ELM" has introduced to handle the class imbalance. An improved feature subset is identified for each class using the class-oriented feature selection approach, hence the features attached with the "minority classes" are specially picked. "WELM" is tweaked to reinforce high-discrimination power input nodes, and an ensemble model is skilled to boost generalization. To advance ensemble diversity, multiple "modified WELM" models are examined on datasets identified by different feature subsets; the low dissimilarity models are re-positioned, and the saved ones are combined as an "ensemble model". Because the majority classes have more information than the minorities, the classifier would become over-fitted to [9] the "majority classes" and under-fitted to the "minority classes" in an unbalanced dataset. Because of the non-linear connections between class labels and attributes, it is accepted that "brute-force search" for the good combination is NP-hard. To solve the issues in this paper, the authors have presented an idea called "swarm fusion", which powers stochastic swarm heuristics to supportively maximize mixtures. When utilizing a neural network as the basis learner, the proposed method outperforms other standard methods in terms of the credibility of trained classifiers by up to

69%. Second, a decision tree is employed to cover the recommended swarm fusion method. The researchers [10] have proposed a weight modification equation that is used to a weighted SVM like a delicate learner of the "AdaBoost" algorithm to resolve class unbalance in the dataset. The factor scores are calculated and assigned to correlated instances by classifying examples according to the "SVM" margin. It is used to differentiate between noisy and borderline states. The proposed solution is compared to a "standard SVM" and "alternative SVMs", which are paired with different "sampling" and "boosting" methods using ten valid balanced datasets.

3 Methods

Classification and machine learning have been researched for several years, and many different types of solutions or algorithms are used for binary and multiple imbalanced data problems. Several basic attracting algorithms are K-nearest neighbours' algorithm, Naïve Bayes classifier, neural network, Support Vector Machine, etc. But these algorithms don't work well on imbalanced data due to ignorance of minority examples. The solutions for imbalance problems are pre-processing or sampling method (to balance instances of classes), ad-hoc implementation of classical algorithms, cost-sensitive learning, and any of these approaches combined with ensemble classifier to achieve performance [5]. An ensemble method is a set of classifiers targeted at boosting the performance capability of the base classifier. The examples of both data pre-processing and ensemble learning are bagging-based (OverBagging, UnderBagging, and UnderOverBagging), boosting-based (SMOTE-Boost, MSMOTEBoost, and DataBoost-IM), and hybrid method (Balance Cascade). The cost-sensitive boosting ensemble methods are AdaCost, Rare Boost, AdaC1, etc., Random Forest. Random forest is another ensemble classifier that uses the advantage of the bagging method along with the decision tree learning [1, 11].

4 Smote Method

The term synthetic minority oversampling technique (SMOTE) stands for "synthetic minority oversampling method". It's an example of an "oversampling method," in which the goal is to interpolate many minorities class instances that are near together to create new rare or minority class instances. It generates instances by picking one (or more, depending on the oversampling ratio required) of a [11] uncommon class example "kNN" at random (k nearest neighbours), and the new instance values are created by interpolating both instances at random. The benefit is that the problem of overfitting is avoided. As a result, decision boundaries have been made for the rare class to extend into the majority class spot. MSMOTE stands for "modified synthetic minority oversampling technique" and is a modification of "SMOTE". The samples of the unusual class are divided into three parts: a secure area, a border area, and a

noisy area. The "MSMOTE" algorithm works in the same way as "SMOTE" in safe areas; it merely chooses the [3, 12] nearest neighbour in border cases; and it does nothing in messy examples.

5 Ensemble Method

One of the popular methods is the ensemble method because of its improving result for imbalance problems. Ensemble methods or multiple classifier systems that train multiple learners are used to create one learner from multiple learners from "training data" to solve the same problem [13]. Ensemble methods are bagging, boosting, random forests, etc. Ensemble methods can be applied to imbalanced data, which are undergone through the sampling process. Many ensemble methods are combined with sampling techniques to form ensemble methods that are more relevant for class imbalance problems [14]. SMOTEBoost is the combination of sampling methods with AdaBoost to construct an ensemble model to overcome the class imbalance issues. In SMOTEBoost, the instance is updated their weights during each boosting iteration, SMOTE is also applied to misclassified rare class instances. In addition, to maintain minority instances by allowing higher weights, misclassified minority instances are also maintained by adding (same) synthetic instances. Like SMOTE-Boost, DataBoost-IM is the extension of boosting, which identifies both majority and minority examples to produce similar synthetic instances and after that reweights the examples to stop a bias toward the majority class [15].

5.1 Complexity of Ensemble

One negative side of the ensemble approaches is that they are more difficult to comprehend than single models. The overfitting problem will arise as the complexity of the system grows [16]. As a result, the complexity of the model as well as the entire modelling technique must be assessed. Because there are more parameters in an ensemble than in the model components, it appears to increase the complexity. When the Generalized Degree of Freedom (GDF) is utilized as an empirical measure of a model's flexibility to determine its complexity, ensemble methods are found to become less complex than just its fixing components [17].

5.2 Clustering Ensemble Methods

Clustering is used to get the inherent texture of the unlabelled data and combine the objects into clusters. When the inter-cluster similarity is minimized, and the intra-cluster similarity is maximized, then it is called good clustering with high-quality

clusters. There are many types of clustering methods that are already developed, e.g., partitioning methods (k-means clustering), hierarchical methods, density-based methods, grid-based methods, model-based methods, etc. [4, 18]. The validity analysis of cluster means to check the aspect of clustering consequences. Clustering evaluations are categorized into internal indices and external indices. Some of the internal indices are Silhouette, Davies-Bouldin, and Dunn where the clustering flows are figured out by considering the genetic characterizes of the known clusters without rebuilding the reference network. The external indices are the Rand index and Jaccard Coefficient where it decides the clustering results by analyzing the selected clusters [19].

Genetic ensemble feature selection (GEFS) is a unique ensemble feature selection approach that looks for the best subset of features to provide to an ensemble in order to improve its accuracy. Furthermore, giving each learner in the ensemble a particular feature subset makes the ensemble more diversified, resulting in a lot of superior ensemble. This algorithm is an example of the classic wrapper model. The GEFS algorithm is a classic wrapper model example. Each genetic algorithm chromosome represents a possible optimal feature collection. Every time the genetic algorithm analyses an individual's fitness, it consults the classifier. If an algorithm has portions that are independent of each other and can be executed simultaneously, parallel processing can be employed to improve its efficiency. Each component learner in the ensemble in GEFS is trained independently of the others [20]. Figure 2 illustrates the cluster ensemble diagram technique.

Clustering ensembles, also known as consensus ensembles, are a type of ensemble in which the basis learners are clusterings. In this, first clusters are generated and then combined. Some of the examples are transformation-based, graph-based, relabeling-based, and similarity-based methods [21, 22]. The key objective of relabeling-based techniques is to redefine the cluster groups of all derive clusterings, so the similar group indicates same clusters beyond the base clusterings, after that design the final model focusing on the coordinated labels. One advantage of these methods is that they increase the possibility of finding connections between distinct base clusterings,

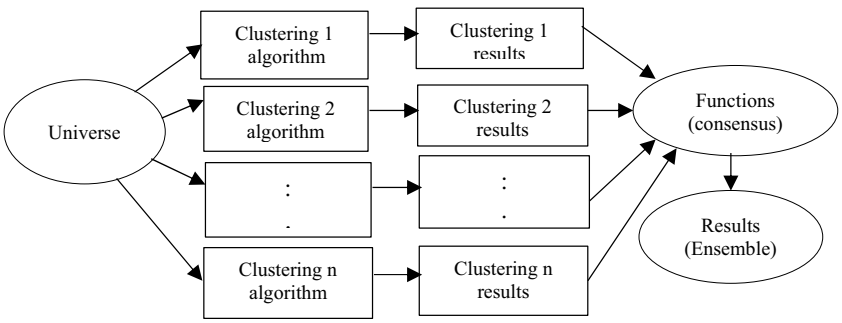


Fig. 2 Process of cluster ensemble

which can be useful in examining clustering results tests. In crisp label correspondence, "reference clustering" methods are frequently viewed as a profiling form of the information set, and grasped correspondence matrices provide intuitive descriptions of the associations between each base and ensemble clustering, as well as each base in soft label correspondence. The lack of this method is that if there is no valid correspondence, then it does not perform well. The crisp correspondence techniques need all base clustering to hold a similar recorded number of clusters, and the result may show in the final ensemble method. The soft correspondence techniques are used to decode an optimization issue including several variables, and it is responsive to triturate to a hinder at the time of a local minimum abstracted from the optimize determination [23].

6 Conclusion and Future Scope

In this paper, different methods are discussed to handle the problems due to imbalanced data. The SMOTE and ensemble methods are elaborated because of their advantages to control the failure due to the imbalanced data. Several works remain to be solved in the future like the higher version of SMOTE and the ensemble method. Rare class and abnormal nature are challenging to identify in imbalanced data, so it is a vast and interesting topic for research.

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Comparison of Machine Learning Approaches for Anticipating of COVID-19 Active, Recovered and Death Cases in India

Sipra Sahoo, Binita Kumari, and Debahuti Mishra

Abstract Outbreaks of the COVID-19 that emanated in Wuhan city of China have been causing worldwide health concerns since December 2019 resulting in a global pandemic declared by World Health Organization (WHO) on March 11, 2020. It has highly affected social, financial matters and health too. In the study, COVID-19 affected people's statistics are taken into account for predicting the upcoming day's movement in a total count of infected cases in India. Regression models especially multiple linear regression, support vector regression are implemented on the dataset for observing the curve of the infected cases and forecast the total active, total deaths and total recovered cases for next coming days. The usefulness of regression techniques is studied. These techniques analyze and predict the rise and spread of COVID-19. We investigate how well mathematical modeling can forecast the rise using datasets from https://covid19india.org. Here, a comparison of multiple regression and support vector regression is done. It can be concluded that these models acquired remarkable accuracy in forecasting COVID-19. We also want to compare the distribution of COVID-19 in different nations and try to predict potential instances as soon as possible.

Keywords Support vector regression · COVID19 · India · Prediction · Multiple linear regression

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1 Introduction

The year 2020 was a disastrous year for mankind for the novel coronavirus originated in Wuhan City of China in November 2019. In March 2020 declared as a pandemic by World Health Organisation (WHO) and a on February 11, 2020 coronavirus disease renamed as COVID-19. It was spreading like wildfire and COVID-19 infectivity is greater than influenza infection. This virus has the potential within human body to cause the alteration. Precise determination of genetic variation is essential to understanding the emergence of this infection. Because of serious side effects and many adverse impacts including depression, anxiety and financial damage, the governments of the different countries have taken public policy decisions in both the health and economic aspects.

The United States of America, Brazil, India, Russia along with South Africa are the most affected countries due to COVID-19 having the largest number of death and active cases in the world according to WHO estimation. *As per covid19india.org, the early report of COVID-19 for India was found on* January 30, 2020. The government of India is continuously trying to save the life of the people by introducing various policies like testing, lockdowns, shutdowns, social distancing, travel restrictions etc.

Yet forecasting the worldwide pandemic dynamics of infection is of significant importance.

A number of researchers have developed a variety of predictive methods for COVID-19 future trends for some severely affected countries and globally, Mathematical and statistical models, machine learning as well as deep learning prototypes have been implemented for time series interpretation of this epidemic [1]. In the study, overall count of confirmed, recovered and death cases for an upcoming 60 days has been predicted using two machine learning techniques mainly multiple linear regression as well as support vector regression techniques and their performances are compared.

2 Related Work

It is necessary to foresee medical practices for the basic healthcare system. Computer-assisted healthcare forecasting was used in many fields including risk for heart disease, mortality from pneumonia, risk of death from critical care. Such programs offer medical professionals a clearer understanding and analysis of clinical activities. In this research, we are building on recent methodological developments to provide COVID-19 with a clinical predictive model. In the literature, similar research on clinical prediction of COVID-19 are minimal. Modern-era relies primarily on Artificial Intelligence (AI), like Data Science; and Deep Learning (DL) is one of these techniques latest flag bearers.

Patient Information-Based Algorithm (PIBA) for prediction of casualty resulting out of coronavirus in China is proposed in [2]. In [3], different Auto-Regressive

Integrated Moving Average (ARIMA) models having many different parameters (0,2,1), (1,2,0) and (1,2,0) were used for predicting the epidemic curve of COVID-19 for adopting preventive steps for the European countries like Spain, France and Italy.

Predictive algorithms such as Artificial Neural Network (ANN), Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), CNNLSTM and CNNRNN are proposed in [4].

In the study [2], a partial derivative regression along with a non-linear machine learning (PDR-NML) model was used for forecasting of COVID-19.

3 Materials and Method

3.1 Support Vector Regression

Minimizing the error rate is the objective of regression whereas support vector regression is trying to approximate the best value within a certain threshold value called as epsilon. Kernel, hyperplane, boundary line and support vector terms are used in support vector regression. Kernel is used in mapping of data from low dimension to data of high dimension. Hyperplane is a separation line meant for differentiating data classes and is used to predict continuous value or target value. Support vectors are the closest data points to the boundary.

3.2 Multiple Regression

Multiple regression (MLR) or multiple linear regression is a statistical prediction model that maps the relationship of dependent variables and independent variables by fitting a linear equation to observed data. This is an extension of an Ordinary least squares (OLS) regression where only one independent variable is used. The dependent variable is predicted depending upon two or more independent variables, which are uncorrelated with each other. Residuals should be shared with a mean of 0 and variance σ.

Formula and calculation of multiple linear regression

$$yi = \beta 0 + \beta 1 + \beta 2xi2 + \cdots + \beta pxip + \varepsilon$$

where $i = n$ observations selected randomly

$yi =$ dependent variable

$xi =$ ndependent variables

$\beta 0 =$ y-intercept

$\beta p =$ slope coefficients for every independent variable

$\varepsilon =$ residual or error of the model.

The determination coefficient (R-squared) is an analytical dimension that is used to estimate how much of the result variation in the independent variables can be interpreted by the variability. As a result, R2 cannot be used alone to determine which predictors should be included in a template and which should be excluded. R2 can only be between 0 and 1, with 0 implying that none of the independent variables can reliably predict the outcome and 1 suggesting that all of them can.

3.3 Preparation of Dataset

The dataset for Coronavirus 2020 for India was collected from https://covid19india.org and stored in.csv file. The columns include the date, total confirmed, daily confirmed, total recovered, daily recovered, total deceased and daily deceased cases on a daily basis from January 30, 2020 to August 14, 2020.

The overall visualization of the whole COVID-19 dataset for India is represented in Fig. 1. Figure 2 represents the daily overall confirmed cases for COVID-19 India dataset. It shows an exponential boost in the daily overall confirmed cases. Figure 3 represents the daily overall recovered cases for COVID-19 India dataset. It also shows an exponential increase in the daily overall recovered cases. Figure 4 represents the daily overall deceased cases for COVID-19 India dataset. The descriptive statistics for the dataset is evaluated and represented in Table 1.

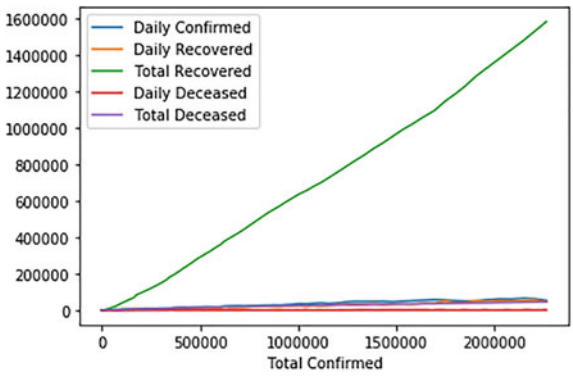

Fig. 1 Overall COVID-19 India dataset

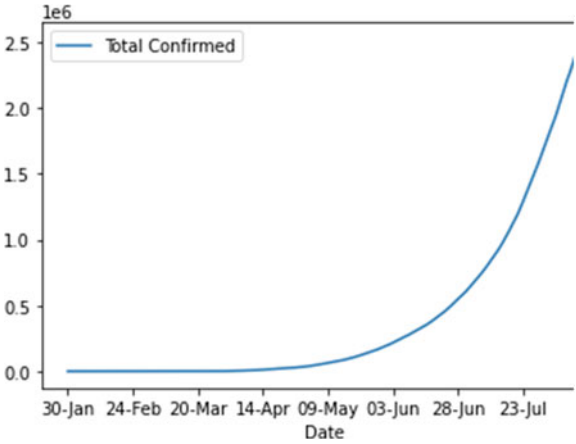

Fig. 2 Daily total confirmed cases for COVID-19 India dataset

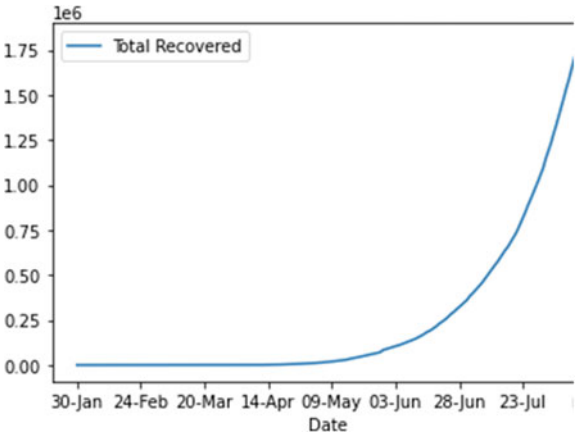

Fig. 3 Daily total recovered cases for COVID-19 India dataset

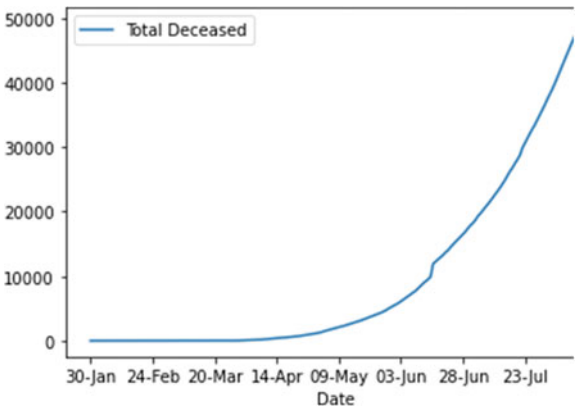

Fig. 4 Daily total deceased cases for COVID-19 India dataset

Table 1 Descriptive statistics for COVID-19 India dataset

	Daily confirmed	Total confirmed	Daily recovered	Total recovered	Daily deceased	Total deceased
Mean	12,221.9	368,008	8652.31	228,984	240.561	8982.72
Std	17,842	590,004	14,036.6	396,447	311.259	12,895.3
Min	0	1	0	0	0	0
25%	26.5	191.25	1.75	18.75	1	3.75
50%	3341.5	54,679	1228	16,038.5	100	1837
75%	17,202.2	477,539	11,817.2	275,185	404.25	15,008.2
Max	67,066	2.39548e+066	57,759	1.69585e+06	2004	47,150

3.3.1 Data Processing

The dataset has been partitioned into two parts for Training (80%) and Testing (20%). Initially, the dataset was checked to find any missing values but no missing values were found. Min–max normalization is applied to the dataset so as to scale them between 0 and 1, which is given by:

$$Y = \frac{x - x_{min}}{x_{max} - x_{min}}$$

where Y being the new scaled value, x is the value before scaling, $x_{\min}$ expresses the minimal value of the column which is to be scaled, and $x_{\max}$ expresses the peak value of the column to be scaled.

It is vital to understand the correlation between the features of a dataset. Thus, a correlation between the features is calculated. The Correlation Coefficients are calculated and they take values between -1 and 1. A negative value equates to negative correlation and a positive value equates to positive correlation. Zero means that the features are not correlated. The sign of the correlation coefficient signifies

Index	Daily Confirmed	Total Confirmed	Daily Recovered	Total Recovered	Daily Deceased	Total Deceased
Daily Confirmed	1	0.990531	0.984329	0.982506	0.883911	0.992247
Total Confirmed	0.990531	1	0.992863	0.998167	0.868283	0.989561
Daily Recovered	0.984329	0.992863	1	0.991757	0.859909	0.980517
Total Recovered	0.982506	0.998167	0.991757	1	0.850349	0.980336
Daily Deceased	0.883911	0.868283	0.859909	0.850349	1	0.89837
Total Deceased	0.992247	0.989561	0.980517	0.980336	0.89837	1

Fig. 5 Correlation table for COVID-19 India dataset

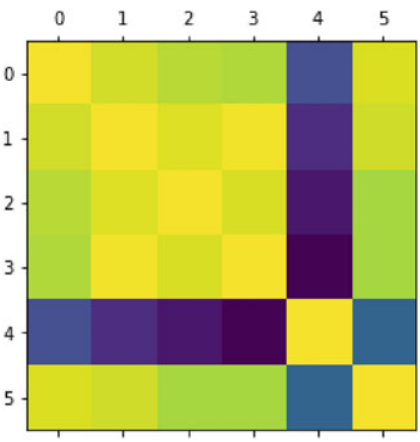

Fig. 6 Correlation plot between features for COVID-19 India dataset

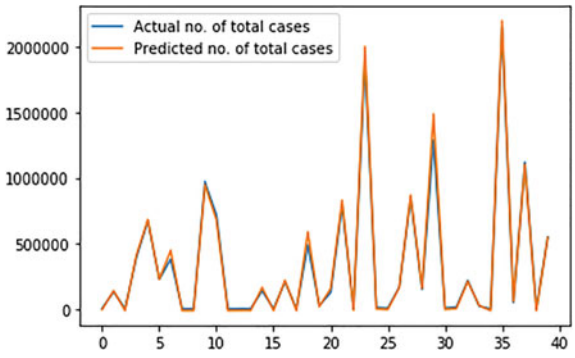

Fig. 7 Graphical presentation of actual versus predicted values for the total number of confirmed cases using multiple linear regression for COVID-19 dataset

the relationship direction. Figure 5 represents the correlation among the features of the dataset, which is very close to +1.

From Figs. 5 and 6, we can infer the positive correlation ship between the features.

3.3.2 Visualization

For the multiple linear regression and supporting vector regression models in Figs. 7, 8, 9, 10, 11 and 12, the regression fitting of the data with the predicted test data is plotted for the overall count of confirmed cases, dead cases and recovered cases.

3.3.3 Performance Calculation

The performance of the model is calculated for the reliability of the predictive outcome. The R^2 score, Root Mean Square Error (RMSE), Mean Square Error (MSE),

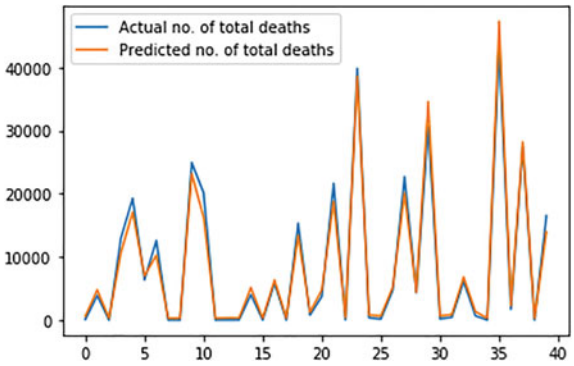

Fig. 8 Graphical presentation of actual versus predicted values for the total number of deceased cases using multiple linear regression for **COVID-**19 dataset

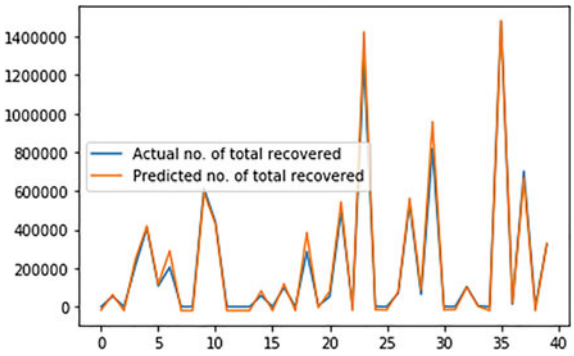

Fig. 9 Graphical presentation of actual versus predicted values for the total number of recovered cases using multiple linear regression for **COVID-**19 dataset

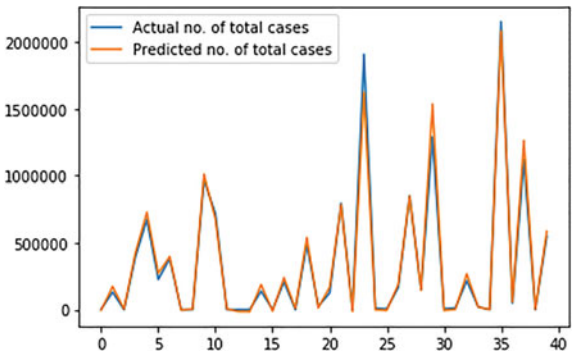

Fig. 10 Graphical presentation of actual versus predicted values for the total number of confirmed cases using support vector regression for COVID-19 dataset

Mean Absolute Error (MAE) and accuracy percentage are calculated and applied for model performance comparisons for foreseeing the overall confirmed, deceased and recovered cases of the COVID-19 data for India. The multiple linear regression model performance using the above-mentioned parameters is shown in Table 2. Similarly, the model performance is shown, for support vector regression, in Table 3.

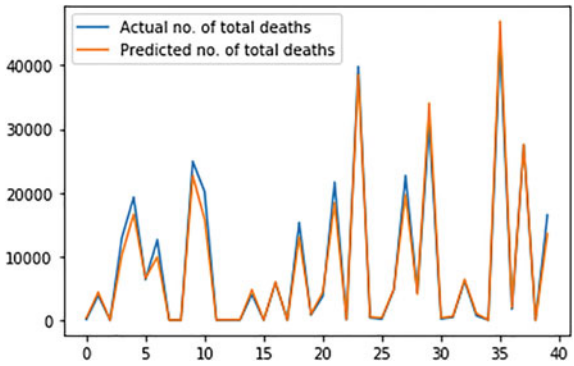

Fig. 11 Graphical presentation of actual versus predicted values for the total number of deceased cases using support vector regression for **COVID-**19 dataset

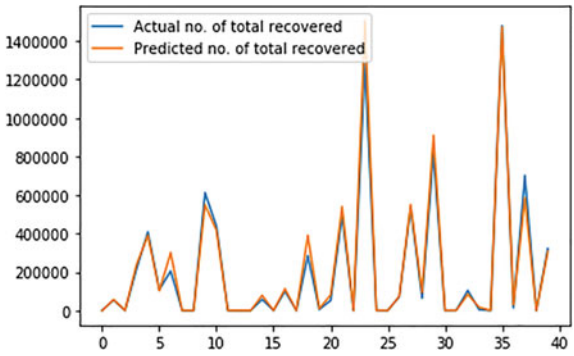

Fig. 12 Graphical presentation of actual versus predicted values for the total number of recovered cases using support vector regression for COVID-19 dataset

4 Result

The dataset has been partitioned into training set and test set for performing prediction. The training set consists of 80% of the total dataset, and testing set consists of rest 20% of the entire dataset. The training set is used to train the multiple linear regression technique. The number of overall confirmed cases, total deceased cases and total recovered cases are predicted with other characteristics of the dataset as the input, respectively. We have already seen that there is a relation between the features as shown in Figs. 7 and 8. A visualization of actual and predicted values for the overall count of confirmed cases, overall count of deceased cases and overall count of recovered cases using multiple linear regression and support vector regression for COVID-19 dataset is shown in Fig. 7, 8, 9, 10, 11 and 12, respectively. From the figures, we see that the predicted values are very close to the actual values. This informs about the performance accuracy of the multiple regression model.

Table 2 represents the multiple linear regression model performance for overall confirmed, overall deceased and overall recovered **COVID-**19 cases for India. It shows the values for MAE, MSE, RMSE, Score and prediction accuracy for the three different cases, respectively. Similarly, Table 3 represents the support vector

Table 2 Multiple linear regression model performance for overall confirmed, overall deceased and overall recovered COVID-19 cases

Data	MAE	MSE	RMSE	Score	Accuracy (%)
Overall confirmed	24,872.228195824442	1,903,630,287.5873134	43,630.61181770562	0.9929398519817478	99
Overall deceased	1139.2779553181667	2,517,024.7834812673	1586.513404759401	0.981736599834556	98
Overall recovered	27,679.997870432446	1,791,578,696.4650893	42,327.04450425389	0.9850864421575575	98

Table 3 Support vector regression model performance for total confirmed, total deceased and total recovered COVID-19 cases

Data	MAE	MSE	RMSE	Score	Accuracy (%)
Overall confirmed	36,860.48662441899	4,813,586,542.146238	69,380.01543777746	0.9821474612440152	98
Overall deceased	982.5669113811097	2,690,190.543007471	1640.180033718089	0.9804801181415923	98
Overall recovered	25,226.814941818295	2,601,709,405.5704594	51,006.954482408175	0.9783427075875828	98

regression model performance for overall confirmed, overall deceased and overall recovered **COVID-**19 cases for India.

The prediction for the next 60 days by multiple linear regression is shown in Figs. 13, 14 and 15 for the overall confirmed cases, overall recovered cases and overall deaths, respectively. Similarly, the forecast for the next 60 days by support vector regression is shown in Figs. 16, 17 and 18 for the overall confirmed cases, overall recovered cases and overall deaths, respectively. It is observed that by using both the regression models for the historical data as on August 14, 2020, the future

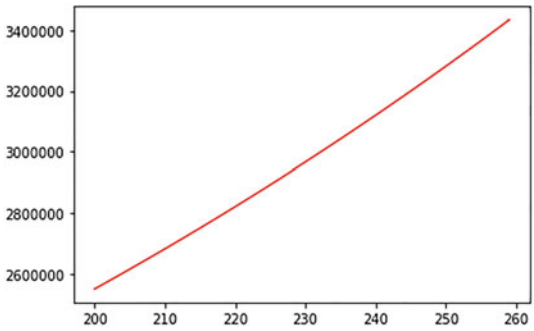

Fig. 13 Forecast of overall confirmed cases for 60 days by MLR

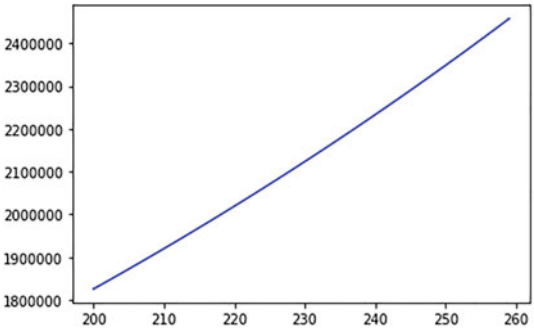

Fig. 14 Forecast of overall recovered cases for 60 days by MLR

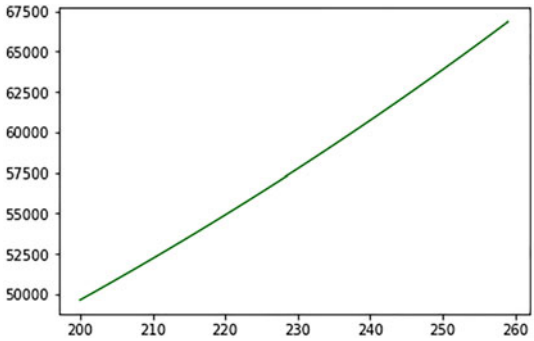

Fig. 15 Forecast of overall deceased cases for 60 days by MLR

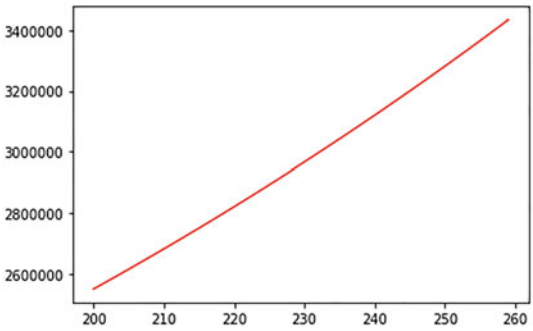

Fig. 16 Forecast of overall confirmed cases for 60 days by SVR

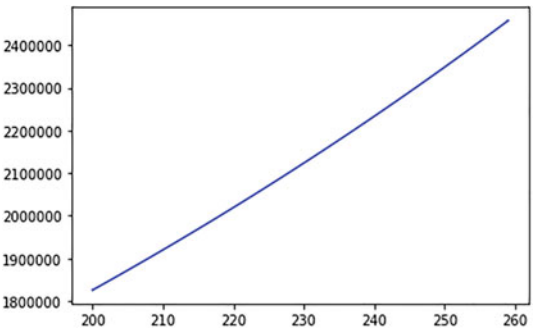

Fig. 17 Forecast of overall recovered cases for 60 days by SVR

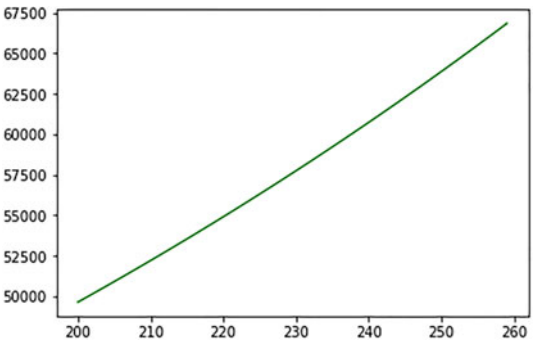

Fig. 18 Forecast of overall deceased cases for 60 days by SVR

values for confirmed, recovered and deceased cases are predicted to be more than 3,433,500, 2,457,000 and 66,800, respectively, towards the end of October 2020 for India.

5 Conclusion

In our study, we implemented two prediction models, namely, multiple linear regression and support vector regression for a period of 197 days (January 30, 2020 to August 14, 2020) for predicting the values for total count of cases for confirmed, recovered and deceased COVID-19 numbers for India. It was found that the models are very effective to foresee the future prediction for overall count of confirmed cases, overall count of deaths and overall count of recovered cases for India. The models show very good accuracy. Based on the past trend, the future forecast has been done for the next 60 days. Multiple linear regression as well as support vector regression shows the forecast accuracy of 98% for the overall count of recovered and overall count of deceased cases. In case of total confirmed cases, support vector regression shows 98% accuracy whereas multiple linear regression shows 99% accuracy. By using both the regression models for the historical data as on August 14, 2020, the future values for confirmed, recovered and deceased cases are predicted to be more than 3,433,500, 2,457,000 and 66,800, respectively, towards the end of October 2020 for India. Thus, the accuracy is great. But the spread of COVID-19 cases is high for future, and, thus, proper measures need to be taken to control the same.

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QoS-Aware Performance Analysis of Reactive Protocols for MANETs

Prabhat kumar Sahu, Binod Kumar Pattanayak, and Niranjan Panda

Abstract MANET permits transportable nodes to operate in a wireless medium particularly in the absence of any type of infrastructure. It is a wireless device connected by wireless links. QoS and routing are the major critical issues of MANET, which have not yet been solved by many researchers. Because of the network dynamic topology, it is very tough to assurance QoS is more challenging in such network. So, we have discussed the taxonomy of MANET Routing Protocols to enhance QoS metrics and compare each class of protocols. MANETs routing is classified into two categories: Unicast and Multicast Routing. Here, we compared two types of routing protocols under reactive category. The basic objective of this research proposal is to analyze and compare two reactive routing protocols like DSR and AODV on the basis of some QoS performance metrics such as throughput, delay, etc. implemented using a Network Simulator NS-2.

Keywords MANETS · Routing protocols · AODV · DSR · QoS

1 Introduction

MANETs are ad hoc networks principally established as wireless networks without any pre-existing infrastructure like base stations or routers. Point-to-point communication for this type of arrangement is implemented by means of Wi-Fi skill but without going through any type of contact point [1]. These networks operate through wireless nodes, which link directly over a common wireless channel where these wireless nodes are independent upon each other as they don't need any base station

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or router etc. This type of network topology basically meant for some emergency activities where almost impossible to establish any base station for point-to-point communication such as natural calamities like flood, earthquake, military service, rescue mission team. For example, suppose some firefighters have to put out risky fire in a big forest where all the rescue team need to communicate continuously with each other. As, installing a cable connection or establishing an infrastructure is next to impossible, in such a scenario, ad hoc network comes to rescue. Using these networks, firefighters can easily communicate with each other. Ad hoc network can also be used to share files/data from one computer to another computer. For a single-hop ad hoc network [2], it is required. For example, any type of point-to-point communication between your system with your friend's system, you can easily create an ad hoc network topology between two systems and start transferring the data. This can be done by means of ethernet crossover chain or wirelessly using Bluetooth. In order to operate in a multiple nodes environment, it needs to set a multi-hop ad hoc topology for any type of point-to-point communication between systems. For example: MANET, VANET. The intermediate nodes act as a router, which are used to transmit data packets from source to destination in multi-hop ad hoc network [3].

2 Routing Protocols in MANETs

Routing protocol is always used to solve various problematic issues of routing in MANETs. Unicast routing protocols are factorized into three groups for instance Proactive, Reactive and Hybrid Routing Protocol [4]. In Proactive Routing, all the route information is updated frequently that makes it easy to locate the route availability immediately between nodes. In Reactive Routing, route is established on-demand or whenever needed as shown in fig. 1.

Hybrid Routing is an intermediate topology formed by means of combining the routing mechanism of both Proactive and Reactive Routing Protocol. It refers to find an optimal path between 1 source and 1 destination. If a packet has not reached its destination node and in the midway faces traffic problem, then the traffic packet waits in a queue in the routing table until it receives the routing information of the network corresponding to its destination node. Here, they use a limited number of resources to maintain reliability and can update their routing information frequently.

DSDV is a reactive routing protocol constructed on Bellman Ford Algorithm where each data packet is transmitted among node by using routing tables that are stored in each and every mobile node. As shown in Fig. 1, AODV (Ad Hoc On-Demand Distribution Vector) and DSR (Dynamic Source Routing) are coming under reactive protocol category in MANETs, which overcome the disadvantages of proactive routing protocol means no need to keep routing information in routing table in each node as shown in Fig. 2.

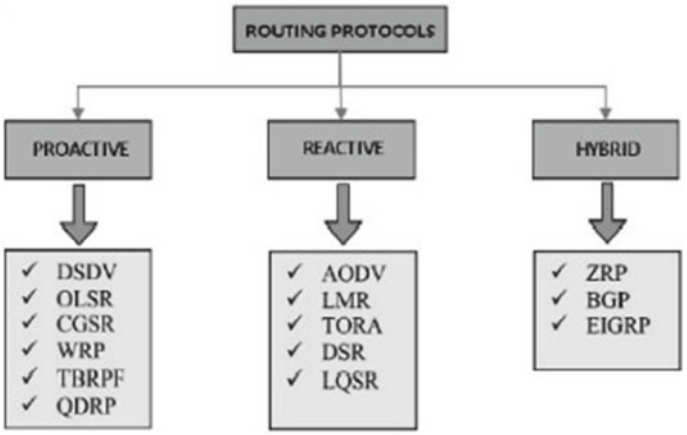

Fig. 1 Taxonomy of routing protocol

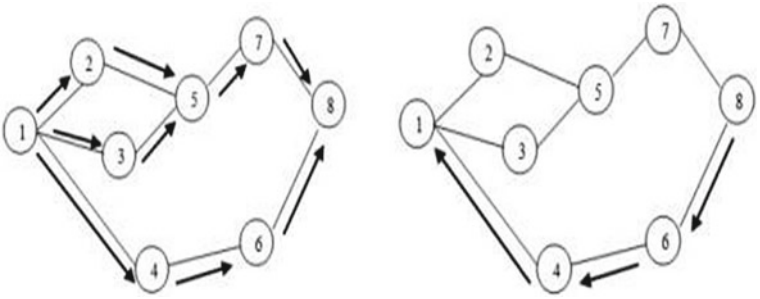

Fig. 2 Ad hoc on-demand distribution vector

3 Quality of Service

The growing of multimedia trends makes Quality-of-Service (QoS) as the most necessary features for MANETs. Features like high mobility, dynamic topology and inadequate bandwidth make it hard to provide QoS provision in MANETs [5]. QoS performance of MANET can be enhanced through parameters like packet delivery ratio, delay, throughput etc. Network congestion for ad hoc network became one of the major concerns that reflect the QoS performance of MANET. Queue management is the best policy to avoid network congestion in MANET. It helps to order the packets flow in the network queue. It supports to control the packet flow in the network by means of deciding the ode rog flow of packets as well as which is to be dropped. Different QoS management techniques are developed to control the network congestions that enhance the QoS performance through parameters like packet delivery ratio, delay, throughput etc. In this network topology, each node has to maintain a system of queue that acts as a storage to store data packets within themselves. To

keep away heavy network traffic and load, MANET used dual queue management techniques as follows [6, 7].

3.1 Passive Queue Management

In order to avoid network congestions, this scheme starts dropping of packets only when the queue is full. Despite several drawbacks, this scheme is informal to implement in the network with less overheads [8]. Example: Droptail

3.2 Active Queue Management

In comparison to passive, this scheme starts dropping of packets before the queue is full. It keeps track of the overflow condition of the queue and starts dropping packets based on number of data packets and statistical probability of queue. The basic purpose of this scheme is to keep away the delay due to network traffic before the queue overflows [9, 10]. Example: RED, REM

4 Performance Analysis, Simulation and Results

The basic goal of our experiment is to examine and understand the effects of various factors of reactive routing protocols for packet transmission by simulating it using Network Simulator (NS2) and to analyze the several performance metrics associated with the network such as throughput and normalizing overheads. This valuation is done by means of comprehensive literature analysis and simulation. Throughput measures the average rate of effective data packets transfer through a network per unit time. Normalized routing overhead measures the proportion of the total data transmitted and the actual data received at each node. In order to view the result of these performance parameters with respect to varying node density and to get the graphical view of the related parameters, we have used Gnuplot on the same platform.

For this research, the quantitative performance parameters have been used as shown in Table 1. The behavior of all the proactive, reactive and hybrid protocols has been simulated using the Network Simulator 2 on Linux platform.

The throughput of AODV nearer to DSR but lower increase multicasting with increasing in zone radius as shown in Figs. 3 and 4, we observed that overall delay for AODV has minimum in comparison to DSR with increasing in zone radius as control overheads increase drastically in the network (Fig. 5).

Table 1 Performance parameters

Parameters	Values
Protocols	AODV, DSR
Number of nodes	10,20,30,40,50
Simulation time	150 s
Environment size	5000 × 5000
Antenna type	Omni directional
Traffic type	TCP (Transmission control protocol)
Packet size	100 bytes
Mobility model	Random waypoint

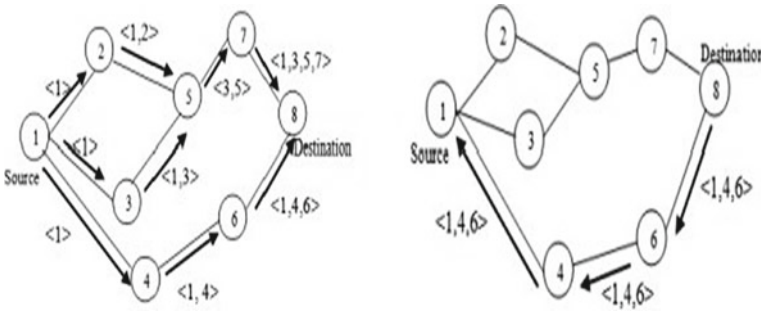

Fig. 3 Dynamic source routing

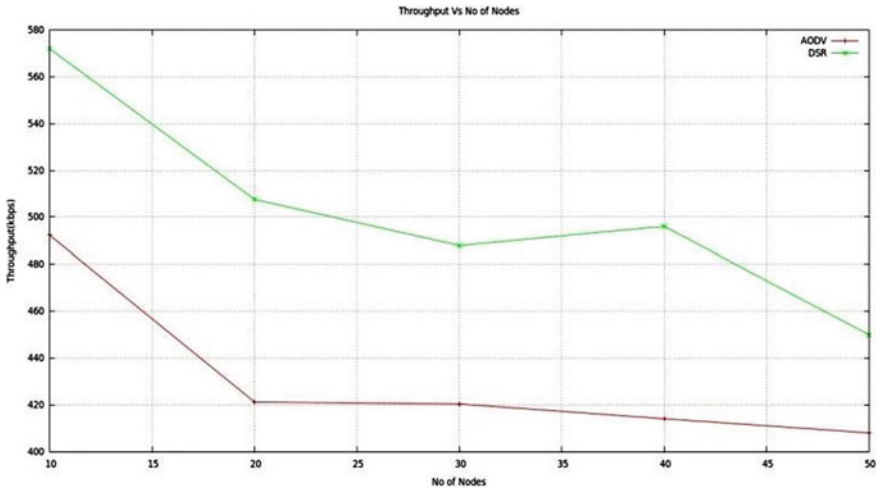

Fig. 4 Throughput vs number of nodes for AODV and DSR

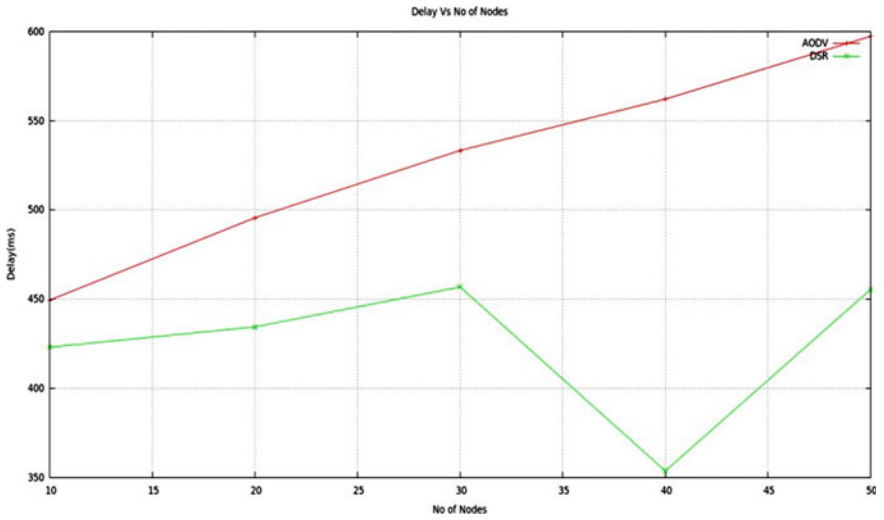

Fig. 5 End-to-end delay vs number of nodes for AODV and DSR

5 Conclusion

As discussed, different queue management techniques are used to avoid network congestions that reflect the QoS performance in MANETs. In this research paper, we have highlighted several features of the mobile ad hoc network as well as calculated the QoS performance of reactive routing protocols like DSR and AODV based on node density in an immobile area. The node density is varied as 10, 20, 30, 40 and 50 in a fixed area. A typical simulation environment has been created to implement AODV and DSR routing protocols using NS2 network simulator, and the network congestions are handled Droptail queue management technique with different QoS performance parameters such as delay and throughput.

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Physical Design of a Multibit D FlipFlop-Based Linear Feedback Shift Register

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Abstract In the emerging world of VLSI technologies, the challenges for the VLSI designers keep raising to produce circuits that consume low power, area and speed. The Linear Feedback Shift Register (LFSR) can be employed to generate pseudo-random patterns in test generators. The standard implementation of LFSR uses D flipflops and exclusive OR connected linearly. The proposed technique uses multibit flipflops for designing the LFSR. Multibit flipflop is used in applications where low power and area is the main concern. The total design area is reduced due to the usage of the multibit flipflop without affecting the performance of the design. The proposed design simulation is done using the Xilinx IDE. The synthesis and physical design are carried out using Cadence Genus and Innovus tools. The result analysis provides that the power of standard eight-bit LFSR is about 92,732.236 nW, and it is reduced to 35,217.804 nW as we use multibit flipflops to implement an eight-bit LFSR. The chip area is also reduced as it uses only four multibit flipflops in place of an eight D flipflop in the proposed design.

Keywords Multibit flipflop · Linear Feedback Shift Register · Synthesis · Physical design

1 Introduction

Flipflops are basic cells in many circuits of VLSI chips. D flipflops are bistable circuits in which D stands for "data", it is the flipflop that stores data, which is a basic memory cell. D flipflop is mainly used to create delay lines in digital applications [1]. The CMOS D flipflop used in the place of buffers reduces delay as well as power consumption, which increases the performance of the circuit [2]. In VLSI technology, low power requirement is one of the important factors. A double edge triggered flipflop stores data on both the edges of a clock and the circuits, which store data either on one of the rising or falling edge is referred to as single edge-triggered

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flipflop. Applications of D flipflop include data storage registers, data transferring shift registers, Linear Feedback Shift Registers, etc. [3].

LFSR is a shift register used to generate pseudo random patterns, which is used in pseudo random test applications of ASIC chips. A LFSR contains flipflops along with XOR gate as a feedback [4]. These circuits are used in Design for test (DFT), Built in SelfTest (BIST), cryptography and many more [7–10]. Reducing the size of LFSR will significantly reduce the power dissipation. Multibit flipflops can be used to reduce the power and area. Multibit flipflops are designed by merging two flipflops. Each multibit flipflop that we want to merge should have same clock and set/reset condition. Designing multibit flipflop will eliminate the extra invertors in the circuit [5]. Multibit flipflops have various advantages such as it reduces the complexity, power consumption, number of hold buffers and clocks skew in sequential circuits [6].

In the paper [11], Yan et al. proposed a two-phase approach for designing a multibit flipflops. It eliminates redundant inverters by merging single bit flipflops. It also reduces the clock power consumption. This work proposed that to design circuit using multibit flipflop technique Routing Length constraint and Bin congestion constraint has to be met. In [12], an algorithm to avoid placement capacity concerns and timing issues was proposed by Shyu. By using this algorithm, multibit flipflop was merged and placed. Lin et al. [13] surveyed techniques that can be employed to design circuit with MBFFs. The paper presents logic optimization with MBFFs.

In [14], Sharma and Kaushal's work concentrates on design of various digital circuits with multibit flipflops. The number of inverters used was reduced as the flipflops are merged and thereby sharing the inverters. Also, they designed a shift register using multibit flip flop. Gautam in [15] surveyed the multibit flipflops concepts. This work also analyzed the design's results with and without MBFF at Physical Synthesis and clock tree synthesis on 90 nm. Also proposed that MBFF can minimize clock skew at the same time because of improved clock routing. In [16], Lin et al. performed timing-driven incremental placement. The placement of combinational logic cells, single bit flip-flops, and MBFFs were defined in this. A clock tree synthesis aware merging of MBFF was proposed here. Comparison of single bit flipflop and multibit flipflops was done in [18] and [17]. In the paper [19], Vishnu et al. primarily focused on the clock tree synthesis (CTS) techniques. According to this, multisource CTS improves timing by decreasing the latency and skew and provides the most structured clock distribution.

The related works pointed out that multibit flipflops can be a solution for the rising concern about power and area optimization. It reduces the power as the inverter number for the clockpath can be reduced. An eight-bit LFSR requires eight flipflops, which consumes more area and power. In this paper, a design for eight-bit LFSR using four multibit flipflops, which further reduce area and power consumption, is proposed. Comparison of the power of both the flipflops has also been carried out along with the physical design of the proposed design.

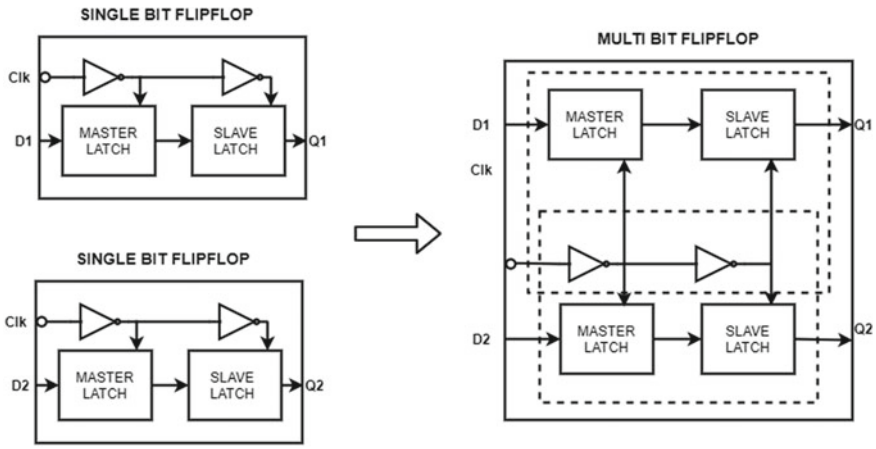

Fig. 1 Merging of single bit flipflops to form a multibit flipflop

2 Multibit FlipFlop

Multibit flipflop is basically merging two single bit flipflops with single clock pulse. They are a cluster of multiple single bit flipflops [14]. Multibit flipflops, unlike the single bit flipflops used now, have multiple inputs and give multiple outputs [18]. This circuit helps to achieve the same functionality as two single bit flipflop [20]. Reducing clock networks will account up to reducing 50% of dynamic power [13]. Along with this, they can also reduce the number of flipflops used [14]. The power is reduced as the clock power can be reduced while merging the flipflops. The clock network in circuits usually consists of inverter-based clock buffers. So, while designing the multibit flipflops, the clock buffers can be made to share between the flipflops thus reducing the power [22]. They also lead to reduction of chip area as the number of flipflops can be reduced.

Multibit flipflops have many advantages. These include reduction of power and area, high performance, smaller delay, controlled clock skew, effective routing resource utilization [13].

The multibit flipflops merging two single bit flipflops are shown below in Fig. 1.

3 Linear Feedback Shift Register

A Linear Feedback Shift Register helps in testing the designed circuits using randomly generated sequence. LFSR is used in BIST for generating pseudo random sequences. It has very simple hardware, which can be implemented for on chip test generation. LFSR is also used in encryption circuitry, data compression circuitry and cryptography.

4 Multibit D FlipFlop Generation

The RTL code for any design can be written using Hardware Description Languages. For the proposed design, RTL code is written using Verilog language. The Verilog code for multibit D flipflop was written, and functionality was verified using Xilinx ISE tool. The code was later verified, and further steps were proceeded using Cadence Virtuoso, NClaunch and Innovus tool. The block diagram for a multibit D flipflop is shown in Fig. 2.

The RTL schematic of multibit D flipflop is shown in Fig. 3.

The figure shows the schematic of a multibit D flipflop. It has two input pins d1 and d2 along with a clock pin. The outputs of the flipflop are q1, q2, q1_bar and q2_bar.

The truth table for the multibit D flipflop is given below in Table 1.

Figure 4 shows the simulation of the Verilog code achieved by running the code in Xilinx ISE.

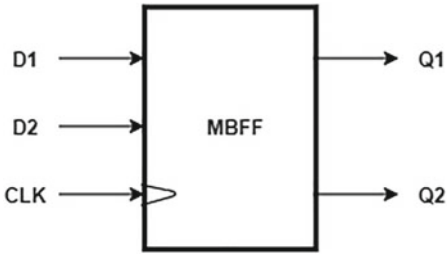

Fig. 2 Multibit D flipflop

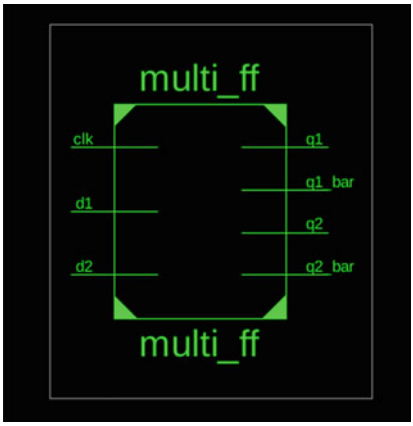

Fig. 3 RTL schematic of multibit D flipflop

Table 1 Truth table for multibit D flipflop

D1	D2	Q1	Q2	Q1_bar	Q2_bar
0	0	0	0	1	1
0	1	0	1	1	0
1	0	1	0	0	1
1	1	1	1	0	0

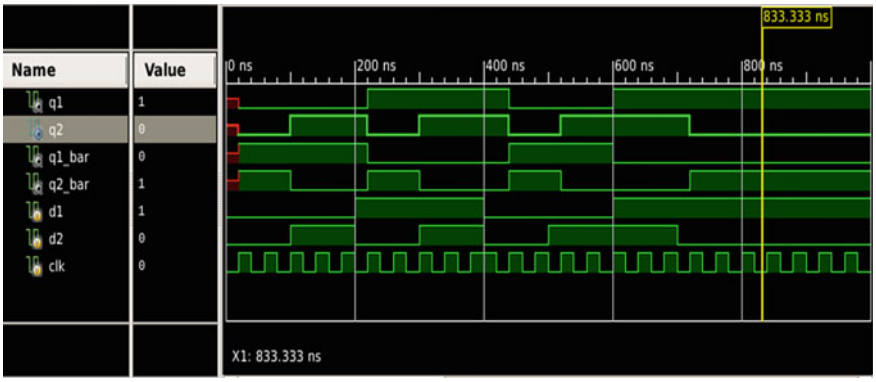

Fig. 4 Simulation of multibit D flipflop

5 Implementation of LFSR Using Multibit D FlipFlop

5.1 Design of Eight-Bit LFSR Using Multibit D FlipFlop

An eight-bit LFSR requires eight flipflops to implement the design. The D flipflops will be serially connected with one's output as second flop's input and so on. The final output will feedback to the input by XORing with the output of the preceding flipflop. The eight-bit LFSR is given below in Fig. 5.

Using the multibit flipflop, the eight-bit LFSR can be implemented using only four flipflops. As the clocks are shared between the flipflops, it will immensely reduce the clock power. Thus, this will lead to the overall reduction of the system power. It also reduces the area of the chip. In this LFSR design, the output is directly fedback to the input. But the input of the last stage multibit flipflop is the XOR-ed value of the previous last stage output and the output of current third stage flipflop. Figure 6 shows the multibit D flipflop-based LFSR.

The truth table of the eight-bit LFSR using multibit D flopflop is given below in Table 2.

The circuit was simulated using Cadence genus tool. The waveform is given in Fig. 7.

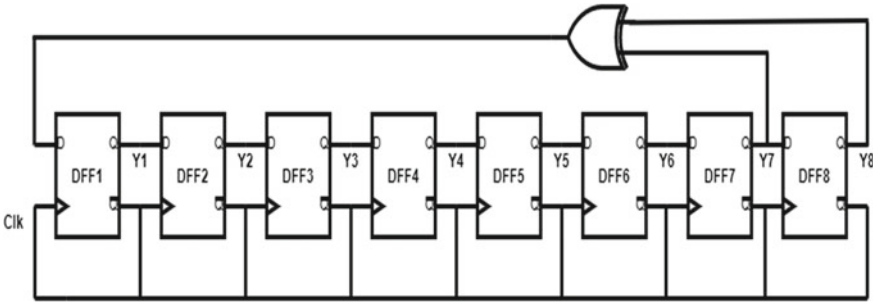

Fig. 5 Eight-bit LFSR

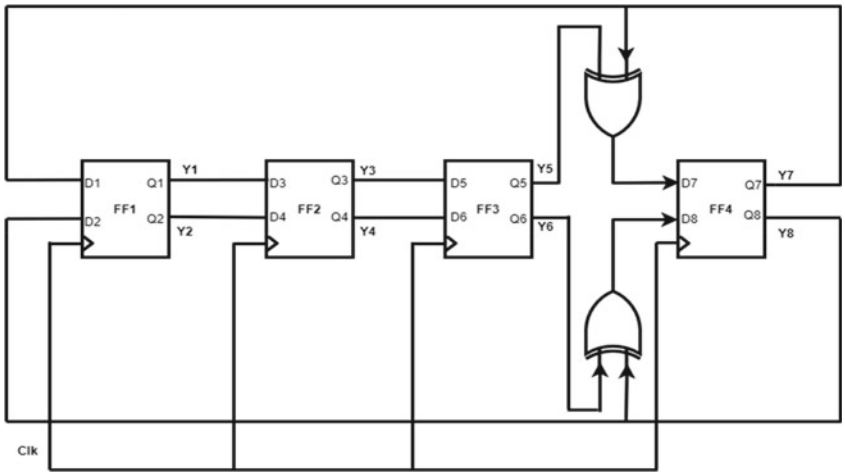

Fig. 6 Eight-bit LFSR using multibit D flipflop

Table 2 Truth table of eight-bit LFSR using multibit flipflop

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
1	0	0	1	0	0	0	1
0	1	1	0	0	1	0	1
0	1	0	1	1	0	0	0
0	0	0	1	0	1	1	0
1	0	0	0	0	1	1	1
1	1	1	0	0	0	1	0
1	0	1	1	1	0	1	0
1	0	1	0	1	1	0	0
0	0	1	0	1	0	1	1
1	1	0	0	1	0	0	1
0	1	1	1	0	0	1	1

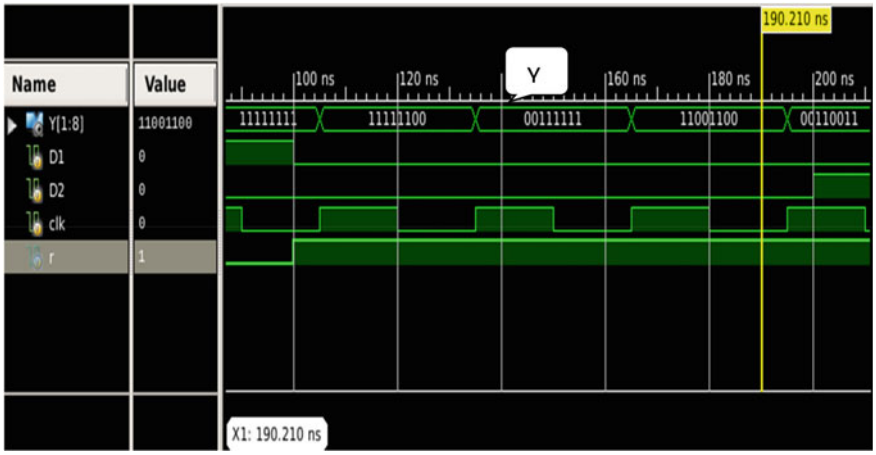

Fig. 7 Waveform of eight-bit LFSR using multibit flipflop

The waveform shows that the output of the LFSR starts from the sequence 1111 1111 and for each clock pulse generates a different sequence until it again reaches to the same sequence it began.

5.2 Synthesis of the Multibit D FlipFlop-Based LFSR

The synthesis of the circuit was also carried out for the proposed circuit using Cadence genus tool. The elaborated and mapped circuit was obtained post-synthesis. The mapped circuitry for the proposed system is given in Fig. 8.

The main purpose of going to multibit design is to reduce the power. So after synthesizing, the power of a normal eight-bit LFSR is about 92,732.236 nW, and the power of multibit flipflop-based LFSR is 35217.804nW. The multibit flipflop-based LFSR power is reduced by almost three times the normal LFSR.

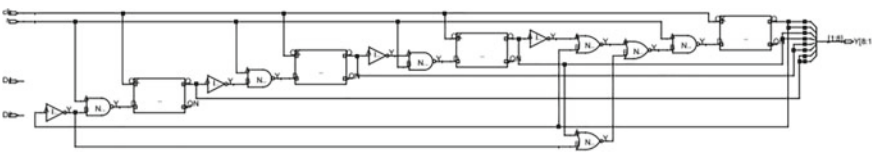

Fig. 8 Mapped circuit of the proposed eight-bit LFSR post-synthesis

5.3 *Physical Design of Multibit D FlipFlop-Based LFSR*

Physical design converts a circuit description into a physical layout. It defines where to place a component, how to connect between the blocks etc. The steps in the physical design process are system partition, floorplanning, place and route and clock tree synthesis. Timing will be verified in each of these processes.

In this work, the physical design process using Cadence Innovus tool after obtaining the netlist file post-synthesis has been carried out. The timing, power and area report were taken through each of the stages, and it is enlisted in the table given below (Table 3). The final circuitry of the eight-bit LFSR after the physical design process is also given in Fig. 9.

Table including the timing, power and area report is given below.

Table 3 Timing, power and area report

Post placement	Power (W)	Area (μm^2)	Timing (ns)	
	0.01091	286.0704	Setup	Hold
			36.690	0.730
Post CTS (clock tree synthesis)	0.01207	286.0704	36.690	0.730
Post route	0.01206	286.0704	36.684	0.730

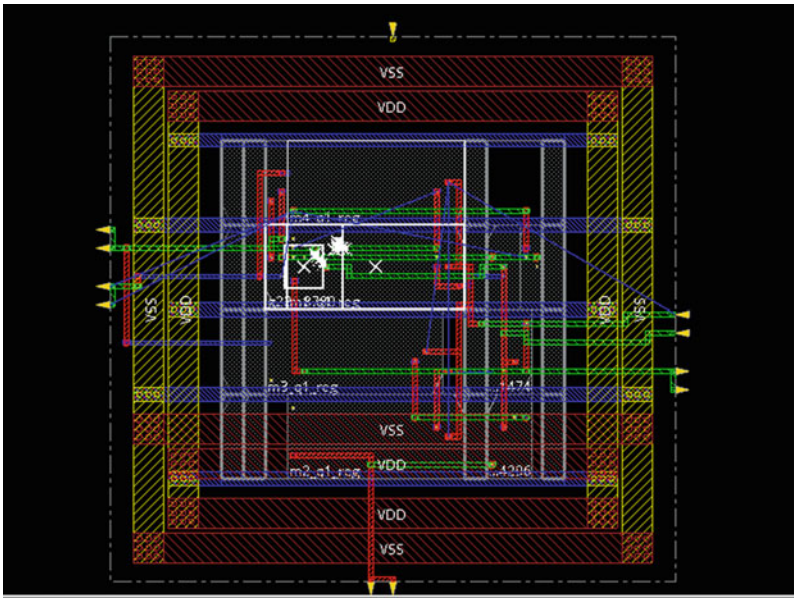

Fig. 9 Eight-bit LFSR using multibit fliplop after physical design process

6 Summary

Flipflops are the basic building block of circuitries in VLSI chip. A large amount of power depends on this because of the clock power of flipflops. So reducing the area or power of the flipflop can get immense advantage to the design. Introduction of multibit flipflops helps to achieve this goal. From this work, it is proved that eight-bit LFSR using multibit flipflops consumes three times lesser power compared to the normal eight-bit LFSR. Also in this work, the design, simulation, synthesis and physical design of the LFSR using Xilinx ISE and Cadence tools have been carried out. Upon the completion of the physical design, the timing, area and power in each of the stages of the physical design have been reported. The normal flipflop-based LFSR design consumes a power of about 92,732.236 nW, and the power of multibit flipflop-based LFSR is 35,217.804 nW. Therefore, the usage of multibit flipflops instead of the regular flipflops can tremendously save power and area of VLSI chips.

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Sentiment Analysis of Twitter Tweet Using Machine Learning

Alok Ranjan Tripathy, Amit Kumar Moharana, Alakananda Tripathy, and Sipra Sahoo

Abstract To express emotions, the users are using emoticons. Previously, for the classification of text, emoticons, or image machine learning techniques, are being used, but emoticons to text being ignored, resulting in the misrepresentation of many emotions. Sentiment analysis is the evaluation of people's attitudes, thoughts, and feelings in order to determine whether they are optimistic, negative, or neutral. In recent years, the use of such emoticons on social media has nearly doubled. This study proposed an algorithm and pattern for sentiment analysis that makes use of both text and emoticons, this study shows that when emoticons are used, the emotion associated with them outweighs the sentiment expressed by textual data processing. This paper defines a social media sentiment analysis scheme that categorizes posts as positive or negative depending on the general polarity of the message. These classifiers often give a judgment score very similar to the decision boundary for a significant number of posts, implying that they are clearly confused rather than absolutely incorrect about these tweets. This paper uses different techniques like Naïve Bayes, SVM, LSTM, logistic regression model to analyze the sentiment.

Keywords Sentiment analysis · Naive Bayes · SVM · Twitter tweet dataset · LSTM

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1 Introduction

The popularity of social networks and society dependent on mobile media has led the young scientists to continue to work on feeling study. Organizations from those days have been keen to evaluate consumers or the public view of their social media products [1]. Online services are linked to the site, internet forum, remarks, tweets, and product data evaluation of social communication [2].

There is an increase in the popularity of the social and electronic media networks. Societies also encouraged to carry out research on feeling analysis via the extreme use of the internet by companies all over the world [3]. Web texts have shaped the market and socio-economic processes. To analyze the sentiments, different methods drive the computer control based on four text classifiers, namely, Naïve Bayes, SVM, LSTM, and Random Forest.

Sentimental Analysis

It is also known as emotion AI or opinion polling. It mostly focuses on identifying subjective data. It is useful to determine how pleased customers are with goods and services. Sentiment analysis examines the polarity of language, determining whether it is positive or negative. Change the notion, boost production, and advertise with the aid of these polarities to help eliminate some negative. The various steps to analyze sentiment data are given in Fig. 1.

Section 2 discusses the related work, the proposed model is being discussed in Sects. 3, and 4 highlights the analysis of results, and Sect. 5 concludes the paper.

The paper highlights the different machine learning techniques to analyze the sentiment of the Twitter tweet.

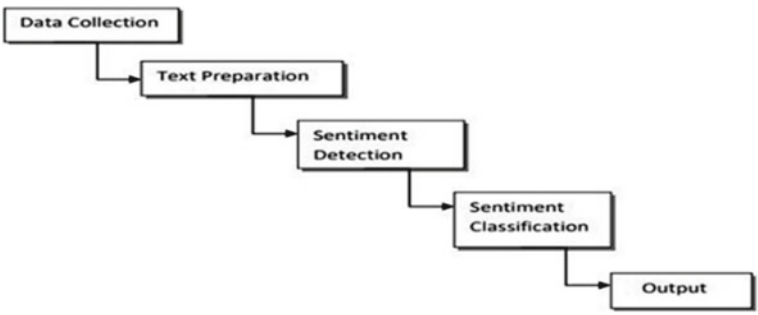

Fig. 1 Steps to analyze the sentiment data

2 Related Work

Badr et al. [4] used SVM and NB algorithms to analyze social media sentiment and used ant colony and particle Swarm optimization methods to achieve 73.62%, 77.30%, and 80.54% accuracy for Naïve Bayes and 76.71%, 80.54% for SVM, respectively. Two approaches were discussed by the author Kawade, [5], sentiment score and polarity count, to analyze the social network Uri assault tweets, achieving 94.3% accuracy for negative results and 5.7% accuracy for positive results.

Nguyen et al. [6] attained an F1-score of 90.2% accuracy utilizing the Vietnamese student feedback corpus and the LSTM support vector machine technique. Taking Twitter tweets, reviews and applying different machine learning algorithm and deep learning algorithm such as NB, SVM, LSTM, and Random Forest. Amazon and IMDB movie reviews were taken by Bansal and Kaur [7] and consider NB, J48, BFtree, and oneR classifier among these the faster one in learning is NB and the more promising one is oneR, for generating the accuracy in classified instances. In [8], Shreyas R Labhsetwar et al. use a dataset of 1000 labeled sentences, 500 +ve and 500 −ve, to conduct sentence-level analysis. It appears that using conjunct analysis with sentence-level analysis will improve accuracy. They discovered that the ML method is inefficient, therefore he used WordNet to improve the accuracy by around 80%. The POSICTCLAS tool for Chinese text is being suggested by Bhargav et al. [9] where the average review size is about 600 words in education review, average reviews of length are about 460 terms in stock review, and 120 words average length in computer review.

Singh et al. are taking sentiment analysis on movie and product review dataset in Turkish and English language using SVM classifier to obtain 91.33% accuracy [1]. Khan et al. [10] worked on Urdu dataset for sentimental analysis and polarity detection.

3 Proposed Model

The Twitter dataset using machine learning and deep learning classifiers such as Naive Bayes, LSTM, SVM, and Logistic Regression is being discussed in the proposed model. The procedure is discussed in Fig. 2.

The different steps of the process include:

- Data collection is very essential. In order to discover or analyze sentiment, a collection of Twitter tweets from the database is used in the proposed model.
- Data Preprocessing is important in data mining. When there is irrelevant, redundant information, noisy or inaccurate data, knowledge discovery become more difficult. It takes a long time to prepare data, and after this step is over, it is time to create the training set. The different steps of preprocessing of data consist of:
  - **Remove Punctuation**: It removes the special characters.

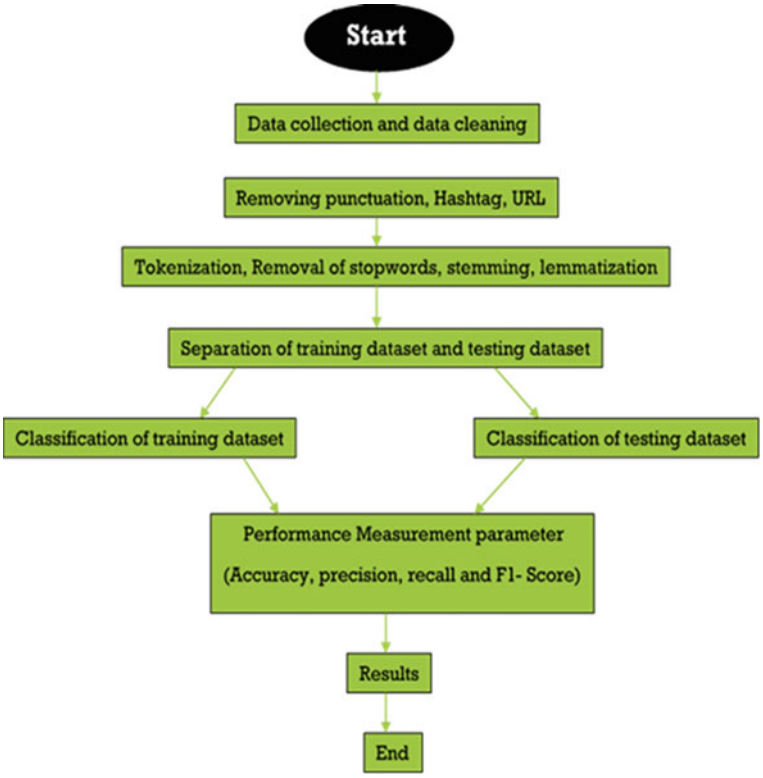

Fig. 2 Flowchart of the proposed model

- **Tokenization**: It breaks a long text into little segments or words, which are referred to as tokens. The phrase is broken up and converted into a token format.
- **Remove Stop words**

  It is a Natural Language Toolkit (NLTK) that includes a collection of terms. It just functions as a filter and used to filter out natural language data after or before processing.
- **Stemming**

  The practice of reducing a term to its underlying word by removing superfluous characters. It reduces the term to its simplest form.
- **Lemmatizing**

  This converts a word's result into its dictionary or canonical form. The resulting lexical form is known as lemma.
- **Vectorization**

This converts the word into a number, which is executed faster. It aids word embedding or word vectorization approach by employing vectorization technology.

– **Bag of word (BOW)**

As the machine learning algorithm is unable to operate with text, it must be transformed into numbers. Because the algorithm requires a vector input, first the materials are transformed into fixed length vectors.

- **Classification of Training Data**

It is the next step, four different classifiers are used for the proposed model.

– **Naive Bayes**:

This is a strong algorithm. It is a probabilistic model that looks like Bayes theorem of the algorithm. It is used to determine the assumption of predictor independence. It is the most basic model that is straightforward to construct.

– **Logistic Regression**:

It is a supervised classification method that uses statically learning techniques. It is a regression model, after all it predicts the probability in a given dataset. It makes use of the sigmoid function. Because it detects defaulters, this approach is employed in the financial industry. It may also be used to forecast binary classes. Logical regression's output, or goal value, is binary in nature. It is used to detect spam, diagnose cancer, and forecast diabetes. Logistic regression may be classified into three types based on number categories: binary, multinomial, and ordinal. Binary and multinomial models are the two types of models.

– **Support Vector Machine (SVM)**:

The enhanced feature sets were utilized for sentiment classification after the outliers were removed using clustering. SVM is mostly used to classify sentiments. It categorizes good and negative feedbacks. Precision, Recall, F-Measure, and Accuracy are all factors that influence the algorithm's performance.

– **Bullet Long Short-Term Memory (LSTM)**:

The inputs are multiplied by weight then the bias is added, and so on, until the output from the last layer is obtained in the feed-forward networks. However, because these networks do not retain memory, they cannot be utilized to process sequential data. This sort of network's input and output are also fixed. Long Short-Term Memory (LSTM) networks can learn long-term dependencies. These networks perform admirably in a wide range of situations. Long-term dependence is not a concern with LSTMs because they are expressly intended to avoid it. It is achieved by LSTM memorizing information over lengthy periods of time, as this is their inherent behavior. The chain structure also exists on LSTM networks, but the repeating module has a different structure.

It contains four interacting layers instead of a single layer of a single neural network.

4 Result Analysis

The proposed model is classified using Naïve Bayes classifiers. In this, the Twitter Tweets are taken as dataset, around 60,000 pieces of data are taken of which 30,000 pieces are used for training and 30,000 pieces are used for testing. The word vector of positive and negative reviews is kept separated, and also it keeps track of positive and bad ratings. Then, using conditional probability, best words are determined. After training the data using Navies Bayes Classifier, the result is obtained as shown in Fig. 3.

There is a comparison graph between SVM and logistic regression based on accuracy and prediction, and it is shown in Fig. 4.

Precision = Correct true predictions/Total number of positive prediction

$$Precision = \frac{TPP}{TPP + FPP} \tag{1}$$

Recall is to figure out the percentage of item actually present in the input.

Recall = Correct true predictions/total of true positive prediction and false-negative prediction

$$Recall = \frac{TPP}{TPP + FNP} \tag{2}$$

F-Measure is the ratio of the harmonic mean of accuracy and memory, which combines precision and recall.

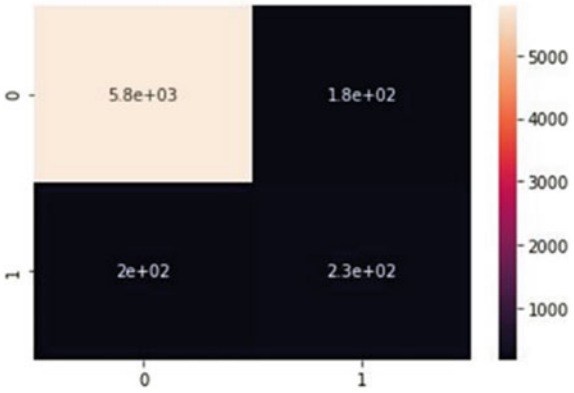

Fig. 3 Naive Bayes classifier

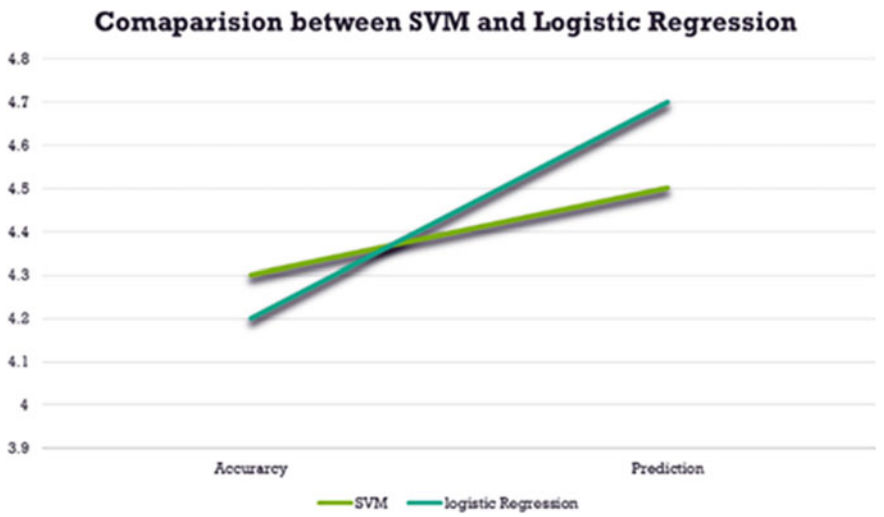

Fig. 4 Comparison between SVM and logistic regression

$$F - Measure = 2 \times \frac{Precision \times Recall}{Precision + Recall} \tag{3}$$

Accuracy is the statistical metric for determining how effectively a classification test properly detects or eliminates a condition. The proportion of genuine findings (including true positive and true negative) among the total number of cases is investigated in the accuracy:

$$Accuracy = \frac{TPP + TNP}{TPP + TNP + FPP + FNP} \tag{4}$$

In Eqs. (1), (2) and (4), TP signifies the True Positive Prediction, False Positive Prediction is denoted as FPP, True Negative Prediction is denoted as TNP, and FNP is denoted as False Negative Prediction.

Figure 5 shows the count of words using LSTM. The accuracy and loss factor of LSTM using bidirectional NN are shown in Fig. 6.

The results for the different parameters for the different classifiers are shown the Table 1.

5 Conclusion

In the proposed work, different techniques of deep learning and machine learning are applied to sentiment analysis for review of the tweets in Twitter. It is the most popular and famous topic through which can know the sentiment of any post or any type of

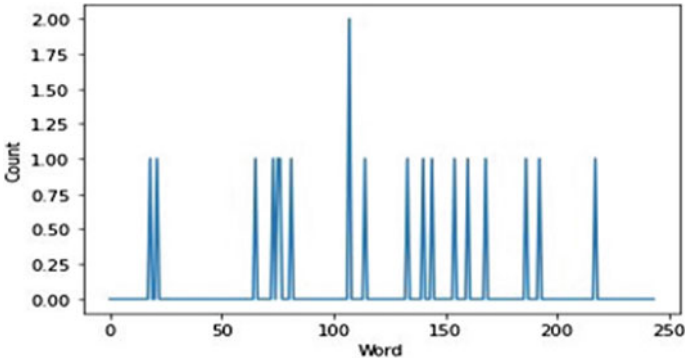

Fig. 5 Count of words using LSTM

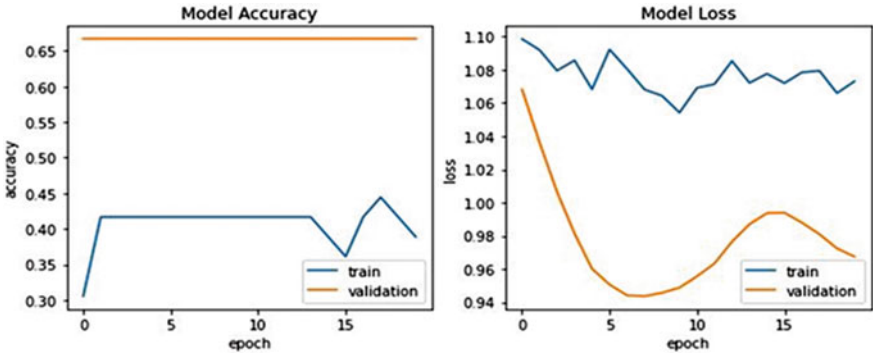

Fig. 6 Accuracy and loss factor of bidirectional LSTM using NN

Table 1 Comparison based on different parameters for different techniques

	SVM	Logistic regression	LSTM	Naive Bayes
Accuracy	0.831	0.74	0.88	0.843
Precision	0.54	0.63	0.75	0.71
Recall	0.55	0.563	0.63	0.59
F1-Score	0.55	0.581	0.78	0.64

text document. The intension of people about other things or people can be known through the sentiment analysis. In this model, the sentiment analysis classification is performed, and their prediction is done through Naïve Bayes, SVM, LSTM, and logistic regression based on different parameters like accuracy, precision, recall, and F1-score. It is observed that for LSTM has better accuracy, precision, recall and F1-score is more as compared to the other model.

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Queuing Theory-Based Analysis of Berth Allocation and Management in Paradip Port for Container Ships

Madhuri Rao, Narendra Kumar Kamila, Kulamala Vinod Kumar, Debahuti Mishra, and Sampa Sahoo

Abstract Allocation of berths and managing service in ports is a challenging task as there are many uncertain factors to address. The overall operational efficiency of the port is indeed dependent on how efficiently berths are managed with minimal service time. The Port at Paradip, Odisha located in the eastern coastal region of India is a crucial port with an increasing inflow of container ship traffic. Container ships carry commodities and goods that often are also inflammable. Docking and undocking operations are further subject to weather conditions and number of man hours. A Port container terminal is considered as a queuing system in this paper, and the efficiency and the impact of affecting parameters are studied with emphasis on Paradip Port structure and incoming ship traffic.

Keywords Berthing · Ship · Queuing theory · Markovian process · Port

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1 Introduction

A port is a dynamic system that can be modelled as a queue with finite waiting areas with many servers or berths with finite service time [1]. Kendall Queuing Theory is essentially based on three parameters: (1) the stochastic inter arrival time distribution between successive arrival of customers in a queue, (2) the distribution of service time and (3) the maximum number of servers in a system. Ship berthing incidents [2] are gradually increasing and needs to be taken care of. Zarzuelo et al. [3] model the Port Berthing process as a Queuing System, where ships are analogous to customers. The servers are the berths, and the service time is the time spent by a ship from the instant it arrives at a berth and till it leaves a berth. Hence, service time is essentially the sum of berthing time and the time spent in docking and undocking operations. The berth allocation and management are dependent on several factors like the arrival time of ships, the overall length and weight of the ships along with the type of commodity it is carrying. Gulshan et al. [4] have studied the impact of high ocean waves and weather conditions on berthed ships at the Paradip Port, which is directly connected to the Indian Ocean. Their study helps in identifying safe locations for berthing ships; however; if existing berths are optimally utilized this problem can be addressed to an extent. Various researchers have tried to solve the berthing process [5–8]. Rao et al. [9] have proposed an Internet of Things (IoT)-based system that enables ship owners to track and monitor the movements of a ship when berthed, but sometimes ships have to wait for many days to get berths. Whether the number of berths operational and available at a port is enough or needs to be scaled up needs empirical data analysis.

2 Structure of Paradip Port

The Paradip Port [10] has 24 operational berths, and berths are allotted to arriving ships based on size and the commodity being carried by ship.

The dimensions of a ship as depicted in Fig. 1 such as Length Overall (LOA), draft and beam also are determining factors for berth allotment. As per the Paradip

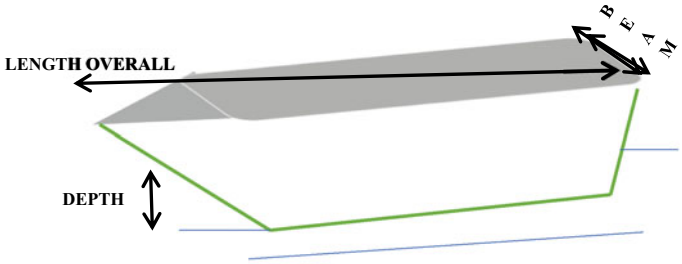

Fig. 1 Ship dimensions

port regulations, berthing of ships with beam over 40 m can only be carried out in day time provided weather conditions are favourable. Ships with LOA greater than 260 m would be berthed in vacant south bay berth only. Berth numbers 1, 18, 19, 20, 21 and 22 are operated via a pipeline and are meant for ships carrying commodities like crude oil and petroleum products. Berths 2–9 and 13 are mechanically operated and deal with coal and iron ore-related commodities. Berths 10, 11, 12, 14, 17, 23 and 24 are not mechanically operated and essentially deal with dry bulk cargo. Berths 15 and 16 are for ships carrying fertilizers. The traffic of ships is considerably increasing in this area, and, therefore, thorough analysis of possible berthing allotments and overall efficiency of the Port needs to be studied. In this paper, berthing scenarios for containerships ships are analysed.

3 Modelling Port as a Finite Queuing System

A Port can be considered as a Multichannel Open Queuing system where the average interval between the arrival of two consecutive ships (AVG_A) as per Eq. (1), here γ is the average number of ships that arrive at the port for a given duration of time. Similarly, if λ is the average service time of ship in a given berth then the arithmetic mean (AVG_S) is the average service time duration per ship, is as in Eq. (2).

$$\text{AVGA} = 1/\gamma \tag{1}$$

$$AVG_s = 1/\lambda \tag{2}$$

The berth occupancy rate μ is determined as in Eq. (3), which is the ratio of arrival rate and service rate.

$$\mu = \frac{\gamma}{\lambda} \tag{3}$$

The number of berths needed S can be determined based on Eq. (3). If $\mu > 1$, it indicates that the number of berths is insufficient and already being 100% utilized. The utilization coefficient σ of the Port is derived in Eq. (4), where S is the number of berths, and μ is the berth occupancy rate.

$$\sigma = \frac{\mu}{S} \tag{4}$$

It may be noted that when σ is <1 then the port is operating in a stable condition, which is very desirable. Often increasing the number of berths can reduce the average waiting time of a ship to avail a berth as well as time spent in getting a service. However, this is incurred at a cost of added infrastructure and human personnel and operating overhead. This needs to be well modelled based on available empirical

Table 1 Berthing details of Paradip Port for May 2020 and May 2021

Queuing parameters	May 2021	May 2020
Number of container vehicles serviced	8	3
Average pre-berthing delay in hours	1.46	1.31
Average service time at berth in days	0.64	0.86
Average turnaround Time	18.55	23.6
% of idle time to total stay at berth	20.57	32.41

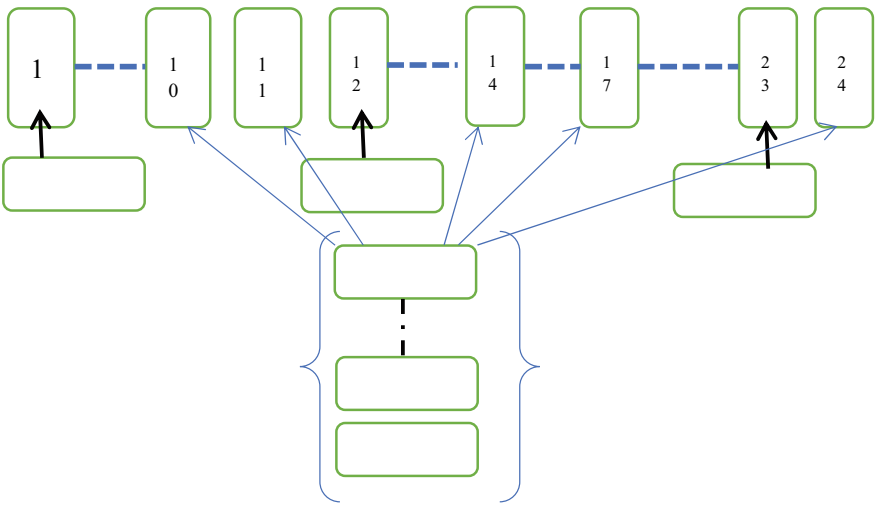

Fig. 2 Scenarios of container ship queue at Paradip Port

data and forecasting possible scenarios that was arise. Table 1 provides the berthing details of Paradip Port as made available at [6] where a comparative value of the parameters for the month May 2021 and May 2021 is indicated. Figure 2 depicts a scenario of the container ship queue at the Paradip Port that is further taken for the simulation study.

4 Simulation of the Queuing Phenomenon for Container Ships at Paradip Port

The Paradip Port has 24 operational berths of which berths 10, 11, 12, 14, 17, 23 and 24 as depicted in Fig. 2. Container ships that carry general dry bulk commodities are allotted a berth that is vacant in First Come First Serve manner. Ships wait in queue for being berthed in open waters. These berths are not mechanical and therefore are human operated by cranes during undocking and docking purposes. Therefore, the Paradip port container ship queue can be modelled as M/D/7 queue. Here, there are

Table 2 Simulation parameters of M/D/7 queue

Simulation parameters	Value
Number of servers	7
Queue capacity	0,1,2,3
Arrival rate	computed as per Eq. (5)
Coefficient of variation of inter arrival time (CVa)	1.31, 1.46 (considered based on Table 1, data available [4]
Coefficients of variation of inter service time (CVs)	0.64, 0.86 considered based on Table 1, data available [4]
Number of iterations	50

seven berths that are analogous to the number of servers, while D is the deterministic or finite service time availed by a ship. The arrival of ships is depicted as M and is essentially a Markovian process as expressed in Eq. (5) [9]. For simulation, Jesse [11] Excel spreadsheet is used, and about 50 iterations or runs are performed.

$$M = P_n = \frac{(\gamma)^n}{n!} \times e^{\gamma} \tag{5}$$

Here, M is the average arrival time of container ships at Paradip port, which is a Markovian process where the probability of arrival P_n is given as per Eq. (5).

Here, γ indicates the average arrival time of ships during a given time period, and n is the number of ships. The simulation parameters are explained in Table 2.

A simulation was carried out with a hypothetical situation when the service time is rather 0.3, and inter arrival time of ships is further reduced to 0.2, i.e. when the ship traffic increases by 150%. Figure 5 depicts the service time vs inter arrival time of container ships with 1.5 times ship traffic of May 2021.

Figures 3 and 4 are quite alike as the port is stable and dealing with optimal usage, but Fig. 5 indicates that if the Paradip Port is required to face 150% more ship traffic, then the number of ships waiting to be served will increase leading to loss for both Shipping Company and the Port Administration.

The total number of ships waiting or being served in May 2020 and May 2021 was almost same where the average waiting time indicated in Y axis is less than 65 h (Fig. 6).

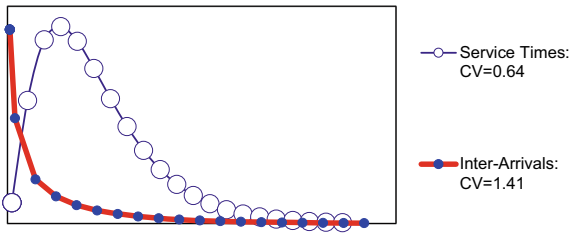

Fig. 3 Depicts the service time vs inter arrival time of container ships for the month May 2020

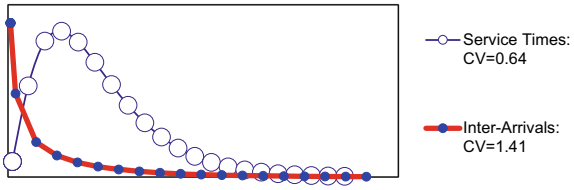

Fig. 4 Service time vs inter arrival time of container ships for the month May 2021

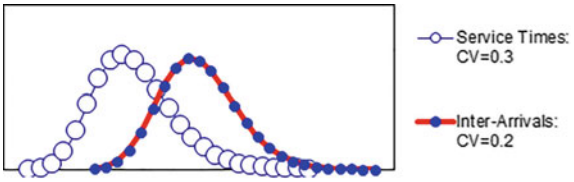

Fig. 5 Service time vs inter arrival time of container ships with 1.5 times ship traffic of May 2021

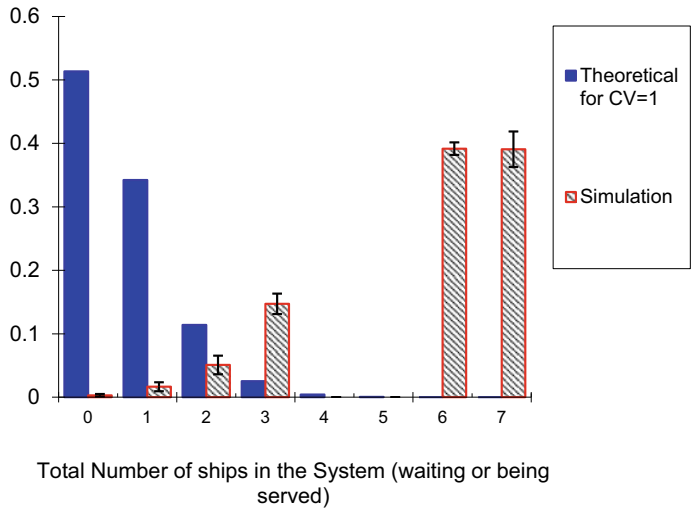

Fig. 6 Total number of ships waiting or being served in May 2020

The X axis indicates the number of servers or berths currently being used, which is 7 as in the case of Paradip Port for Container Ships. From the simulation results, it can be inferred that the current capacity of Paradip Port in handling ship traffic is effective and optimal. However, ship traffic is expected to rise in few years. The port may either need to reduce the service time of ships by making all berths mechanical as well as also plan effective waiting areas for arriving ships with inflammable and sensitive cargo. Setting up of additional berths will incur a huge amount of

cost, and its requirement needs to be analysed frequently. Installing sensors and enabling Internet of Things (IoT) technology on ports and ships can also be effective for avoiding miscommunication and ensuring seamless monitoring. Various ship berthing algorithms can also be explored [12], and integrated with IoT technology can also be very beneficial [13]. Ships approaching harbour can be tracked using an aerial device [14] additional to radar and satellite systems to deal with any situation that arises then and there.

5 Conclusion

In this paper, the current berthing structure of Paradip Port situated at the eastern coast of the state of Odisha is briefed. The container ship berthing process is depicted as a finite queue model M/D/7 type, where the ship arrival to the port is a Markovian process; service time of ships is deterministic with seven container ships berths that are analogous to servers of queue models. The simulation study based on the empirical data available suggests that Paradip Port is currently using the berths in an optimal way. However, if the ships arriving to the ports in increasing by 150% then the berthing process will be affected drastically. A situation like this will lead to the increased ship waiting time for berthing and may cause ship owners to opt for a nearby port with the minimal waiting time.

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Energy Efficient Base Station Location Optimization for Green B5G Networks

Ruchi Sachan, Shatarupa Dash, and Bharat J. R. Sahu

Abstract The penetration of multitude smart devices and billions of Internet of Things (IoT) devices have demanded enhanced data speed and diversified network services. The 5th Generation cellular communication has already been rolled out in many countries. Naturally, 5G and Beyond 5G (B5G) networks have to accommodate variety of services with an exponentially large number of devices. 100% coverage is one of the goals of 5G network. To meet this demand dense small cells are proposed. This places excessive stress on the network service provider in terms of capital and operational expenditure. Moreover, as the coverage area is small, most Base Stations (BS) will be serving a fewer devices. Thus, the energy efficiency per BS will be reduced drastically. In this sense, location intelligence based on energy saving is an important research topic. In this paper, we present a Genetic Algorithm (GA) approach, and its application in estimating the best location for 5G base stations reducing overall energy consumption. Our simulation results show better energy efficiency than the legacy procedures.

Keywords 5G networks · Beyond 5G · Energy efficiency · Genetic algorithm · Green communication

1 Introduction

One of the major goals of 5G and beyond wireless is to provide very high-speed date rates to support emerging applications like augmented reality and high-quality video communications. The 5G and Beyond 5G (B5G) network tries to take benefits from location information and optimize itself using self-organized network and

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artificial intelligence. The location information is properly defined to be effective in wireless network planning and improvements. B5G networks need to deal with an exponentially aggregating number of devices [1] with diverse services requirements. The 5G network has already been defined in mobile communication. As the use of millimeter-wave and THz bandwidth (B5G) restricts the cell sizes, the number of base stations increases naturally in the 5G and B5G ecosystem. Thus, energy efficiency is low and the coverage area per base station is small as such. Thus, the Base Station (BS) location needs to be optimal to proliferate one of the 5G goals: 100% coverage with reduced capital expenditure and operational expenditure [2].

The 5G and beyond 5G technologies have been the emerging studies in academia and industry to indicate the next major phase of mobile communication standards beyond 4G wireless communication networks. The scalability, the reduction of signaling overheads, and the minimization of total energy consumption must be accounted for to allow reasonable costs of network operation. Satisfying these essential requirements in the 5G network, in which network densification is key to modern wireless cellular technology requires that we call for a variety of coordination and cooperation techniques in an ultra-dense heterogeneous network [3]. Furthermore, spectrum efficiency can be enhanced by implementing sharing and coexistence methods alongside the new multi-GHz frequency bands [4].

Coverage optimization using genetic algorithms has been used earlier. For instance, [5] revised the derivate annealing stochastic optimization algorithm to resolve the issue of minimal cost coverage area management for Single Frequency Networks (SFN). Authors in [6] used the transmitter power, the transmitter locations, the number of transmitters, and the antenna height as their decision space variables. Stochastic optimization based on worst-case solution formulation is still better than the best solution achieved through conventional coverage optimization techniques. This work aims to give an extensive overview of this growing research area and highlight the most promising trends from the results using a Genetic Algorithm (GA) optimization technique. GA and its application are proposed to estimate the best location for the 5G BSs in terms of the green aspect, which also resulted in energy consumption.

2 System Model

We considered a hybrid 5G network with a coverage area of $[K \times L]$ Km^2 as our test model, where the BSs (both femto cell and LTE cells) are installed in the given area of our simulation. We assume a set of candidates sites $S = \{s_1, s_2, \ldots s_m\}$ that is given in this scenario. We assume an operational cost for BSs, implanted with each candidate sites $T = \{t_1, t_2, \ldots t_m\}$ for fixed period of time. B number of BSs were used in the simulation. The set of BSs is expressed as $B = \{b_1, b_2, \ldots b_m\}$. The mobile stations can be used at any point in the simulation coverage area. We have enumerated the test points using the set $K = \{1, h, k\}$, where k denotes the number of the base station sites.

The BS has transmission powers are in the range [1–20] watts. In this paper, we have assumed the antenna gain to be 18 dB, with 1800 MHz frequency. However, it varies with different types of cells. We employ the Cost231 HATA urban propagation model [6, 7]. The coverage probability in the area around the location $(X_i; Y_i)$ within a threshold is less than the signal to noise ratio. The Signal-to-Interference-Noise Ratio (SINR) [9] is calculated in Eq. (1).

$$\text{SINR} = M_g(P_t/I) + N \tag{1}$$

where M_g is the Masthead Amplifier (MHA) gain, P_t denoted the base station transmitting power, I and N denoted the interference and noise, respectively. The Path Loss (PL) [10] is determined in Eq. (2).

$$\text{PL[dB]} = P_t \log\log(d/l_b) + G_t - \text{SINR} \tag{2}$$

where P_t is the transmission power, d measures the separation distance between the BS and MS, G_t represents BS antenna gain, and L_b denoted the body loss in dB. Path loss for mmWave SINR is used as described in [9]. The area of coverage (AOC) for the base station is formulated in Eq. (3).

$$\text{AOC}_{\text{cell}} = 3^{1/3}\text{R}^2/2 \tag{3}$$

where R is the radius of the cell.

3 Proposed Approach

We have modeled our network optimization problem to an equivalent genetic algorithm problem.

Encoding: In this paper, our problems decision variables are the on–off constraint P_i, the available power level Q_i, the available antenna heights R_i, and the BS locations (X_i, Y_i). We use both binary and real value representations in our chromosome representation, such as P_i, Q_i, and R_i as binaries and (X_i, Y_i) as real values. Note that Q_i and R_i are only meaningful when P_i is equal to 1 (Table 1).

Table 1 Decision variables

P_i	On–off constraint for BS_i [0,1]
Q_i	Available power level for BS_i [20–70] W
R_i	Available antenna heights for BS_i [50–70] M
X_i	Longitude for BS_i
Y_i	Latitude for BS_i

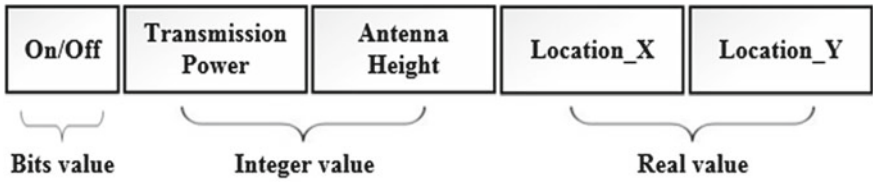


Fig. 1 Chromosome structure

Transmitters and receivers are represented by (X_i, Y_i) coordinates in the proposed GA. A set of candidate transmitters can be presented as a chromosome and a set of chromosomes includes the functionality of the transmitters: transmitter height, power, and their constant antenna gain, the frequency for each user come under a population. Figure 1 describes the structure of our chromosome and how it is organized in our proposed GA. The values that are outside the given ranges of values for the transmitter should be penalized by the predefined criteria in an evolution of the survival chromosome.

Genetic Operation: We applied ornament selection as it selects an individual from a population indirectly according to its fitness value. Because it can easily tune the selection pressure by adjusting the tournament size, tournament selection can produce more diverse individuals that have greater potential to find optimal solutions. Generally, crossover operators are defined by the number of cut points. We applied one-point crossover to maintain population diversity. The cut point was defined as [chromosome size/2] for a chromosome such as that shown in Fig. 2.

Genetic operators mostly consist of selection, crossover, and mutation. A population is generated in a manner to prevent premature convergence in the proposed Algorithm 1 using tournament selection instead of a conventional proportional fitness algorithm such as roulette wheel selection. The tournament selection chooses an individual from a population according to its fitness value. Because, the tournament

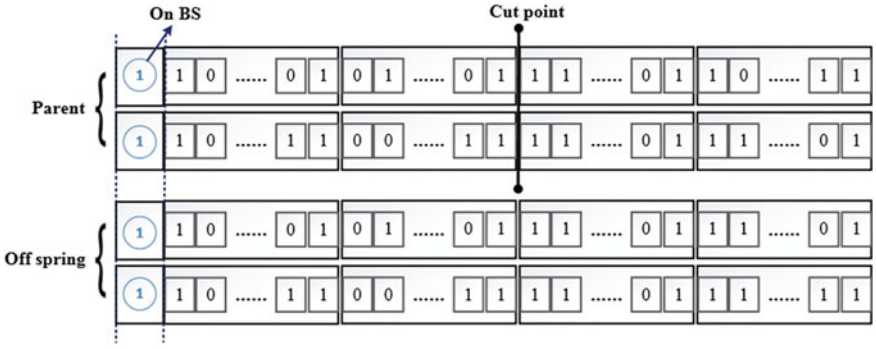


Fig. 2 Crossover

selection can easily tune the selection pressure by adjusting the tournament size, tournament selection can produce more diverse individuals that have greater potential to find optimal solutions.

To generate diversity in the population crossover operation is used. Generally, crossover operators are defined by the number of cut points. We applied one-point crossover to maintain population diversity. The cut point was defined as [chromosome size/2] for a chromosome such as that shown in Fig. 2. We use the first gene in the chromosome to allocate the BS status as On/Off. The mutation operation is applied to a generated child following the crossover operation.

```
    1: Begin
    2: Map chromosome for the possible solution
    3: Initialize the population
    4: Evaluation the population
    5: While (! (Tg) )
    6:  For n = 0 to n = B
    7: Select two individual (si, sj) 2 population by using tournament
selection
    8: Apply one-point crossover to (si, sj) for producing their
offspring(c1, c2)
    9:    for k = 1 to k = 2 Then
    10: Apply mutation to (ck)
    11: Evaluation the individual (ck)
    12: If ck does not exceed the maximum capacity Then
    13: If ck reaches to users within its coverage Then
    14:      Include (ck) to next population
    15:      n = n + 1
    16:      End If
    17:      End If
    18:      End For
    19:      End For
    20:      End While
    21: End
```

Algo 1: GA based green BS optimization

The GA process can be used before the network planning to select BS locations. Moreover, to optimize the network operation BS can be switched on or off in advanced based on the traffic inference and result of our GA procedure. As network planning is done in advanced, the convergence time of GA procedure will not be any concern.

4 Experimental Results

Our proposed GA-based solution and Differential Evolution (DE) are evaluated in terms of the best-optimized coverage individual choice from the population. The fitness parameter is given as $F = \min\left[\sum m^{-1}\left(\frac{P_i \times Q_i}{\mathrm{ANT}_i}\right)C_l\right]\mathrm{W}$, where base station energy efficiency is denoted by m, ANT_i represents the antenna gain, coordinates of the transmitter and receiver are denoted by (P_i, Q_i), and Cl is the cable loss. We

Table 2 Simulation parameters

Carrier frequency [8, 11]	15 GHz
Frame structure	FDD
Population size	200
Number of iteration	100
Transmission power (P_t)	[20–70] W
Receiver antenna gain (G_t)	18 dBi
Base station antenna height	[50–70] m
Cable loss (C_1)	2 m
MHA Gain (M_g)	2 dB
Noise figure (N)	2 dB
Body loss (L_b)	2 dB
Area	Urban
Longitude (X)	126.97796999
Latitude (Upper-left Y)	37.566535
Longitude (Lower-right l X)	126.11596959
Latitude (Lower-right Y)	37.201549
Mobility model	Random walk model
User speed, direction, flight time	[0, 10]m, [0, 2π]degree, [10, 30]s
Propagation model	Cost231 HATA model

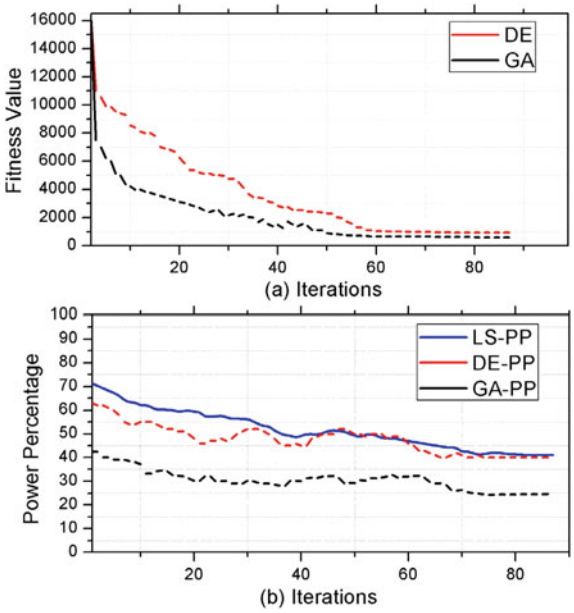
defined a threshold generation T_g for the termination criteria. If the final optimization solution has not been directed from that of the previous generation for T_g generations, then our GA process terminates and returns the best-so-far solution. The 5G simulation parameters are derived from [9] (Table 2).

This scenario allows us to obtain the best location for BSs. After this, we used the best location information to install BSs and conducted the experiment results in terms of energy consumption. The results are shown in Fig. 3. As shown in Fig. 3b, GA-based optimization has a better energy efficiency (10–29% power saving percentage) than either DE or the legacy system (LS). Both GA and DE have similar convergence time as shown in Fig. 3a.

5 Conclusion and Future Scope

In this paper, we have identified the problem of green 5G coverage to cover a given area with low energy consumption. Although genetic algorithms are slow in terms of convergence, they work fine for energy optimization as this problem is not time sensitive. Our experimental results show that genetic algorithm provides up to 29% better energy efficiency than the legacy and the differential evolution techniques. In

Fig. 3 Results



future, this work can be integrated with Artificial Intelligence inference to optimize the BS location for better energy efficiency periodically.

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A Deep Learning Model for Classification of COVID-19 Related Fake News

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Abstract The health crisis caused by COVID-19 throws the whole world into the biggest emergency of the century. Moreover, the pandemic has become awful because of the spread of inadequate and fake news or information among common people. Fake news, gossip and misleading information are on the rise due to the popularity of web-based information sources among people, such as social media, news feeds, online blogs and e-news articles. Monitoring and identifying such fake stories is a prerequisite to cease unwanted panic in this pandemic. But carrying out this task manually is challenging and labour intensive. Computer-assisted pattern recognition can now be used to replace human contact thanks to developments in machine learning, deep learning models and natural language processing. This is also essential for accurately distinguishing between true and false information automatically. A hybrid deep learning classification model has been proposed here to identify and classify the fake news and misleading information on the 'COVID-19 Fake News Dataset' (taken from Mendeley) which is a collection of news or web article related to COVID-19. The proposed classification model has achieved an accuracy of 75.34% and outperforms the existing LSTM and BiLSTM techniques.

Keywords COVID-19 · Fake news · Word2vec · CNN · LSTM

1 Introduction

The Entire mankind is passing through a very difficult time since the outbreak of the COVID-19 pandemic. This pandemic severely affected the lives of many and the

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livelihood of a multitude of individuals. People are unsure about when their livelihood will be back to normal again, with the impact across all levels, particularly socially, economically and in terms of human health. A plethora of fake news about the virus and the treatment not only mislead the public but in many cases leads to unwanted medical consequences. It has elevated an information issue to the forefront of public debate, putting pressure on ordinary people's thinking and beliefs in the face of a crisis. Subsequently urge has emerged to provide a satisfactory solution to the problem of determining what information is true and useful [1]. Several recent studies claim that the dissemination of fake news had a significant impact on the 2016 presidential voting in the United States. False news tales have become ingrained in daily life, exacerbating natural disasters, political violence, intolerance between individuals of various ethnic and cultural backgrounds and even impacting public health. Attempts are being made by governments all around the world to hunt out and solve these issues. According to bbc.com, Germany is all set to enforce a law for regulating fake news and all sorts of negativities that are being circulated using social media. Huge data is generated globally on a daily basis due to the rise of social media and news. The quantity of data produced in this manner is huge, and it frequently contains misinformation. As a result, it is important to verify its veracity. People nowadays mostly consume news through social media and a variety of other online news sources [2]. According to a survey conducted by the Consumer News and Business Channel (CNBC), more individuals are utilizing social media for information instead of newspapers.[1] As a result, in terms of providing real news to such customers, news organizations must first verify the veracity of such online news material. The task is extremely tough for a machine to do since even humans cannot readily determine the validity of a news story after reading it.

Deception detection is the challenge in natural language processing (NLP), with researchers devoting significant time to it. The challenge of identifying false news in our daily lives is considerably more difficult. Deep learning, as opposed to standard feature-based models, has the advantage of having no handcrafted rules or features; instead, it determines the best feature set for a specific issue on its own.

In the context of sentence and document modelling, neural network models have been proven to be superior. Convolutional neural networks (CNNs) and recurrent neural networks (RNNs) are two common deep learning models for natural language understanding; however, their approaches are significantly different. In this paper, we integrate the strengths of both architectures to offer C-LSTM. It uses CNN to extract a succession of higher-level phrase representations, which are then put into a long short-term memory recurrent neural network (LSTM) to generate the sentence representation. It captures both local phrase characteristics as well as global and temporal sentence semantics.

In our study, we use C-LSTM to train semantic representations of sentences for fake news classification. Our experimentation shows that the C-LSTM model surpasses multiple baseline models on a variety of benchmarks.

[1] https://www.cnbc.com/2018/12/10/social-media-morepopular-than-newspapers-for-news-pew.html.

The overall organization of the manuscript is as follows: Section 2 gives an insight into the current literature. Section 3 represents the collection of Dataset and Preprocessing. Section 4 illustrates the proposed C-LSTM based on CNN and LSTM with the word2vec feature. Section 5 explains the results and discussions and is followed by a conclusion in Sect. 6.

2 Related Work

The term 'fake news' is often used to refer to rumours, hoaxes, deception and spam [3, 4]. Bajaj [5] applied different deep learning models for the detection of fake news. This study found that gated recurrent units (GRU), LSTM and bi-directional LSTM (BiLSTM)-based approaches outperform the CNN-based approach. Similarly, Ruchansky et al. [6] created a hybrid deep learning model for rumour detection using social media data. The research suggested that the temporal behaviour of the articles and learning source features about user behaviour are very much essential for the classification of fake news. They also showed that a combination of these two factors enhanced the classifier's performance.

Yang et al. proposed TI-CNN; a CNN-based model to classify text and images [7]. It was trained with both text and image data. CNN allowed their model to visualize the entire input at once that enables it to learn faster than LSTM and other RNN models. Another such approach named DeClarE was proposed by Popat et al. [8]. The proposed approach uses evidence and counter-evidence learned from the web sources to support or discard a claim. Karimi and Tang proposed a novel paradigm for detecting false news [9]. The proposed framework learned the Hierarchical Discourse-level Structure of Fake News (HDSF), which represents each sentence individually in a tree-like structure. HDSF surpassed all other techniques with an accuracy of 82.19%. Elhadad et al. tested three publicly accessible datasets using a mixture of features extracted from online news content and textual metadata (ISOT, FAKES and LIAR) [10]. They obtained 100% accuracy on the ISOT dataset, 62% accuracy on the LIAR dataset and 58% accuracy on the FAKES dataset using various approaches.

3 Dataset Collection and Preprocessing

We have collected the COVID-19 Fake News dataset from Mendeley[2] for our experimental purpose. The dataset included around 6000 items published in a variety of media outlets throughout the world between 15 January and 15 February 2020. Three keywords were used to collect these news articles: corona, coronavirus and COVID-19. Unrelated news stories have been carefully discarded. The news stories

[2] https://data.mendeley.com/datasets/zwfdmp5syg/1.

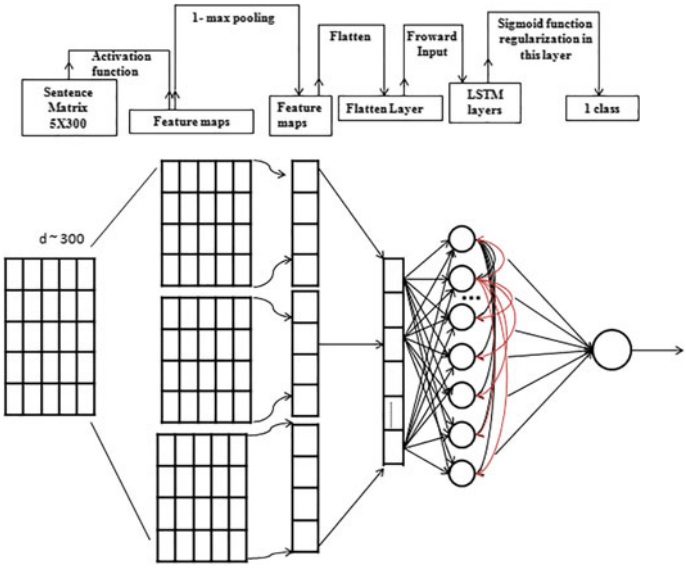

Fig. 1 The architecture of C-LSTM deep learning neural network model

were classified as 'True' and 'False'. After cleaning, the final dataset contained 4072 news articles, 2426 of which were labelled 'True' and 1646 of which were labelled as 'False'.

Data preprocessing is an essential data mining technique that transforms unstructured data into a more accessible format for further analysis and interpretation. The different steps of our preprocessing task are removing the aforementioned impurities and executing tokenization (splitting sentences); removing string punctuations, stop words and stemming.

4 Proposed Methodology

The C-LSTM architecture is depicted in Fig. 1; it comprises two major mechanisms: a deep CNN and a LSTM. The following two subdivisions detail the use of CNN to extract features at the more superior level of word sequences and LSTM to obtain long-term feature relationships between word sequences.

4.1 Feature Extraction Through Convolution Layer

A filter matrix slides across a sequence in the one-dimensional convolution to detect the features at various locations. Let $x_i \epsilon R^d$ be the ith word vector with d-dimension in

a sentence. Let $x \epsilon R^{L \times d}$ represents the sentence with length L. Let $m \epsilon R^{k \times d}$ represents the filter with K length for convolution operation. A sliding window matrix (vector) w_j containing k successive word vectors at each place j in the sentence is denoted as

$$w_j = [x_j, x_{j+1}, \ldots, x_{j+k-1}] \tag{1}$$

A weighted filter m is used in conjunction with window vectors (k-grams) at each point to produce a weighted feature map $c \epsilon R^{L-K+1}$. The weighted feature map for window vector w_j is created for each component c_j as follows:

$$c_j = f(w_j \cdot m + b) \tag{2}$$

where "·" is symbolized as element-wise multiplication; $b \epsilon R$ is represented as a bias name and f is specified as a nonlinear transportation function. In our model, we have chosen ReLU as the nonlinear transportation function. Various filters are used in the C-LSTM model to create multiple weighted feature maps. For n equal-length filters, the produced n feature maps are rearranged for every window w_j to provide feature representations.

$$W = [c_1; c_2; \ldots; c_n] \tag{3}$$

Semicolon indicates the concatenation of column vectors in this case. The i^{th} filter produces a feature map as c_i. Every row W_j of $W \epsilon R^{(L-K+1) \times n}$ is the nouveau representation of feature for the sliding window vector at point j, which has been created by applying n filters to the window vector. The higher-order window representations are then inputted into the LSTM described below. After the convolution, a max-over pooling is commonly used to choose the most significant features from feature maps.

4.2 Long Short-Term Memory

LSTM deep learning model is an advancement of RNN. The current input of the RNN is the output of the previous step. It's true that when there's a large gap between two time steps, conventional RNNs become incapable of learning long-term dependencies. To overcome this problem, LSTM was inaugurated by Hochreiter and Schmidhuber [11]. It is designed by a series of gates in R^d based on the hidden state h_{t-1} and current input x_t at each time step, the input gate i_t; the output gate o_t; and the forget gate f_t. These gates determine how to moderate the present hidden state h_t and the present memory cell c_t jointly. The memory dimension of the LSTM is denoted by d, and the dimension of all vectors is the same. The transition functions of the LSTM are as follows:

$$i_t = \sigma(W_i \cdot [h_{t-1}, x_t] + b_i) \tag{4}$$

$$f_t = \sigma(W_f \cdot \left[h_{t-1}, x_t\right] + b_f) \tag{5}$$

$$q_t = \tanh(W_q \cdot \left[h_{t-1}, x_t\right] + b_q) \tag{6}$$

$$o_t = \sigma(W_o \cdot \left[h_{t-1}, x_t\right] + b_o) \tag{7}$$

$$c_t = f_t \odot c_{t-1} + i_t \odot q_t \tag{8}$$

$$h_t = o_t \odot \tanh(c_t) \tag{9}$$

Here, σ represents the activation function named sigmoid in range [0, 1], $\odot$ represents the pair-wise multiplication and *tanh* signifies the hyperbolic tangent function in range $[-1, 1]$. LSTM is specifically built for understanding long-term dependencies from sequential data; so, we apply it to the convolution layer in order to learn about relatively high feature relationships.

For fake news classification, we use the LSTM's hidden state output of the final step which is the representation of the whole document and apply a softmax activation layer on top. The entire model is trained using the cross-entropy error.

$$H_p(q) = -\frac{1}{N}\sum_{i=1}^{N} y_i \cdot \log(p(y_i)) + (1 - y_i) \cdot \log(1 - p(y_i)) \tag{10}$$

Here, the label is named as y and the predicted probability ($p(y)$) of the outcomes for all N training points. To learn the model parameters, we use SGD (stochastic gradient descent). The maxlen denotes the maximum sentence length in the training set. Because our model's convolution layer requires input with fixed length, we separate every sentence with a specific symbol indicating the unknown words. In the test dataset, padding is done on the sentences less than *maxlen* in the same manner, and sentences longer than *maxlen* are basically trimmed to *maxlen*. Here, the size of *maxlen* is 300.

We have used the pre-trained word2vec model[3] to represent the words as in vector form. The word vector has a dimensionality of 300.

5 Results and Discussions

Throughout the section, we have assessed the efficiency of our proposed technique and compared it to existing systems on the same dataset. In Table 1, we have depicted that the C-LSTM includes word2vec feature and obtained the accuracy score 75.34%.

[3] https://code.google.com/archive/p/word2vec/

Table 1 Comparative study of the proposed model with existing models

Model name	Feature vector	No. of epochs	Accuracy (%)
LSTM	Word2vec	10	68.70
BiLSTM	Word2vec	10	72.31
C-LSTM (proposed)	Word2vec	10	75.34

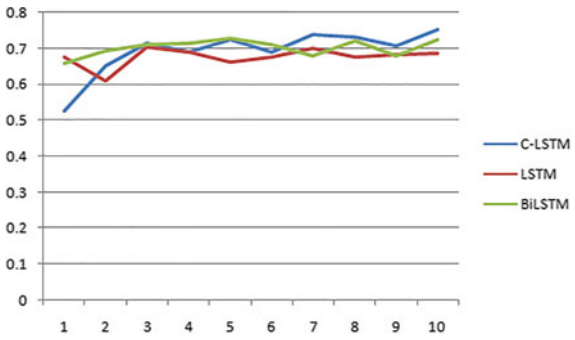

Fig. 2 Graphical representation of accuracy on validation dataset by C-LSTM, LSTM and BiLSTM

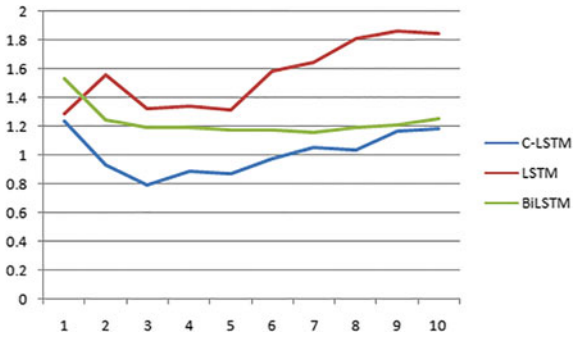

Fig. 3 Graphical representation of loss on validation dataset by C-LSTM, LSTM and BiLSTM

We have shown a comparative study of our proposed technique C-LSTM with the other models (LSTM and BiLSTM) presented by Abhishek Koirala in Table 1 [12].

From Table 1, we have observed that our proposed model gives higher accuracy than the existing models. A comparison of the accuracy and loss function of C-LSTM, BiLSTM and LSTM on the validation dataset is presented in Fig 2 and Fig 3.

6 Conclusion

The experiments demonstrated above highlight that C-LSTM-based deep learning model is more efficient than LSTM and BiLSTM models in COVID-19 Fake news

classification. However, selecting correct models is a prerequisite. Additionally, inconsistency in the dataset may result in deviation of the model. False news items come in a variety of forms. Certain news stories include entirely incorrect information, while others contain just partially inaccurate content. In this pandemic, situation to take precautionary measures and to prevent the fear of this crisis among people these kinds of fake news and misleading information floating over different Media must be eradicated. The proposed model is a step forward in the right direction of research for the purpose.

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A Review on Knowledge Discovery from Databases

Niraj Singhal and Himanshu

Abstract Knowledge discovery is defined as the method used for discovering interesting, previously unknown and potentially useful patterns from a massive amount of data. It is an integrative area of research, including illustrative work from areas such as database technology, machine learning, and pattern recognition, extraction of valuable information, neural network, artificial intelligence, high-performance computing and data visualization. The process of finding knowledge from the data is also getting more important as the data is increasing every day. This paper discusses the process of knowledge discovery and also gives description about the challenges faced when knowledge is discovered. It also presents the work done in the related area and their comparative analysis.

Keywords Knowledge discovery · Machine learning · Data mining · Complex data · Pattern evaluation

1 Introduction

Knowledge discovery in databases (KDD) is a dynamic field of research that promises high returns in many professional and scientific domains. The corporate, government and scientific communities are being shunned by the incursion of data that is consistently stored in online databases. Analysis of this data and extracting out some meaningful pattern in a felicitous manner is impractical. The process of KDD involves searching for useful knowledge from the data gathered from various sources. The current scenario is characterized by increasing enormous amount of data and all kinds of human efforts are being generated and shelved. This vast amount of data is recorded as computer databases are managed by computer technology in an easy way. Data is being collected and assembled across a wide variety of areas at a dramatic

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pace. New development of tools and computational theories are urgently required to help human being in withdrawing valuable information from the enormously rising proportions of digitalized data [1]. These tools and theories together constitute the main part of the dynamic field of KDD.

At abstraction levels, the field of KDD is mainly concerned with developing various strategies and methods for generating meaningful data. The major problem came across knowledge discovery is mapping low-level data into another more abstract, compact and useful form [2]. Fundamentally the process includes implementation of specific data mining techniques for pattern recognition and extracting useful knowledge.

Many techniques used for handling these tasks include cluster analysis, regression analysis, multidimensional analysis, numerical taxonomy and several other statistical methods. Many practical problems are solved by using such techniques. However, they are mainly focused on extraction of quantitative and statistical data, and as such they have some limitations. While discovering knowledge from single data source, the problem lies in that only of one type and less amount of information is obtained. So, there is a need of efficient methods to collect the vital information from multiple data source [2]. In this paper, a survey of various approaches which are useful in this area has been carried out. A comparative study of the approaches has also been presented.

2 Related Works

Knowledge discovery is referred to as the process of observing hidden designs and patterns from an enormous volume of the data sets. It includes transformation of the obtained patterns into comprehensive and easily understandable information. The domain of knowledge discovery comprises various processes that are carried out at various stages through which the basic rules of the knowledge discovery domain are made. It involves the possible analysis and interpretation of the evaluated patterns to decide what is called knowledge [3]. This includes schematic enciphering, preprocessing, sampling and projections of data before we move for data mining.

2.1 Steps Involve in Knowledge Database Discovery Process

Seven major aspects should be considered before selection of databases for their analysis. To understand the database prerequisite knowledge is required which is as follows [4]

- Cleaning of Data—The process of removing the irrelevant and noisy data from gathered data.

- Integration of Data—The process of combining adverse data collected from numerous sources into one common source.
- Selection of Data—The process in which the relevant data required for analysis is decided and retrieved from data collection.
- Data Transformation—The process of converting data to the appropriate form as required.
- Data Mining—The process of applying techniques so that potentially useful patterns can be extracted.
- Pattern Evaluation—The process of identification of unrevealed patterns to represent knowledge.
- Knowledge representation—The process in which data mining results are represented using visualization tools.

The complete knowledge discovery process is shown in Fig. 1.

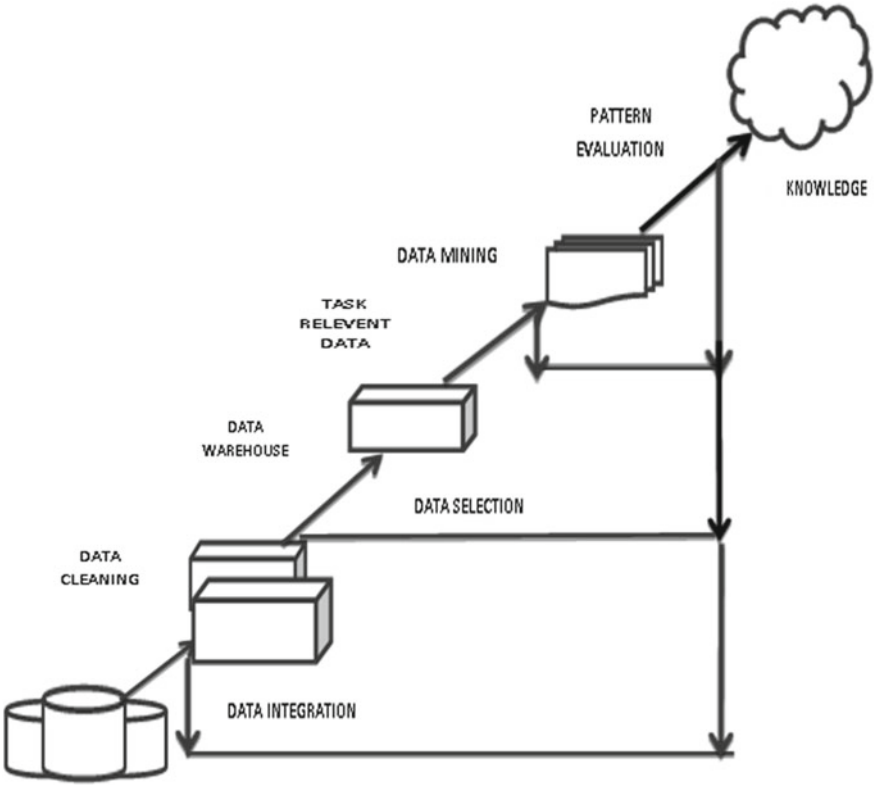

Fig. 1 Knowledge discovery process

2.2 Issues and Challenges in Knowledge Discovery

Knowledge discovery is developing into a trusted discipline; however, there are still many challenges that need to be resolved. There are some issues and challenges those are identified in knowledge discovery process [5].

- Noisy and Incomplete Data—"Data Mining is the way of acquiring information from massive volumes of data". Generally, the data collected is heterogeneous and noisy. The extensive amount of data is irregular and unreliable. Such kinds of issues may arise due to human errors or due to instruments which are used for data collection.
- Distributed Data—In this process, the data is passed through many stages. It can be easily carried out using internet or through individual systems. It is critical to unify all the data because of organizational and technical reasons.
- Complex Data—The data obtained is really heterogeneous which may include text, spatial data, audios, videos, images, words, etc. It is tough to handle such diverse kinds of data and focus on requisite vital information. Sometimes we need to create new systems and equipment's to separate crucial facts and information from the data.
- Performance—Fundamentally, the presentation of the data mining framework is dependent on efficiency of techniques and methods used. If algorithms and techniques used are insufficient, then it adversely affects the presentation of data mining.
- Scalability and Efficiency of the Algorithms—Efficient and scalable algorithms are to be used in order to extract valuable information from vast amount of data.

3 Review of Literature

Knowledge discovery covers a wide area of research. The work done in the area is as follows.

Silwattananusarn and Tuamsuk (2012) discussed the suitable methods and techniques which are needed in future to serve the requirements of data mining field as it is becoming more complex day by day [6]. According to Tomar et al. (2013) data mining is most active and likeable area of research which is capturing its attention in medical applications. [7]. Fan et al. (2014) explained knowledge discovery as the capability of obtaining useful statistics from a wide variety of datasets that because of its variability, volume and velocity [8]. Saurkar et al. (2014) described data mining as "interdisciplinary field which includes integrated databases, machine learning technique, artificial intelligence, statistical approaches etc.". The data mining technique helps in extraction of hidden information and knowledge by digging deep into the data [4]. Real time analysis of streaming data is becoming the most efficient and fastest way for obtaining useful knowledge (Bifet et al. 2014). This allows firms to respond rapidly whenever a trouble appears to ascertain the enhanced performance

[9]. Purcell (2014) stated that knowledge discovery databases consist of unstructured, semi-structured and structured data sets which cannot be handled using the traditional methods and systems. Data storage technique is used for object-based storage [10].

Reddi and Indira (2014) explained that a combination of heterogeneous, homogenous, unstructured, semi-structured data is known as big data. It also suggested a model for shifting and handling of vast quantity of data over the network [11]. Ibrahim et al. (2014) said that due to the presence of partitioning skew a huge amount of data transfer occurs which causes negligence on the reduce input among different data junctions and also develop a novel algorithm named LEEN [12]. Gamache et al. (2015) discussed the idea of linking various text mining techniques to convert the unstructured data in the forms of texts into structured data in the forms of numbers so that various statistical and mathematical algorithms can be applied [13]. Baker et al. (2015) primarily deal with the development of techniques which can be used for analysis and discovery of novel and useful information [14]. Soni (2015) discussed the prediction of future sales and trends based on patterns related to customer's behaviour. This helps in increasing profits by assisting policymakers in decision-making [15].

Kaplan and vakili (2015) proposed a version to generate a text primarily-based degree of understanding recombination that they ultimately comprise as an impartial variable into their econometric version [16]. Kumar and Chatterjee (2016) focused on clarifying the relationship between techniques applicable for data mining and knowledge discovery and also discussed the data mining techniques, specialized methods for certain type of data and field [2]. Angus (2018) figured out document similarity measures in order to explore the link between search distance and firm performance [17]. Hariri et al. (2019) discussed about the capability in creating and managing information that has been a dominant factor in the growing era of technology [18].

Sankari and Shraddha (2019) introduced the application of data mining techniques on information generated from educational settings. The usage of educational data mining and analysis of data about learners and their contexts is the key to successful inference model of educational data [19]. Kumar and Basha (2020) have discussed the methods of accessibility of high volume of text-based data that needs to be examined for retrieving information [20]. Roozbahani and Rajabzadeh (2020) focused on past and current status of researches on big data in the medical and science-related areas [3]. Abdualgalil and Abraham (2020) focused on machine learning for knowledge discovery in big data. According to him machine learning needs to be more explorable, so that interacting with various kinds of data will become easier for a learner [1]. Lauw and Wong (2020) have discussed original research results, current new ideas and advanced experiences from all knowledge discovery-related areas such as data mining, machine learning, artificial intelligence, decision-making systems and other emerging applications [21].

4 Comparative Study

All the approaches discussed in earlier section use different techniques. These also differ on various parameters like technique used, database type, accuracy, sensitivity, specificity and fidelity. A comparative analysis of all approaches discussed is presented in Table 1.

Table 1 A comparative analysis

Name of authors	Technique used	Database type	Accuracy	Sensitivity	Specificity	Fidelity
Silwattananusarn et al. (2012)	Machine learning	Single	Yes	Yes	No	Yes
Tomar et al. (2013)	Machine learning	Multiple	Yes	–	No	No
Fan et al. (2014)	Classification	Single	Yes	Yes	Yes	No
Saurkar et al. (2014)	Clustering	Single	Yes	–	Yes	Yes
Bifet et al. (2014)	Machine learning	–	No	Yes	Yes	No
Purcell (2014)	–	Single	Yes	No	Yes	–
Reddi et al. (2014)	Classification	Single	Yes	Yes	No	Yes
Ibrahim et al. (2014)	OLAP	Single	Yes	–	Yes	No
Miner et al. (2015)	–	Single	No	Yes	Yes	No
Baker et al. (2015)	Machine learning	Multiple	Yes	Yes	Yes	No
Soni et al. (2015)	–	Single	Yes	–	Yes	Yes
Kaplan et al. (2015)	–	–	No	Yes	No	Yes
Ajay Kumar et al. (2016)	Machine learning	Single	Yes	–	No	No
Rüdiger et al. (2017)	Classification	Single	Yes	–	Yes	Yes
Angus (2018)	Clustering	Single	Yes	No	Yes	No
Hariri et al. (2019)	Machine learning	–	Yes	No	Yes	–
Sankari et al. (2019)	Machine learning	Single	Yes	Yes	No	Yes
Kumar et al. (2020)	Regression	Multiple	Yes	–	No	No

(continued)

Table 1 (continued)

Name of authors	Technique used	Database type	Accuracy	Sensitivity	Specificity	Fidelity
Roozbahani et al. (2020)	Machine learning	Multiple	Yes	Yes	Yes	No
Abdualgalil et al. (2020)	–	Single	Yes	–	Yes	Yes
Lauw et al. (2020)	Machine learning	Multiple	No	Yes	Yes	No

5 Conclusion

The knowledge discovery process primarily aims at finding out the exact information from the large datasets. The implementation of knowledge database discovery methods and techniques will help users to extricate meaningful information from virtually accumulated large amount of data. For industries like telecommunication, retail, biomedical, etc., such techniques are used widely. These techniques are proved to be helpful in predicting future trends and allow business activities proactive, dynamic and present valuable and useful knowledge which is simply understandable to human being. This paper provides an outline of the knowledge database discovery process. It presents a detailed study of knowledge discovery with various studies like steps, principle and challenging issues. A primary goal of this paper is to elucidate the relation between knowledge discovery and data mining. It also defines the knowledge database discovery process and important data mining techniques.

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A Novel Learning Approach of Adaptive Cyber Defense System for Smart Cities

Niraj Singhal and Arpit Chhabra

Abstract The paper includes a researching model from an attacker simultaneously and repeatedly manages attacks. Under this, a model is proposed in which iterative learning system that allows the defender to identify optimal. When the increase number of attacks targeting information and knowledge stealing information and security component, it protects the data and denying right full access to information and evolved to develop numerous natural variety of protection to assist them to avoid and eliminate danger and adapt to surroundings for survival. An adaptive cyber defense system is employed here to boost our systems resilience by security levels and metrics with transparency and secret writing. Pseudo-code illustration converges to the foremost response with regard to the attacks once the wrongdoer diminishingly traverses the system.

Keywords Security · Adaptive cyber defense system (ACDS) · Learning algorithm

1 Introduction

Smart cities are brewing the easy target for cyber threats and security attacks, which leads to disrupt the system, as in smart cities every system is connected to another and the security of sensitive data is under un-president threat. In order to adapt the system from threats, one can use passive immunity concept previously introduce to us in the form of vaccination. As in vaccination an inactive antigen (foreign particle) is added to the body and in against to protect the body from antigen and form antibodies and create a memory of an antigen to save the body from upcoming antigens. Similarly, one can introduce the number of harmless threats to a system which in turn deal with threats and secure the data, system will form a response against threats and adapt it from upcoming threats.

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2 Problem Identification

Detection requires context such as known threat opens a new set of challenges. Current cyber defense system is mostly static. So, the attackers have enough amount of time to explore and equally create the foremost the vulnerabilities of smart city eco-system. In order for smart cities to pursue technology-centric smart solutions, the Adaptive cyber defense system (ACDS) needs to upgrade with detection efficacy monitoring and critical alert monitoring. Threat detection is to uncover all related activity exposing all phases that do not discover ever before which seems to be malicious activity that may be similar to the previously discovered and also identify the breadth of security incident.

3 Related Works

Smart cities are typically pictured as constellations of contraption across several scales that are connected through multiple networks that provide continuous information concerning the movements of people and materials in terms of the flow of alternatives concerning the physical and social form of the city [1]. Detection needs context like legendary threat opens a replacement set of challenges. Thus as for good cities to pursue technology-centric good solutions, they need to upgrade with detection effectiveness watching and necessary alert watching. Threat detection is to uncover all connected activity exposing all phases that do not discover ever before that looks to be malicious activity which is able to be virtually just like the antecedently discovered and additionally determine the breadth of security incident [2]. Privacy and security issues with smart cities, and presents on the basis to designate the future developments among this space. It additionally presents a thematic taxonomy of security and privacy issues with good cities to spotlight the security necessities for coming up with a secure good town, determine the prevailing security and privacy solutions, and gift open analysis problems and challenges of security and privacy in good cities [4]. The varied nature sciences are necessary to their understanding which can be a moving objective there in urban communities themselves are getting more and more superb through the terrible advancements for utilizing them [5]. Security includes felonious access to data and attacks inflicting physical disruptions in service convenience. As digital members are additional and additional instrumented with information offered concerning their location and activities, privacy looks to disappear. Privacy protective systems that gather information and trigger emergency response once required are technological challenges that go hand-in-hand with the continual security challenges [6]. If a network is to figure with success, its users have to be compelled to collaborate. Collaboration takes the form of following a network protocol and involves some resource disbursement on an area of the user. Therefore, users cannot mechanically be expected to follow the protocol if they are not forced to [9].

3.1 Problems Related to Cyber-Attacks/Threats

Increasing number of malicious application targeting users directly through smartphone and tablets is as follows [3]:

- Malware getting more complex, effective, and difficult to detect points to new spread channel through application market places dynamics of which have been understood.
- Growing use of social media will come up with personal cyber threats cyber security is a complex problem which required use acceptance and involvement it and orientation for adaptive and intelligent technology on services, processes and application-level network level and terminal level also multi-factor approach which are social logical political and legal issues.
- Cybersecurity solutions road maps consider all possible sources point to continuous vulnerability and risk management continuous and adaptive mitigation.
- Create and security understanding and culture in the society elaborate internationality.

3.2 Four Stages for Adaptive Cyber Security

The four stages of associate reconciling security design area unit as predict, prevent, respond, and defect. These are often in brief outlined as

- Predict—assessment of risk, anticipate attacks within and outside the system or malware, implement standard systems and procedure.
- Prevent—harden and isolates the systems to forestall security threats.
- Respond—investigate origin of incidents, style policy changes, conduct ex-post-facto analysis.
- Defect—order risks at initial level defect and contain incidents areas.
- These four stages—combined with policy, observations, and measures the area unit to produce a system with a capability to quickly trace and answer suspect behavior at the supply. This happens with things like malware connecting at associate termination, or a user acting suspiciously [6].

4 Approach Applied

Under risk analyzing security model during which the observation of cracks stay continuous and improves a cyber security risk amendment and evolve over time historically security strategies of the past enclosed antivirus software's intrusion detection system, intrusion interference system, and firewalls, these approaches measured merely are not enough any longer as a result of the event practices and

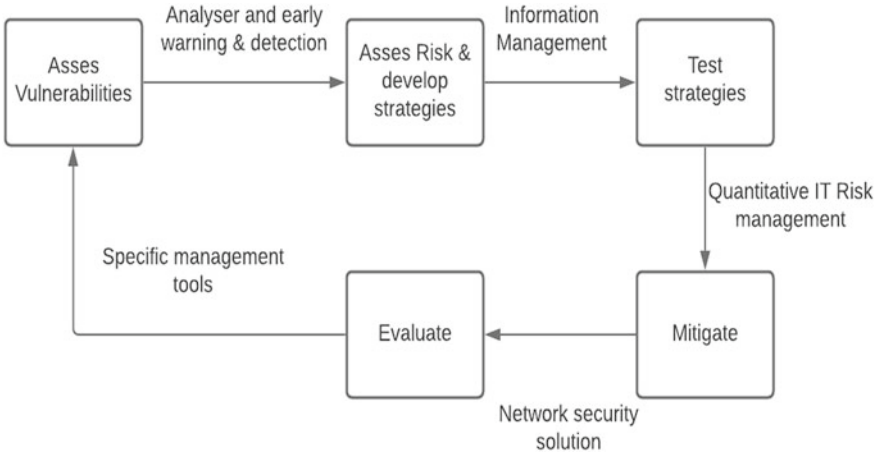

Fig. 1 Risk analyzing model

therefore the atmosphere are not any longer static, security system got to be integrated with continued readying and it's similarly as within the virtual cloud and hybrid atmosphere [7] (Fig. 1).

5 Proposed Work

In learning algorithm, input data (called training data), is fed to the algorithm. The training data is pre-classified and labeled. It is referred to as learning because the process of algorithm learning from the training dataset can be considered as a tutor supervising the learning process [8]. The training method resume till the model attains a desired level of accuracy on the training information. This approach needs having a dataset that represents the system into account and may be accustomed to estimate the performance of the chosen methodology [10]. A typical learning task is classification that has become a lot wide employed in response to quickly ever-changing developed surroundings and link of everything, the goal of adaptive security is to make a feedback circuit of the threat visibility detection and bar that consistency become more practical. A learning cycle goes through many phases as delineated in pseudo-code is given (Fig. 2).

First, it starts from starting point. During the pre-processing, the data set is purified and checks the system in ideal status. One has to deal with an ever-involving advisory since the attacks are unknown so one can't learn the signature of the attacks from the previous danger. Rather than previous learning signature created and Adjust Queue() under Sample Move() function which is basically learned from the network traffic and finds the deviant pattern that is malicious under Looks_For_Attacks() function. A constant update for result based on new evidence that has been created

```
Start;
Check starting point;
Check Finishing point;
Find Idealposition()
Sample Move()
{
    Adjust Queue;
    Look for Attacks();
    Look_Injunction();
    Sample Move();
}
Check Sample_if_there()
{
    Current Co-ordinates_samples;
    End point Injunction();
    Check if(Current==Injunction)
    {
    Stop();
    }
    else
    {
    Sample Move();
    }
}
```

Fig. 2 Various phases of learning cycle

as Look_Injunction() under the sample move. It is essentially designed to cut off offensive agent by perceptive it and police investigation what data the assailant is when and wherever it came. One of the most important tasks is mining the data from the observer attack that is used for the process of features extraction from the previous attack pattern under the checkSample_if_there() and finding out the current coordinates of samples if the current co-ordinate is equal to the endpoint directives then initially stop or interrupt the network connection or call the Stop() for do not connect to the specific server or change the connection frequency or data transfer volume other right it moves again.

6 Analysis

In this segment, a set of study on the higher than explicit learning algorithmic program has been conferred. The asymptotic running period of time currently depends mainly on the informational structure that to represent this, which permits identification of the minimum label in constant time, with look-ups, deletions, and insertions then being performed in logarithmic time. The complexity of the pseudo-code begins with the Check Starting point $O(1)$ and the Check Finishing point with $O(1)$, at the initial level of FindIdealposition(), at Sample Move() functions state the complexity is $\sum O(n) = n2 + n$. Now at the adjust Queue and Look for Attacks() where it maintains the communication link and carried out the substantial efforts where one find the complexity $O(1)$ and at Look_Injunction() where two nested loops encountered at O(n2). By calculating the complex function from previous attack pattern with Current_Co-ordinates_samples() with $O(1)$ so the total complexity of an algorithm is calculated as $\sum \text{total} O(n) = n2 + 4n$. At normal implementation and simply making an attempt to run such datasets or perhaps in giant datasets that will have an effect on the period further as may affect the decision-making method just in case of a true on-time necessity system.

7 Conclusion

Adaptive safety calls for sturdy answers that contain quite a few functions and safety measures for predicting threats and making sure complete community and last protection. Taking a enterprising method to safety, allows firms to greater simply adapting to the converting risk panorama and provoke speedy incident reaction measures to stop breaches earlier than they could divulge sensitive information much better, earlier than they benefitting to get entry at all. It is difficult for the defender to ingress to all the private and confidential data of the attackers and it is miles hard for the defender to set up a particular version of with the restrained statistics approximately the opponent version that are forestalls and the defender for deciding on right defenses to limit the utilities and can also additionally spend full-size time and efforts to guard an asset.

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A Relative Study on Machine Learning-Based Algorithm Used to Develop Recommender Systems

Avinav Pathak and Mamta Bansal

Abstract The research paper focuses on review of methods and techniques utilized for designing a recommending system using machine algorithms for e-commerce platforms. It also discussed developing innovative machine learning-based algorithms for e-commerce platforms. The paper gives a critical review and finds some scientific gaps in the literature related to machine learning-based recommendation systems and their designing methods. It then provides a suitable methodology to design and develop a machine learning algorithm for e-commerce platforms by using an improved approach of recommendation systems.

Keywords Recommendation systems · Machine learning algorithms · Filtering · E-commerce platforms · Data collection

1 Introduction

The web has become an essential tool to satisfy a consumer search on any domain. Due to the exponential growth of social networks and the customization of content structures created by online users, personalization is a desirable feature for each website. Content recommendations that are related to the software tools and strategies that propose stuff for the user to utilize in efficient manner. Recommendation systems are the subset of the information cleaning systems that anticipate user's ratings for an object. Suggestions made by the feedback framework are based on the decision-making process of the consumer, etc. what to learn, what to the lookout for. These recommender systems will educate from the experiences of their clients and suggest the items which they will find most suitable among all the possible outcomes. Recommender systems (RS) have surged in popularity in recent years, with

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applications spanning a wide range of areas such as online book purchasing, home appliances, movies, and electrical devices, healthcare professionals and hospital's advice for the patients suffering from diseases, the institute level recommendations for the students as well as professors and also the hotel and restaurant recommendation systems for tourists. There are a number of different varieties of the product suggestive systems and each of them is based on a separate machine learning method for data refining. Content-based Filtering, Collaborative Filtering, Complementary Filtering, and Hybrid or Novel recommendation systems that combine Content Based and Collaborative Filtering-Based methods are the primary types.

Content-Based Filtering keeps track of a user's behaviours, such as procrastination. The Collaborative filtering techniques involve the gathering and examining the data on the patterns as well as attitudes of user groups and anticipating what each user wants to be based on their resemblance to other users.

Next is the complementary filtering in which the system learns the likelihood that two or more than two products will be purchased in an integrated manner. As such, algorithms are based on the recommendation of products which are complementary to some other items or products, i.e. they are defined by product instead of being defined by the user, as in Context-Based Filtering and Collaborative Filtering.

Hybrid recommendation systems: Hybrid techniques combine the above two algorithms to make recommendations.

2 Related Work

Numerous researchers and scientists have contributed to this field. In this research paper, the author has cumulatively discussed and provided a review of machine learning-based algorithms for e-commerce platforms. A few are mentioned below.

The scientific research is conducted by the author on Web-Based Rating Prediction System for Shopping Marts. The author has used content-based filtering and applied this to the recommendation system which is based on collaborative filtering. They have also proposed an automated rating scheme for another collaborative filtering that reduces the probability of any of the imprecise user review data items or details. The automatic rating system is also used to predict the user's behaviour [1].

In this scientific study, there are two-fold approaches. First is that they have done a comparison on customer's purchase and customer feedback after purchase, i.e. what a customer feels during buying of product and after purchasing the product. Secondly, they have developed a recommendation system as per the user satisfaction level using a novel associative classification method, i.e. mining of multiclass information from need rating data [2].

The research work comprises integrating collaborative filtering with extracted opinions for movie reviews. The relationship between a user's movie review and movie ratings is analysed. To model this, the author has organized and managed all the inclusive ratings with feature rankings specially provided for a moving picture

or movie into a variable value after that it applies a variable iteration technique for surveying the architecture of these variables [3].

In further research, the mobile content recommendation systems for re-examining users are also suggested. The content-based filtering is employed with the current mobile content recommendation model. When any user exchanges the information related to mobile linked data rankings, there is a change from the suggestions which were applied on the past experiences by some other users, to the individual suggestions based on the user preferences [4].

This scientific study explains a two-step method. In the first step, the author's proposed solution is distributed over three steps to suggest the products by pre-processing, which consists of obtaining user profiles from the Movie Lens dataset. They defined views from user feedback in the second stage. Then they deduced the weight of the consumer and the weight-based opinion of the object from the chosen name. Finally, two algorithms based on SlopeOne and SVD algorithms are used to forecast the recommendation method [5].

In this study, there is a comparison of details of the various categories of recommender systems and best voted recommendation methods and their uses [6].

A unique method to suggest structures based on a neuro-fuzzy approach is used in this work. The user can utilize the neuro-fuzzy method to decide whether or not to suggest processed objects. The approach offers users the ability to understand and model decisions applied to their behaviours in the test domain. Hence, a ranked list of top-ranked objects is provided to the consumer based on virtual rank for each of these objects. They have developed an AI system to conduct experiments [7].

In the research work, the authors show how the scores and consents of applications can be helpful for an efficient recommendation framework. User rankings and consents are extracted via the web crawling method. An overview of mobile protection research is developing in popularity [8].

A study has also been conducted on the replica-based collaborative filtering recommendation framework with good precision and consistency recommendations, incorporating clustering approaches like the k-means ++ method in order to minimize the metrics of values. The exploratory results revealed that the recommended Collaborative Filtering Suggestion method has reasonable correctness [9].

Further in research, a novel machine learning method to suggest effective programmes for students based on their educational background. The approach first categorizes a new student by using the k-means clustering algorithm based on their previous results. Next the collaborative filtering method will be applied in the cluster to recommend a few suitable courses [10].

3 Comparative Study

The paper discusses the comparative analysis of machine learning-based recommendation systems for e-commerce platforms.

In 2001, a Web-Based Rating Prediction System for Shopping Marts was developed. The author used content-based filtering and applied this to the recommendation system which is based on collaborative filtering. They also proposed an automated rating scheme for the collaborative filtering method that reduces the possibility of any inappropriate user review data. The automatic rating system is also used to predict the user's behaviour [1]. But the issue was novel data mining techniques were not integrated with the existing system by the author that can predict accurate results. In 2010, the authors have followed a two-fold approach. First is that they have done a comparison on customer's purchase and customer feedback after purchase, i.e. what a customer feels during buying of product and after purchasing the product. Secondly, they have developed a recommendation system as per the user satisfaction level using a novel associative classification method, i.e. mining of multiclass information from need rating data for developing a machine learning-based system. The issue or drawback in this study was the authenticity of consumer needs and desires also has a direct influence on the efficacy of the recommendation framework that was missing in the system.

Later on, in 2012, authors have proposed a new approach of integrating collaborative filtering with extracted opinions for movie reviews. The authors organized general ratings and also feature-based rankings for any movie and then applied a variable iteration method for searching the architecture of that variable. But still better opinion extraction methods could have been used that could derive accurate results [3]. Further, in 2013, the authors proposed an approach to recommend books in the computer science field by analysing the user queries on the Google search engine for a book. They have extracted the queries from users, proposed some features for the usefulness of books, and then weighted these features. But still, one can automate the proposed technique to reduce the workload and time.

Further, in 2013, methods and techniques were designed and developed for tourist guidance. The authors have worked on features and opinions of users and analysed their sentiments available online on social media apps like Twitter [11]. Different types of contextual data were used. But still, the scope of improved algorithms was present as it was a time-consuming process of opinion extraction.

Later in 2014, using the user feedback score, authors have presented a recommendation process, taking the implicit feedback from users to users and rate their operations for a better recommendation that can satisfy the consumer [12]. But the major drawback of this approach was that the authors have used only five parameters to rate the operations. More than five parameters can also be used.

Further, in 2014, authors have proposed corpus-based information extraction method. The authors have observed with a variety of machine learning representations and sets of features and employed statistical tests to pick the optimal classifier for each element of the restaurant. But logistic regression and SVM can be used for more sophisticated results in the future.

In 2015, the authors proposed a new suggestion approach, which uses the integrated elements of the mining techniques of classification and opinion. To distinguish positive and negative feedback, classification techniques helped to classify the attributes of a book into various groups for research and opinion mining techniques.

This recommendation framework recommends books to a consumer when considering the functionality they are searching for [13]. But deep learning algorithms could have provided better results in this study. Further, in 2016, the authors proposed a feature-based opinion extraction and analysis from book reviews on the internet. The scores of the characteristics are quantified using Ordered Weighted Aggregation (OWA), a well-known fuzzy averaging operator. To guarantee that the suggested books have the most coverage of these traits, linguistic quantifiers are added to over-extracted features, but this method was again very much time-consuming and cannot be applied to a larger data set [14].

In 2017, the authors proposed a system which generates the reports for both producers and customers. All products dashboard is created where the user can view the product and its ratings based on the reviews. In addition, the consumer may learn about the product's features. The consumer may track the product's performance over time and compare it to other comparable items on the market [15]. But the efficiency of this method drops majorly when passive voice sentences and complex sentences were used by the customer or user.

After that in the year 2020, a machine learning method was proposed to recommend learners appropriate courses based on their learning history and past performance [10]. But better neighbourhood formation can be achieved by using improvised machine learning-based algorithms and classification methods.

4 Data Extraction and Pre-processing

There are three approaches to develop recommendation systems;

(a) Content-Based Method
(b) Item Based
(c) Model-Based.

In this research, a model-based approach of collaborative filtering to build an algorithm for e-commerce platforms is proposed. In the model-based approaches, using available historical data, a model is built with weights learned automatically. The learned weights will be used to make new predictions about the items, and the final findings will be ranked in a specified order before giving recommendations. Model-based recommendations are much more accurate than heuristic-based approaches such as neighbourhood methods. In heuristic methods, the weights of products/product content are more static, whereas, in model-based recommendations, the weights are determined by auto-learning. Using data-driven techniques, the model-based approach extracts numerous previously unknown patterns.

The data can be extracted using online data repositories available on the internet or it can also be collected from user-based polls and surveys related to specific products like electronic gadgets through various social media platforms and online interfaces like Google Forms. After we have collected the data related to a particular item or a product, in our cases it is electronic gadgets, then we have to apply the data

filtering methods and techniques available. As we are using matrix factorization and single value decomposition methods in a model-based approach, we can deploy basic filtering and processing methods on our data. Matrix factorization and Single Value Decomposition methods are some data mining techniques that we will use to mine and extract the data or the ratings. The dataset has three features or values user items, item ids and ratings. To clean or filter the data we have to remove the header information from the collected or downloaded data. Hence now we have the extracted and filtered data for building a machine learning-based system to recommend products.

5 Proposed Recommendation Model Using Collaborative Filtering Technique

i. In this study, an appropriate web-based recommender system is to be designed and developed which will involve a detailed analysis of the methods available for recommending the products to the consumers. The data sets available for a given electronic gadget on the web have to be analysed using proper and optimum machine learning methods. Relevant data has to be extracted from the web and then processing of this data is initiated as described in Fig. 1.
ii. As the data is processed, filtration techniques and methods are used for filtering the real comments or reviews of electronic gadgets or products. These reviews may have redundancy also which can be further processed or cleaned using appropriate algorithms.
iii. After the filtering or cleaning of the data is completed, the aspect or feature of the electronic gadget is selected as seen in Fig. 1. This feature is used for comparison of the product available in the market. We use machine learning methods for accomplishing this task.
iv. Next, we evaluate the results after selecting the relevant product features by comparing the products on an aspect basis. These results are further used for recommending the products or electronic gadgets to the consumers available. We can also analyse the present system with the system developed.

6 Conclusion and Scope of Research

The author has proposed a new methodology to develop a machine learning-based algorithm for e-commerce platforms to recommend products to customers purchasing items on e-commerce platforms. He has utilized data filtering, data attribute optimizing and data redundancy reduction techniques and methods and then applied an algorithm to recommend products to customers on e-commerce platforms to propose a novel approach in this research field. This paper also covers a comprehensive review of techniques to develop recommendation systems for e-commerce platforms. The algorithm proposed will be of great help for customers who have to select the best

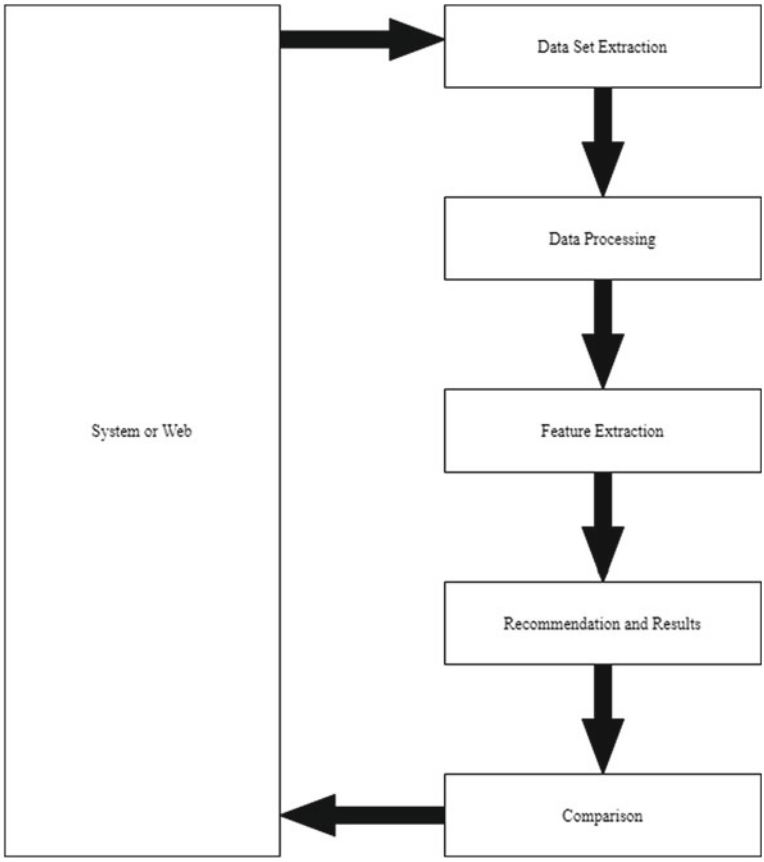

Fig. 1 Proposed research work process flow

and appropriate product as per their requirements on e-commerce sites. There is a lot of scope for further work in the proposed approach.

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Secure Watermarking to Protect Colour Images on Social Media from Misuse

Deepti Varshney, Birendra Kumar Sharma, and Mamta Bansal

Abstract Nowadays the use of electronic media is increasing very rapidly. Especially during the pandemic situation of COVID-19, it has been increased very fast. During lockdown people shared their images on social media, IT industries are working online and people are sharing data to each other in online mode, i.e. in multimedia mode. Multimedia data contains text, video, audio and software, etc. Social media is one of the big platforms to share their contents in multimedia form. Every person is sharing his/her data without knowing about intruders. Intruders can misuse the data posted on web. Social media is the biggest platform for scammers. Hence, the security of digital content is the major issue before us. Various researchers are doing work in this area. Watermarking technique is the most usable protecting techniques from misuse of digital information. The proposed technique in the paper using secure watermarking is useful to protect colour images using unique ID Aadhar number, Discrete Wavelet Transform and Singular Value Decomposition. The experimental results show that this technique is robust and can be used to claim the authenticity during any legal issue.

Keywords DFT · Social media · DWT · Discrete cosine transform · Similarity ratio · SVD · Mean square error

1 Introduction

The use of internet is increasing everyday. The number of internet users in the world was 4.72 billion in Apr 2021, which is around 400 million more than in 2015 [1]. Even in India 700 million users were found till 2020. This figure is expected to

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increase to 974 million by 2025 [2]. From the above statistics, it can be observed that the number of internet users is increasing everyday. From the last year in the situation of lockdown due to coronavirus, social media [3] become the main platform to share the digital contents. People are getting bored at home therefore they share their images, text, videos, etc. on internet. This is one of the easiest ways to share their emotions to each other. But the security of our data is a major concern. When we share the data on the internet, another person can misuse it. Digital content can be easily modified. So, this is needed to make our data secure and also maintain the integrity [4] and ownership [5] of the data. Watermarking is one of the techniques to maintain the integrity and proof the ownership of data as and when required.

There are two ways of watermarking [6]:

a. Watermarking in Spatial domain
b. Watermarking in Frequency/transform domain.

In the first technique, i.e. Spatial domain, the values of pixels of original images are modified, whereas in transform domain technique, first transformations are applied on original images then modification is done on transformed coefficients [7].

Transform domain techniques are further classified as follows:

- Discrete Cosine Transform (DCT),
- Discrete Fourier Transform (DFT),
- Discrete Wavelet Transform (DWT).

Discrete Cosine Transform: DCT decomposes an image into different frequency bands which is known as low, middle and high frequency bands. It is easy to embed watermark into the middle frequency bands of an image because it does not affect the visual parts of the images [8] (Fig. 1).

Discrete Fourier Transform: Discrete Fourier Transform [9] is one of the techniques which can be used in watermarking to hide the digital information content in the digital images. DFT is a technique to find the equally spaced finite spectrum of frequencies by equation

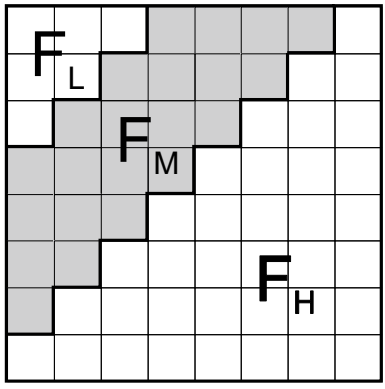

Fig. 1 Frequency band of DCT

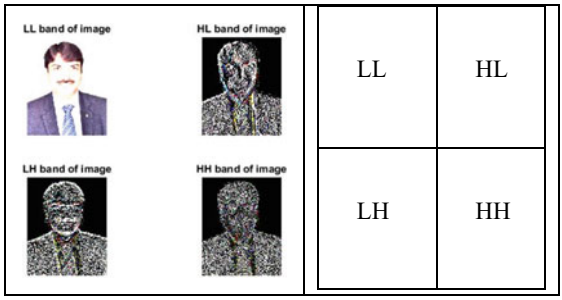

Fig. 2 Four component of DWT

$$X_k = \sum_{n=0}^{N-1} x_n e^{-j2\pi kn/N} \quad k = 1\text{to}N$$

Here, the periodic functions are sine and cosine/sine or cosine waves which have equal duration which construct the coefficients of the signal known as Fourier transform.

Discrete Wavelet Transform: DWT decomposes an image into different frequency sub-bands. These frequency bands are known as lower frequency band and higher frequency band. These frequency bands are represented in Fig. 2 as LL, LH, HL, HH components where LL: Low Low, LH: Low High, HL: High Low & HH: High High. It can be further decomposed in the next level [8, 10].

Among all, DWT is robust watermarking technique of images due to its multi-resolution characteristics.

2 Basic Structure of Watermarking

Basic structure of embedding and extraction watermarking process of the digital images is given in Figs. 3 and 4. Figure 3 represents the embedding process of watermark, and Fig. 4 shows extraction process of watermark [11–13].

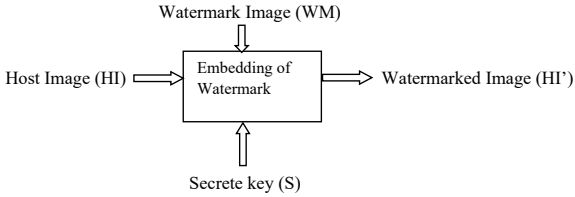

Fig. 3 Embedding process of watermarking

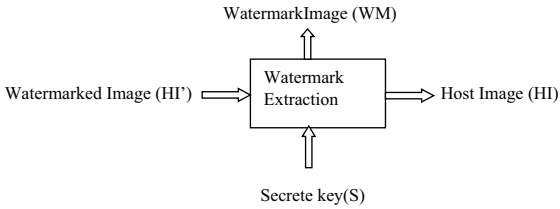

Fig. 4 Extraction process of watermarking

3 Watermarking Requirements and Its Applications

Digital watermarking requirements and according to requirements its applications are shown in the table [10, 14, 15]:

Requirement	Applications
Imperceptibility	Fingerprinting and copyright
Robustness	Authentication of data, integrity verification and copyright
Security	Copyright protection, tracking of digital data, content authentication, fingerprinting, indexing
Capacity	Integrity and Tamper detection
Computational cost	Image protection
False positive	Ownership and copy control
Watermark keys	Copyright protection
Tamper resistance	Authentication and integrity
Reversibility	Applications in medical field

4 Singular Value Decomposition

Singular Value Decomposition (SVD) of the matrix of an image of size $N \times N$ is

$$\mathrm{IM} = XYZ'$$

where X and Z are unitary matrix

Y is a diagonal matrix and

Z' is the transposed matrix of Z.

The diagonal elements of Y, denoted by σ_i are called the singular values of IM which can be represented in decreasing order, i.e. $\sigma_{i>}\ \sigma_{i+1}$.

Here, the columns of X denoted by X_i's are called left singular vectors while the columns of Z represented by Z_i's are called right singular vectors of IM.

X_i and Z_i satisfy condition:

$$\mathrm{IM}Z_i = \sigma_i X_i$$

$$X_i'\mathrm{IM} = \sigma_i Z_i'$$

5 Proposed Method

The watermarking process is proposed for colour image using unique ID Aadhar number, DWT and SVD. The host image breaks into its three components, i.e. R, G, B. DWT is done on G and B components and multiple DWT is applied on R component. Then apply SVD on LL0 of R component. Also apply DWT on watermark image. Then apply SVD on LL component of watermark image. One threshold value is calculated using Aadhar number which is used to embed the watermark image into original image. Figures 5 and 6 show the embedding and watermark extraction process, respectively.

Embedding Process Variable Declaration:

Io: Original Image

R, G, B: Red, Green and Blue Components of image

An: Aadhar number

Wm: watermark image

β: Threshold value

LL0, HL0, LH0, HH0: Four components after applying DWT on Red image

LLG, HLG, LHG, HHG: Four components after applying DWT on Green image

LLG, HLG, LHG, HHG: Four components after applying DWT on Blue image

uy, sy, vy′: Three components of SVD matrix of LL0

LL4, HL4, LH4, HH4: Four components of the watermark image by applying DWT

uw, sw, vw′: Three components of SVD matrix of LL4

Extraction Process Variable Declaration:

An: Aadhar number

WmI: Watermarked image

β: Threshold value

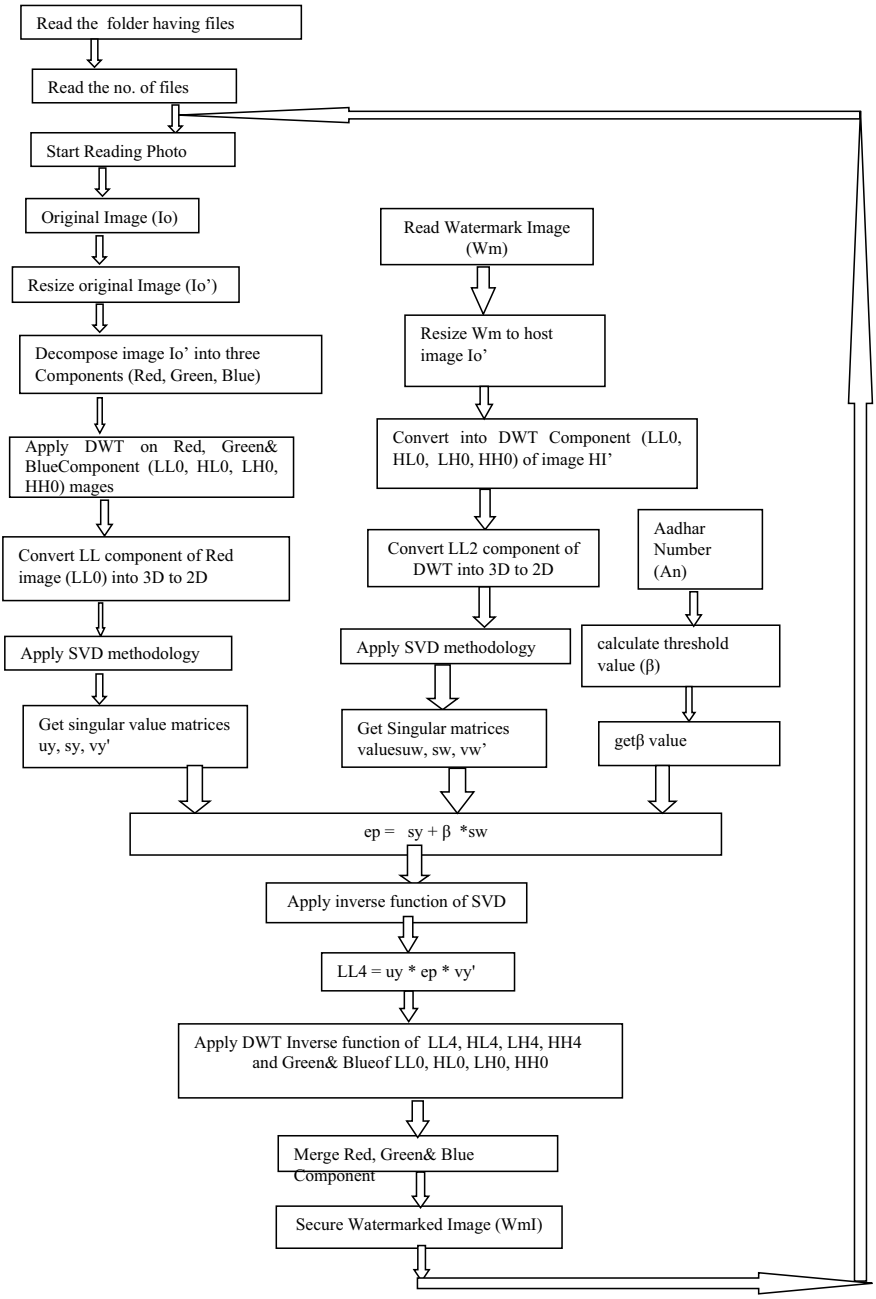

Fig. 5 Embedding of watermark

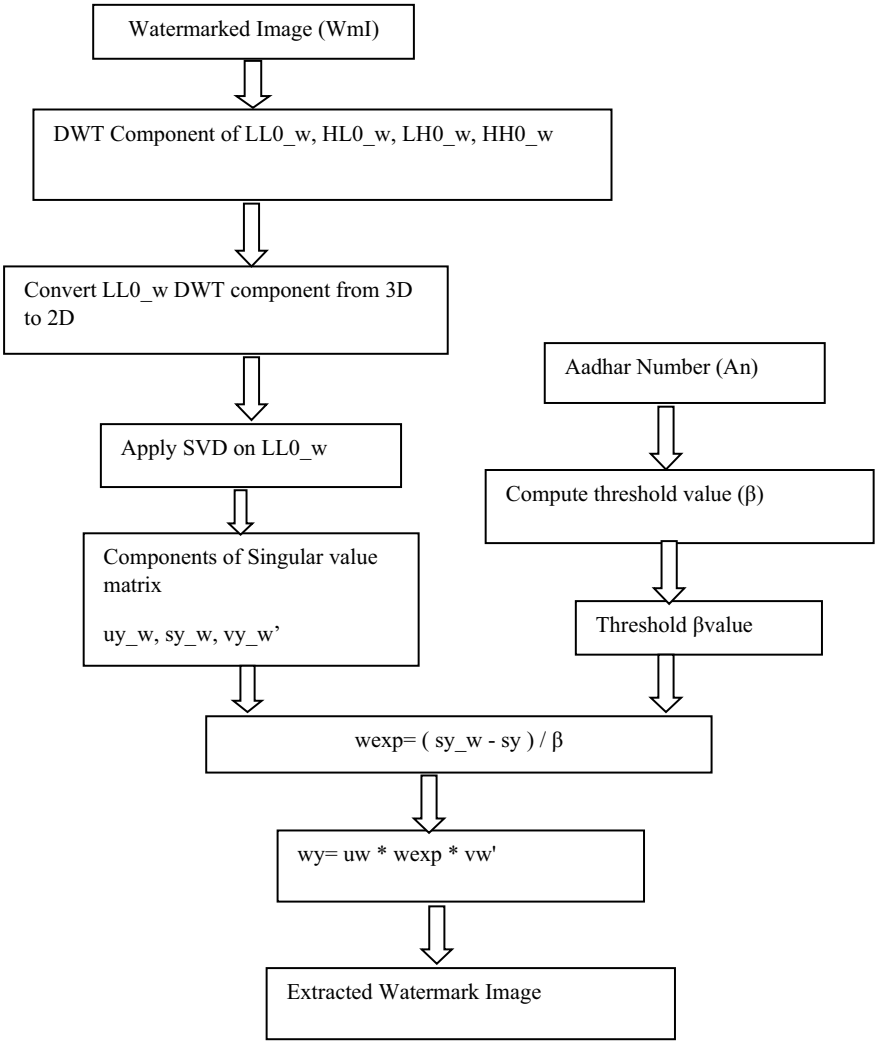

Fig. 6 Watermark extraction process

LL2_w, HL2_w, LH2_w, HH2_w: Four components of the watermarked image after applying DWT

uy_w, sy_w, vy_w′: Three components of SVD matrix of LL2_w

wexp: Inverse value.

6 Results of the Proposed Method

The results of the above-proposed technique are given below and show that the watermarked image and host image are the same. Also, it can be shown that the extracted watermark and the original watermark are the same (Figs. 7 and 8).

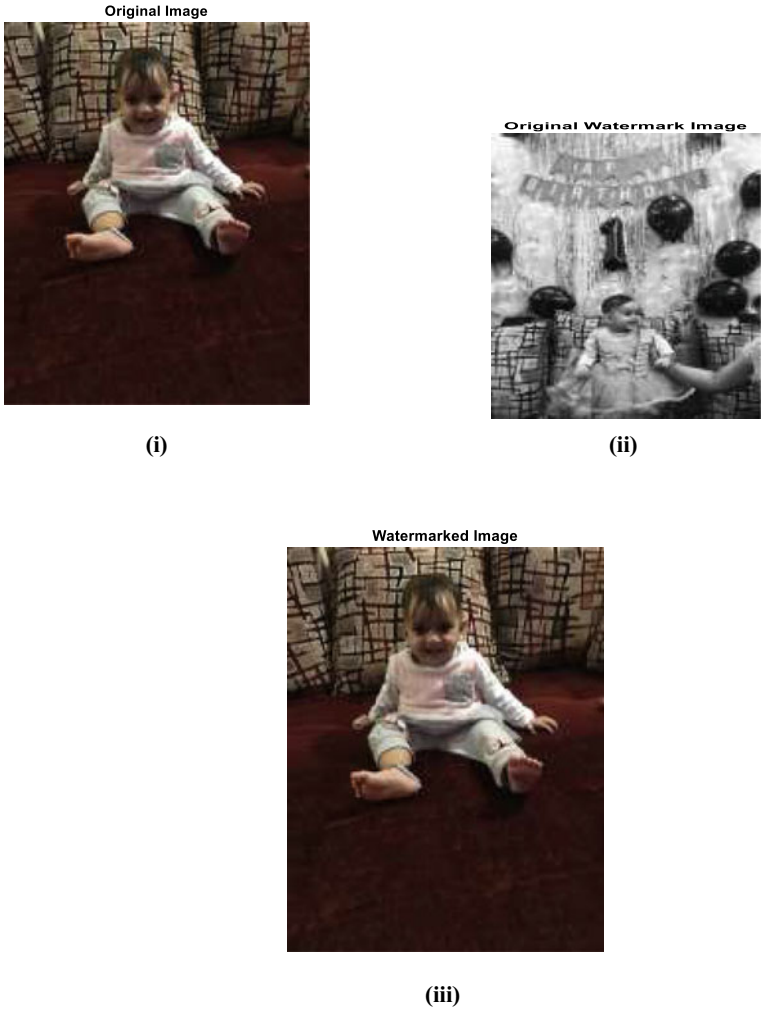

Fig. 7 Result from watermark embedding process. **a** Host image, **b** watermark. **c** Watermarked image

Fig. 8 Result from watermark extraction process. **a** Watermarked image, **b** extracted watermark

7 Performance Analysis

The performance of images is measured by the different researchers using the given below methodology:

- MSE: Mean Square Error,
- SR: Similarity Ratio.

7.1 MSE: Mean Square Error

The MSE can be defined by given below formula between OriginalImage (Io) and watermarkedImage (WmI) [16]:

$$\text{MSE} = \frac{\sum_{\text{row,column}}[\text{Io}(\text{row}, \text{column}) - \text{WmI}(\text{row}, \text{column})]^2}{\text{row} * \text{column}}$$

where row: row size of image and

column: column size of image.

The value mean square error of watermark and extracted watermark is 9.001898 e-25, which shows both images are similar.

7.2 Similarity Ratio (SR)

Similarity ratio can be calculated as follows:

$$SR = \frac{S}{S + D}$$

where S and D are matched and mismatched pixel positional value number between host image and watermarked images.

Similarity Ratio of the proposed method is 1 which shows that extracted image is exactly similar to original image.

8 Conclusions

Nowadays people are using internet to share their contents such as text, audio, video and software. Specially, during COVID-19 IT sectors are working online as well as people are sharing data in online mode on Facebook, WhatsApp, Namaste, Twitter, etc. which is not secure. There are chances of misusing data specially photos. The proposed technique is used to improve the security of images as well as can claim the ownership of the data for any legal issue. The experimental results show that this method is secure. The use of Aadhar number, DWT and SVD make it more secure as compared to other techniques.

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Smart Cities Mission in India: A Review

Niraj Singhal and Aviral Kumar Singhal

Abstract The main objective of the mission of smart cities in the country (India) is to provide its residents a good quality life to live, a clean and reliable environment, with applications of smart solutions for all. A smart city promotes the sustainability to the cities to provide adequate infrastructure. Smart people are required for smart cities mission, who can participate in reforms and governance, effectively. The involvement of citizen of the country is very much needed in the governance. The aim of this paper is to present a review on objectives, mission, selection process, features, vision and challenges of smart cities mission in the Nation.

Keywords Mission of smart cities · Smart people · Features of smart cities · Smart cities strategies

1 Introduction

On June 25, 2015, the mission of smart cities (SCM) was launched by the Government of India. However, it is true that there is no specific definition of a smart city and it provides sufficient liberty to the city and town planners to define themselves as per their understanding for 'smartness' [1]. In India than, say Europe, a smart city will be having a different connotation. Even in India also, there is no specific of defining a smart city [2]. Smart cities mean different to different people, as per their concern. The smart development of a city varies from nation to nation and also city to city. Depending upon the level of development, it also depends on willingness to change, the resources available, and aspirations of the concerned residents. One can say that a 'smart city' is an urban area which is highly advanced in terms of sustainable infrastructure, modes of communication, and viability of market. It is a type of city where information technology (IT) is the primary requirements to provide the essential services to the citizens [3]. Some essentials of smart cities [4] are shown (see Fig. 1).

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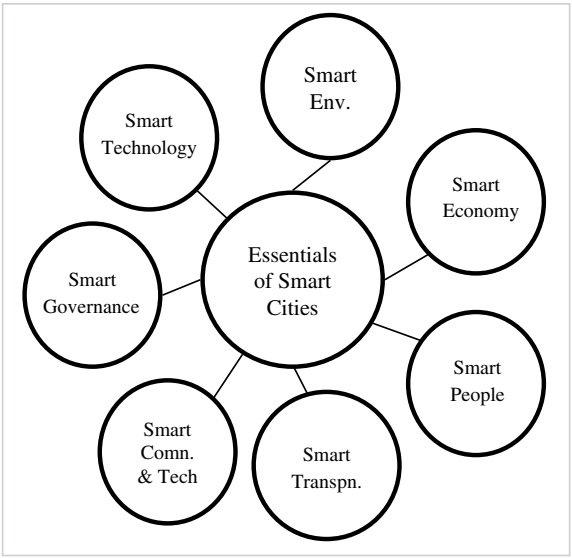

Fig. 1 Essentials of smart cities

The mission of smart cities mainly focuses on uplifting urban development initiatives that will make cities more sustainable, hygienic and also the centers of economic growth. A smart city is said to be one that plans to meet its objectives and challenges in a sustainable manner as well as implementing the principles of good governance for the residents [5]. The purpose of the smart cities mission is, to improve the quality of life and economic growth of life of residents by harnessing technology and local area development that will lead to the smart outcomes [6]. Such cities also portray the opportunities for the cities flooded with the modern technologies that are essential for smart cities, to transform the way with which such cities are governed, run, and experienced [3].

According to smart cities mission in India, it is expected that sustainable environmental footprints and infrastructure for the citizens to have a good quality of life to live for the residents, that is very much needed in smart urban areas. A smart city includes affordable housing schemes, an efficient public transport, drinking water and regular supply of electricity, effective methods of waste management, sanitation and hygiene, healthcare services and facilities of education for all residents. For ensuring citizen participation in local governance and community matters, robust information technology is also required [7]. The primary focus would be, the inclusive and sustainable development, to create a model that acts as an example to other aspiring cities. It is required so that the creation of similar smart cities can be catalyzed and examples can be replicated in several different parts of the nation [2].

The usage of smart city solutions in a city enables the citizens to use data digitally, the information and technology infrastructure for improving their life. In this way, the comprehensive development will improve the quality of life of its residents by creating employment and enhancing income resources for all, especially

for the disadvantaged and poor citizens [6]. There are several technological platforms involved in the development of smart cities, that includes automated sensor networks, smart communication methods, and data centers for enhancing lifestyles of people. Currently, the development of a city depends on the city's hard infrastructure and social infrastructure along with the availability and effective quality of Information and Communication Technologies (ICTs) [3].

In India, the state holders were asked for nomination of the cities to take part in the process. Then, the administrative bodies of such cities were asked to submit smart city plans (SCPs) for urban renewal. Then, based on the analyses, one hundred cities in the country were selected to receive funding from the government for implementing the plans and it was also decided that these projects be completed by the year 2023 [7].

2 Related Work

The purpose of taking initiative for smart cities is to promote sustainable and inclusive infrastructure of the cities to give better quality of life to live, to its residents. It is to provide smart solutions to the citizen and good infrastructure, a clean, healthy, and sustainable environment. Now, let us see the objectives, some features, and the strategy to be implemented for developing smart cities.

2.1 Objectives

Some of the core infrastructure elements that would be useful for the development of a smart city, includes.

- To provide modern health and education facilities for all.
- An effective public transport system over domestic one.
- To provide ample opportunities for business, jobs, and livelihoods for its citizens.
- To provide proper facilities for safety and security of the people, and amusement.
- Availability of high-quality daily services, i.e., all the time supply of water and power.
- To increase energy efficiency services, reducing water conservation facilities, and proper recycling of waste materials for production of energy [8].
- Smart economy—competitiveness and innovation.
- Through easily accessible tools and guidance the capacity of urban institutions is enhanced. Having a decentralization agenda by strengthening avenues for citizen participation.
- Urbanization by enhancing the living life conditions of residents in a city [5].

Some guiding principles for the smart city's framework are shown (See Fig. 2).

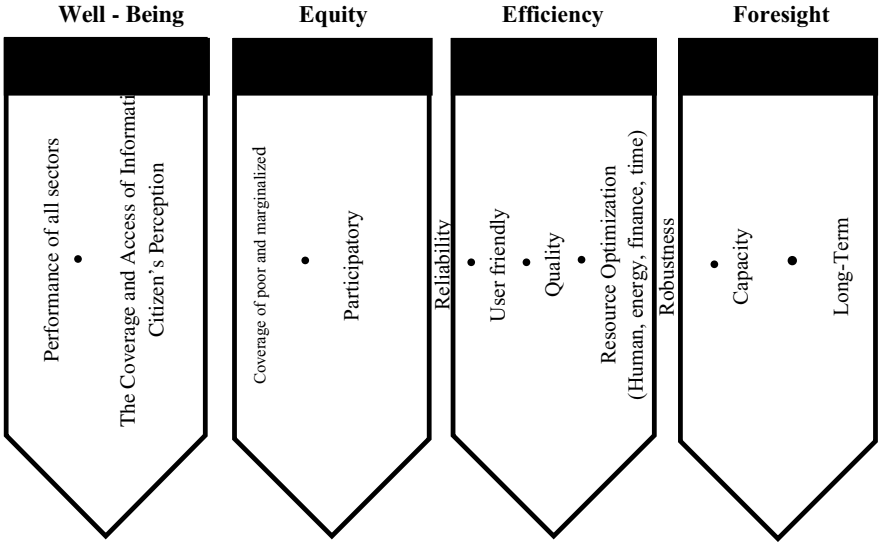

Fig. 2 Some guiding principles for mart cities

With the increasing urban population and rapid growth of areas, the concerned stakeholders are in need for the smarter ways to improve the quality of life for its inhabitants, to manage complexities of the cities and to increase effectiveness and efficiencies. It is evident that it requires technical manpower to monitor and integrate infrastructure for the smart cities for better optimization of the resources while maximizing services to its residents [8].

2.2 Features

Now, we present some features of Smart Cities:

- In area-based developments, it involves planning of 'unplanned areas of the city', for promotion of mixed land use.
- Making the residents friendly governance and to be cost effective.
- Reducing the traffic congestion and air pollution to boost the economy at local level, to promote communication facilities and to ensure security of inhabitants.
- Housing for all. To preserve land and develop open spaces, parks, and playgrounds. Creating the amusement spaces to enhance the quality of life of residents, reducing the effects of heat, and implementing the eco-balance.
- To provide identity to the city, based on the activities like, economics, education, health and hygiene, business opportunities and culture, etc.
- Promoting the variety of public transport options for the citizen of the city.

The applications of such smart solutions are required, to develop better infrastructure and provide efficient services. It is needed, providing cheaper services using fewer resources making the cities less vulnerable to disasters by [2].

2.3 Strategy

The strategic components applied in the smart cities mission according to area-based development are, Retrofitting, i.e., improvement to be done in the city, Redevelopment, i.e., converting a normal city to a smart city, Greenfield development, i.e., extension of the city and Pan-city initiative, in which all parts of the city need to be covered to provide smart solutions to its citizens.

Retrofitting includes, planning of the existing built-up area of the city to achieve the objectives of a smart city. It requires to make the existing area of the city to become more efficient and livable to provide better life to its citizens and to provide better facilities to increase the level of life. **Redevelopment** affects the replacement of the existing built-up area and environment of the city, to enable its citizens with enhanced infrastructure using mixed land use and increasing the density.

For addressing the needs of the expansion of population, it is essentially required that developments based on Greenfield be taken into account across and around such cities. It is also obvious that application of smart solutions in the transportation sector will reduce the average commute time or cost to the people and will also improve their life. Other sectors like, waste management or recycling can make provide better health and hygienic living conditions for the residents [2, 8, 9].

2.4 Smart Cities Selection Process

The Mission of selecting the city as smart one was started in the form of a competition. It was named as Smart City challenge. The process of selecting the proposed smart cities is shown (see Fig. 3) [2].

The idea of selection process of the smart cities is purely based on completion. It also follows some challenging processes for selecting cities in stages.

In January 2016, twenty potential smart cities were selected in Round-1, based on All India competition. In May 2016, thirteen more potential cities were selected, in September 2016, twenty-seven were selected, in June 2017, thirty more were selected. And, in January 2018, in fourth round, nine potential smart cities were selected. The Government of India plans investment of Rupees 2,01,981 crore was proposed for ninety-nine potential smart cities.

There had been two phases in the selection process of potential smart cities:

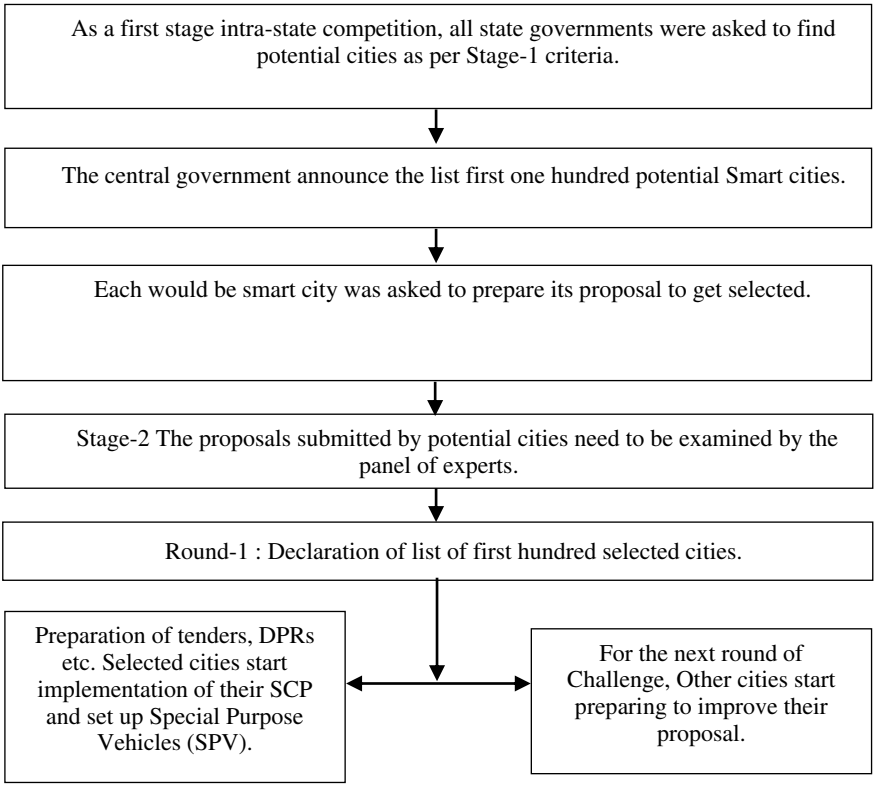

Fig. 3 Steps in selection of smart cities

Phase-1: Shortlisting of potential smart cities by the State governments

In this phase, the cities in the states will compete. The state government/union territory are responsible for shortlisting the potential smart cities and to recommend these names. The MoUD will finally announce the list of selected one hundred probable smart cities.

Phase-2: Challenge Round for Selection

Government of India under smart cities mission has announced thirty new cities, taking to a total number of ninety cities. In India the government has already announced to develop one hundred smart cities. The state governments announced their own grey cities mission, by which the new Town Kolkata and Mumbai backed out from this mission. These twenty cities will be contesting under smart city mission, For the remaining ten slots: Itanagar, Biharsharif, Diu, Silvassa, Kavaratti, Navi Mumbai, Imphal, Shillong, Dindigul and Erode, Bidhannagar, Meerut, Rai Bareilly, Ghaziabad, Saharanpur, and Rampur contested [4].

2.5 Challenges

For selection of probable smart cities, the Ministry of Urban Development (MoUD) has used competitive method. The main challenges seen for the development of the cities are to understand the concepts of retrofitting, their expansion, redevelopment, and Greenfield development. The mission requires smart people and technocrats who actively participate turning a city into smart one and to work better in governance and reforms. The involvement of citizens is very much necessary in development and governance. Their involvement is needed for development and deployment of smart solutions, implementing the reforms, doing more for designing and implementing to make the smart city's developments sustainable and to give better life to its citizens [2, 9].

3 Conclusion

The mission of smart cities in India is to convert a traditional city to smart city. Its purpose is to provide a better and healthy life to the people. It is planned that a smart city will meet its aspirations and challenges in a sustainable manner by implementing the principles of good governance for its citizens. According to the mission in India, it is expected for the citizens to have a good quality of life, assured water and electricity supplies, public transport, waste management, education facilities, sanitation, healthcare facilities, affordable housing, especially for economically-weak sections of society. This paper has presented all such issues of smart city mission in the country.

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Breast Cancer Diagnosis with the Support of Machine Learning Algorithms

Shivendra Goel and Mamta Bansal

Abstract Breast Cancer is a widespread problem for most of the women around the world. This cancer can be detected by identifying tumors, i.e. malignant and benign. Doctors in the field of breast cancer diagnosis required reliable diagnosing procedure for finding malignant tumors. In this field, a fast pace software tool is required to accurately find malignant tumors. In this area, a large number of researches are going on around the world. In this work, various ML Algorithms are identified and applied on the Breast cancer data, to identify appropriately the malignant tumors, and an accuracy comparison of these ML algorithms is also presented in this paper.

Keywords Recursive partitioning and regression trees (Rpart) · Random forest (Rf) · WHO-world health organization

1 Introduction

Women death rate due to breast cancer is very high according to WHO. Cancer starts with wild partitions of one cell, which consequences in a tumor. There are two types of tumor; benign and malignant. The growth of a Malignant tumor is very fast and invades its neighboring tissues, and these tissues can be damaged. The malignant tumor causes Breast cancer in women. In some of the countries like Malaysia, breast cancer has been the most common form of cancer [1]. There is a rising curiosity in machine learning from the last few decades. This rising curiosity is accelerating toward research and creation of Software tools for Cancer Diagnosis. ML plays a very important role in research and development acceleration in this area [3–5].

Here, ML algorithms have been used namely, Recursive Partitioning and Regression Trees, Random Forest and SVM for Breast Cancer Diagnosis using a Breast Cancer dataset [2].

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Table 1 Dataset classes

S.no	Classes
1	Total Class distribution: 569 Out of which 357 benign tumor and 212 malignant tumor

2 Dataset

In this work, data from the Kaggle [2] is chosen for study and analysis based on Machine Learning (ML). This Dataset is having 569 instances. For each Breast Cancer image, all features were computed and resulting in thirty more features. Following Table 1 depicts the Dataset Classes [2].

3 Machine Learning Algorithms

3.1 Recursive Partitioning and Regression Trees (Rpart)

Rpart is a technique for multivariable analysis. Recursive partitioning creates a decision tree to facilitate and appropriately categorize members by splitting them into sub-parts based on numerous independent variables.

3.2 Random Forest (Rf)

Random forests are a band learning technique for classification and regression, and at the time of training, this algorithm operates by creating many decisions trees.

3.3 Support Vector Machine (SVM)

Once assigned a SVM training dataset of labeled data for each group, SVM is able to categorize data.

3.4 Implementation and Results

In this present work, Rpart, Rf and SVM algorithms are applied to perform classification on the breast cancer dataset [2]. This result and performance of all these three

Table 2 Experimental results

	MSE	RMSE	Accuracy (%)
Rpart	0.052631579	0.229415734	94.737
Rf	0.029239766	0.170996392	97.076
SVM	0.011695906	0.108147614	98.830

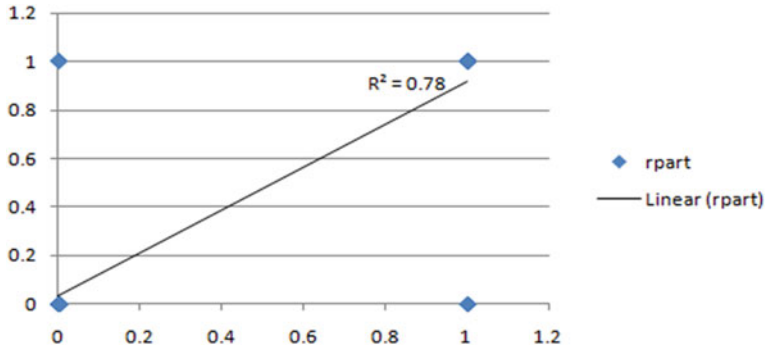

Fig. 1 Graph 1: Rpart (rpart)graph depicting R^2

algorithms are compared to find out which algorithm is better for Breast Cancer Diagnosis. Table 2: shows the experimental results with the Accuracy of these machine learning algorithms.

While comparing the result received from these entire machine learning algorithms, it was observed that the accuracy of the SVM algorithm is very high approximately 98.830% which is higher than Rf and Rpart algorithm for breast cancer dataset [2] classification to perform diagnosis. Also, the accuracy of Rpart is only approximately 94.737% which is lower than both Rf and SVM algorithms. Similarly, MSE and RMSE of SVM are very low as compared with the other two algorithms.

The following graphs (from 1 to 3) in Figs. 1, 2 and 3 show R square (R^2) values generated from the Machine learning algorithm during implementation.

From Graphs 1, 2 and 3, it is easily visible that the value of R^2 is 0.949 for SVM which is very good as compared to the other algorithms, i.e. Rpart and Rf.

While comparing the result received from all the ML algorithms, i.e. Rpart, Rf and SVM, it is observed that in terms of Accuracy and R square (R^2), the SVM is found good for Breast Cancer Diagnosis on the present dataset [2].

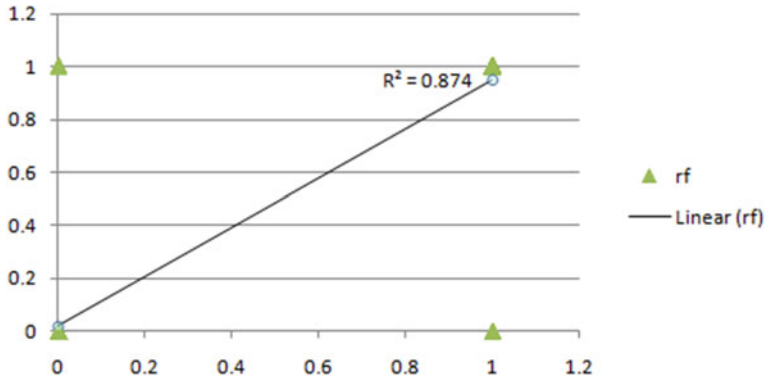

Fig. 2 Graph 2: Rf (rf) graph depicting R^2

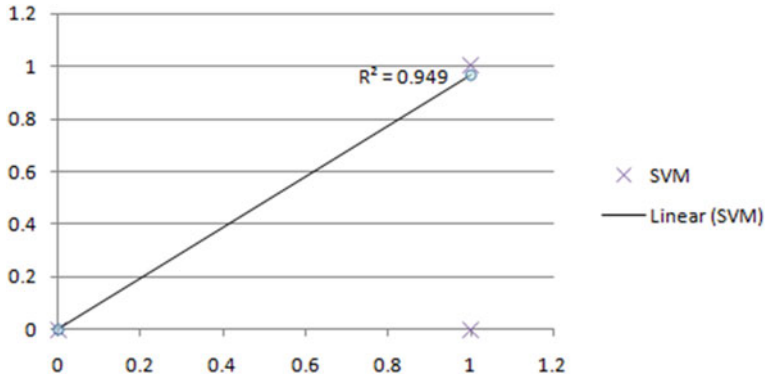

Fig. 3 Graph 3: SVM graph depicting R^2

4 Conclusion

In some of the countries like Malaysia, breast cancer has been the most common form of cancer. There is a rising curiosity in machine learning from the last few decades. In this work, some ML Algorithms were identified and applied on the Breast cancer data, to identify appropriately the malignant tumors, and an accuracy comparison of these ML algorithms is also presented in this paper. While comparing the result received from all the ML algorithms, i.e. Rpart, Rf and SVM, it is observed that in terms of Accuracy and R square (R^2), the SVM is found more suitable for Breast Cancer Diagnosis on the present data.

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Analysis of Current Recommendation Techniques and Evaluation Metrics to Design an Improved Book Recommendation System

Sushma Malik, Anamika Rana, and Mamta Bansal

Abstract Sometimes users face difficulty in searching required content on the digital platform due to an enormous amount of information. But this hassle may be solved with the assist of a recommender system (RS). RS plays a fundamental role in reducing information overloading. It also provides the item based on the interest of the user. RS plays a significant role on E-commerce sites, online auction, and on any online platform. The Book recommender system (BRS) is now mostly used by books e-commerce sites. This paper surveyed the machine learning techniques which have been implemented to design the BRS. Six types of approaches are identified to design the BRS like clustering, Collaborative Filtering, Content-Based, Association, Opinion Mining, and Hybrid technique. The hybrid technique is designed by the combination of various techniques.

Keywords Recommender system (RS) · Book recommender system (BRS) · Collaborative filtering (CF) · Content-based (CB) · Opinion mining (OM) · Machine learning (ML) · Association rule (AR)

1 Introduction

By the fast escalating of Internet users and IT, every task of human beings is executed by the technology-implemented objects, and users can move from the era of scarcity of data to the information overload era. Various expert systems are intended to resolve the information overload problem and to provide the smooth processing of information by reducing the workload of human beings [1–3]. RS is a form of an expert system that screens the massive data present over the Internet based on some criteria and provides the recommendation to the consumer based on interest [4, 1]. Lots of users are using the net as a resource of information for comparison of products that

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would like to buy online with the escalation of the economy and the initiation of new technologies. Users are using the Internet to discover the most excellent deal to spend their money with an extensively existing list of online products. In this competitive environment, lots of vendors are using different strategies to generate a center of attention for the customers. At this time, customers are facing difficulty to classify the relevant information from the ocean of information. RS helps to solve this trouble by providing the appropriate data or information based on user's profile which is generated on the basis of searching history and their resemblance with other users. RS provides the recommendation list of products to the consumer on the user's preferences. Websites use the RS process to provide useful products or relevant suggestions to the consumer to accomplish their requirement [5]. RS is the replication of human advisors and experts who assist human beings to decide on many real-life problems. RS is designed for the online business sites to make available the recommendation to the online buyers and also amplify the profit of the seller. RS is not the latest term in the Internet era. It becomes an essential tool for many E-commerce sites like Amazon, Flipkart, Netflix, YouTube, and many more. Now RS has extended its domains and used in every online site to recommend movies and shows for entertainment, transports, hotels, and places for the tourist, for patients, recommend doctors and telemedicine services, and recommend novels and books to readers [1, 6, 7]. RS collects various types of data about the user's tastes, suggestions, and preferences, and after implementing the recommender approaches on that data, provides suggestions to the consumer to find suitable products online sites [8]. RS enhances the sales of E-Commerce sites by using the following approaches [9]:

Convert the Browsers into Buyers: Sometimes users just visit the sites to collect information but close the websites without buying any product. At that time, RS is employed to provide the list of products that may be users want to purchase.

Increasing Cross-sell: RS also helps the seller by increasing the cross-sell by recommending the supplementary products for the consumer to purchase. The order size given by the user should be extended if the recommendations provided by RS are liked by the user.

Building Loyalty: User loyalty has a vital role in the business strategy where the site's competitors are just one click away. RS helps to increase and improve the loyalty between users and sites by providing a value-added relationship between them.

The main motive of research paper is to examine the Machine Learning strategies that are used to layout the BRS which assist the person to get the notion of books on their interest. We searched famous databases like Google Scholar for the collection of related research papers. For searching the required result, the keywords like 'book recommender system', 'book recommendation system', and 'recommendation for books' are entered in the search bar.

2 Background of Traditional Techniques of Recommendation

Clustering

It is an unsupervised learning algorithm of ML. In this technique, a set of data is portioned into a number of disjoint subsets and each subset encloses data elements that have similar characteristics. So in clustering technique, dataset is portioned into a homogenous group based on given characteristics like similar objects are set aside in a group and dissimilar objects are kept in another group [10]. Figure 1 shows the functioning of the clustering technique.

Content-Based Filtering

In CBF, expect that users who favored objects with sure attributes withinside the records will like similar forms of items or products withinside the future. This approach compares the item features with the user profile and then provides the recommendation [12]. Figure 2 represents the CB technique. The content analyzer is the main part of the CB that transforms the unstructured data into the feature of the item, a profile learner that develops the profile of the consumer by identifying patterns among representation of items or products consumed by the target consumer, and a filtering component that generates recommendation of items or products on the basis of consumer profile [13, 14]. Bayesian classifier, decision trees, cluster analysis, ANN, etc. techniques are used for the profiling [15]. Figure 3 shows the working of BRS based on the CB approach.

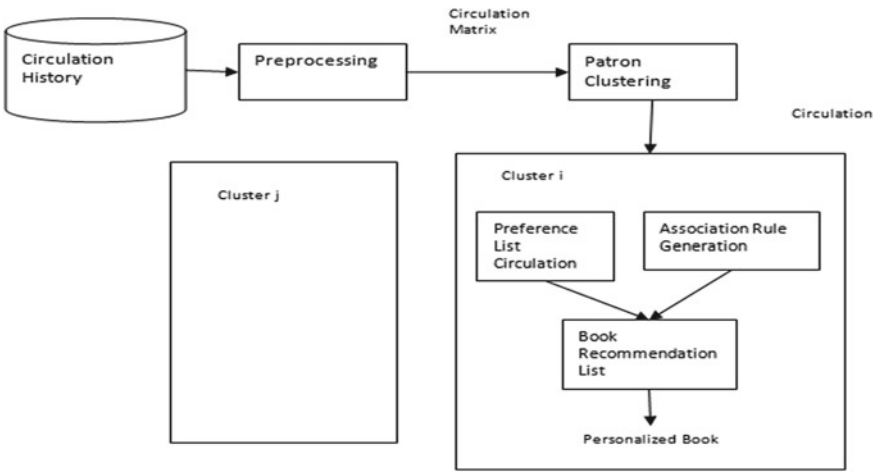

Fig. 1 Clustering Technique [11]

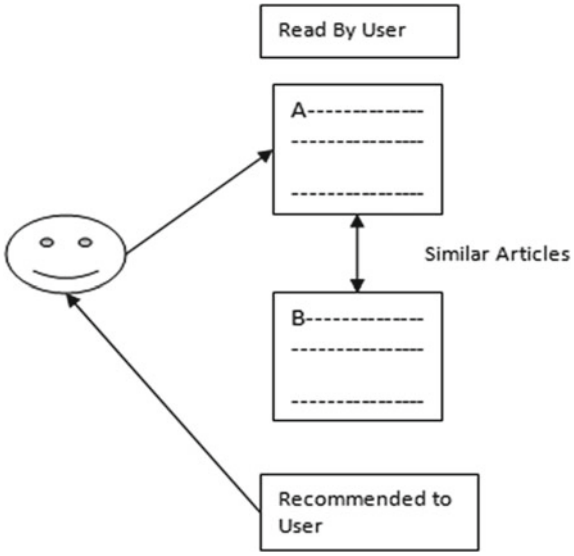

Fig. 2 Content-based technique

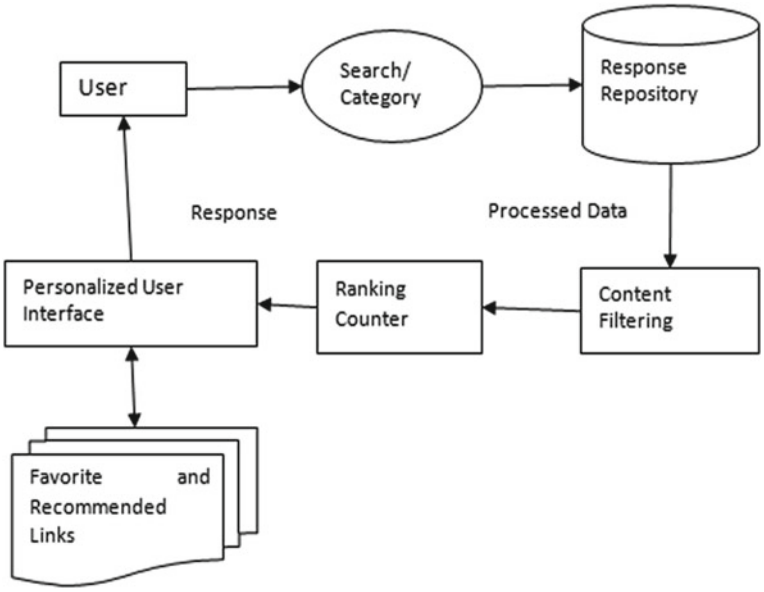

Fig. 3 Flow diagram to design BRS on the basis of CB technique [5]

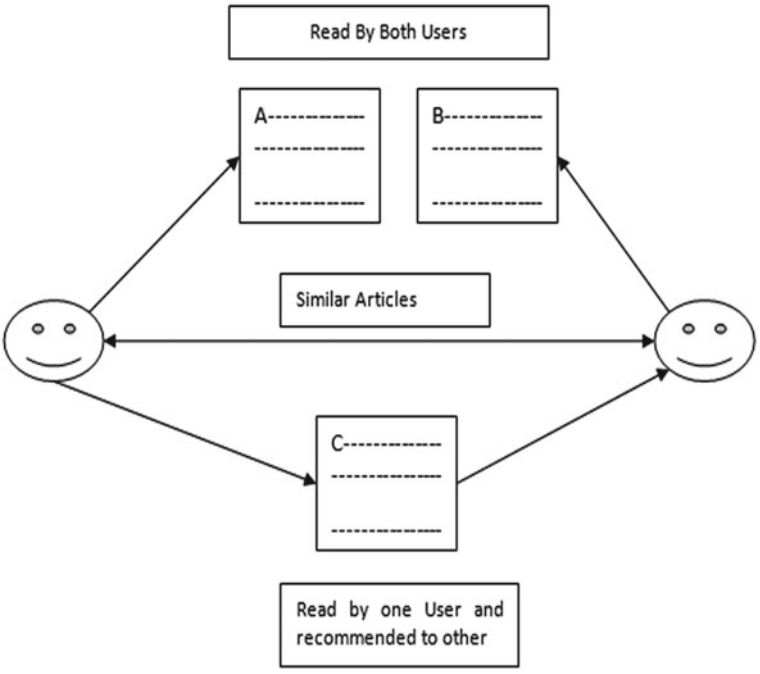

Fig. 4 Collaborative filtering technique

Collaborative Filtering

The most known recommendation technique used on the Internet is CF. CF uses the user's details, ratings, and reviews from all the users to build up the RS. The main point of this technique is to analyze the existing active user with similar interests and characteristics to the current user to generate recommendations shown in Fig. 4 [16, 17].

Scalability, cold start, and sparsity are some problems that affect the performance of the CF recommendation technique [18, 19]. CF also has two drawbacks grey sheep and shilling attack. Grey sheep problem occurs when RS predicts the possibilities of that person whose flavor is absolutely one of a kind from different users [20, 21]. The flowchart of BRS based on CF is described in Fig. 5 [22].

Association rule

AR is the interesting approach of ML and is employed in Market Basket Analysis. This technique is used by various big retailers to discover the associations between products. The AR is utilized to provide the suggestion of products according to of their presence along with other products. This approach is very helpful to provide recommendation to new users who wish to make a purchase [17]. AR is used to dig out the interesting correlation and relation between the transaction data. It is used to make out the buried knowledge from the E-commerce generated data [17, 23].

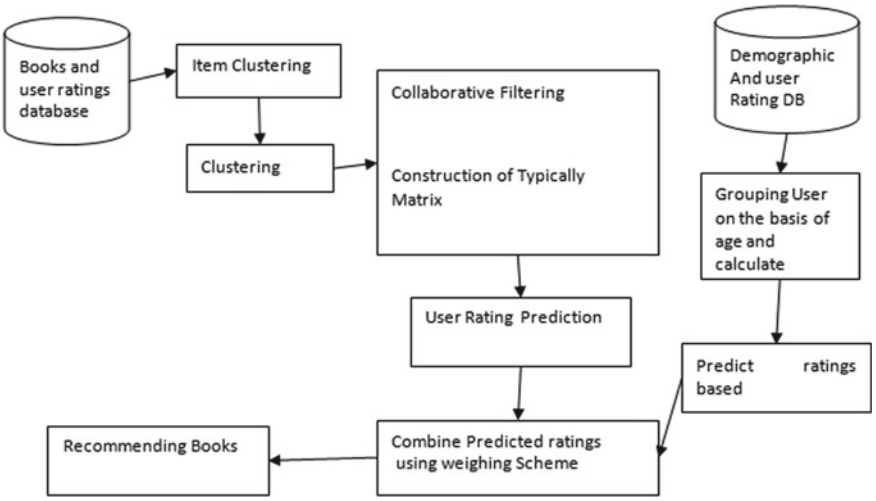

Fig. 5 Flow diagram to design BRS on the basis of CFT [22]

Support can be present as the fraction of the transaction T that contains the itemset X, it can be represented as in Eq. 1, and confidence represents the frequency of both products occurring when one product exists in the transaction. It is the ratio of the transaction that contains products X and Y to the number of transactions that contain X and it can be represented as in Eq. 2

$$S(X) = \frac{\text{Frequecy}(X)}{T} \tag{1}$$

$$C(X) = \frac{\text{Frequency}(X, Y)}{\text{Frequency}(X)} \tag{2}$$

Opinion mining

OM is the study of sentiments of the users and their opinion about products or objects and various features of the objects [24]. OM is used to develop BRS [25]. It analyzes the user's opinions, sentiments of products, and services. The essential part of OM is to categorize every comment into 'positive' or 'negative' opinions. If the user gives a review has liked the book at that time, feedback is labeled as 'positive' and on the other side, if a user gives a review has disliked the book at that time, feedback is labeled 'negative'. This feedback is classified into positive or negative based on the review given by the user. The Naïve Bayes approach of OM is implemented to differentiate the documents into liked and disliked groups. Figure 6 represents the flow diagram of BRS.

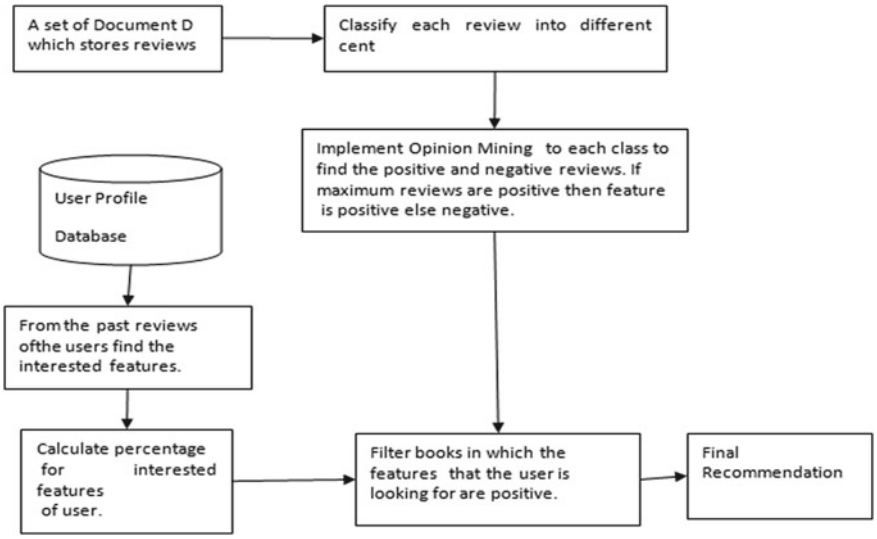

Fig. 6 Flow diagram to design BRS on the basis of OM technique [25]

Hybrid

The hybrid recommendation technique is the combination of more than two techniques of recommendation to make available the suggestion of a product to the consumer on their interest or preferences. By the use of hybrid technique, the drawbacks of one recommendation technique are removed and integrated the advantages of diverse recommendation techniques. There are a number of ways to integrate the recommendation techniques to design the effective hybrid recommendation technique. In [26] present, the hybrid BRS combines CF and CB approaches with demographic attributes. New users and new items on sites face cold start problems in RS but this problem can be sorted out by this technique. The flow diagram to design the hybrid BRS is shown in Fig. 7.

3 Literature Review

Most successful online companies are using strong techniques to design the RS. The core utility of BRS is to recommend the books to the user based on the user's interests. González et al. [27] using the questionnaire to identify the importance of an RS and minimize the information overload problem of the user. Implicit feedback technique is used for the evaluation of books by exclusive intervention of users. This evaluation can be performed by getting the data from the application by the user action performed on them [28]. Vaz et al. [29] use the two combined CF approaches to increase the recommendation method, where one suggests books and the other

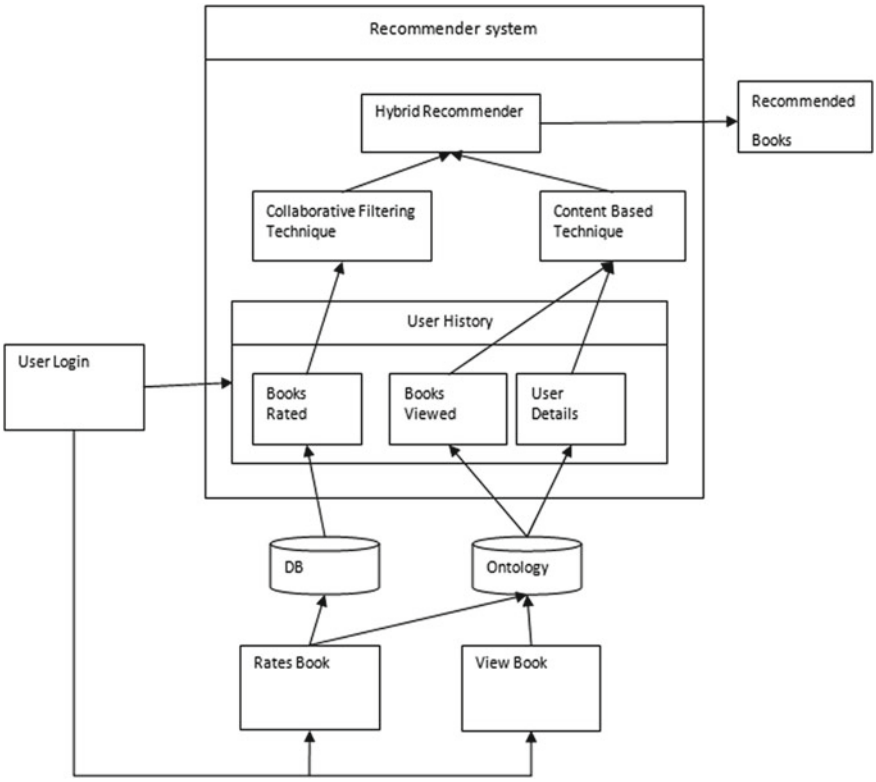

Fig. 7 Flow diagram to design BRS on the basis of hybrid technique [26]

recommends writers. A commendation can be improved by using the author's preferences in the selection of books. Yang and Hung [30] use text mining and classification techniques to introduce the BRS by using keyword extraction technique and Keyword-Book Mapping technique with text mining and classification techniques of data mining. The Association rule is used by Luo [31] to design the individualized RS for online sites to sell books and also assist the customers in searching and buying online. Tsuji et al. [32] introduced the hybrid BRS to propose the number of books by the use of CF and AR to the user on the basis of their preference and also resolve the dilemma of data sparsity and cold start problems. The OM method is used by Sohail and Ali [33] to develop the BRS.

Chen et al. [34] propose an intelligent mobile location-aware BRS with map-based guidance to solve the problem to select books and recover the consumption rate of library resources by using the AR technique. Hybrid BRS is proposed by Pathak et al. [35], Kanetkar et al. [36] using the features of content, CF, and CB recommendation techniques. It generates optimal recommendation for books for the user. Introduced [37] the hybrid BRS in which the CF technique is employed to recognize the good quality of books, AR of mining is applied to clear out out the

transaction to discover more potent reference and type approach is implemented to set up the diverse training of fee and publishers. Yada [38] initiated the BRS named Serendy, which recommends the books to the consumer by the use of comments given by the user's friend on their Twitter account. Proposed a library BRS [39] by using the AR of data mining according to user profile loaning. Xin et al. [40] proposed method firstly to detect communities with similar taste by identifying influential entities; by the use of CF approach, books are suggested to the user. Sohail et al. [41] proposed the BRS based on the rank-based scoring method. Tewari et al. [42] proposed the BRS based on OM and Naïve Bayes classifier to advise the top-ranking books to the user especially when the user visits the website the first time. Tsuji et al. [43], More [44] developed the BRS with the help of association rule by the use of loan records and bibliographic data of books and users. Tewari et al. [45, 37] introduced the BRS which amalgamates the features of CB, CF, and AR of mining to present efficient and effective recommendations.

Saquib et al. [46] used the positional aggregation-based scoring (PAS) approach to score the books and also assign weight to generated score with fuzzy quantifiers. The hybrid recommendation method is introduced by [26, 47–50] through the grouping of content, context, and collaborative strategies due to the fact that these algorithms fail to propose the efficient recommendation. Rajpurkar [51] introduced the hybrid BRS by integrating the features of CB and CF and AR to suggest useful and proficient books recommendation to the consumer based on their needs and interest. Classification and Opinion Mining techniques are utilized by [25] to design BRS. Parvatikar and Joshi [52] proposed system using the grouping of CF and Association Mining. Similarities among the items are calculated with the help of CF and to fill the vacant ratings in the matrix by association mining approach. Kurmashov and Latuta [53] proposed a BRS web service that uses the CF recommendation technique to present the suggestion of books to the users by using the user preference data which the user inserts while doing registration. Guo et al. [2] introduced the BRS in which firstly it finds out the main factors which affect the user evaluation of books by using the correlation theory. Gil et al. [54] use the MapReduce programming model on the Hadoop platform to design the BRS which is capable of processing the keywords matching computations. Hybrid BRS was designed [55] by the implementation of book content, CF, CB approach, and AR of mining to provide accurate and relevant books. BRS was proposed by [56] on the basis of time-sequential CF commendation which combined with the knowledge learning system of the college by using the CF approach. Mathew et al. [57] designed the hybrid BRS with CB and CF recommendation techniques and AR to provide the useful and proficient recommendation of books. In the proposed model by [58], online reviews of books are analyzed and features of books are extracted by human intelligence which helps the user in the recommendation process of books by using OM approach. Li et al. [59] introduced hybrid BRS by combining the CF with LDA (Latent Dirichlet Allocation), Word2vec, and LFM (Latent Factor Models) methods. Ahmad et al. [60] present the group RS with a CF method with aggregation techniques.

Patel and Dangra [61] and Rathnavel and Kelkar [62] use the CB and CF strategies to discover the listing of books consistent with content material and scores consistent with hobby and shops tips withinside the user's net profile. Mariana et al. [63] designed the BRS the use of data mining to method the several information with the aid of using imposing affiliation evaluation on mortgage a report of the user and it's also discovered the exciting courting in a massive information set. K-means clustering method is implemented to synthesize the data into different groups that are developed on the basis of similarity of data without previous information by [64]. The hybrid BRS is designed by [65] by considering many parameters like attributes of the books and also personality-based mapping of the user with the help of CB and CF techniques of recommendation. Jomsri [66] design the BRS, which uses the profile of the user with book category and book loan by the use of AR. BRS is designed by [67, 68, 22] implemented the use of the CF technique of recommendation.

The OM approach is utilized [69] for the book recommendation process to the user. [70] introduced the dynamic RS by extorting the significant data from a number of E-Portals and used the hybrid filtering technology on the collected data to offer the advice of books to the person of their interest. Sariki and Kumar [71] presented the BRS based on the CB recommendation technique. It uses the Named Entity Recognizer (NER) to rank books and provide a recommendation to the user. Pasricha and Solanki [72] proposed BRS based at the recognization of opinion leaders in spotted groups of social networks through the use of information related to user's interest, preferences, age, and online to be had at the social network.

Hybrid BRS [73, 74] is provided to the university students with CB and CF is improved by clustering. User-object scoring and clustering are used to relieve the information sparsity problem. Rana and Deeba [19] proposed a BRS that uses CF with Jaccard Similarity (JS) to provide more accurate recommendations by removing the problems of scalability, cold start, and sparsity. JS is a ratio of not unusual place customers (who rated each book) divided through the sum of customers who rated the two books individually. Hybrid BRS was developed [75] by using the CF and AR to provide the recommendation list of books and also solve the data sparsity and cold start problems. Anwar and Uma [76] proposed the BRS on Cross-Domain Sequential Pattern Mining (CD-SPM) approach to give a better recommendation by merging the Wpath, CF, and SPM. Wpath is used to locate the semantic similarity of gadgets belonging to more than one domains. Ifada et al. [77] introduced the probabilistic-keyword CF method to provide the recommendation of the books to the user in a library and to minimize the sparsity problem of CF.

4 Evaluation Metrics

An RS is a kind of intellectual system that makes use of personalized recommendations of products or items to the consumer based on consumer past activity or behavior on websites. The main motive of RS is to enhance the consumer enjoy, and consumer enjoy may be assessed by the usage of the diverse assessment metrics. A

number of evaluation metrics are used in the surveyed papers like precision, recall, RMSE, MAE, etc.

Mean Reciprocal Rank (MRR): In a comprehensive approach, the position of the product or item is ranked first in the ranking system. In the ranking system, 'r' denotes the rank of the item. Reciprocal rank (RR) can be represented as in Eq. 3.

$$\mathrm{RR} = \frac{1}{r} \tag{3}$$

MRR of all the products or objects for his or her respective first ranked product is given in Eq. 4.

$$\mathrm{MRR} = \frac{1}{n} \sum_{i=1}^{n} \mathrm{RR}i \tag{4}$$

In Eq. 4, 'n' is the whole wide variety of various objects and 'i' represents the object's sequence. MRR offers the diploma of the relevance of a selected product or object for the customer.

Recall: Recall calculates the number of positive predictions made out of all predictions. So the recall is the division of relevant recommendations to the total relevant recommendations. Recall can be expressed as in Eq. 5.

$$\mathrm{Recall} = \frac{\text{True positive (TP)}}{\text{True Positive (TP)} + \text{True Negative (TN)}} \tag{5}$$

Accuracy: Accuracy is one degree of ways regularly the set of rules classifies a data factor effectively. Accuracy is the range of effectively anticipated data factors out of all of the statistics factors. Equation 6 represents how to calculate accuracy.

$$\mathrm{Accuracy} = \frac{\text{Number of correct predictions}}{\text{Total number of predictions}} \tag{6}$$

Precision: Precision can be identified as the fraction of applicable occurrences to the entire occurrences. Calculation of precision is shown in Eq. 7.

$$\mathrm{Precision} = \frac{\text{Relevant Instances}}{\text{Total Instances}} \tag{7}$$

F-score: F-score, also well-known as F1-score, is utilized to measure the accurateness of the model on a dataset. It is the amalgamation of recall and precision of the model. Equation 8 represents the formula of F-score.

$$F - \text{Score} = 2 * \frac{\text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}} \tag{8}$$

Mean Absolution Error (MAE): MAE deals with the average magnitude of the faults in a set of forecasts. It is the average over the test sample of the absolute differences between forecast and actual observation [78]. MAE can be calculated with Eq. 9.

$$\text{MAE} = \frac{\sum_{i=1}^{N} |Pi - Qi|}{N} \tag{9}$$

P symbolizes the predicted data and Q represents the actual observation.

Root Mean Square Error (RMSE): RMSE is the standard deviation of the forecast errors. It places extra emphasis on large absolute mistakes and decreases the RMSE.

$$\text{RMSE} = \sqrt{\frac{1}{n}} \sum_{u,i} (p_{u,i} - r_{u,i})^2 \tag{10}$$

where p is the anticipated score for consumer u on object i and r is the real score. 'n' is the entire wide variety of scores at the object set.

Mean Average Precision (MAP): MAP is given by Eq. 11

$$\text{MAP} = \frac{1}{n} \sum_{i=1}^{n} P(U_i) \tag{11}$$

$P(U_i)$ is the precision of ith user and 'n' is the number of users.

5 Research Gap

In this literature study, it is observed that BRS faces a number of problems during the recommendation of books to the user. Some problems are listed below.

Cold Start problem: When a new book is added to the RS, at that time, there is less chance to recommend the new book to the same someone. The same situation occurs when a new user is added to the RS. This situation is known as the cold start problem. It becomes a difficult task for RS to recommend the books to the user without any knowledge of the taste of the user [72].

Dataset: Mostly RS work on the rating system, but other factors like comments, remarks, and references also play an important role in the recommendation. So recommender systems also need to consider the datasets having these factors [72].

Scalability: The main issue faced by today's BRS is scalability of algorithms that are used to design the BRS with huge real-time datasets. It's a challenging task of the RS algorithms to deal with large and dynamic real-time datasets. The main sources of the datasets are item-user interactions like ratings and reviews [50].

Data sparsity: Usually, the majority of the users are not rating the items which arise the sparsity problem in the rating matrix. This problem declines the search for the group of users with the same kind of taste.

Memory Performance: To develop the BRS, researchers use the algorithms of clustering to provide better memory performance which puts aside the memory resources. The increase of users on the RS platform also increases the computational issues and influences the memory performance [72].

Grey Sheep User Identification: The most used CF technique forecasts the unknown preference of the consumer on the basis of consumer's preferences or on the basis of identified similar user preferences. A user with a high correlation with other groups of users is called the white user while otherwise called grey sheep users who have less correlation with any other group of users. Grey sheep users increase the rate of error in the recommendation process. This problem is faced by a number of researchers during the development of BRS.

6 Proposed Work

1. We summarize the current literature of ten years (2010–2020) on book recommender systems.
2. We listed the recommendation techniques which are used to design and develop the BRS like CF, CB, Hybrid, AR, and opinion mining. Also, we explain the working of each recommendation technique.
3. Also, we highlight the functioning of various evaluation metrics. A number of evaluation metrics are used in the surveyed papers like precision, recall, RMSE, MAE, Accuracy, Precision, etc.
4. We design the hybrid book recommendation system based on the collective character of CF and CB approaches on demographic attributes [79].
5. We work on the design of BRS to identify the grey sheep users and provide the recommendation of the item to these kinds of users because grey sheep users affect the accuracy of the RS and also provide inaccurate predictions.

7 Future Perspectives in RS

The recommender system plays a critical role on the Internet platform where a vast amount of data is generated in a single unit of time. RS is extremely customizable to the E-commerce sites for the users. RS facilitates the E-commerce sites to build the

belief of the consumer by providing the items on their interest and preferences and also change the site visitor to its loyal customer. RS acts as the delicate salesman over the virtual platform for the consumer and increases the sales and information awareness of items among the users. The BRS helps the customer or user and librarian to make available books on their interest. Most of the study papers mentioned above have used the affiliation rule, OM, CF, and CB, and lots of extra ML strategies are used. The wide variety of ranges is applied withinside the advice process like information extraction, information preprocessing, and advice era ranges. Till now, strategies like classification and clustering are applied withinside the facts preprocessing stage. Now CF, CB, opinion mining, and AR approaches are brought into play to design the BRS. The recommendation process of BRS can be enhanced by the usage of integration of these techniques to produce the hybrid BRS.

8 Conclusion

RS has an imperative role in the binary platform where an enormous amount of binary data is generated within a second. Now everything is available on the online platform. Users can study the books online or can also be purchased. But on the digital platform, a huge number of books are available which creates the problem for the user to select the books based on their interest. So to resolve this problem, BR is introduced. A number of approaches are used to design the BRS. In this research paper, we reviewed the ten years of research papers on BRS from 2010 to 2020. This paper reviewed the ML techniques which are practiced to design the BRS and these techniques can be classified into six categories like clustering, CF, CB, Association, OM, and Hybrid technique which are the integration of any above-mentioned approaches or techniques and also discussed in details. It also discussed the evaluation metrics which are used to evaluate the performance of BRS. This paper helps those researchers who work in the same domain.

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Software Testing and Test Case Optimization: Concepts and Trends

Vinita Tomar and Mamta Bansal

Abstract Software testing aims at identifying the defects and errors in any developed system. Software testing has been viewed as an optimization problem, indicating that various optimization approaches might be used to address software testing challenges. This research paper discusses the significance of software testing and concepts of test case optimization under regression testing. It describes many forms of regression testing and their approaches and identifies several gaps. A literature survey has been done on test case optimization in regression testing, including test case generation, test case prioritization, and test case minimization. A new methodology is also suggested to overcome the gaps.

Keywords Software testing · Regression testing · Optimization · Test case generation · Minimization · Prioritization

1 Introduction

Software testing is a procedure for thoroughly testing the runtime and software quality. It is also known as the process of verifying and validating an application under test to detect bugs and errors. Basic testing of the software is carried out in the environment in which the software is intended to be used. It checks correct and effective output during operation. The test should systematically discover different types of errors in the shortest time and with the least workload. Testing must prove that the software seems to be running according to specifications. The information gathered during testing can be used to determine the software's reliability and quality. The test case must be made in order to improve software quality.

Software testing can be performed manually or automatically. Manual testing entails manually testing software without using any automated methods, whereas automated testing entails creating scripts and using software to test the system.

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Software development and planning are incomplete without testing. It's used at all stages of the software development process. It is usually divided into the following different stages: requirements analysis, test planning, test development, test execution, evaluation exit criteria, and test closure. The software testing method is introduced to aid in the early detection of software defects, as the cost of modifications in the maintenance phase rises if errors are identified later in the SDLC [1].

Functional and non-functional testing are two basic categories of software testing [2]. Functional testing involves testing the functionality of software applications, whereas non-functional testing tests the non-functional features of the application such as performance, reliability, usability, security, and many more.

Software testing is aimed at ensuring the application software matches the users' specifications. Good Test coverage is required to ensure the application software runs as expected. To generate coverage lists, the test cases need to be designed to provide maximum chances of finding various errors or bugs. The effectiveness of the test cases is measured by the number of defects or errors reported. This is done by using heuristic techniques. The automated generation of test data helps to reduce costs and time when developing test cases.

2 Regression Testing

When a modification is made to a software application, it is possible that other portions of the application may be affected. Regression testing is utilized to make sure that fixed bugs did not result in violations of other functions. Regression testing is a form of software testing in which test cases are re-executed to ensure that the previous functions of the application are still functional and that the new changes haven't introduced any mistakes. The most important aspect of the software development life cycle is regression testing [3]. The goal of regression testing is to make sure that changes, such as a bug fix, should not cause another bug to be found in the application. It is carried out by selecting suitable test cases from the test suite. The test cases cover the modified and affected sections of the code. Test cases are usually automated because they need to be executed again and again, and manually running the same test case is a time-consuming task. Prioritization of regression test cases is one of the most essential tasks in the regression testing process [4]. Unit regression, partial regression, and complete regression are three categories of regression testing.

2.1 Regression Testing Techniques

Regression testing can be classified as follows:

1. **Test case selection**: It re-executes a test from the test suite. It will not be necessary to re-execute the complete suite. The test cases are chosen based on the module's code changes.
2. **Test case minimization**: It is used to minimize test costs in terms of execution time, resources time, etc. Test suite minimization is the optimization task of identifying the smallest subset of test cases in the suite that satisfy similar coverage requirements as the original suite.
3. **Test case prioritization**: It prioritizes test cases in the test suite according to many parameters such as code coverage, risk modules, functions, and features, among others.

3 Optimization in Software Testing

The term "optimize of the testing process" means the practice of making the testing process faster while maintaining its correctness. The test optimization process can be carried out by altering how the test cases are executed, such as running the tests in the optimal sequence or executing the tests that cover the changes in the build. Optimization is the process of accomplishing certain goals using minimal resources and better methods than other contemporary methods. To ensure software quality, optimizing test suites from the start is essential. There are several effective ways for optimizing test suites for efficient outcomes. An optimization algorithm is a search method whose goal is to find the best solution to a problem to satisfy one or make an objective function that may be subject to a set of constraints. It is a way to find the maximum or minimum value of a function or process. It can either refer to maximization or minimization.

4 Significance of Software Testing

The significance of software testing are as follows:

1. Early software testing saves both time and cost.
2. It helps to verify that all the software requirements are implemented correctly or not.
3. It helps in determining the functionality, reliability, usability, efficiency, maintainability, and portability of the software.
4. It improves the consistency and performance of a software product or application.
5. The primary goal of testing is to identify and eliminate defects and errors.

6 It helps developers and testers to compare actual results with expected results to improve the quality.
7. It gives confidence in the quality of the final product. High-quality products delivered to customers help win their trust.
8. It ensures that the stored and processed data is protected from unauthorized access and hacker intrusion.
9. The test makes it easier to add new features to the application or products.
10. A good test allows other developers to better understand the purpose of the code.

5 Literature Survey

In the field of software testing optimization, numerous researches have been conducted. Some of them are mentioned below.

Dhareula et al. [3] proposed a flower pollination approach for regression testing test case prioritizing. Only those test cases were included in this study that covered the most defects in the shortest amount of time. The results were validated using the average proportion of fault detected metrics. It was concluded that the flower pollination algorithm's stopping criteria for test case prioritization were found to be largely dependent on the nature and size of the application.

Hourani et al. [6] considered the Artificial Intelligence main features that can be used in software testing. The result showed that AI-driven testing will be the better option for quality assurance work as artificial intelligence can give better results in software testing than other techniques. It was concluded that artificial intelligence software testing will enhance the quality of the software and organizational efficiency will also be improved.

Durelli et al. [7] provide all the information on the research for machine learning and software testing. Machine learning algorithms are mostly utilized for test case generation, refining, and evaluation, according to their research work. Also, software testing operations are automated using machine learning techniques.

Shrivathsan et al. [8] proposed two fuzzy-based clustering techniques for test case prioritization. The novel similarity coefficient and dominancy measure were used by the researchers. They used the arithmetic sum-product method to assess. The results of the testing revealed that the proposed algorithms improve the chances of choosing more related tests. Although it all depends on the cluster size, this strategy increased the efficacy of test case prioritization techniques. It was concluded that the regression testing process can be successfully handled by grouping test cases.

Preethi et al. [9] proposed the automated test case generation system that generates the test cases automatically. It also evaluates the test cases and gives the test reports. Researchers have used a genetic algorithm that generated test cases using the fitness value function. They have also used classification and regression trees algorithm to generate test cases reports. The results showed that this automated system can be used

on all types of testing. They have suggested developing a system for non-functional testing types in future work.

Ahmad et al. [5] proposed a combination of two techniques. Researchers first created test cases based on prioritized test cases based on test variables and then used the ant colony optimization technique to calculate the best sequence with the shortest execution time and highest defect rate. It was concluded that by combining these two methods, they got the best solution for the problem. They have suggested implementing the Ant colony optimization-based algorithm and to compare with other search-based algorithms in the future.

Panwar et al. [10] proposed a Cuckoo search algorithm and an improved ant colony optimization algorithm to summarize test cases in an optimized sequence in a time-constrained environment. Researchers worked on nature-inspired optimization algorithms and searched for better optimization for the test case prioritization. Cuckoo search is more effective and easier to implement than other optimization techniques as it just uses one parameter. It was concluded that the proposed hybrid cuckoo algorithm was shown to be extremely beneficial for prioritizing test cases.

Khari et al. [11] generated a testing tool for automated use that consists of two key automated software testing components. The first is the creation of a test suite, and the second is the optimization of a test suite. For automated defect detection, this optimized test suite is used. The researchers used an artificial bee colony and cuckoo search algorithm. The researcher in this study gave a set of minimal test cases. They also used maximum path coverage.

Manivasagam et al. [1] proposed an optimization technique. This method is used to select potential features. It will make software defect prediction more accurate. Using metaheuristic search, the researchers have utilized a technique based on fuzzy mutual information. The results revealed an improvement in routine prediction for three different classifiers utilized in the study. It was concluded that the proposed optimization technique has greater accuracy in terms of predicting software defects.

Ozturk et al. [12] suggested a bat-inspired test case prioritization algorithm. The researchers adopt several features of the algorithm, which include test execution time and code errors, to the notion of the algorithm while constructing it. The proposed method was then compared to the existing methods and found to be the most effective. And due to test case complexity, the code increases, and the average percentage drop in fault detection in this method is less than the drop produced by the other four compared by four algorithms.

Babbar [2] in this study described the common test cases and test techniques used for error detection. He discussed unit testing, integration testing, and system testing as well as other forms of software testing methodologies. He has also described in detail testing techniques namely black box testing and white box testing along with their advantages.

Luo et al. [4] conducted a thorough investigation and compared the efficacy and a likeness of defects for static as well as dynamic test case prioritization techniques at various test case granularities. The results revealed that at the test case level, a static methodology outperformed a dynamic technique, whereas dynamic outperformed

static at the test method level. It was concluded that that test case prioritization techniques perform differently in different disciplines.

6 Scientific Gaps

In the existing work, the emphasis was given to optimizing test cases for maximum path coverage. Coverage of the critical path is more significant than code coverage percentage in quality testing. The existing test case optimization techniques lack costs and benefits when test suites have many critical paths that need to be prioritized. There is a lack of multi-objective optimization algorithms that can focus on both coverage, criticality, and resources simultaneously. Existing optimization techniques include Genetic Algorithm, Ant Colony Algorithm, Particle swarm Algorithm, and Firefly. However, as there have been a lot of improvements been done in this area, newer algorithms must also be explored. The previous research used code coverage as a criterion, which differs from defect detection criteria. When used to fault detection-based prioritization problems, metaheuristic algorithms may produce a variety of outcomes.

7 Methodology

The methodology for test case optimization for proposed work will be as follows:

Step 1 To search for novel optimization techniques. The extensive study of the metaheuristic algorithms will determine the complexity, challenges, opportunities, and limitations of each algorithm to determine the sustainability of the algorithm for the proposed work.

Step 2 To create the test cases and minimize the dimensions of test suites by disposing of excess test cases. Assess the optimum test coverage requirement and prioritize the test cases.

Step 3 To compute the values of metrics and assess the efficacy of the proposed test case optimization for regression testing with existing approaches.

Figure 1 shows a flow chart for optimizing test case generation, prioritization, and minimization of proposed work:

8 Conclusion

Every software development and planning process is incomplete without software testing. The objective of software testing is to detect defects and errors in a developed system that has already been developed. Various regression testing techniques and

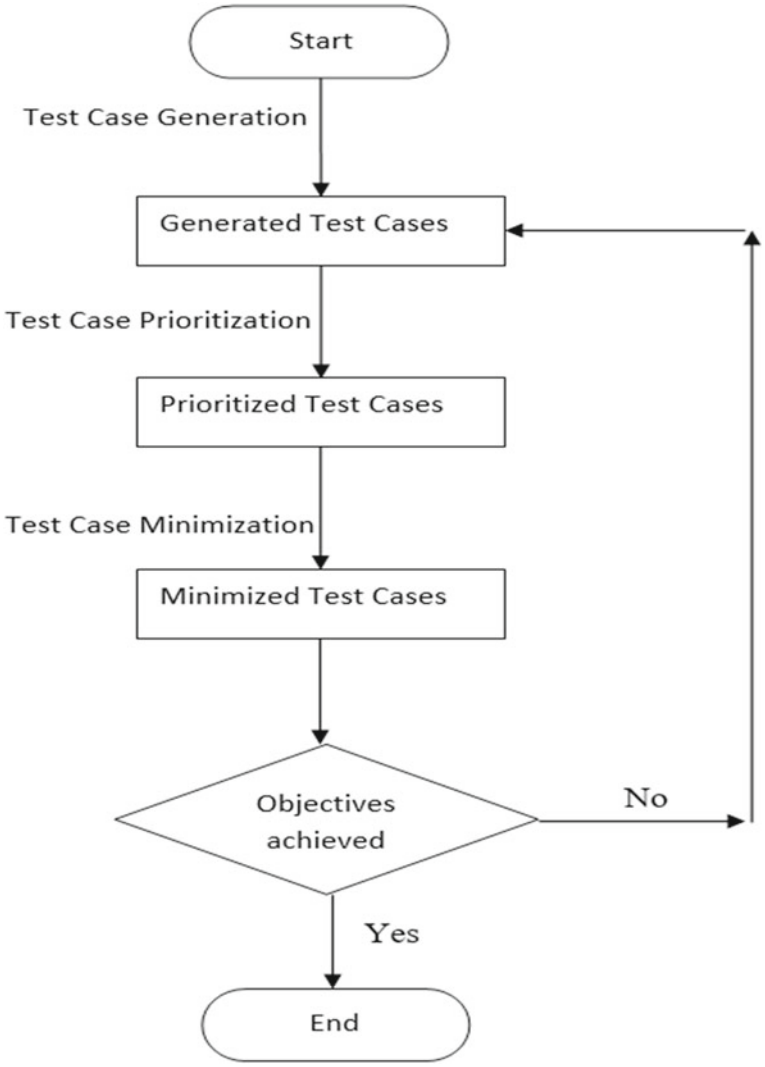

Fig. 1 Optimization of test case generation, prioritization, and minimization

the importance of software testing are explained in this research paper. Several gaps have been identified using a literature survey. The existing test case optimization techniques lack costs and benefits when test suits have many critical paths that need to be prioritized. There is a lack of multi-objective optimization algorithms. This paper describes the proposed methodology for the optimization techniques by extensive study of metaheuristic algorithms. The value of metrics will be computed and the efficacy of the proposed test case optimization for regression testing will be compared with the existing approaches.

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Euler Totient Function and Fermat-Eulller Theorem Based on Optimized Key Management Scheme for Securing Mobile Agents Migration

Niraj Singhal, Pradeep Kumar, and Dhiraj Pandey

Abstract As mobile agents move automatically on distributed networks, the security of agents and platforms is of prime concern. Over the years, mobile agents-based software applications have grown exceptionally. It also has increased the threats to the security of such applications. In the mobile agent paradigm, most of the protection schemes discuss the protection of platforms only and provide fewer directions on the security of mobile agents which is still a complicated issue. In this paper, a mathematical key management technique has been presented to solve the problem of agent security and its authentication during the hopping of agents in different platforms. Here, a novel agent security approach based on the Euler totient function and Fermat-Euler theorem is developed to secure a secret key among 'n' number of mobile agents. At the time of execution, the mobile agent reconstructs the secret key based on the proposed technique. An evaluative judgment, comparing with various agent security schemes, has been presented, along with their complex nature. The proposed approach has been implemented and its various features are tested. The results indicate that the computing here is much more secure and easier in comparison to traditional client–server and code on-demand paradigms.

Keywords Mobile agents · Degree of mobility · Euler totient function · Fermat-Euler theorem · Distributing computing

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1 Introduction

Mobile agent (MA)-based framework is an amendment on mobile agents for the distributed processing. It is a software process with intelligence that works on the behalf of its user. The mobile agent paradigm provides a high degree of flexibility in processing. There are three main categories of computing, i.e., Client–server computing *(computing a server provides services to client),* Code on-demand Computing *(sever sends executable code from a server to a client on the request from the client side*), and Agent-Based computing *(An intelligent piece of code along with process form the mobile agents, which works on the basis of host and migrate automatically from one host to another host).*

In client–server approach, data moves from one user to another, but the movement of data takes more bandwidth of the channel. In the case of the Mobile agent approach, instead of movement of data, a process moves from one host to another which takes less bandwidth of channel as compared to the client–server approach. The mobile agent-based computing is shown in Fig. 1.

The mobile agent follows a life cycle during the communication to agent and platform, as shown in Fig. 2

During the lifetime of a mobile agent, various phases that occur are Creation (a newly agent is created and initialized state of agent), Cloning (duplicate mobile agent is created), Dispatch (agent is dispatched and communicate to agent and platform), Deactivation (agent is in sleep state save in to memory), Activation (agent is activated from the memory), Retraction (agent is ready to execute operation), Communication (occur among agent and host), and Disposal (in the final state, a mobile agent terminated after completion of process).

Security is a major concern for mobile agents as they move from host to host. There are Confidentiality (in any developed frameworks, confidentiality should not be compromised during communications either by hoped agents or by different platforms under execution of agent process), Data integrity (data and information should be in the original form not tampered by any third party. The integrity needs to maintain for any secure operation of mobile agents, both local as well as other platforms on which agent moves for execution.), and Availability (availability means data and information that are required by platform or agents should be available. The agent platform will make it available to both local and remote agents). Security parameters are shown in Fig. 3.

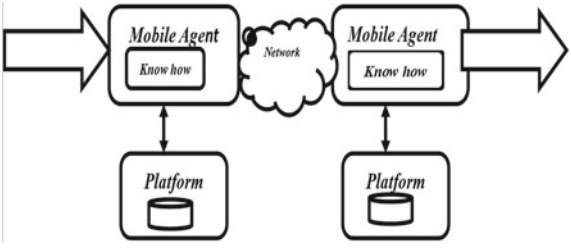


Fig. 1 Mobile agent computing

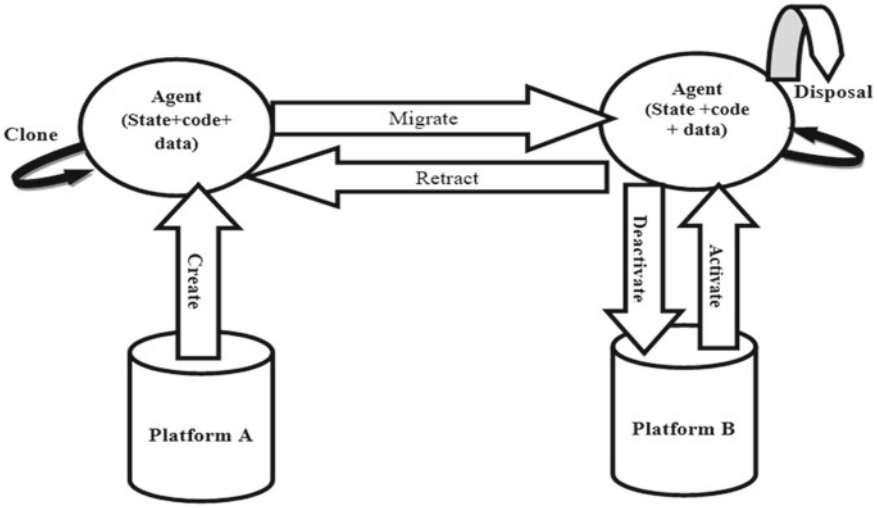
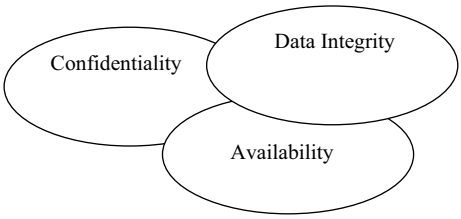


Fig. 2 Mobile agent life cycle

Fig. 3 Security parameters



Apart from these above-mentioned parameters, authentication of the identity of agents and platform is also needed for user actions[1]. A major issue to design mobile agent paradigm is the security of mobile agent during the transmission on distributed networks. In the existing agent systems, most of the concentration was on deciding the working of agents rather than security[1]. Most of the schemes lack in implementation of an effective security for mobile agents. Some popular issues related to attacks on mobile agent frameworks are highlighted in Table1.

It shows that there is a need of securing mobile agents to support interoperability between the agent's framework and the security of paradigms [1]. From centralized monolithic computing, the Security of mobile agent has been less explored till date in research. So, there is a need of developing a strategy that can work in a secure distributed environment.

In this paper, a secure key management scheme of mobile agent in the agent-based environment has been proposed. The algorithm of the proposed mathematical model is categorized into main three parts, i.e., initialization, share creation, and reconstruction of shares. In the initialization part, we select a secure key 'S' for authentication of mobile agent during execution and transformation of code. The

Table 1 Attacks on mobile agent frameworks

	Attacks of agent during execution on platform	Attacks of agent during execution on agent	Attacks of platform during execution on agent
Masquerading	✓	✓	✓
DOS	✓	✓	✓
Unauthorized access	✓	✓	
Repudiation		✓	
Eavesdropping			✓
Alteration			✓

creation of the public share of every mobile agent $0 \leq i \leq n$ is done in the second step of the algorithm. At last, the corresponding share is determined using a threshold-based scheme (Si, pi).

The complete structure of the article is as follows. Sections 2 and 3 have been describing mainly about the agent-based frameworks and problem statement. Section 4 presents the proposed approach along with preliminaries. The performance evaluation of the approach along with implementation has been discussed in Sect. 5. Conclusions with future work have been highlighted in Sect. 5.

2 Related Works

The main classifications of security threats include information disclosure, denial of service, and information corruption. These types of dangers can be examined in more depth as they relate to the agent architecture. Mobile agents simply provide more opportunities for exploitation and misuse, considerably increasing the scope of threats.

A Verifiable Secret Sharing (VSS) technique based on the Chinese Remainder Theorem (CRT) and Shamir's approach has been proposed by several researchers in the field of agent security. Verma et al .[2] proposed the idea of security using CRT which is helpful when the shareholder is not honest and uses multiple secret shares in multilevel groups. All the participants are categorized into various levels and every level has a dynamic threshold value. Reconstruction is done when sufficient numbers of shares are available. Iftene [3] proposed a scheme to support voting for the person with multiple authorities based on CRT. Each authority has a different weight or threshold in the scheme. Lein et al. [4] proposed multiple level share designed based on CRT. Ersoy et al. [5] suggest a secret share based on the homomorphism aspect of CRT. Meng et al. [6] suggested a general access structure for secret sharing using CRT. It divides the secret in a hierarchical structure in a way that higher level can access the lower level share, to regenerate the secret. In Multilevel Secret Sharing Scheme (MTSS), only one secret is used in each level.

A CRT-based threshold RSA (Rivest, Shamir, and Adleman) algorithm has been proposed by Sarkar et al. [7]. It generates consistent shares of the secret for the shareholder and provides security during the reconstruction of the key. Zou et al. [8] proposed a CRT-based multiple secret key distribution technique using secure and fast electronic voting. Shyu et al. [9] described a secret image sharing technique based on CRT. A secret sharing technique based on the sum of weights of shareholder involved in the regeneration of secret has been suggested by Shi et al. [10]. This technique is based on the fusion of the Lagrange interpolation and CRT. Reddy et al. [11] proposed a protocol for general threshold-based multiple secret sharing schemes that give multiple secrets, and recovery of the secret is also visible in nature.

Deshmukh et al. [12] suggested a scheme of security using binary trees and boolean operation. The height of the binary tree decides the security of the scheme. The higher the height of the tree, the better is the security nature. In a complete binary tree, each node has a random share and it does not reveal any data. If an attacker has fewer shares than the threshold value, data will not be revealed. A scheme based on uni-variate and bi-variate symmetry polynomial to reduce coefficients of shares for each group is suggested by Meng et al. [13]. A sharing scheme based on robust reversible data hiding scheme suggested by Liu et al. [14] proposed a verifiable technique in which each shareholder is allocated a shadow share which provides higher security during the recovery phase. A combiner authenticates each shareholder before submitting information.

Cheating detection during the generation of verifiable shares is also proposed by many researchers using different techniques. Yi et al. [15] proposed two efficient (t, n) Threshold Password Authentication Secret Sharing (TPASS) technique for any 'n' greater than 't' that provides security of secret of the user during the reconstruction of secret. Wu et al.[16] designed sharing scheme (k, n) Secret Image Sharing for Distributed Cloud Network (SISDCN), where 'k' shareholder can reconstruct share using Distributed Cloud Network (DCN) on images. Liu et al. [17] proposed two cheating detection schemes on (k, n) sharing technique of secret. The first scheme identifies the cheating and the second provides a higher authentication for secret regeneration.

Binue and Kumar [18] proposed a dynamic technique designed on the elliptic curve, to provide higher security. This scheme also identifies cheating identification.

The work carried out by the above researchers in the direction of security of mobile agent paradigm is mainly concerned with the platform security rather than the mobile agent. During the hopping of agents from one hop to another, the security of the agent as well as platform security should be of concern to save it from any adversaries.

3 Proposed Work

One needs to have a robust and efficient security mechanism to make the mobile agent framework more secure in nature. The popular encryption technique has been solving the security issues using traditional ways of generating a key. The encryption techniques in turn lead to key handling issues and different attacks and its countermeasures required to make an agent secure enough. The security of a mobile agent is entirely based on the robustness of a key which an agent generated and its secure key management techniques. The problem in the case of mobile agent security is beginning from the source platform of agents that is completely trusted and secure. This trusted environment is difficult to carry to other agent platforms during the course of its hopping. When an agent is moved to another hop, its protection is minimal compared to source hop. Such an agent protection scheme may be adequate based on a few applications, but it is not optimal in nature. A few strategies for identifying unauthorized changes to an agent's behavior include execution tracking, partial result encapsulation, and mutual itinerary recording.

The proposed approach describes a scheme in which an agent moves between the hops and maintains its security based on its key and threshold decided. The non-trusted hop station or hackers of agent code requires a proper threshold value to open the process associated with the key to the agent. For the security of mobile agents, the proposed approach is based on Euler's totient function and the Fermat-Euler theorem. A secret key for the execution and authentication of the mobile agent has been generated and used at the mobile host during the life cycle. The secret is divided into 'n' number of shares based on the proposed approach and it selects a random value between lower and upper bound. The mechanism uses a threshold-based decision for a particular key shared during movement for authenticating a mobile agent.

3.1 Preliminaries

The basic preliminaries used here are Shamir's scheme, Euler's theorem, Lagrange's Interpolation, and CRT. The Euler totient function and Fermat-Euler theorem has been used here to generate a secure key for agent. Shamir's threshold scheme along with CRT is used to compare the designed scheme on polynomial interpolation.

Chinese Remainder Theorem (CRT). The threshold value at each distribution level of the threshold secret sharing system is generated using the Chinese Remainder Theorem (CRT).

Consider the co-prime integer $p_1, p_2, p_3, \ldots p_n$ and $\alpha_1, \alpha_2, \alpha_3 \ldots \alpha_n$ random integer 'x' system of simultaneous congruence relation,

$$\begin{aligned} X &\equiv \alpha_1 \left(\text{mod } p_1\right) \\ X &\equiv \alpha_2 \left(\text{mod } p_2\right) \\ &\cdots \\ X &\equiv \alpha_n \left(\text{mod } p_n\right) \end{aligned} \tag{1}$$

has a unique solution modulo,

$P \equiv p_1, p_2, \ldots p_n$, for any given integers $\alpha_1, \alpha_2, \ldots, \alpha_n$.

$$P = p * p_2 * \ldots * p_n$$

$$x \equiv \alpha_1 P_1 c1 + \alpha_2 P_2 c2 + \cdots + \alpha_n P_{ncn} (\text{mod} P)$$

where $P_i == P/n_i \text{and} c_i \equiv P_i^{-1} \left(\text{mod } p_i\right)$.

Fermat-Euler theorem: In number theory, the Euler is a very important concept, the Euler totient Function (φ (n)): For $n \geq 1$, $\varphi(n)$ represents the total number of positive integers less than n and co-prime to n. If n is a prime number, the Euler totient returns $\varphi(n) = n - 1$.

If n is not prime $\varphi(n) = n\left(1 - 1/p_1\right)\left(1 - 1/p_2\right) \ldots \left(1 - 1/p_n\right)$, $p_1 < p_2 < \cdots < p_n$ prime numbers.

The Fermat-Euler theorem based on the Euler function theorem says that for positive integer n, and δ in such a way, $\gcd(\delta, n) = 1$, then

$$\delta^{\varphi(n)} \equiv 1 \bmod n \tag{2}$$

where $\varphi(n)$ is Euler's totient function.

Shamir's Secret Sharing: Let us consider $\beta_0, \beta_1, \beta_2, \ldots \beta_{k-1} \in GF(p) F(x) = (\beta_0 x^0 + \beta_1 x^1 + \beta_2 x^2 + \cdots + \beta_{t-1} x^{t-1}) \bmod p$, $F(0) = \beta_0 =$ session key and 'p' is a large prime number, and $\beta_1, \beta_2 \ldots,$ and β_{k-1} are randomly chosen real number from Z/PZ. On the basis of node identity, generate 'n' partial keys. At the receiver side, select 't' randomly share out of 'n' partial share and generate the Lagrange polynomial

$$F(x) = \sum_{i=1}^{k} \Upsilon_i \prod_{1 \leq j \leq k, j \neq i} \frac{\chi - \chi_j}{\chi_i - \chi_j} \tag{3}$$

Since $f(0) = \beta_0 =$ S, the secret key evalute using

$$\text{Secretkey}(S) = \sum_{i=1}^{k} P_i \Upsilon_i \tag{4}$$

where $P_i = \prod_{1 \le j \le k, j \ne i} \frac{\chi_j}{\chi_j - \chi_i}$.

Secret share is generated by using 't' partial share by using F(0) $= \beta_0$ mod p.

3.2 Countermeasure of Agent Security

To unlock the process associated with the mobile agent, a security scheme based on a robust key generation method is proposed here. The cryptographic condition is hidden through the number of threshold and secret keys divided among a number of shares. For the security of mobile agent, an approach based on the Euler totient function and the Fermat-Euler theorem has been proposed. In this secure agent framework, a secret key for the execution and authentication of the mobile agent is generated at the mobile host during the life cycle. The secret is divided into 'n' number of shares based on the scheme shown in the algorithm and select a random value between lower and upper bound. We have 'n' shares (as shown in Fig. 4), {S1, P1}, {S2, P2}, {S3, P3}, {S4, P4}….. {S5, Pn}. Platforms at which mobile agents want to execute their task on behalf of the user reconstruct the secret key for execution and authentication of the mobile agent.

The algorithm of the proposed mathematical model is made in three parts initializations, share creation, and reconstruction of share.

i. *Initialization:* Host (User) select n positive integer in such a way

- Select a secret key S($0 \le S < p_0$) *for* authentication of mobile agent during execution and transformation of code.
- Select positive integer $p_0 < p_1 < p_2 < p_3 \ldots < p_n$.

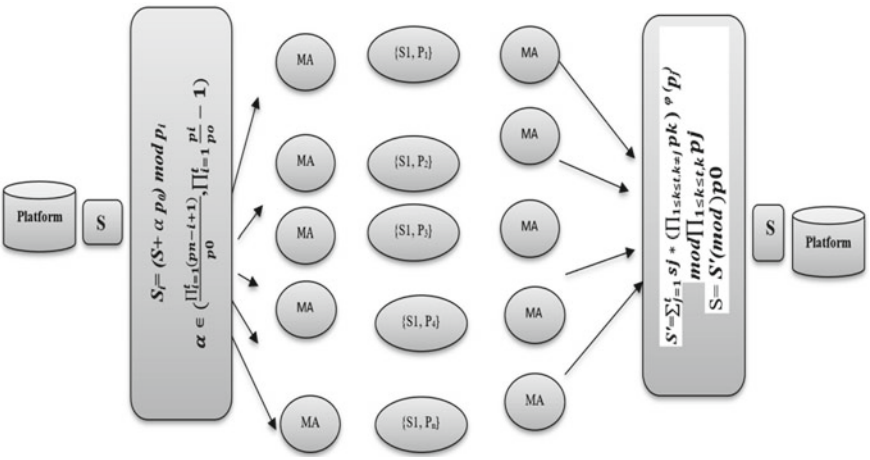


Fig. 4 Proposed framework based on the Euler totient function and the Fermat-Euler theorem

- $\gcd(pi,\ pj) = 1$ for every $i \neq j \leq n$
- $\prod_{i=1}^{t} p_i > (p0+1) \cdot \prod_{i=1}^{t-1} p_{n-t+i+1}$

ii. Share creation

- $S_i = (S + p_0) \bmod p_i$ public share of every Mobile agent $0 \leq i \leq n$
- $\alpha \in \left(\frac{\prod_{i=1}^{t} (pn-i+1)}{p0}, \prod_{i=1}^{t} \frac{pi}{po} - 1 \right)$

iii. Reconstruction of Secret share S

- gcd(A, B) :
- if$(a == 0)$
- *return b*
- *return* gcd$(B\%A, A)$
- ***Euler totient*** $\varphi(p_j)$***:***
- $R = 1$
- *for* $i = 2$ *to* n
- if(gcd$(i, n) == 1$) :
- $R = R + 1$
- *return R*
- corresponding share are (S_i, p_i) *to respective modulo* $p_i 0 \leq i \leq n$
- $S' = \sum_{j=1}^{t} sj * \left(\prod_{1 \leq k \leq t, k \neq j} pk \right)^{\varphi(pj)} \bmod \prod_{1 \leq k \leq t, ks} pj$
- $S = S' \bmod p0 / * p0$ Is public parameter

The algorithm makes a reliable environment in such a way that a malicious agent cannot uncover the agent process by reading straight the code of the agent. The developed technique focuses on mobile agent security and evolves along the traditional lines of key generation security techniques of the mobile agent framework. A simple example below demonstrates how the proposed scheme works in different chosen threshold values for 'n' number of distributed shares for a secret key generated using the proposed approach.

Considering n + 1 integer's$[p0 - p4]$ based on the algorithm. Select Secret(S) $= 6,\ S < p0,$ and $\alpha = 19$.

i. N (no. of shares) = 4, T(threshold) = 2
List of *p0, p1, p2, p3, p4*: [7, 11–13, 17]
Enter the value of $\alpha = 19$, Enter the value of secret share S = 6.
Generated shares: [3, 7, 7]
*p1, p2, p3, p4***:** [11–13, 17]
t = 2 take any two pair share 1 and share 4 (7, 11) and (3, 17).
$S1 = \left(7(17)^{\varphi(11)} + 3(11)^{\varphi(17)}\right)\%(11 * 17) = 139$
S = 139%7 = 6. Reconstructed secret share = 6.

ii. $N = 4, T = 3$
Enter the value of $\alpha = 19$. Enter the value of secret share **S = 6.**
Generated shares: [3, 7, 7]
p1, p2, p3, p4: [11–13, 17]
t = 3 take any three random pair (7, 11), (9, 13) and (3, 17)
$S1 = \left(7(17 * 13)^{\varphi(11)} + 3(11 * 13)^{\varphi(17)} + 9 * (11 * 17)^{\varphi(13)}\right)\%(11 * 17 * 13) = 139$
S = 139%7 = 6. Reconstructed secret share = 6.

iii. $N = 4, T = 4$
Enter the value of $\alpha = 19$. Enter the value of secret share S = 6.
Generated shares: [3, 7, 7]
p1, p2, p3, p4: [11–13, 17]
t = 4 take all pair at a time (7, 11), (9, 13), (7, 12) and (3, 17)
$S1\left(7(17 * 13 * 12)^{\varphi(11)} + 3(11 * 13 * 12)^{\varphi(17)} + 9 * (11 * 17 * 12)^{\varphi(13)} + 7 * (13 * 11 *\right.$
$\%(11 * 17 * 13 * 12) = 139$
S = 139% 7 = 6. Reconstructed secret share = 6

4 Implementation and Results

The proposed approach based on Euler's theorem with n = 10 shares along with k = 2 onward has been picked up for different threshold values. Table 2 represents the time taken by CRT to completely generate and reconstruct any integer range secret code value divided into a chosen number of shares and different chosen threshold values as indicated. Table 3 shows the time elapsed to the same process using the proposed scheme using the same set of conditions as set earlier.

Table 2 Time taken versus threshold for CRT

CRT t	2	4	6	8
1	0.0031	0.0055	0.0066	0.0059
2	0.0035	0.0034	0.0052	0.0069
3	0.0057	0.0054	0.0065	0.005
4	0.006	0.0057	0.0068	0.0081
5	0.0065	0.0065	0.0041	0.0069
6	0.003	0.0079	0.0047	0.0056
7	0.0067	0.0048	0.0058	0.0069
8	0.0061	0.0068	0.0087	0.0078
9	0.0046	0.0074	0.0073	0.0079
10	0.0065	0.0033	0.0049	0.0051
Avg	0.00517	0.00567	0.00606	0.00661

Table 3 Time taken versus threshold for Euler's totient

Euler t	2	4	6	8
1	0.0034	0.0042	0.0055	0.0071
2	0.0027	0.0033	0.0045	0.0045
3	0.0048	0.0051	0.0035	0.0057
4	0.0058	0.0055	0.0066	0.0059
5	0.0052	0.0041	0.0044	0.0056
6	0.0066	0.0055	0.0042	0.0057
7	0.0043	0.006	0.0046	0.0058
8	0.0035	0.0029	0.0043	0.0048
9	0.0047	0.004	0.0059	0.006
10	0.0049	0.0052	0.0042	0.0051
Avg	0.00459	0.00458	0.00477	0.00562

It is observed from the results that the execution time of the proposed approach is quite low as compared to the CRT scheme for the agent's key security. The best case and average case analysis of the proposed scheme have also been checked over CRT-based key generation and color highlights in the tables indicate the obtained result in the best case. The average case value has been picked up based on ten different results obtained on the same set of conditions. Every 'n' number of shares created was distributed on different machine instances and implementation is done using Python language. Here, 'n' number of shares generated on the basis of the Euler theorem, out of 'n' share, we want at least 't' share to regenerate the secret share for the execution of agents on platform. If less than 't' share wants to regenerate secret share, they can't generate. The security of this algorithm is based on the Euler totient function.

The graph shown below is based on the experimentation done with different settings as indicated above. Thresholds were introduced to check the recovery of dynamically decided value alternately to make the system more robust. At most of the tested values, the traditional key generation based on CRT was found to be a low performer with respect to the proposed scheme. When compared to CRT, the performance of the suggested system was found to be consistent in terms of time efficiency. In this light, the suggested system was proven to be very useful in detecting and counteracting assaults on agent-based security in any agent framework. Performance between threshold values versus total turnaround time taken to regenerate the session in average case is shown in Fig. 5. Performance between Threshold values versus total turnaround time taken to regenerate the session in the best case is shown in Fig. 6.

Table 4 represents the time taken by CRT to completely generate and reconstruct any integer range secret code value divided into different numbers of shares in the plane. Table 5 shows the time elapsed to the same process using the proposed scheme using the same set of conditions as set earlier. It is observed from the experimentation

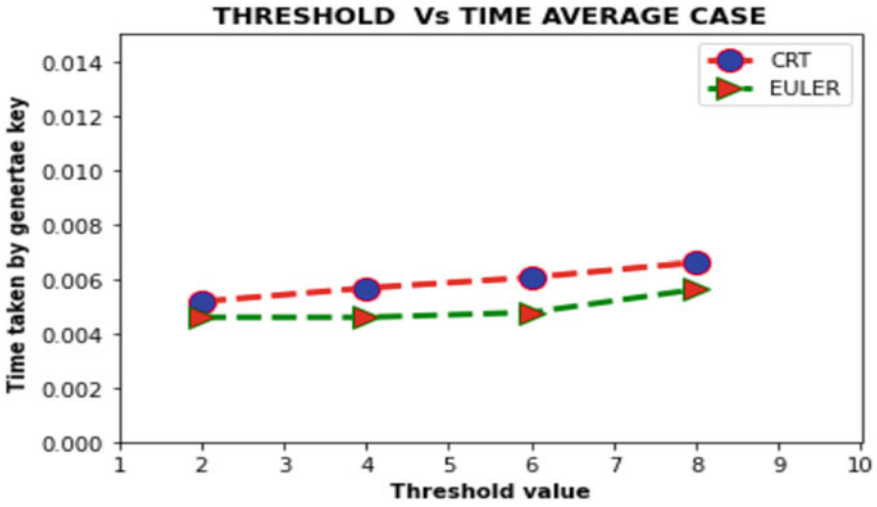


Fig. 5 Threshold value versus time average case

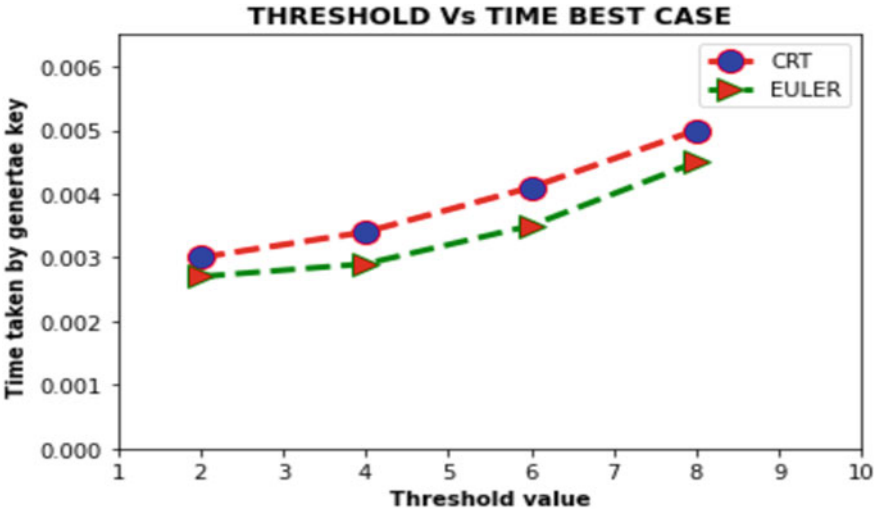


Fig. 6 Threshold value versus time best case

that the execution time of the proposed approach is still better even in the case of different numbers of share plain chosen as the compared to CRT scheme for agent's key security. The best case and average case analysis of the proposed scheme have also been checked over CRT-based key generation and color highlights in the tables indicate the obtained result in the best case. The average case value has been picked up based on ten different results obtained on the same set of conditions.

Table 4 Time taken versus number of mobile agents for CRT

CRT n	5	10	15	20	25	30
1	0.0065	0.0045	0.0084	0.011	0.0136	0.0079
2	0.0037	0.006	0.007	0.0096	0.0073	0.0081
3	0.0044	0.0068	0.0073	0.0127	0.00917	0.0086
4	0.0033	0.007	0.0083	0.0089	0.0081	0.0098
5	0.0041	0.0042	0.0076	0.0068	0.0103	0.0136
6	0.0052	0.0052	0.0048	0.007	0.0061	0.0074
7	0.0039	0.0057	0.0078	0.0087	0.0092	0.0128
8	0.0043	0.0055	0.0061	0.0084	0.00703	0.0098
9	0.004	0.0062	0.0062	0.0076	0.0099	0.0087
10	0.0039	0.0094	0.0042	0.0075	0.0098	0.0097
Avg	0.00433	0.00605	0.00677	0.00882	0.00905	0.00964

Table 5 Time taken versus number of mobile agents for Euler's Totient

Euler n	5	10	15	20	25	30
1	0.0031	0.0038	0.006	0.0053	0.0085	0.0061
2	0.0038	0.0065	0.0078	0.01	0.0059	0.0077
3	0.004	0.005	0.0057	0.0059	0.016	0.013
4	0.0035	0.0042	0.0065	0.007	0.0095	0.0089
5	0.0041	0.0046	0.0076	0.0073	0.008	0.0068
6	0.0032	0.0045	0.0035	0.01	0.0107	0.0099
7	0.0039	0.0063	0.007	0.017	0.0095	0.0099
8	0.003	0.0037	0.0069	0.0091	0.0053	0.016
9	0.004	0.006	0.0038	0.0082	0.0101	0.0085
10	0.0036	0.0069	0.01	0.0084	0.0063	0.0075
Avg	0.00362	0.00515	0.00648	0.00882	0.00898	0.00943

Figure 7 shows the performance between the Number of mobile agents versus the total turnaround time taken to regenerate the session in the average case. Figure 8 shows the performance between the number of mobile agents versus the total turnaround time taken to regenerate the session in the best case. The graph shown is based on the experimentation done with different numbers of mobile agents as indicated above. The number of mobile agents was introduced to check the recovery of the secret key from the scheme and observations were made to check the nature of the complexity of algorithms based on the increasing number of shares plane of secret information.

At most of the tested values, the proposed scheme generates optimal and fast results compared to traditional approaches. The analysis of key generated with the proposed scheme and CRT along with Shamir's approach has been compared in terms

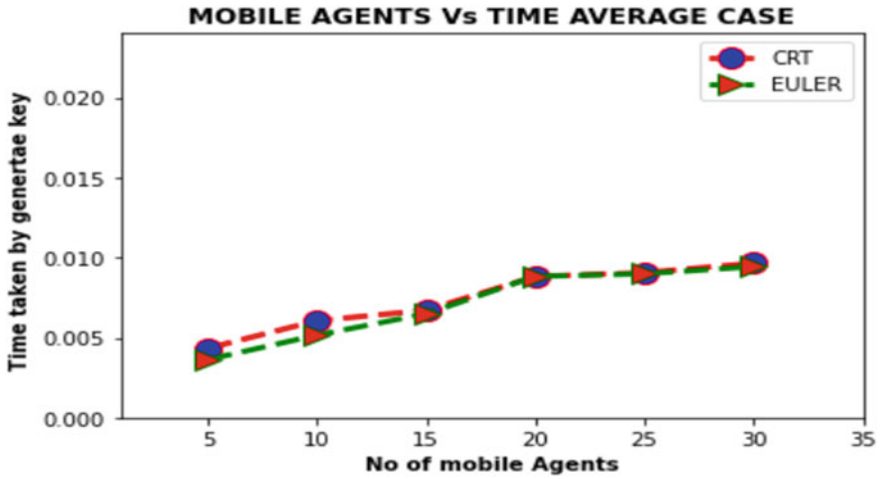


Fig. 7 No of mobile agents versus time in average case

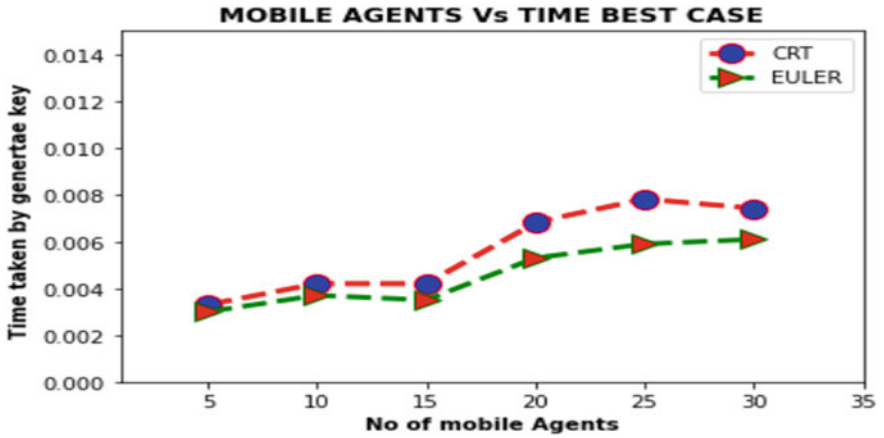


Fig. 8 No of mobile agents versus time in best case

of security features and time complexity. The analysis of the scheme indicates that the secret is safe, and the adversary cannot make any effect as the threshold is chosen dynamically for different hops before reconstruction. The secret can be recovered in O (t) number of operations while O ($t\log^2 t$) number of operations is needed for Shamir's scheme which indicates that the proposed scheme has linear complexity and gives a better result.

5 Conclusion

Securing the mobile agent during communication between different platforms is still a crucial issue. In this paper, an extension by fusion of Euler's totient and the Fermat theorem has been designed to make it more secure. It gives the insurance of key security using threshold values and a robust key management scheme. It helps to monitor the security of access of agents only to legitimate number of users. Authentication of any agent by other hosts is an equally important parameter of security. The model extends the key security as well as the key management scheme. The time complexity of the Euler totient-based framework is linear. It focuses toward improving the security aspects of agents, and in turn, it opens up new directions of other research to meet other security requirements. In the future, a more generalized model may be developed to cater to the need of agent's security as well as identify the untrusted hosts that will be useful for critical applications. This will help to save the computing paradigm of mobile agents from cheating and several new application areas will be benefited from the proposed work.

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Multitiered Dynamic Threshold-Based Mobile Agents Secure Migration Using Lagrange Polynomial and Chinese Remainder Theorem

Niraj Singhal and Pradeep Kumar

Abstract A mobile agent is a software process that works repeatedly on the behalf of its owner. Mobile agents are an emerging computing area that replaces client–server computing model. Mobile agent processes different types of activities during its life cycle and executes code on another non-trusted host computer in a malicious heterogeneous environment. Because of the intelligence of mobile agents, they are being used in many applications like E-commerce, parallel computing, network management, etc. Providing protection for mobile agents is one of the prime issues in the broadening of mobile agent computing. Mobile agent technology faces security issues from mobile agents and platform sides. This article proposed a multilevel secure key management among mobile agents and platforms with a changeable threshold for different levels. The proposed approach is based on the Shamir secret share and Chinese remainder theorem. The novelty of this work is dynamical changing threshold value 't' provides higher security as compared to the traditional approach.

Keywords Mobile agent · Mignotte's sequence · Lagrange interpolation · Threshold value · Chinese Remainder Theorem (CRT)

1 Introduction

Mobile Agents are the composition of small programs and may keep on migrating as a unique independent unit from one platform to another. Mobile agents can execute on a remote platform and suspend its execution, migrate to another platform, and continue its execution on another platform. Because of the self-driven mobility of mobile agents through the distributed network, mobile agents may face malicious

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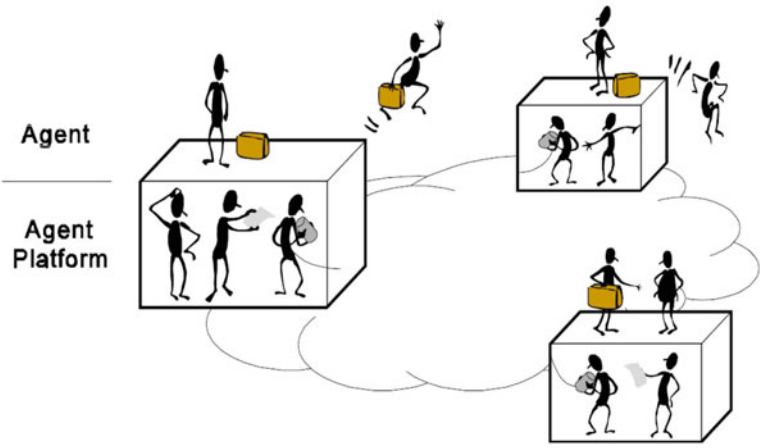

Fig. 1 Agent system model NIST

agents and platforms. Figure 1 shows the execution of mobile agents on other mobile hosts.

There are many applications in which distrusted information retrieval require mobile agent are using frequently. Mobile agent technology is useful in distributing computing because mobile agent takes less bandwidth and low latency and works automatically as compared to traditional computing.

Mobile agents migrate in a non-trusted heterogeneous environment from one hop to another hop automatically to perform the job assigned to them. Vulnerability to security can access important information by an unauthorized entity. Attacks on mobile agents are categorized into four main parts; the first Agent against platform, the second Platform against agent, the third Agent against agent, and the fourth other to both agent and platform.

The complete structure of the article is as follows. Sections 2 and 3 have been describing mainly about the agent-based frameworks and problem statement. In Sect. 4, the proposed approach has been given along with preliminaries. The performance evaluation of our approach along with implementation has been discussed in Sect. 5, and in Sect. 6, conclusions have been highlighted with future work.

2 Related Works

The major types of security risks include information disclosure, denial of service, and information corruption. These types of threats can be examined in greater depth as they pertain to the agent architecture in a variety of ways. Mobile agents simply provide more opportunities for exploitation and misuse, dramatically expanding the scope of threats.

Meng et al. [1] designed a tightly coupled multi-group secret sharing scheme to provide flexibility at the time of regeneration of secret keys. If sufficient number of participants collaborates recover the confidential key. Jia et al. [2] based on the Chinese remainder theorem proposed a novel threshold changeable secret share (TCSS) model (CRT). The TCSS technique uses a small share size and best time complexity as compared to other techniques. Yan et al. [3] designed using the Chinese remainder theorem, and the author created a lossless generic access structure for private picture sharing.

Li et al. [4] designed a multi-secret sharing decentralized technique based on multi-target MSP. Muhil et al. [5] presented a cloud security mechanism based on the Shamir secret sharing. Liu et al. [6] presented a model, for the security of packet and session key. Using quantum key distribution and otp algorithm provide unconditional data security. Takahashi et al. [7] The ramp technique was used to create a revolutionary secret sharing scheme. In this scheme, many participants can independently regenerate secret. Narad et al. [8] built a Shamir and artificial Neural Network with backpropagation-based group authentication secret sharing scheme. Many-to-many authentication is established by a given approach. Abdallah et al. [9] analyze the sharing techniques Shamir's sharing scheme, Rabin's IDA, and hybrid sharing. Basit et al. [10] Using polynomials and a one-way function, a Hierarchical Multistage Key Sharing Scheme was devised. Strong security is provided by a one-way function, a threshold value, and a hierarchical structure. Yuan et al. [11] On the basis of a one-way function, a variable threshold secret sharing technique was presented.

Phiri et al. [12] Based on Shamir's scheme, the Elgamal algorithm proposed a new (t, n) threshold secret key sharing mechanism called the Polynomial Based Linear Scheme (PBLS). Shehada et al. [13] For real-time applications, a new broadcast-based Secure Mobile Agent Protocol was proposed. Higher security is provided by the proposed mobile agent architecture, which employs a combination of private and public cryptography schemes. Fragkakis et al. [14] produced a comparison of mobile agent security among different protocols. On the basis of comparison, mobile agent security faces a lack of security trust and models. Adri et al. [15] proposed a trust score-based itinerary planning algorithm for decision-making for authentication of mobile agents and platforms. Trust ability is based on the coefficient of variance. Trust score is calculated by five parameters; persistence, competence, reputation, credibility, and integrity. Srivastava et al. [16] proposed an algorithm to provide self-protection of the mobile agent in such a way it can assure confidentiality and authentication at the time of execution in a malicious environment. Raji et al. [17] proposed a new algorithm to provide anonymity of both mobile agent owner and the

itinerary. The proposed algorithm is more advantageous compared to the previous algorithm.

Chen et al. [18] Using Euler's theorem and modular arithmetic, we proposed a secret sharing mechanism for n users with a threshold value. The proposed secret sharing scheme has a linear time complexity.

3 Problem Statement

According to the research on protecting migrating agents, there are a variety of ways for providing security for migrating agents, but none of them currently provide an overall framework that incorporates compatible techniques into an effective security model. The old host security mindset prevails, and protection mechanisms inside the mobile agent paradigm continue to prioritize safeguarding the agent platform. However, the focus is gradually shifting toward developing solutions aimed at migrating (mobile) agent security, which is a considerably more complex problem.

Mobile agent-based framework uses the recourses of different hosts for the execution of code. Because mobile agents freely move in a heterogeneous environment, this is the main reason mobile agent opens for attack. So, there is a requirement to design such a framework that solves the security problem of the mobile agent as well as the platform.

The problem to design a mechanism is a challenging task because of the autonomy and mobility of mobile agent. A new scheme is proposed here for the security of mobile agent and platform based on multilevel key management and dynamic threshold value. The mobile agent and platform require a dynamic threshold value for different levels of authentication. A strategy based on the Lagrange polynomial and the Chinese remainder theorem is proposed for secure mobile agent migration. Multilevel secret keys for the execution and authentication of mobile agent migration have been generated. At the first level, the Secret is divided into 'n' partial shares based on the Lagrange interpolation, and at the second level, each partial share generated at the first level is further divided into m parts using CRT. Dynamic threshold value is also used at each level.

4 Proposed Solution

In a mobile agent system, a multitier dynamic threshold offers the core security requirements against many types of threats. The proposed multilevel architecture based on the Shamir secret share and Chinese remainder theorem provides the security at multilevel with a dynamic threshold value.

4.1 Preliminaries

4.1.1 Shamir's Secret Sharing

In 1979, Shamir presented a secret share method based on a threshold. Secret keys are splits into 'n' partial shares with threshold 't'. At the time of regeneration, if 't' number of authentic participants is involved then generate a secret key. According to the Shamir share, consider 't' real number $\beta 0,\ \beta 1,\ \beta 2, \ldots \beta \mathrm{k}-1 \in \mathrm{GF}\ (\mathrm{p})$

$$\mathrm{F(x)} = \left(\beta 0 + \sum_{i=1}^{k-1} \beta_{\mathrm{i}} \mathrm{x}^{\mathrm{i}}\right) \bmod \mathrm{p} \tag{1}$$

$\mathrm{F}(0) = \beta 0 =$ session key and 'p' is a large prime number and $\beta 1,\ \beta 2 \ldots,$ and $\beta \mathrm{k}-1$ are randomly chosen real numbers from Z/PZ. At the receiver side, select 't' randomly share out of 'n' partial share and generate the Lagrange polynomial.

$$\mathrm{F(x)} = \sum_{\mathrm{i}=1}^{\mathrm{k}} \Upsilon_{\mathrm{i}} \prod_{1 \le j \le k, j \ne 1} \frac{\chi - \chi_{\mathrm{i}}}{\chi_{\mathrm{i}} - \chi_{\mathrm{j}}} \tag{2}$$

Since $\mathrm{f}\ (0) = \beta 0 = \mathrm{S}$, the secret key evaluates using

$$\text{Secret key(S)} = \sum_{i=1}^{k} P_i \Upsilon_i \tag{3}$$

where

$$P_i = \prod_{1 \le j \le k, j \ne i} \frac{\chi_j}{\chi_j - \chi_i} \tag{4}$$

Secret share is generated by using 't' partial share by using $\mathrm{F}\ (0) = \beta 0 \mathrm{modp}$.

4.1.2 Chinese Remainder Theorem

Consider the co-prime integer p1, p2, p3 , … pn and $\alpha 1,\ \alpha 2,\ \alpha 3 \ldots \alpha \mathrm{n}$ random integer 'x' system of a simultaneous congruence relation

$$\begin{aligned} \mathrm{x} &\equiv \alpha 1 (\mathrm{mod p1}) \\ \mathrm{x} &\equiv \alpha 2 (\mathrm{mod p2}) \\ &\cdots \\ \mathrm{x} &\equiv \alpha n (\mathrm{mod pn}) \end{aligned} \tag{5}$$

has a unique solution modulo.
p1, p2, ... pn, for any given integers $\alpha 1, \alpha 2, \ldots \alpha n$.

$$\begin{aligned} &P = p * p2 * \ldots * pn \\ &x \equiv \alpha 1 P1 c1 + \alpha 2 P2 c2 + \cdots + \alpha n Pncn (\mathrm{mod} p) \end{aligned} \tag{6}$$

where $Pi = P/ni$ and $ci \equiv Pi - 1 (\mathrm{mod} pi)$.

4.1.3 Mignotte's Sequence

Let us consider 'n' positive integer, be $n \geq 2$, and $2 \leq t \leq n$. The consecutive numbers are pairwise co-prime such that it satisfies the condition on n integers

$$\prod_{i=0}^{t-2} Pn - i < \prod_{i=1}^{t} Pi \tag{7}$$

4.2 Proposed Model

Here, a multilevel dynamic variance threshold technique for mobile agent is proposed to provide the security of secret share among participants. This model shown in Fig. 2 works as a two-level hierarchy; in the first level of hierarchy, the platform breaks the secret key among the n mobile agents using the Lagrange interpolation with modular arithmetic with a dynamic threshold value. At the second level, each mobile agent has a partial share generated by first level; further, this partial share is split into 'm' shares using the Chinese remainder theorem dynamic threshold value. This model provides a higher level of security against the attacker by confusion and diffusion.

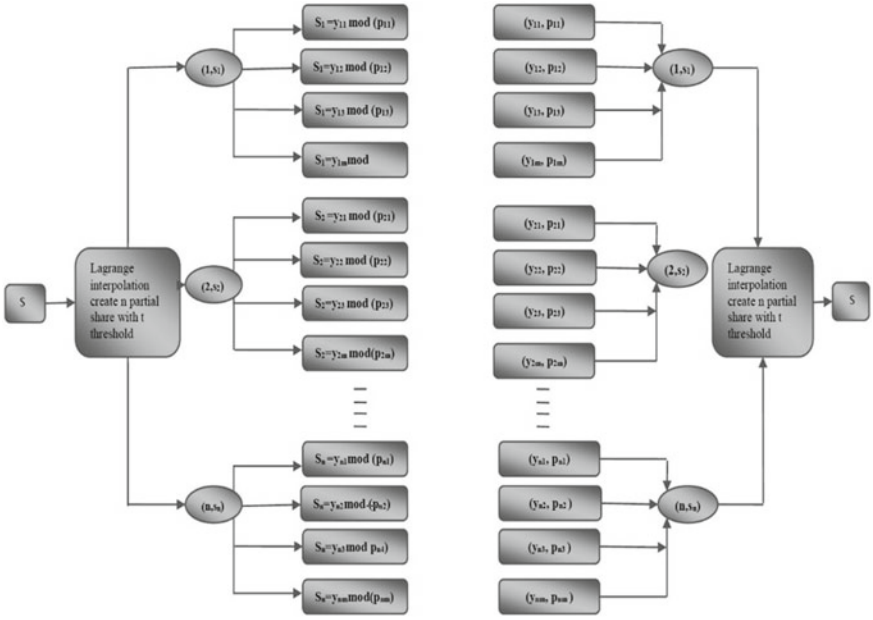

Fig. 2 Multitier dynamic threshold-based mobile agents secure migration

A. Share generation

Input: *Take input (i, S_i) using Lagrange interpolation*
Output*: Generate (y_i, p_i) using CRT*

i. At level 1 Select any secret share in such a way S<p
ii. Using Lagrange interpolation splits the secret key s in to 'n' partial shares S_1, S_2, S_3….S_n
iii. At level 2 for all i=1 to n
iv. For each S_i 0< i < m Generate m number of share using CRT (y_i , p_i) at different threshold value

B. Regenerate the secret key

Input: *for each level take input (y_i, p_i)*
Output: *Generate (i, S_i)*

i. for i=1 to n
ii. for j=1tom
iii. Generate (i , S_i), by applying Chinese remainder theorem
iv. Apply Lagrange interpolation generate secrete key for every transaction.

Now considering the following example.

Level 1: At level 1, using the Shamir secret sharing based on the Lagrange interpolation, now user considers secret key 25 which is randomly selected by a random number generator.

After applying the Lagrange interpolation number of user n = 3 and threshold at level 1 is t = 3. Generate 3 partial shares (3, 43), (9, 79), and (2, 37).

Level 2: At level 2, each partial share generated by the Shamir secret further divide into m parts here m = 6 for (3,43) and $t_1 = 3$ at each level applying Chinese remainder theorem with variable threshold for each transition.

m = 6 for (3, 43) and $t_{1\,=}$ 3 (y_1: 102, m_1: 149), (y_2: 22, m_2: 151), (y_3: 127, m_3: 157), (y_4: 116, m_4: 163), (y_5: 103, m_5: 167), and (y_6: 160, m_6: 173).

m_0: 47, $m_{\,=}$ 6 for (9, 79) and $t_{2\,=}$ 2 (y_1: 89, m_1: 251), (y_2: 135, m_2: 257), (y_3: 205, m_3: 263), (y_4: 30, m_4: 269), (y_5: 155, m_5: 271), and (y_6: 0, m_6: 277).

m0: 83, m = 6 for (2, 37) and $t_{3\,=}$ 4, (y_1: 33, m_1: 127), (y_2: 122, m_2: 131), (y_3: 44, m_3: 137), (y_4: 114, m_4: 139), (y_5: 141, m_5: 149), and (y_6: 32, m_6: 151).

m0: 41.

Mobile agent migrating automatically in a malicious environment when mobile agent reaches another platform generates partial secret keys by applying inverse Chinese remainder theorem with a respective threshold value. If the sufficient number of shares is not available at the time of the regeneration phase, it cannot generate partial secret keys.

$Xi = y_i * \mathrm{mod}^* p_i\ t \leq i$.

$t_1 = 3$ for generate secret share required 3 authenticate share out of 6 shares.

s = 102mod 149, s = 22mod151, and s = 127mod157, $m_0 = 47$.

Applying CRT s mod $m_0 = 43$.

$t_2 = 2$ for generate secret share required 2 authenticate share out of 6 shares.

s = 89mod 251 and s = 135 mod257 m0 = 83.

Applying CRT s mod $m_0 = 79$.

$t_3 = 4$ for generate secret share required 4 authenticate share out of 6 shares.

s = 33mod 127, s = 122mod131, s = 44mod137, and s = 141mod151 $m_0 = 41$.

Applying CRT s mod $m_0 = 37$.

After getting these partial shares, applying the Shamir secret share to generate a secret key, we require 2 shares out of 3 shares because the threshold value in the Shamir secret share initially considered t = 2. Generated secret share is 25.

5 Implementation and Results

Based on Shamir's secret share and the Chinese remainder theorem, a framework is proposed with two levels of security; at level one generates 'n' partial share using the Shamir secret share, and each partial share generated at level two is further divided into 'm' parts. Table 1 presents response time of security/authentication of Reputation-based Model, Trust Scoring System, Trust Ranking System, and Multi-level security. From the results, it has been observed that the response time of the

Table 1 Comparison of response time among Reputation-Based Model (TBM), Trust Scoring System (TSS), Trust Ranking System (TRS), and Multilevel security model

S. No	No of mobile agents	Response time in seconds			
		Reputation-based model	Trust scoring system	Trust scoring system	Multilevel security
1	5	0.48	0.36	0.18	0.23
2	10	0.93	0.69	0.34	0.3
3	15	1.39	1.05	0.53	0.48
4	20	1.94	1.41	0.71	0.8
5	25	2.28	1.82	0.9	0.83
6	30	2.85	2.15	1.1	0.98
7	35	3.44	2.48	1.2	1.23
8	40	3.84	2.85	1.4	2.11
9	45	4.35	3.25	1.6	2.12
10	50	4.76	3.54	1.74	2.27
11	55	5.22	3.89	1.95	2.38
12	60	5.96	4.33	2.18	2.46
13	65	6.25	4.65	2.34	2.72
14	70	6.68	5.05	2.5	2.78
15	75	7.14	5.38	2.69	2.96
16	80	7.67	5.73	2.85	3.16

multilevel model is far better than among the Reputation-based Model and Trust Scoring System, but has a slightly high response time as compared to Trust Ranking System. In this framework, at the first level secret, if divided into 'n' share, and each 'n' share is further divided into 'm' share for security point of view. In the proposed model at level 1, 'n' number of shares are created on the basis of the Lagrange interpolation, out of n secret required 't1' share to regenerate the secret share at level 1. We are using different thresholds at different levels. If less than 't1' share wants to construct secret shareholder can't generate. At the second level, we are using different thresholds for each share. Security of this mechanism is based on the Lagrange interpolation and Chinese remainder theorem. Experimental results are shown in Table 1 and graph Fig. 3. It was observed that the response time of the proposed model is much better than the other two models.

6 Conclusion and Future Scope

Security of mobile agent during migration in a non-trusted environment is still a major issue. In this article, design a multilayer framework by fusion of the Shamir secret share and Chinese remainder theorem to authenticate mobile agent at different levels.

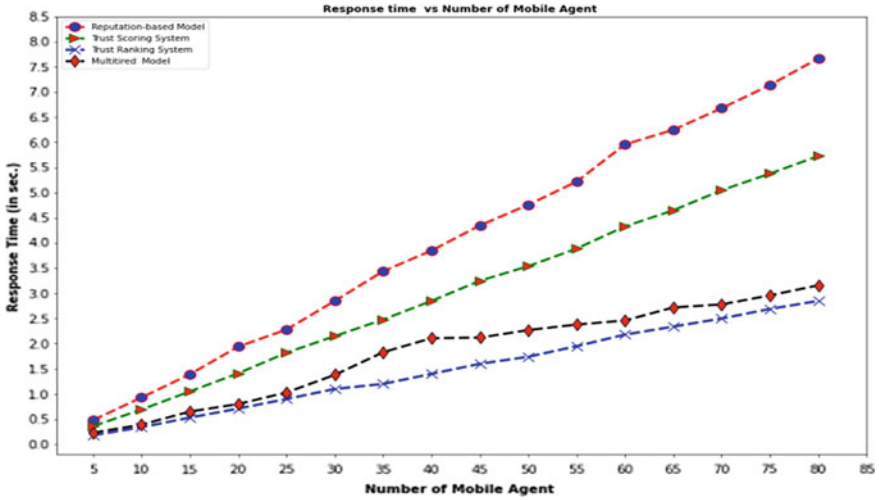

Fig. 3 Number of mobile agents versus response time

The dynamic threshold value, a combination of the Shamir and CRT, provides high-level security. This model helps to identify the unauthorized group of shareholders at a double level with a dynamic threshold value. Agent authentication is an important aspect in terms of security. The proposed model for agent migration increases the security of key as well as optimized key scheme. It focused on improving secure mobile agent migration in an open environment. In future work, such types of models will be designed that identify malicious agents from the set of agents. This would help to avoid the unwanted computation for authentication.

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Microstrip Patch Antenna Consisting AMC and MTM for Breast Cancer Detection

Brahmanand Singh, Awanish Kumar Shukla, Manpreet Singh Manna, and Bramh Prakash Dwivedi

Abstract Oncology is the branch of medical science which deals with the detection and cure of tumors. Tumors can be classified as malignant and benign tumors. In the year 2021, approximately 281,550 new cases of intrusive breast Tumor will be detected,1 in which 8 women will be detected with breast cancer (13%) whereas there is a 2.6% chance that she will die. In the following paper, an MTM-based antenna was proposed with coplanar waveguide feed; because it is easily available and cheap, the proposed antenna was fabricated using FR4 with the height of substrate 1.6 mm and a dielectric constant of 4.6. The complete size of the suggested structure is 76 × 36 mm2; the radius of the circular shape patch is 10 mm with a circular slot of 2.7 mm. The proposed antenna has a bandwidth of 5.3 GHz from 4.9 to 10.2 GHz with three resonant at 6.1, 6.7 and 9.6 GHz.

Keywords Oncology · MBI · CPW feed · MTM

1 Introduction

Tumors can be classified as malignant and benign tumors; early detection and preventive measures play a crucial role in curing them. Early detection increases the survival rate up to 97% in such cases. Early detection of Breast Tumors involves three-step processes, the first step includes physical examination of the patient, the second step involves Mammography using available imaging medical techniques and the last step

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includes invasive process, needle biopsy (fine-needle or larger core-needle) and less often from a surgical biopsy.

FNAC (Fine Needle Aspiration Cytology) is such process to confirm the reports obtained by the mammography imaging. Current medical technologies for early detection include X-Ray Mammography, Ultrasound Techniques, MRI (Magnetic Resonance Imaging), PET (Positron Emission Tomography) and CT-Scan (computed tomography Scan) as imaging techniques.

An antenna was proposed with a coplanar waveguide feed. Because it is easily available and cheap, the antenna is built on FR4 with a thickness of 1.6 mm and a relative permittivity of 4.6. The model was made with a revised circular patch with the ground on the same plane. The complete size of the suggested structure is 76 × 36 mm2; the radius of circular shape patch is 10 mm with a circular slot of 2.7 mm.

2 Structure of the Proposed Antenna

Antenna Dimensions

Because it is easily available and cheap, the antenna is built on FR4 with a substrate height of 1.6 mm and a dielectric constant of 4.6. The model was made with a revised circular patch with the ground on the same plane. The complete size of the suggested structure is 76 × 36 mm2; the radius of the circular shape patch is 10 mm with a circular slot of 2.7 mm (Figs. 1 and 2).

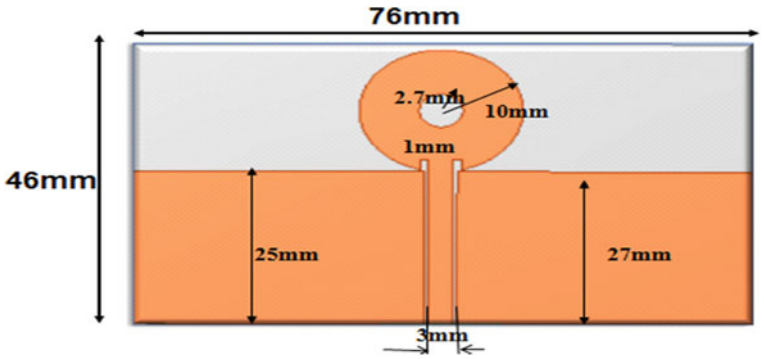


Fig. 1 Structure of the antenna

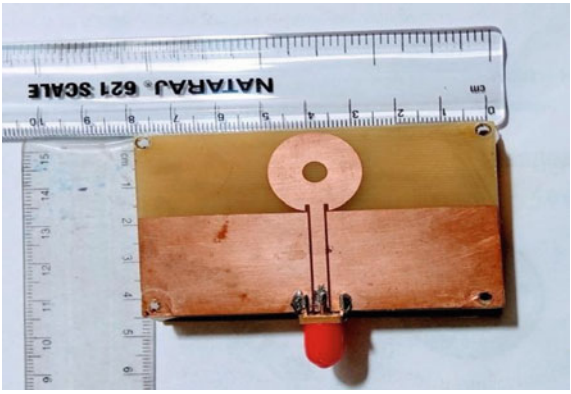


Fig. 2 Structure of the fabricated antenna

3 Result and Discussions

Two layers of AMC and MTM surface structure play a very significant role in the enhancement of Co-Planner Waveguide performance and hence it shows suitability for MWI applications. The simulated reflection coefficient with AMC and without AMC meant for the antenna has been presented in Fig. 3. From the simulated results, the antenna bandwidth is 5.3 GHz from 4.9–10.2 GHz with three resonant at 6.1, 6.7 and 9.6 GHz. The AMC and MTM combination with antenna makes some additional resonant at 5, 5.3, 6, 6.3 and 9.5 GHz, and some resonant are moved to the left due to the capacitance properties produced in between the antenna, MTM and AMC structure (Figs. 4, 5, 6, 7, 8, 9, 10 and 11). The radiation pattern of the investigated antenna are displayed in Figs. 12, 13 and 14.

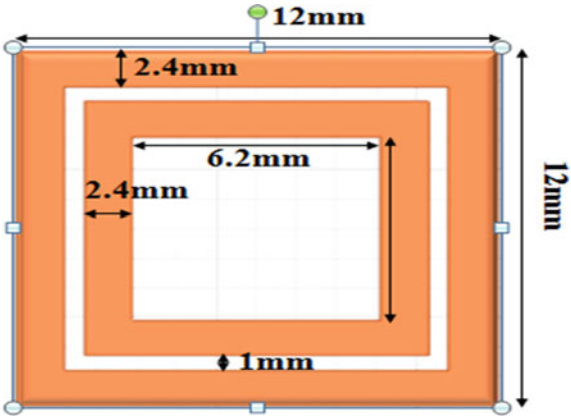


Fig. 3 Structure of AMC

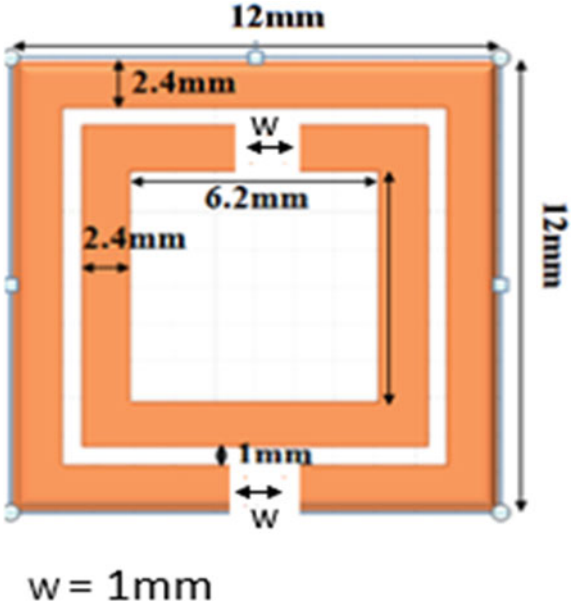


Fig. 4 Structure of MTM split ring resonator

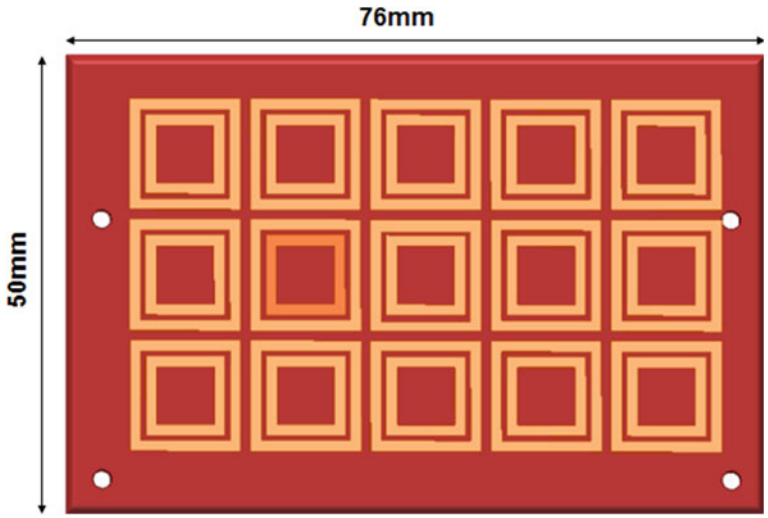


Fig. 5 Structure of AMC on the lowest layer

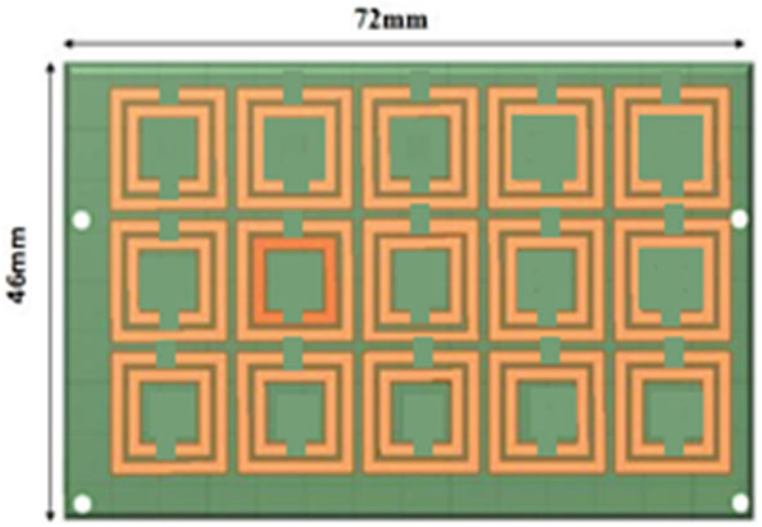


Fig. 6 Structure of MTM split ring resonator on middle layer

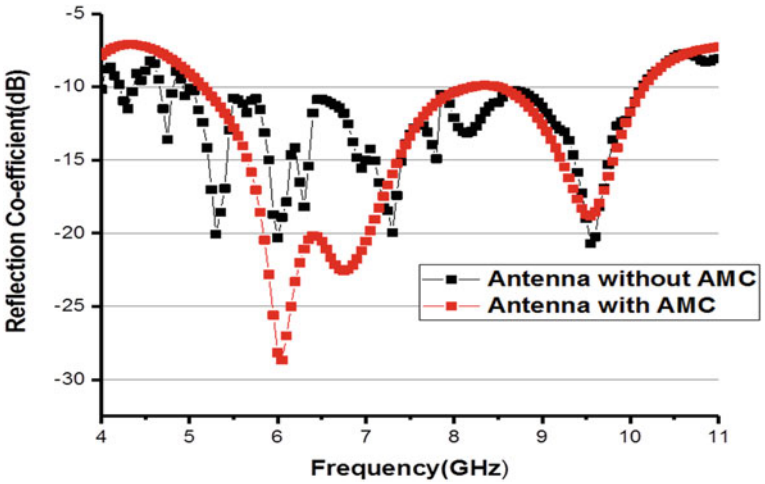


Fig. 7 S11 of the antenna with and without AMC

4 Breast Cancer Detection

a. Modelling of Breast Phantom

Considering the breast tissue electrical property, breast phantom has been prepared. The skin, fat and glandular tissue are three layers of 3-D hemispherical breast

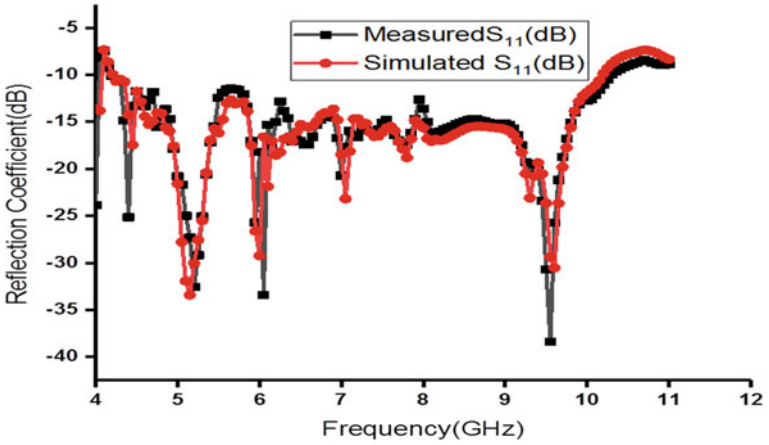


Fig. 8 S11 measured and simulated of the antenna with and without AMC

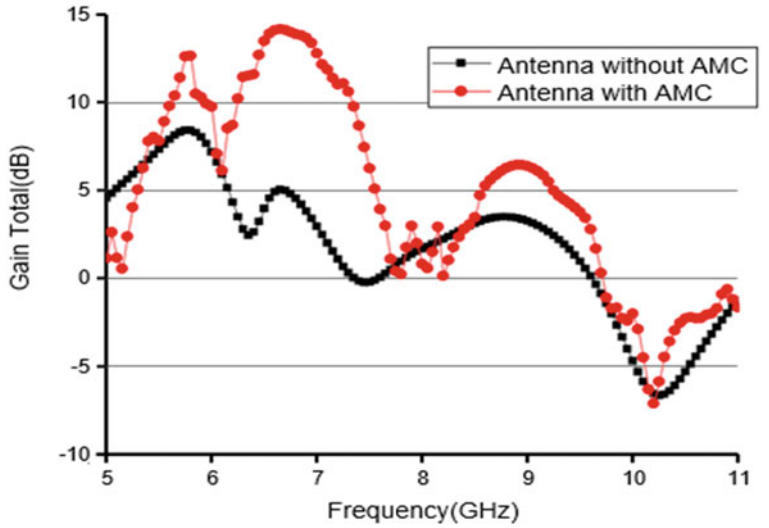


Fig. 9 Gain of the antenna with and without AMC

phantom. The outermost skin layer has a relative permittivity of 38 F/m, a conductivity of 1.49 S/m, with a thickness of 5mm, the middle one is fatty tissue layer having a relative permittivity of 9 F/m and a conductivity of 1.49 S/m, with a thickness of 15mm and the inne most is glandular tissue layer with a relative permittivity of 14 F/m and a conductivity of 0.5 S/m with a thickness of 35mm. And lastly, the tumor having a conductivity of 4 S/m and relative permittivity of 50 is inserted in the glandular tissue with 4.5, 3.5 and 2.5 mm radius (Fig. 15).

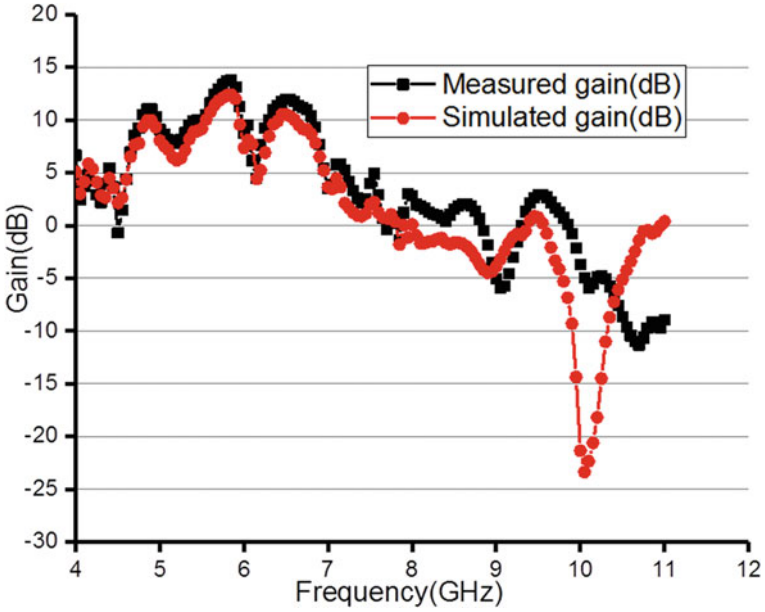


Fig. 10 Measured and simulated Gain of the antenna with and without AMC

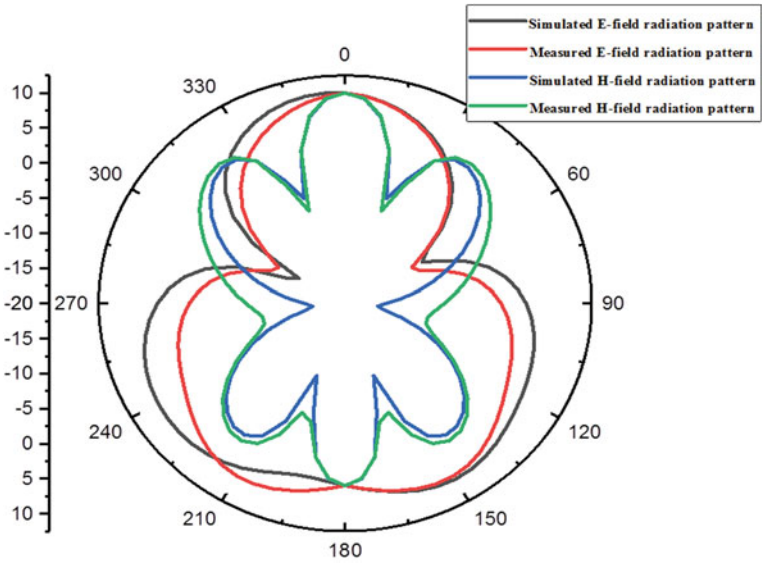


Fig. 11 Radiation Pattern of the antenna at 5 GHz

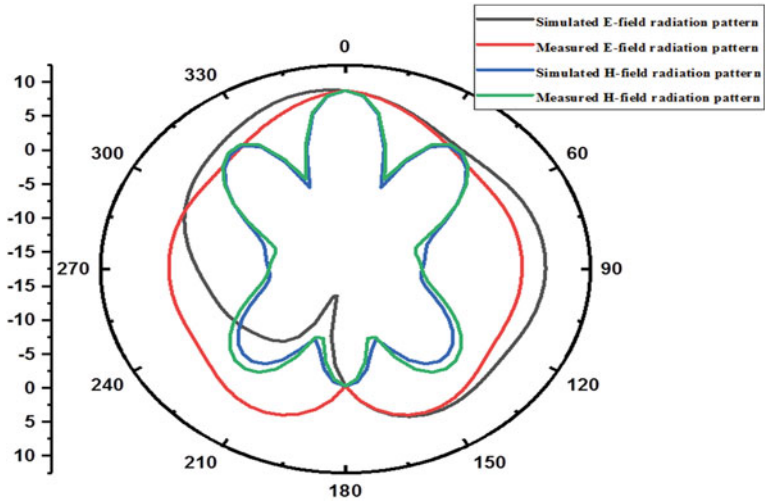


Fig. 12 Radiation Pattern of the antenna at 6 GHz

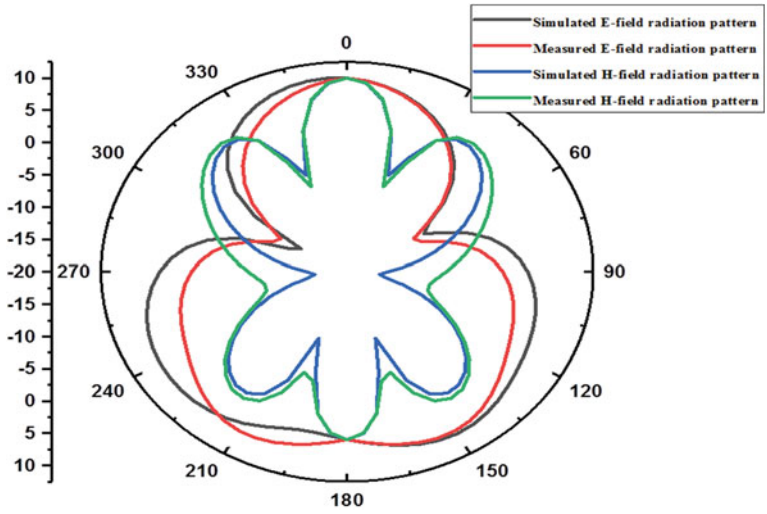


Fig. 13 Radiation Pattern of the antenna at 6.3 GHz

b. Tumor Detection

The SAR value was simulated taking 1.0g volume tissue, for different tumor sizes inserted in the glandular tissues, and variation is found in SAR 1g value. The tumor of size 2.5mm is created at location (0, 0, 25) mm. The max. Local SAR1g value for layers and tumor is 137.98 W/kg, 93.79 W/kg, 60.798 W/kg and 310.80 W/kg

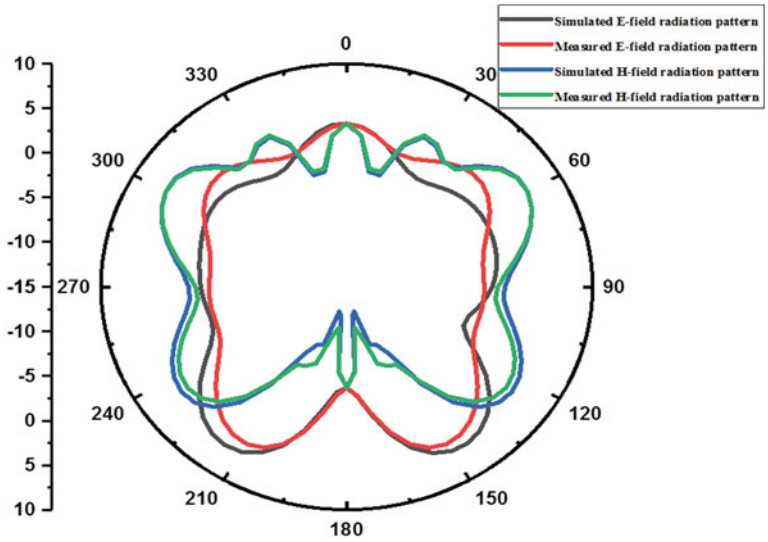
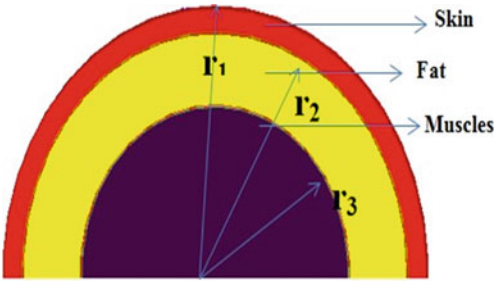


Fig. 14 Radiation Pattern of the antenna at 7.3 GHz

Fig. 15 Breast Phantom



correspondingly. The maximum Avg SAR1g value for layers and tumor is 13.080, 3.9080 and 6.901 and 26.02W/kg (Figs. 16, 17, 18 and 19).

5 Conclusions

The CPW-fed antenna with MTM split ring resonator as the middle layer and AMC as lowermost layer has been proposed, and this arrangement improves the antenna characteristics especially gain; the gain is increased about 5 dB. The energy leakage is reduced due to the reflection properties of the AMC structure and hence the antenna becomes unidirectional. A phantom model of the breast with layers as skin, fatty tissue and glandular tissue is designed for SAR calculation. The malignancy was created in the glandular tissue layer and had a number of sizes at the changed location.

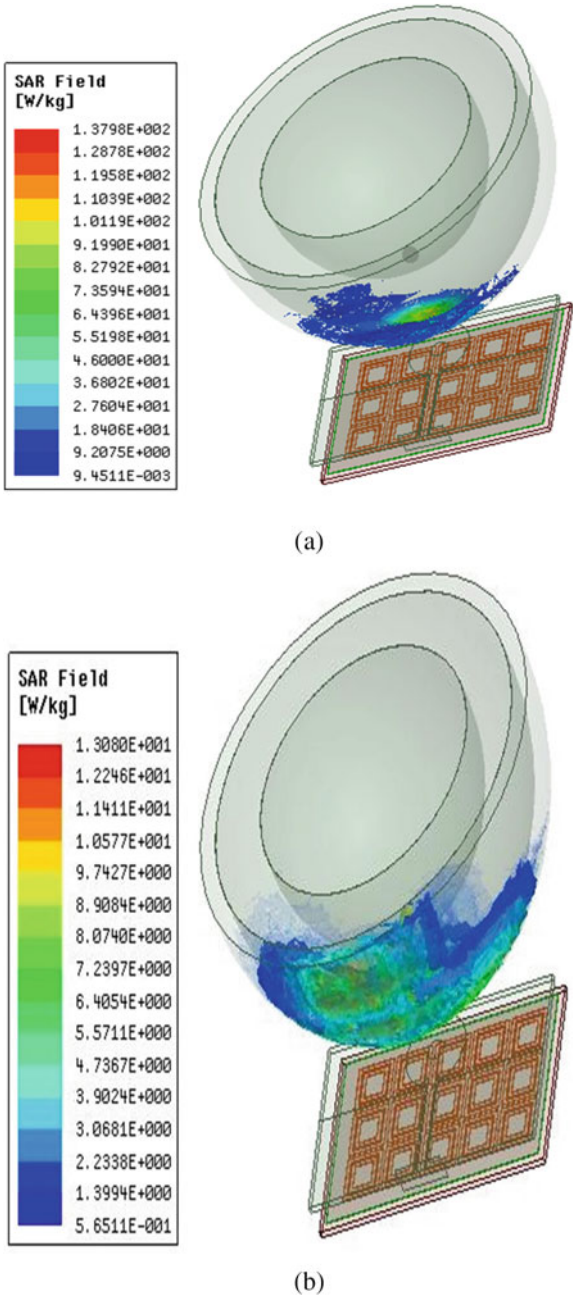


Fig. 16 **a** Skin layer—SARlocal. **b** Skin layer—SARaverage

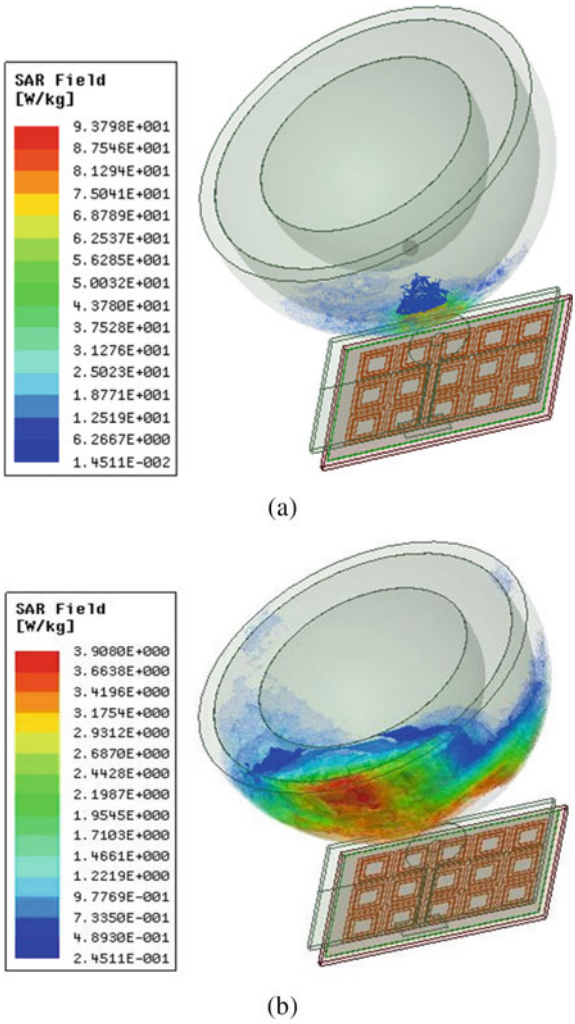


Fig. 17 **a** Ftty layer—SARlocal. **b** Fatty layer—SARaverage

The SAR1g is calculated by the UWB antenna to spot the tumor. The max. value of local and average SAR1g value calculated are 40.045 and 5.0450 W/kg for complete breast.

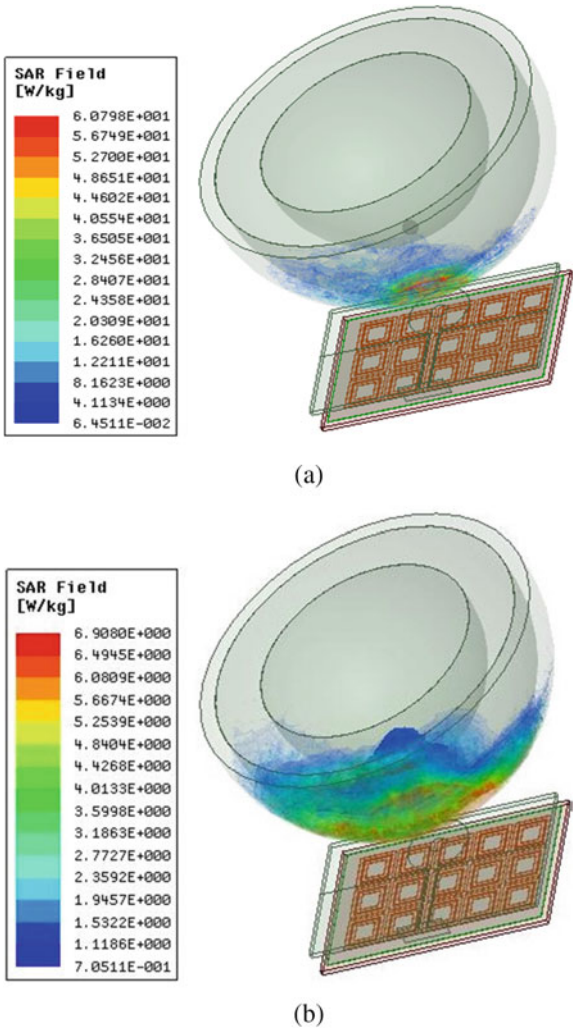


Fig. 18 **a** Glandular layer—SARlocal. **b** Glandular layer—SARaverage

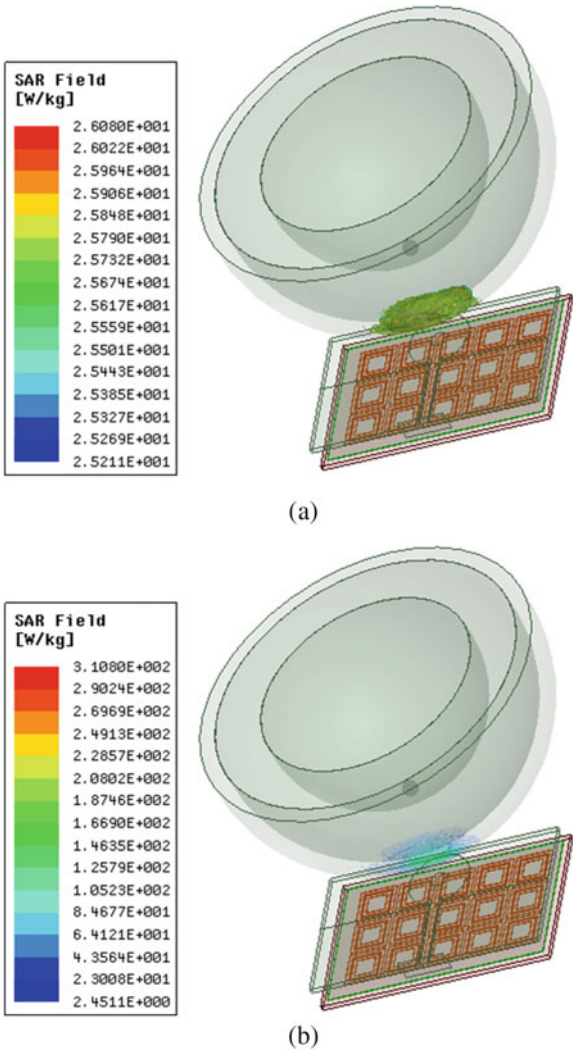


Fig. 19 **a** Tumor—SARlocal. **b** Tumor—SARaverage

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Reduction of PAPR in OFDM Systems Utilizing Active Constellation Extension and Subcarrier Grouping and Convex Optimization Techniques

Bramh Prakash Dwivedi, Awanish Kumar Shukla, Inderpreet Kaur, and Brahmanand Singh

Abstract A new ACE technique is proposed to decrease the PAPR, using convex optimization and subcarrier grouping techniques. In comparison to the traditional ACE scheme, the iterative tactics involve exhaustive FFT/IFFT computation, and the anticipated schema is implemented to obtain the optimum result. Also, a low-complexity completion is recommended to decrease the intensive IFFT computation, and these techniques not only result in minimal signal distortion but also do not requisite extra side information. In the ACE schema, the simulation on modulated symbols are performed within the so-called *permissive regions* to duplicated corresponding clipped-version signal. The Active Constellation Extension (ACE) schema restricts the "average signal power increase" to not more than 1 dB.

Keywords OFDM · PAPR · Subcarrier grouping and convex optimization

1 Introduction

In OFDM waveform PAPR occurs due to enormous dynamic range of power amplifier. In OFDM High PAPR basically arises due to IFFT pre-processing (i.e., OFDM signal contains large number of individually modulated sub-carriers which may provide a large peak when added up with same phases). In this case, across sub-carriers data symbols are added up thus produces high magnitude Peak signals. When the signal varies in dynamic or linear range, that is the inputs and outputs are

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linearly associated (that is around this mean, there is small deviation of the voltage, then signal will be considered in linear amplification range). As in OFDM system the swing of instantaneous power is comparatively large than that of the mean power thus signal will enter to non-linear range, in such situations amplification is non-linear. Due to this non-linear amplification OFDM capabilities are lost (i.e., orthogonality is lost), thus introduces very large amount of inter-carrier interference. Thus, PAPR leads to ISI (Inter Symbol Interference) in OFDM systems. To achieve high output power efficiency in radio communication systems depends on high power amplifiers, so their operation generally lies in saturation region. Nonlinear characteristics of the power amplifier are very tender to difference different signal amplitudes. As PAPR increases the difference in OFDM signals also increases. Thus, high values of PAPR of a power amplifier will lead to inter-modulation between different subcarriers, thus will also introduce inference to the system. Thus, reducing BER performance.

This PAPR also leads to back flow power for linear amplifiers. Thus having poor power efficiency. DAC must have enough dynamic range to acclimate these large peaks in the case of OFDM signals as a result of high PAPR. Even though, a high precision Digital to Analogue Convertor do support high PAPR with low quantization noise, the implementation cost of the circuit is very high. In contrast, low precision Digital to Analogue Convertor is cheaper and its quantization noise is more. As the number of sub-carriers increases in OFDM, OFDM signals follow the Gaussian distribution. In such type of distribution average of the peak signal rarely occur and uniform quantization by the ADC is not desirable. Clipping leads to in band distortion and out-of-band expansion (Adjacent channel interference) [2].

2 Conventional Systems

In year1999, Korngold and Jones introduced the ACE technique. It uses Projection-Onto-Convex-Sets (POCS) method [5] for the extension the points lying outer in a particular constellation to reduce the PAPR to optimum level. The real time application of such schema was too complex, thus Korngold and Jones in 2003 proposed methodology for fast PAPR reduction [6]. Thus, introducing the PAPR reduction to modern communications. PAPR reduction is achieved in ACE by modifying, signal constellation in data-bearing channels without lacking BER. Signal modifications can be done without effecting BER as follows: Fig. 1 displays QPSK constellation. In the following figure, constellation point (1, 1) can be easily moved in the shaded area without effecting BER as the distance remain same.

If the point is moved away from constellation's decision boundaries leads to either same or in some cases lower BER, with a trade-off of additional transmitted power. This principle can be QAM and M-PSK constellations. For constellations related to QAM, outer points adjusted away from the constellations. The transmitted signal power is increased for the processed data block. The additional power required depends on peaks. But day to day practical scenarios large signal peaks occurs infrequently, leading to negligible effect on transmission systems. In [7], modified ACE

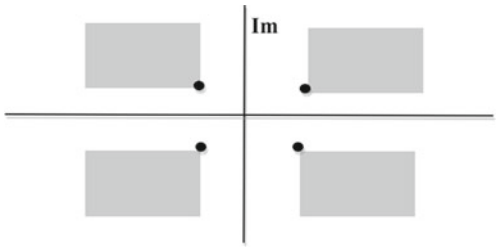

Fig. 1 ACE technique; QPSK constellation

algorithm proposed gives an enhanced PAPR reduction performance in compression to ETSI standard without an extra increase in transmitted signal power. Artificial Neural Networks based technique is implemented at the receiver side, thus providing enhance BER performance when ANN is trained on ACE algorithm.

Numerous factors of the ACE algorithm examined in [8] besides the average power increase, a technique achieve faster convergence of the algorithm has been proposed. Another techniques with faster convergence in [9]. Influence of clipping threshold investigated and optimized algorithms utilizing adaptive clipping in [10] to accomplish much better performance. In [1] ACE was formulated as convex optimization so as to achieve much better performance. In [2] Convex optimization algorithm allows for trade off, PAPR reduction, and constellation distortion. Influence of pre-distortion on ACE was keenly investigated. In [3] authors have investigated a technique utilizing ACE with pre-distortion algorithm, nonlinear distortion has been compensated and improves PAPR reduction. In [4], ACE utilized at the output of Partial Transmit Sequence (PTS) algorithm to boost PAPR reduction implementation. In [10] ACE has been used in combination with Repeated Enliping, ACE-RE leads to faster convergence and lower complexity.

ACE combined with Erasure Pattern Selection (EPS) investigated in [11] to introduce redundancy that is used for both error correction and PAPR reduction. ACE or active set extension (ASE) is a PAPR reduction technique which utilizes modulation constellation over active subcarriers, thus OFDM data block is modified or pre-distorted such that the PAPR of the modified data block is moderated with no considerable degradation the BER implementation. In the proposed modification process, certain outer constellation points are dynamically extended toward the outside of the original constellation. Figures 1 and 2 displays QPSK and 16-QAM modulation constellations with implementation of ACE.

In QPSK, constellation points are positioned at the corners of the shaded regions. Darkened regions are called reasonable regions as if a traditional constellation point is reallocated to another location within the corresponding reasonable region, minimum Euclidean distance among a new allocated constellation point and other constellation point in other reasonable regions is surely not to be less compare to the minimum distance among the traditional constellation points.

As well as, average transmit power by reason of constellation modification is equitably insignificant and, thus, no significant degradation in BER. In 16-Quadrature amplitude modulation constellation, the outward corner constellation points have

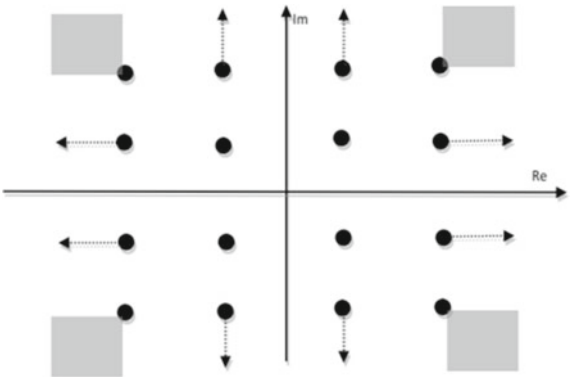

Fig. 2 ACE technique 16-QAM constellation

their equivalent reasonable regions, while for the external non-corner constellation points the reasonable areas are straight lines opening at the point and goes to infinity. Active constellation extension technique concurrently reduces bit error rate a little while noticeably decreasing PAPR.

Moreover, no side information required thus no data rate loss. This technique up surges average transmitted signal power, finds restricted applicability to modulation scheme utilizing bulky constellation size.

3 Investigated PAPR Reduction Schema

This analysis offers a new PAPR reduction schema for the OFDM systems on the basis of active constellation extension method, where convex optimization and subcarrier grouping methods are used. In contrast to the conventional ACE schema in which iterative methods needs severe FFT/IFFT computation, the planned schema is employed only once to attain the optimum solution. Also, a low-complexity execution is projected to decrease the exhaustive IFFT computation.

Take an N subcarriers OFDM system. The signal in frequency-domain can be specified as $\mathrm{Y} = [\mathrm{Y}[0], \mathrm{Y}[1], \ldots, \mathrm{Y}[\mathrm{N}-1]]\mathrm{T}$ where Y[k] is the QAM symbol on the kth subcarrier. Multiplexing $\mathrm{Y} = \mathrm{Y}[0], \mathrm{Y}[1], \ldots, \mathrm{Y}[\mathrm{N}-1]$ using an IFFT process, the OFDM signal in time-domain $\mathrm{y} = \left[\mathrm{y}[0], \mathrm{y}[1], \ldots, \mathrm{y}[\mathrm{N}-1]\right]$ can be found as

$$y(n) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} Y_k e^{\frac{j2\pi kn}{N}}, \text{ for } n = 0, 1, \ldots N-1 \tag{1}$$

Here PAPR of this OFDM signal is given as-

$$PAPR = \frac{\max[y(n)]^2}{E\{|y(n)|^2\}} \tag{2}$$

Figure 3 shows a block diagram of the noval PAPR reduction schema. As represented, time domain representation of signal x is initially acquired by the frequency domain symbol vector X which is modulated by IFFT and then $c_{clip} = \overline{y} - y$ is extracted fromclipped signal $\overline{y}$ which is the clipped off portion of signal:

$$\overline{y}[n] = \begin{cases} y[n] & |y[n]| \le A \\ A\exp\{j\theta[n]\} & |y[n]| \le A' \end{cases} \tag{3}$$

for n = 0, 1, …, N − 1, where θ[n] symbolizes the phase of y[n], i.e., y[n] = |y[n]| exp{jθ[n]}, A represents the clipping level, and $C_{clip} = [C_{clip}[0], C_{clip}[1], \ldots..C_{clip}[N-1]]T$. The frequency domain clipped-off part of signal $C_{clip} = [C_{clip}[0], C_{clip}[1], \ldots.., C_{clip}[N-1]]T$, Is then created from c_{clip} via a FFT, and is modified according to the ACE constraints represented as

$$C[n] = \begin{cases} C_{\text{clip}}, & \text{if } Y[n] \text{ is an outer point and } Y[n] + C_{\text{clip}}[n] \\ & \text{falls with in the permissive region} \\ & 0, \text{otherwise} \end{cases} \tag{4}$$

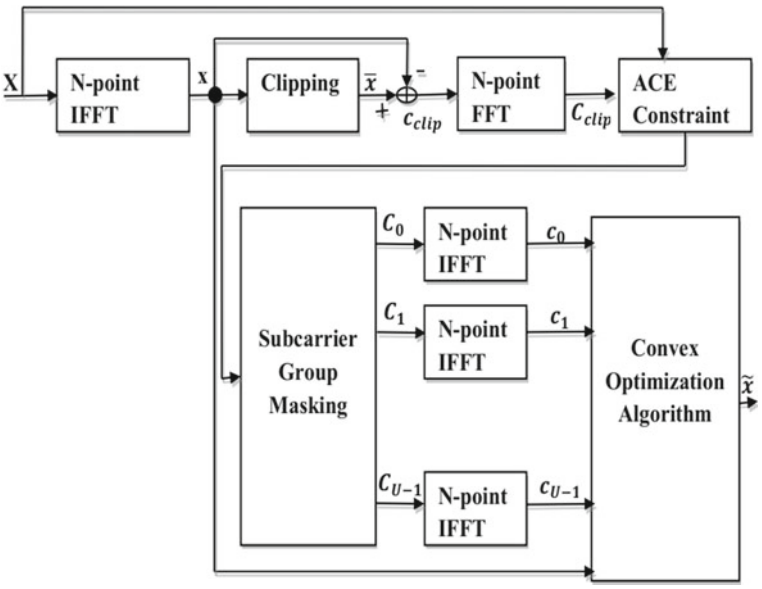

Fig. 3 The proposed ACE scheme

for n = 0, 1, ..., N − 1, to get C = [C[0], C[1], ..., C[N − 1]]T, in the signal constellation diagram an outer point represents the point with boundless detection area and the tolerant region represents the area for a specific outer point as long as higher distance between the outer point itself to its nearby outer points. A major dissimilarity between the projected ACE-based schema and the traditional scheme is in the operation of processing of C. Precisely, the projected schema division of the N subcarriers of OFDM into U different non overlapping sets, with the signals of the u_{th} set composed in according to a set of subcarrier indices represented by Γ_u. Here, $\Gamma_u \cap \Gamma_v = \varphi \forall v \, 6 =$ u and $\cup U - 1$ u $= 0 \, \Gamma_u = \{0, 1 \ldots (N - 1)\}$. C is now prolonged into UN × 1 vectors Cu's and masked by the divided index sets Γ_u's as below:

$$C_u[k] = \begin{cases} C[k], if k \in \Gamma_u \\ 0, otherwise \end{cases} \tag{5}$$

for k = 0, 1, ..., N − 1 and u = 0, 1, ..., U − 1 with $C_u = [C_u[0], C_u[1], \ldots, C_u[N - 1]]^T$ by IFFT over C_u gives $c_u = [c_u[0], c_u[1], \ldots, c_u[N - 1]]^T$. The transmitted signal of the projected schema is represented as

$$\hat{y} = y + \sum_{u=0}^{U-1} a_u c_u. \tag{6}$$

Here the given parameters $\{a_0, a_1, ..., a_{U-1}\}$ are the real-valued, non-negative, and are set in a way that to achieve the least achievable PAPR. To decrease PAPR of$\hat{x}$, the function will be now given by

$$a^* = \arg\min_{a \in \mathbb{R}^U} \left\{ ||y||_\infty^2 \right\} = \arg\min_{a \in \mathbb{R}^U} \left\{ \left|\left| y + \sum_{u=0}^{U-1} a_u c_u \right|\right|_\infty^2 \right\}, \tag{7}$$

where $\left[a^* = a_{0,}^* a_1^* \ldots\ldots\ldots\ldots\ldots a_{U-1}^*\right]^T$ is the optimum resultant vector, $\mathbb{R}^U$ represents the set of U-D real numbers, and $|| \cdot ||\infty$ is the infinity-norm. The above can be solved by using the convex optimization algorithm as formulated in [11, 12]. After all the calculation on $\hat{y}$ we find new PAPR as-

$$PAPR = \frac{\max[y(n)]^2}{E\left\{|y(n)|^2\right\}}, \tag{8}$$

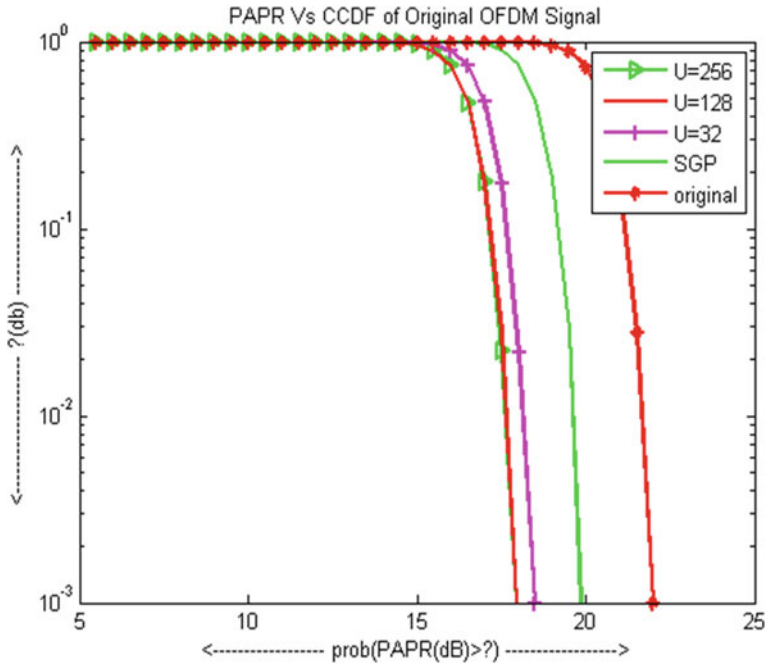

Fig. 4 PAPR versus CCDF

4 Simulation Results

Here with 256 subcarriers and 64-QAM performance of the PAPR of the projected active constellation extension schema is showed for an OFDM system. The CCDF of the PAPR of x represented as PAPR(x) is acquired as the standard.

Besides, the studied group numbers are constrained to powers of two for easiness of execution. Lastly, a classic choice of the clipping level A = 16.98 dB is utilized, when moving the constellation points to get the PAPR of the clipped signal. Figure 4 relates the PAPR reduction performance of the projected schema with the ACE-SGP schema. The performance gain of the projected schema as compare to the original ACE-SGP scheme is approximately 1.46 dB for U = 32 and Prob(PAPR(x) $> \gamma$) = 10^{-3}.

5 Conclusion

A unique Active Constellation Extension scheme based on the subcarrier grouping methodology is projected for PAPR diminution in the OFDM systems. The projected schema produces optimal instead of sub-optimal solutions as compare to the unique

Table 1 Parameter used in simulation

No. of bits to be processed	1024
Modulation	QAM
Ary	64
No. of subcarrier	256
Bandwidth	20 MHz
Sub carrier spacing	$7.81 * 10^4$
Symbol Period	12.8 ms
Guard band	3.2 ms
Symbol Duration	16 ms
Carrier Frequency	$3.6 * 10^9$
FFT size	256

Table 2 Simulation result for 64-QAM

Modulation	Original OFDM	ACE-SGP	U = 32	U = 128	U = 256
64-QAM	22.014	20.40	18.94	18.32	18.38

ACE-SGP scheme. Also, conventional ACE has need of iterative operations and an N-point FFT/IFFT pair in every iteration. On the other hand, the projected schema should be executed only once to obtain the optimum solution. Degree of freedom has been increased in the optimization process for more reduction in peak to average power ratio by using this subcarrier grouping method. Moreover, a low-cost execution for partitioning subcarriers into no. of groups is delivered. The simulation outcomes exhibited that for an OFDM system with N = 256 subcarriers and 64-QAM. The performance gain of the projected schema as compare to the original ACE-SGP scheme is approximately 1.46 dB for U = 32 and Prob(PAPR(x) $> \gamma) = 10^{-3}$.

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IoT Based Smart Garbage Collector and Waste Management System

Bramh Prakash Dwivedi, Muskan Kishore, Shatakshi Srivastava, and Sukriti Shanker

Abstract This project work proposes IoT Based Smart Garbage Collector and Waste Management System, which can segregate waste into metallic, non-metallic, wet, and dry waste. Here a smart garbage system is programmed to transmit information signal about the unwanted waste, to facilitate suitable action. Number of motors and sensors are interfaced with Arduino board. This project aims in build up a unique method to analyses garbage management on internet of thing. The design structure of the system is based on the processes in real-time scenarios.

Keywords Smart bin · Moisture sensor · Internet of things · Metal sensor

1 Introduction

In India, garbage is unwanted as one, mixing degradable and non-degradable wastes, triggering the spread of a lots of pandemics. In our day to day life, generally we see the garbage bins being burdened and all the trash falls out causing in pollution. Due to growth in population, automation, and gainful growth, a tendency of main increase in Municipal Solid Waste (MSW) making has been found everywhere in the world clean and green, this programmed waste arrangement bin is an ingenuity acquired here to make it more commendable. While the present bins and samples that discrete wastes [1].

According to a cleanliness survey called "Swachh Survekshan mission 2016" lead under the Swachh Bharat mission by the ministry of urban development, it was established that about half of the Indian population facade the crisis of inadequate trash group and management. Corresponding to center of science and environment, inventive permission and recycling approaches must be presented in its place of landfill sites. Most of the times it is observed that the public dustbins are overflowing with garbage. Unhygienic conditions as well as the unattractiveness create a non-positive effect of a city. The usual way of dumping waste is by unintended and

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abandoned discarding at landfill regions. This technique is dangerous to health of mankind, animal, and plant life. The present smart trash bins just distinct out trashes that are wet and dry, non-metallic, and metallic. In this paper, a programmed smart waste bin archetype is employed with the effective waste isolation system in fastened manner which escapes the unnecessary extent of [2].

Partition of waste advantages in enhancing the reusable materials and regulated unwanted scarcity, which might effect in discharge of injurious gasses. In India the refinement of domestic trash is made at the municipal plants, where heavy equipment's are use up for labeling out reusable materials. Execution of isolated bins for assembling of trash materials is ensured, but it does not return its point due to absence of cognizance and negligence. The current system for collecting municipal garbage does have some means to carry out the appropriate dumping or its time to time maintenance [3, 4].

2 Methodology

The Smart bin is equipped with different sensors and components. It covers a trash pooling tray at the topmost where someone drops the trashes in to the bin. The waste pooling tray comprises a moistness sensor which concludes the type of garbage (wet or dry) and two bins separately. Both bins are attached with an IR proximity sensor which is used at the highest level. When the garbage pile up to this point, the sensor starts reading and send signal to the GPS module and via Wi-Fi installed in system, the GPS will transmit data to the Cloud Server and alerts its existing location.

By the use of C language in embedded system the necessary code for proper controlling of the motors and the sensors is done. As in embedded system the input ports and the output ports will be well-defined clearly. In this method IDE compiler is used to compile all the codes and to upload all the codes to the board with the help of A-B wire. Here Node MCU is also used so that system should connect to the hotspot. It is connected to Wi-Fi so that ARDUINO MEGA can be updated with real tome inputs, by this real time input device can made decision, by this monitoring to current status can be done (Fig. 1).

3 System Flow

The programmed process of estrangement starts with the classification of garbage in the first section. In this section, an IR sensor and a metal detector are positioned. To start process of segregation there are IR sensors that detect the presence of trash. Now after detection of garbage using IR sensors the metal detector start working and validates that metal garbage is there. Now if there is any metal present there metal sensor create a magnetic field across the metal object (this current in an induced current), by this magnetic field there will be some changes in the electric field. Once

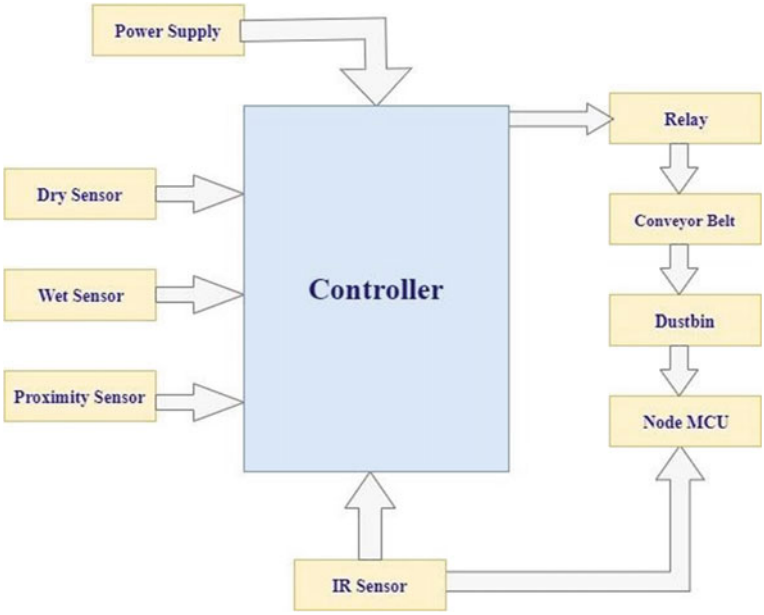

Fig. 1 Block diagram

detection of metal is done the garbage in the first section are guided precisely to the storage section, where three different bins are there one for metal one for dry garbage and one for wet garbage. But if the garbage in the first section is nonmetallic then this garbage will directly sent to second section and here in second section an IR sensor is depleted to confirm the existence of the garbage. On the basis of output provided by this IR sensor the moisture sensor start working or stays idle. In the second section the moisture sensors is used to verify whether garbage is dry or wet.

Internet of Things and Image Processing are the two main technologies that will be used in the accomplishment of the project. The garbage management system based on internet of things is an incredibly pioneering system that will facilitate to retain the cities hygienic. Here in the projected system for getting information about when bins are fully filled there is NODEMCU module. By using this module information of fully filled bins can be transmitted to municipal office after getting this information they can send someone to pull together the garbage.

The setup will be placed in such a way that it will encourage the usage of dustbin in a locality. A camera will be placed, having the Image Recognition System that will count the person's usage of dustbin. This data will be saved and according to the count of person's usage, some reward points or gift hampers will be provided to that person living in the locality.

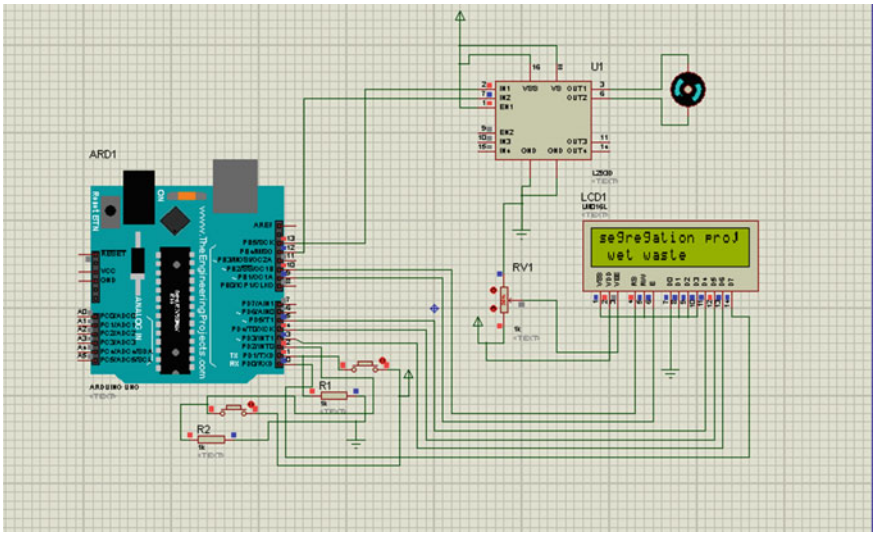

Fig. 2 Wet garbage detection

4 Results

Here in this project practical condition is simulated. In simulation IoT based smart bin system will work properly and proper segregation of waste material will be done. All the steps involve are clearly shown through LCD, and this output is also updated on cloud server so that this data can be used in future. System is verified by performing no. of tests by increasing amount of garbage or decreasing amount of garbage in the smart bin. And by the help of Wi-Fi module, as the level of garbage in bin is changed one notification will be sent to the authorities each and every, i.e., whether the dustbin is full or empty. Here at the last it can be seen that whole system is working fine as it is planned initially. For maintaining accuracy of system all the hardware component are well connected. And separation of garbage is done smoothly without any failure. The facial recognition process for counting the person's usage of dustbin has been implemented successfully (Figs. 2, 3, 4, 5, 6 and 7).

5 Conclusion

IOT based smart garbage collector and garbage management system helps the people to supervise the garbage easily and effectively. It is independent of calling or waiting for the specific person to vacant the dustbin. The segregation method of execution saves the time and reduces manpower. IOT based Smart Garbage Collector and Garbage Management System is successfully implemented to separate and categorize

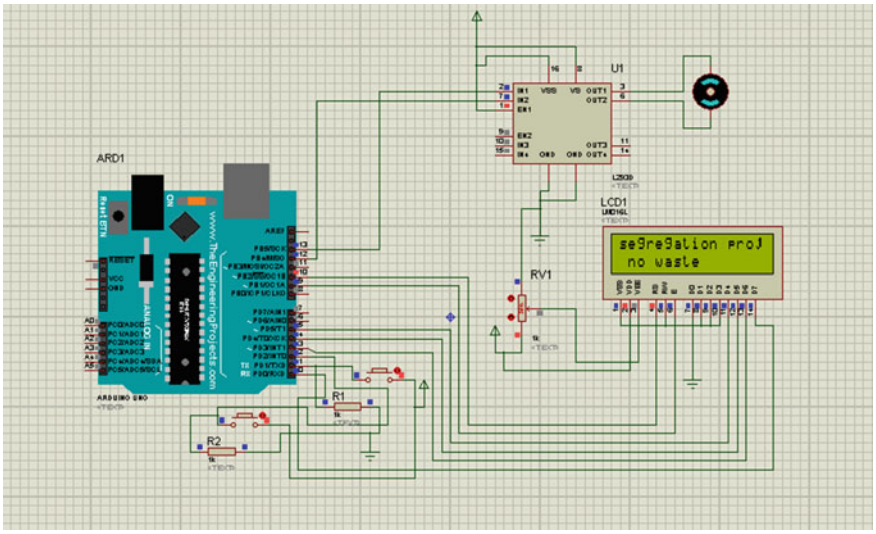

Fig. 3 Dry Garbage detection

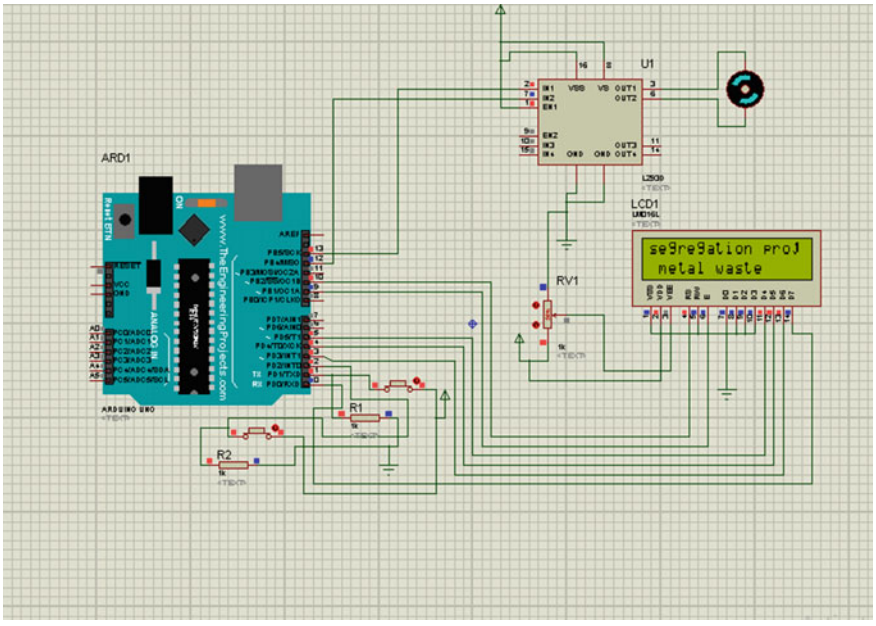

Fig. 4 Metal garbage detection

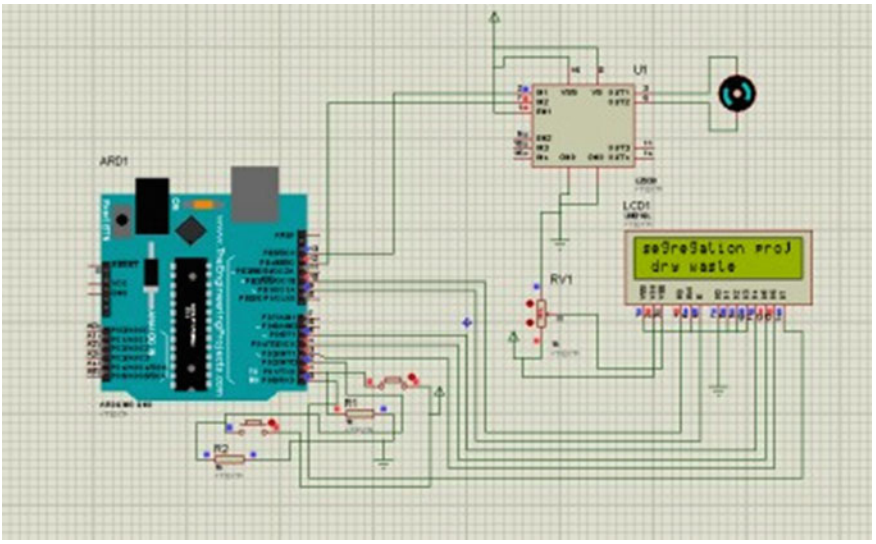

Fig. 5 No garbage detection

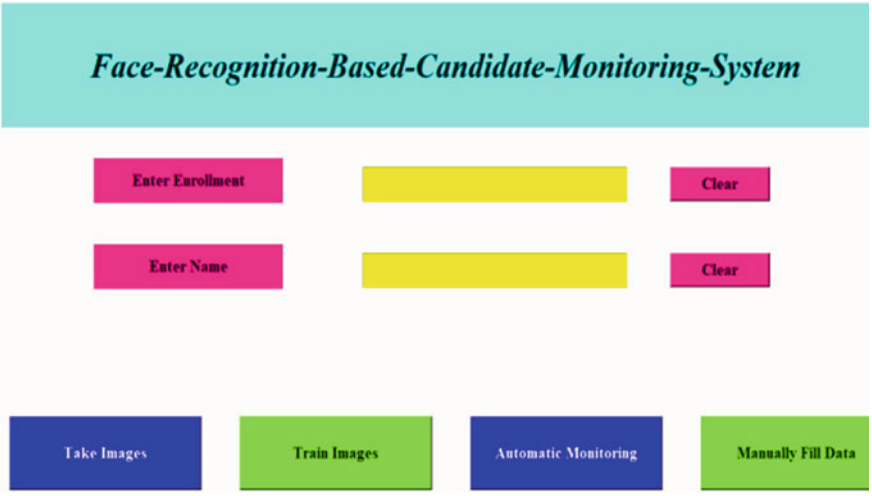

Fig. 6 GUI for face recognition system

the garbage into metal, non-metal, dry, and wet garbage. The people will be fit and healthy and are not prone to any diseases caused by these garbage materials. This system assures notifying the authority when the garbage level reaches its limit. The mission Swachh Bharat by Govt. of India can be implemented easily. It will also contribute a lot to the society to provide a clean and hygienic environment.

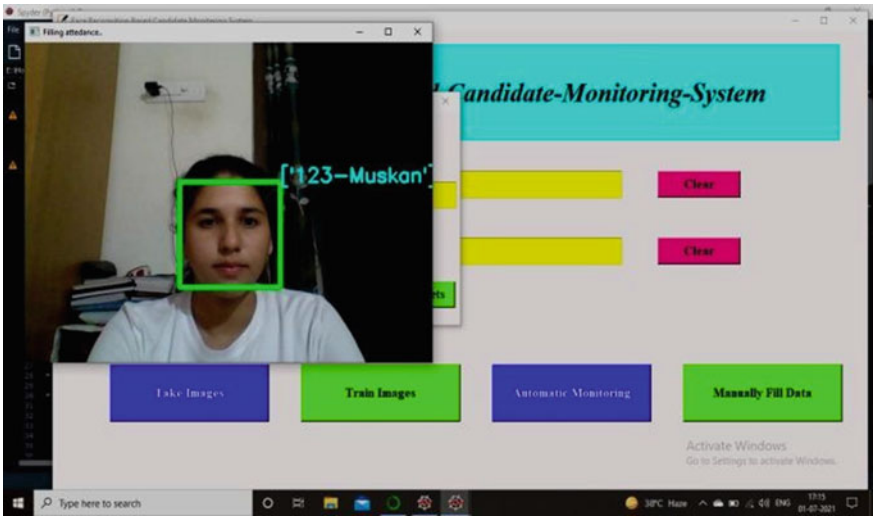

Fig. 7 Face Detection

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Enzyme *Acetylcholinesterase* Inhibitory and Total Antioxidant Activities of Three *Salacia* Species: Implications for Diabetes Associated Cognitive Decline

Manisha Rastogi and Shiva Sharma

Abstract Cumulative research evidences suggest that diabetes mellitus may exacerbate cognitive impairment due to persistent chronic hyperglycemia. *Salacia* species have gained considerable popularity for diabetes and its complications management. The present study aims to investigate the *acetylcholinesterase* (AChE) inhibitory and total antioxidant activates of three *Salacia* species viz., *S. oblonga, S. reticulata,* and *S. chinensis* through in-vitro assays. The outcomes of this study indicate that the three *Salacia* species exhibit moderate to good *in vitro AChE* inhibition activity. Moreover, these *Salacia* species were found to exhibit potent anti-oxidant activity in DPPH assay. These outcomes suggest that the three *Salacia* species may ameliorate diabetes associated cognitive decline by inhibiting *AChE* enzyme activity and scavenging free radicals. However, extended research is warranted to ascertain these in vitro outcomes by pre-clinical and clinical studies.

Keywords Diabetes mellitus · Cognitive decline · Salacia · Acetylcholinesterase · Antioxidant

1 Introduction

Diabetes mellitus (DM) is an ever-rising common metabolic anomaly with the current prevalence of 9.3% globally and is expected to increase to 10.9% by 2045 accounting for 700million population [1]. It is characterized by chronic hyperglycemia that can negatively influence the central and peripheral nervous system at functional and structural level [2–4]. In 2006, Mijnhout and his colleagues first coined the term 'diabetes associated cognitive decline' (DACD) which had eventually transformed as an established risk factor for cognitive dysfunction [5, 6]. Moreover, increasing evidences suggest that DM and cognitive disorders like Alzheimer's disease occurs more often than by chance [7]. Evidences related to the elevated enzyme *AChE*

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activity in diabetic rat brain further suggested diabetes induced alteration in cholinergic neurotransmission with consequent impairment of cognitive activity [8, 9]. Acetylcholinesterase enzyme plays an essential role in cholinergic neurotransmission as well as in several non-cholinergic functions [10, 11]. Further, chronic hyperglycemia mediated oxidative stress may further disrupt the *AChE* enzyme activity leading to cognitive dysfunctions and overall neuronal injury in diabetic brain [9, 12–15]. Treatment with antioxidants including melatonin, toccopherol, lycopene, curcuminoids, and resveratrol were reported to protect neurons against diabetes associated neurodegeneration as well as learning and memory deficits [9, 14, 16]. Our previous research findings have also demonstrated that treatment of curcuminoids, a potent antioxidant, modulates diabetes-induced neurodegeneration [17]. Therefore, medicinal plants with potential anti-diabetic activity can also serve as good candidates for the management of diabetes induced cognitive decline. Roots of *Salacia* species, particularly *S. oblonga, S. reticulata, and S. chinensis* have been extensively used both as food supplement and Ayurvedic medicine in countries including India, Sri Lanka, China, Japan, and the United States in diabetes and its associated complications management. Numerous pharmacological studies demonstrated modulatory effect of *Salacia* roots over multiple targets associated with DM like lipogenic gene transcription involving peroxisome proliferator-activated receptor-alpha (PPAR-α), alpha-glucosidase, aldose reductase, and pancreatic lipase [18]. Overall, considering the association of DM with cognitive dysfunction and the potential role of *Salacia* species in the treatment and management of DM, the present study aims to explore the in vitro *AChE* inhibition as well as total antioxidant activity of three *Salacia* species viz., *S. oblonga, S. reticulata,* and *S. chinensis.*

2 Material and Methods

2.1 Plant Material

The standard hydroalcoholic root extract of *S. oblonga, S. chinensis,* and *S. reticulata* was purchased from M/s Natural Remedies Pvt. Ltd., Bangalore, India. Mangiferin content which is a marker compound for *Salacia* species has been quantified by HPLC (Waters, USA) with PDA detector. The mangiferin content was found to be 0.98%, 1.12%, and 1.72 % in *S. oblonga, S. chinensis,* and *S. reticulata,* respectively.

2.2 Chemicals

Acetylcholinesterase (AChE) type VI-S, from electric eel 658 U/mg solid, 5,5-dithiobis[2-nitrobenzoic acid] (DTNB), acetylthiocholine iodide (AChI), galantamine HBr, and 2,2-diphenyl-1-picrylhydrazyl (DPPH) were purchased from Sigma

Aldrich (St. Louis, USA). Other analytical grade chemicals were purchased from Merck (Germany).

2.3 AChE Inhibitory Activity

AChE inhibition activity was performed by the method as described previously with slight modifications [19, 20]. Briefly, 3 mM DTNB (125 µl), 15mM ATCI (25 µl), Tris–HCl buffer (50 µl), and diluted samples (25 µl) were added to 96 well microplate, and the absorbance was read at 405 nm. To the reaction mixture, 0.3 U/ml AChE (25 µl) was added followed by absorbance kinetically read at 405 nm for a total of 3 min. Enzyme activity was evaluated up to the concentration of 40 mg/mL and represented as a percentage with and without any inhibitor.

2.4 Total Antioxidant Potential Assessment by *DPPH* Assay

The antioxidant activity was performed as described previously with slight modifications [21]. Briefly, 1mL of 100 µM DPPH solution was mixed with diluted extract of Salacia species (1 mL). The reaction mixture was read at 519 nm post incubation of 30 min at ambient temperature and in dark.

2.5 Statistical Analysis

The in-vitro outcomes were statistically compared by One Way ANOVA using Graph Prism Pad software version 8. Further, IC_{50} values were calculated through log probit analysis by the same software.

3 Results and Discussion

In the present study, standard root extract of *S. oblonga, S. chinensis,* and *S. reticulata* were analyzed for their in vitro *AChE* inhibiton and total antioxidant activity. To the best of our knowledge, the AChE inhibitory activities of three Salacia species have been reported for the first time (Fig. 1). *Salacia oblonga* exhibited maximum inhibitory activity whereas *S. chinensis* and *S. reticulata* have shown moderate inhibition activity (moderate: 25–49%; maximum: 50–100%). The maximum *AChE* inhibition property of *S. oblonga* (87.94 ± 4.66%), *S. chinensis* (43.71 ± 3.31%), and *S. reticulata* (32.88 ± 4.43%) was observed at the concentration of 20 mg/mL, 30 mg/mL, and 10 mg/mL respectively. The activity of *S. oblonga* extract cannot be read

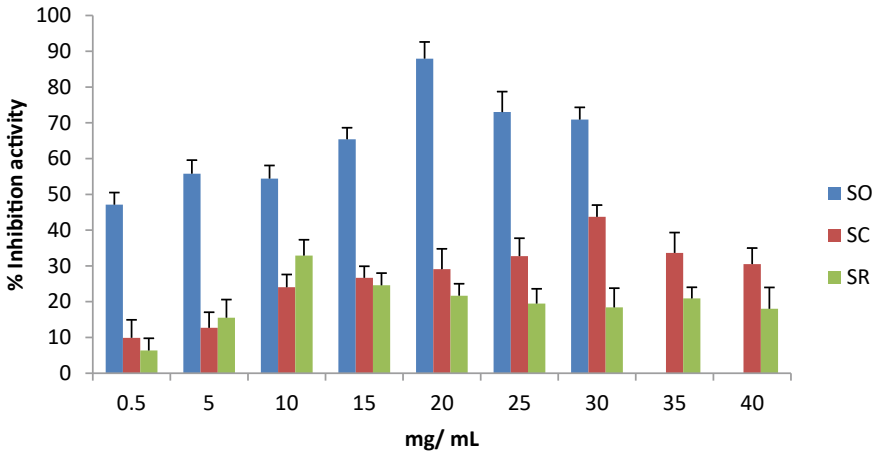

Fig. 1 AChE inhibitory activity (% inhibition) of three *Salacia* species. Values represented as Mean ± SD of triplicate. One Way ANOVA represent overall statistical significant differences between them ($P<0.05$).

after 30 mg/mL due to the color interference of the extract. In statistical analysis, the ACHE activity was found to be significantly different among the 3 tested species of *Salacia* ($P<0.05$). The extract of *S. oblonga* exerted 50% inhibition (IC_{50}) at the concentration of 14.98 mg/mL, whereas the remaining two species exerted inhibitory effect at less than 50%. Galantamine was used as a positive control, and its IC_{50} value was recorded at 2.8 μM. Based upon the present study outcomes it is suggested that while all the three *Salacia* species may profoundly inhibit *AChE* enzyme activity, and *Salacia oblonga* has shown comparatively better in-vitro *ACHE* inhibitory activity. The exact mechanism for the diabetes related cognitive decline remains obscure; the inter-connection of *AChE* and oxidative stress has been reportedly hypothesized [22, 23]. Hyperglycemia induced oxidative stress and altered *ACHE* activity may lead to substantial hydrolysis of neurotransmitter acetylcholine with subsequent down regulation of acetylcholine receptors resulting in progressive cognitive impairment in diabetic patients [10, 13, 24]. Thus, *AChE* inhibitors which intend to prevent the loss of neurotransmitter acetylcholine by inhibiting enzyme *acetylcholinesterase* and consequently cognitive deficits may act as an important therapeutic target in the prevention and management of diabetes associated memory dysfunction. In the present study, the three *Salacia* species have shown moderate to good in-vitro *AChE* inhibition activity. Thus, it is speculated that these *Salacia* species, particularly *S. oblonga* may act as a potent therapeutic agent in the prevention and management of diabetes associated cognitive decline.

The total antioxidant activity of *Salacia* species was determined by DPPH assay, and the results were represented in Fig. 2. All the three *Salacia* species possess potent free radical scavenging activity and *Salacia oblonga, S. chinensis,* and *S. reticulata* were found to exhibit maximum free radical inhibition activity of 74.64 ± 5.6, 78.05

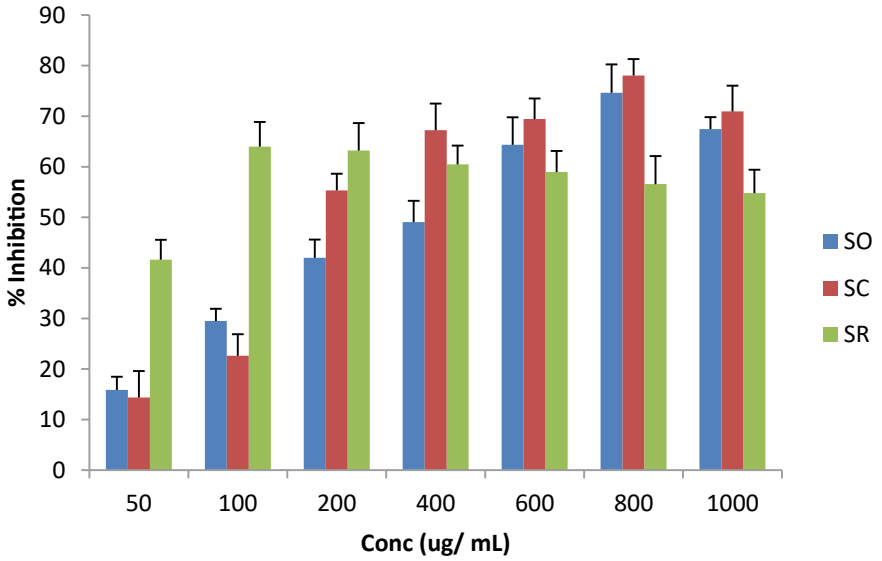

Fig. 2 DPPH inhibition activity (% inhibition) of three *Salacia* species. Values represented as Mean ± SD of triplicate. One Way ANOVA represents overall statistical significant differences between them except for the concentrations of 600 and 1000 μg/mL ($P<0.05$).

± 3.24, and 63.99 ± 4.87% at the concentration of 800 μg/mL, 800 μg/mL, and 100 μg/mL respectively. In statistical analysis, the total antioxidant activity was found to be significantly different among the 3 tested species of *Salacia* except for two concentrations viz. 600 and 1000 μg/mL ($P<0.05$). The 50% inhibitory concentration of *S. oblonga, S. chinensis,* and *S. reticulata* were determined at 442.72 μg/mL, 156.41 μg/mL, and 42.54 μg/mL respectively. The standard BHT has shown IC_{50} at 79.72 μg/mL. The overall in-vitro antioxidant outcomes demonstrated higher antioxidant potential of *S. reticulata* in comparison to the remaining two *Salacia* species. Hyperglycemia mediated oxidative stress acts as a decisive factor in *AChE* activation found in diabetic brain [23]. Oxidative stress leads to the excessive free radical generation which damages the cellular membrane and thus alter membrane functions [25]. These membrane alterations are further responsible for the conformational modifications in the *AChE* enzyme, which is an important biological component of the membranes [26, 27]. In this context, antioxidant treatment may inhibit the conformational and functional changes in *AChE* enzyme associated in DM.

Based upon the in-vitro outcomes of the present study, it is hypothesized that the three *Salacia* species may act as potent drug candidates for the amelioration of diabetes associated cognitive impairment due to their *AChE* inhibition and antioxidant activity. However, further animal and human studies are warranted to confirm the present findings.

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Physical, Physicochemical, and Structural Characteristics of Three, Four, and Five Mukhi Rudraksha

Shiva Sharma, Durg V. Rai, and Manisha Rastogi

Abstract Elaeocarpus *ganitrus* (Roxb.), popularly known as Rudraksha, is known for its numerous medicinal and spiritual benefits. In our previous studies we have reported the differences in the electromagnetic and compositional characteristic of three types of Rudraksha namely 3 Mukhi (3MR), 4 Mukhi (4MR), and 5 Mukhi (5MR). Aim of the present study is to extend the knowledge about the differences in the structural, physical, and physiochemical characteristic of 3MR, 4MR, and 5MR. Basic physical analysis includes estimation of weight (gm), moisture, ash content, volatile matter content, bulk density, specific gravity, and crude fiber content of selected Rudraksha. Physicochemical characteristics involve evaluation of pH, TDS, conductivity, resistivity, and salinity of water mixed with Rudraksha powder. Structural analysis of whole beads carried out using Scanning Electron Microscope (SEM) techniques. The outcomes were statistically compared through One-way ANOVA followed by *Posthoc Tukey test* by using Graph Prism Pad Software version 8.0. All the three types of Rudraksha showed significant variations in their physical and physicochemical properties. The surface characteristics of different Mukhi Rudraksha demonstrated the rough nature of 5MR, while the surface of 4MR and 3MR was relatively smooth. Future research is warranted to decipher the association between the differences in physical, physicochemical, and morphological characterictics with its electromagnteic behaviour.

Keywords Physical · Physicochemical · Structure · Rudraksha · SEM

1 Introduction

Elaeocarpus *ganitrus* (Roxb.) is an ornamental stony fruit popularly known as Rudraksha [1]. It is a member of *Elaeocarpaceae* family and is known for numerous medicinal and spiritual benefits since time immemorial [2]. Globally, there are around

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360 species of Elaeocarpus, out of which 120 species belongs to Asian countries and 27 species found only in India that spread from Gangetic plains region to Himalayan regions.

E. *ganitrus* exhibits extensive range of pharmacological actions such as analgesic, anti-inflammatory, anti-diabetic antihypertensive, anticonvulsant, antioxidant, anti-asthmatic, antidepressant, sedative, tranquillizing, hypnosis, hydrocholeretic, and cardio stimulatory [3–6]. Applications have also been reported in the management of headache, fever, chicken pox, mental disorders, burn or pox marks, and wound [7]. Ayurveda has defined multiple ways to use Rudraksha to obtain its multifarious benefits including physical wearing, oral intake as powder, and consumption of Rudraksha boiled milk or dipped water. The primary mechanism behind its pharmacological action is stated to be its electromagnetic property and research conducted by our group has demonstrated the contributions of mineralogical, biochemical, phytochemicals, and elemental components in the same [8]. There are twenty one types of Rudraksha beads (1–21 Mukhi) on the basis of the presence of number of natural grooves (thin vertical lines, popularly characterized as Mukhis [9]. In traditional literature each Mukhi Rudraksha has been stated with different pharmacological activities and in our previous research we have documented the differences in the electromagnetic and compositional characteristic of three types of Rudraksha namely 3 Mukhi (3MR), 4 Mukhi (4MR), and 5 Mukhi (5MR) [10–12]. The present study aims to extend the knowledge about the differences in the structural, physical, and physiochemical characteristic of 3MR, 4MR, and 5MR abundant in nature.

2 Methodology

Rudraksha beads were collected from the repository of Kunwar Shekhar Vijendra Ayurvedic Medical College and Research Centre, Shobhit University, Gangoh.

2.1 Sample Preparation

The collected beads were subjected to high pressure air blower followed by thorough rinsing under running tap water and double distilled water to remove adhering dust particles. Further, the beads were shade dried under controlled conditions. These beads were used for physicochemical and structural analysis. For physical analysis, grounded uniform powder prepared by mixer and sieved shaker were used [13].

2.2 Physical Analysis

Basic physical analysis include estimation of weight (gm), moisture, ash content, volatile matter content, bulk density, specific gravity, and crude fiber content of selected Rudraksha. Briefly, a total of 100 completely dried Rudraksha beads were weighed using analytical digital weighing balance with 1 mg accuracy. AOAC (1990) method was used to access the Moisture, Total ash, and Volatile Matter content in 2 gm of Rudraksha bead powder and crude fiber content [14–16]. Fixed carbon content was calculated by subtracting the percentage compositions of moisture content, volatile matter content, and ash content from hundred [17, 18].

2.3 Physicochemical Analysis

Physicochemical characteristics included evaluation of pH, TDS, conductivity, resistivity, and salinity of water mixed with Rudraksha powder. Briefly, 1 gm of fine Rudraksha powder was added to the 100 ml of distilled water with slightly alkaline pH 7.8 and stirred continuously for 1 h using magnetic stirrer. All samples were prepared in triplicates and measured with the help of pre-calibrated water quality analyzer. Same samples were further used for conductivity, TDS, and salinity measurement through previously calibrated electrode with known conductivity solutions 74, 110, and 1710 μS/cm. Resistivity was calculated as the inverse of conductivity [19].

2.4 Structural Analysis

Structural analysis of three, four, and five Mukhi Rudraksha whole bead was carried out using Scanning Electron Microscope (SEM) (Zeiss EVO40). Rudraksha beads were coated with a highly conductive material (gold) to facilitate easy interaction of the electron beam with the material surface, and the obtained signals were detected by the detectors and stored in image format (.jpg) using ImageJ software.

2.5 Statistical Analysis

Statistical outcomes were obtained through One-way ANOVA followed by *Posthoc Tukey test* by using Graph Prism Pad Software version 8.0. $P < 0.05$ was considered to be statistically significant.

3 Results and Discussion

The present study reported for the first time the comparative outcomes of the physical, physicochemical, and structural characteristics of 3MR, 4MR, and 5 MR to the best of our knowledge. Table 1 demonstrated the different physical properties of 3MR, 4MR, and 5 MR. The average weight of all the selected Mukhi Rudraksha showed statistical significant differences with an average weight lied in the range of 2–4 g and in the order of 3 MR > 4 MR > 5 MR ($P < 0.05$).

Previous study conducted by Rai (2004) also reported Mukhi wise weight differences in the average weight of 3 MR, 4 MR, and 5 MR (1.85 gm, 3.19 gm, 2.57 gm respectively); however, these were different from present outcomes (3.36, 2.2, 2.17 gm) [20]. Similar order was also noticed for the bulk density and the present study outcomes (0.81–1.06 gm/cc) were comparable with the previous reported findings (0.721–1.309 gm/cc) [16]. Bulk density is often used as the qualitative measure to test Rudraksha originality, and it is quoted that the original Rudraksha sinks in the water. The possible reason of the sinking of Rudraksha beads despite having lesser bulk density than water is the uneven distribution of the mass of bead due to presence of non-uniform presence of seeds in inner chambers or also due to the irregular surface therefore minimizing the contact area and displacement of lesser volume of water [21]. The percent total moisture content and the volatile matter content also showed statistical significant differences between the selected Mukhi Rudraksha and

Table 1 Physical characteristics of selected Rudraksha

Parameters	3 MR	4 MR	5 MR	P value
Weight (g)	3.36 ± 0.19$^{@}$	2.20 ± 0.12*	2.17 ± 0.12$^{\#}$	< 0.0001
Total moisture content (%)	11.53 ± 0.66$^{@}$	14.14 ± 0.81*	15.30 ± 0.88$^{\#}$	0.0002
Total ash content (%)	29.13 ± 1.68$^{@}$	35.51 ± 2.05*	24.72 ± 1.43$^{\#}$	< 0.0001
Volatile matter content (%)	3.03 ± 0.17$^{@}$	2.43 ± 0.140*	3.68 ± 0.21$^{\#}$	< 0.0001
Fixed carbon content (%)	54.39 ± 3.14	46.0 ± 2.66*	54.38 ± 3.14$^{\#}$	0.001
Crude fiber (%)	61.51 ± 3.55$^{@}$	65.49 ± 3.78	50.17 ± 2.90$^{\#}$	0.0004
Bulk density (g/cm^3)	1.06 ± 0.06$^{@}$	0.95 ± 0.05*	0.81 ± 0.047$^{\#}$	0.0002
Specific gravity (g/cm^3)	3.41 ± 0.19	3.21 ± 0.18	3.12 ± 0.18	0.086

(Data representing mean ± SD of six samples for each Mukhi Rudraksha (except for weight where mean and SD is calculated for 100 samples). Statistical significant changes were obtained using One Way ANOVA and Posthoc Tukey test**.** Inter-group comparisons were represented as $^{*}P < 0.05$ 3MR vs.4MR; $^{\#}P < 0.05$ 4MR vs.5MR; $^{@}P < 0.05$ MR vs.3MR.)

was found to be in the order of 5 MR > 4 MR > 3 MR ($P < 0.05$). Study conducted by Kumar et al. reported 9.7% of moisture content in Rudraksha bead, which was less than the present study (11.53–15.5%) [22]. Statistical significant variations were also noticed in case of percent total ash and crude fiber content within the selected Mukhi Rudraksha and was found in the order of 4 MR > 3 MR > 5 MR ($P < 0.05$). Study conducted by Singh et al. reported total ash content of 1.5% in Rudraksha bead, which was considerably lower than obtained by us (24.72–35.51%) [21]. Significant differences in percent fixed carbon content was noticed in case of 4 MR when compared with 3 MR and 5 MR ($P < 0.05$). The percent crude fiber content was found to be significantly reduced in 5MR as opposed to 4 MR and 3 MR ($P < 0.05$). No significant differences were documented in case of specific gravity among selected Mukhi Rudraksha; however, the values (3.12–3.41 gm/cc) are much higher when compared with water (1 gm/cc). This further supports the sinking of Rudraksha beads when dipped in water. The significant variations in the physical characteristics of 3 MR, 4 MR, and 5 MR from the previous published reports can be overall attributed to the differences in Rudraksha origin and random selection of Rudraksha beads without Mukhi wise segregation by the previous studies.

Table 2 illustrates the statistically significant variations in all the physicochemical characteristics (pH, TDS, conductivity, resistivity, and salinity) of 3 MR, 4 MR, and 5 MR when compared with control normal water as well as inter Rudraksha groups ($P < 0.05$). All the selected Mukhi Rudraksha tends to reduce the pH of the normal control water therefore shifting the slightly alkaline normal water into slightly acidic in nature. On acidic to alkaline pH scale, the order was found to be 4 MR > 3 MR > 5 MR. Similar trend and order was noticed in case of resistivity. The remaining physicochemical variables namely total dissolve solids (TDS), conductivity, and salinity were found to be increased in all selected Mukhi Rudraksha when compared

Table 2 Physicochemical characteristics of selected Rudraksha

Parameters	Control	3 MR	4 MR	5 MR	P value
pH	7.8 ± 0.56	6.50 ± 0.67$^{@\$}$	6.26 ± 0.36$^{*\$}$	6.75 ± 0.39$^{\#\$}$	< 0.0001
TDS (ppm)	20 ± 0.12	135.077 ± 7.82$^{@\$}$	130.27 ± 7.53$^{*\$}$	153.12 ± 8.86$^{\#\$}$	< 0.0001
Conductivity (μS)	41 ± 1.7	261.914 ± 15.15$^{@\$}$	257.01 ± 14.87$^{*\$}$	306.05 ± 17.70$^{\#\$}$	< 0.0001
Resistivity (kΩ)	24.3 ± 1.98	3.66 ± 0.21$^{@\$}$	3.73 ± 0.22$^{*\$}$	3.13 ± 0.18$^{\#\$}$	< 0.0001
Salinity (ppt)	0.00 ± 0.00	1.04 ± 0.06$^{@\$}$	1.03 ± 0.06$^{*\$}$	1.05 ± 0.06$^{\#\$}$	< 0.0001

(Data representing mean ± SD of six samples for each Mukhi Rudraksha. Statistical significant changes were obtained using One Way ANOVA and Posthoc Tukey test**.** Inter-group comparisons were represented as $^{*}P < 0.05$ 3MR vs. 4MR; $^{\#}P < 0.05$ 4MR vs. 5MR; $^{@}P < 0.05$ MR vs. 3MR; and $^{\$}P < 0.05$ control vs. 3MR, 4MR, 5MR.)

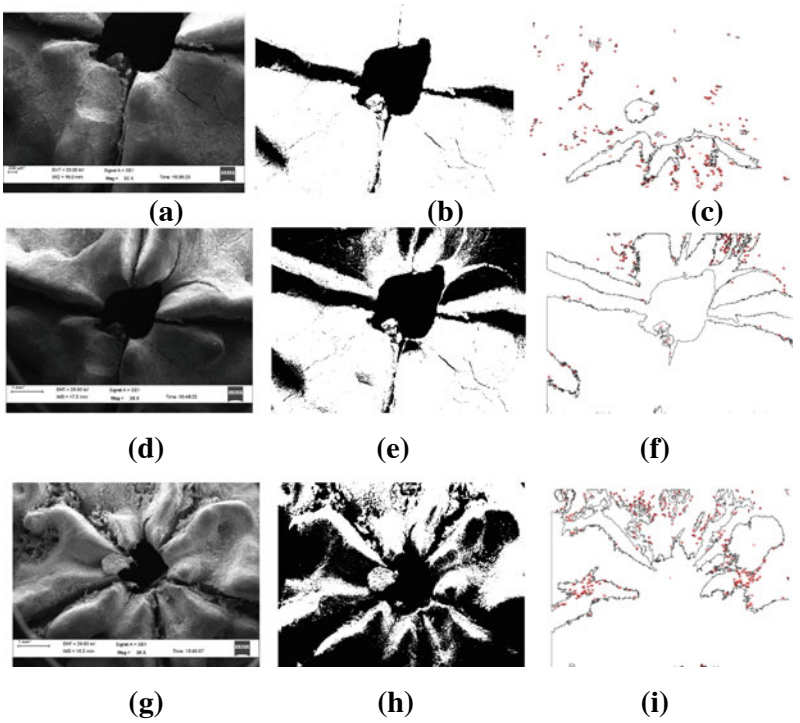

Fig. 1 SEM outcomes for different mukhi Rudraksha. Figure representing SEM analysis of 3 MR at 50X, 4 MR & 5 MR at 38X Magnification

with normal water in the order of 5 MR > 3 MR > 4 MR. No previous evidences were available related to the physicochemical outcomes of Rudraksha.

Scanning electron microscopy was used for the morphological analysis of the Rudraksha. This analysis was carried out at diffeerent level of zooming as per the requirement of the bead structure. Figure 1a–b indicates the results for 3 M Rudraksha at 48X, 4 M Rudraksha at 50X Fig. 1c–d, 5 M Rudraksha at 38X magnification Fig. 1e–f. Results show ridges and the long cyllindrical line passing from apex to bottom in all the three types of Rudraksha. Five mukhi Rudraksha was found with some fibrous type structure in between the cyllindrical line; whereas same texture was absent in 3 and 4 M Rudraksha. Morphology also indicates the empty space between the ridges that is showing irregular symmetry of the Rudraksha. Futher the figures differentiated the angular distance between the ridges and the natural opening among the different mukhi Rudraksha as shown Fig. 1a–f.

Cylindrical lines were wider in mid of the Rudraksha and narrower at the apex whereas larger working distance at lower magnification stated roughness of five mukhi Rudraksha. Further, extensive analysis of SEM results was carried out using ImageJ software. The image selected for analysis was at 50X magnification for 3 M Rudraksha and 38X magnifactaion for 4 M and 5 M Rudraksha as it adequately

Table 3 Morphological outcomes for scanning electron microscopy images using image J software

S. No	Type of Rudraksha	Pore count	Mean pore size (mm)	Nature
1	3 MR	107	0.0025	Smooth, porous
2	4 MR	188	0.0030	Smooth, porous
3	5 MR	755	0.0040	Rough, porous

showed the details and structre of Rudrakha. Analysis using Image J software generated results concerning pore count, mean pore size while the SEM original images indicate the surface of the Rudraksha. SEM analysis showed smooth and porous structure of the 3 M and 4 M Rudraksha, whereas 5 M Rudraksha was found rough and porous perhaps due to the presence of fibrous content in the ridges. Porosity and the mean pore size was also high in 5 M Rudraksha (Table 3). The porous structure of Rudraksha may have wider pharmaceutical applications with excellent absorption characteristics [23–26].

4 Conclusion

To conclude, all the three types of Rudraksha showed significant variations in their physical and physicochemical properties. The surface characteristics of different Mukhi Rudraksha demonstrated the rough nature of 5MR due to the presence of fibrous content in the ridges, while the surface of 4MR and 3MR was relatively smooth. Although, the association between physical, physicochemical, and morphological characterictics with its electromagnteic behaviour remains undeciphered and warrants future research.

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A Comparative Evaluation of Immune Response of Pre and Post Antiretroviral Therapy (Art) in Male and Female HIV Patients

Vinay Malik, Tung Veer Singh Arya, and Amar Prakash Garg

Abstract The significance of the study lies in the fact that it allows a comparison between different disease stages (Stage 1, Stage 2, Stage 3, and Stage 4) in HIV patients before and after 6 months of ART therapy. Understanding hematological status in each patient is important not only to assess safety of the therapy in view of long term treatment but also to compare any significant deviation from normal value. Secondly, the study allows us to assess the levels of sex hormones in HIV infected indicating gonadal status of the infected patients. Similarly, biochemical parameters related to vital organ like liver gives us an idea of the state of health of the individual as well as the preparedness for the therapy. We are optimistic about the outcomes of the study in terms of understanding the state of overall health of the patient prior to therapy and the expected targets for therapy. The study should help us in understanding the role of the underlying mechanisms of the abnormal expression of the markers thus lending us choice to target particularly the same. Co-relating the expression of the various markers among the cohorts should further elaborate the coherent mechanisms in play and the inter-dependent nature of the various manifestation of the HIV infection. The study should address the gaps in knowledge regarding the hematological status among HIV patients at different disease stages. Such inter stage comparisons are rare and valuable at the same time as it provides an idea about the progression of the disease in multiple patients. Moreover, it compares the liver health among the four disease stages which is an estimation of the damage associated with the hepatic system with the progress of the disease. Finally, it should give us an idea about the correct time to start the ART so as to minimize the disorders magnifying with the progression of the disease.

Keywords HIV · CD4 · Osteoporosis, IL6 · DEXA · Vitamin D · Hematological parameters

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1 Introduction

Acquired Immunodeficiency Syndrome (AIDS) is among the most disastrous pandemic that humanity has faced in the last few decades [1]. The ongoing global HIV/AIDS pandemic has already claimed more than 35 million lives. Since its inception around 37 years ago, the disease still persists in more than 37 million people worldwide who live with HIV [2]. In fact, even today, there is still lack of a universal vaccine for HIV that would be viable as well as available to all. HIV infection mainly in economically weaker countries if untreated progresses to AIDS and ultimately results in mortality [2]. Although substantial efforts have been made toward ending the HIV epidemic, major challenges still persists in the context of epidemic control of the disease. Current therapies have been successful in limiting HIV transmission that occurs from mother to child and through blood transfusions. However, unsafe sexual practices and injection drug use have been difficult to limit and hence the pandemic is still persistent in current times. This will require advancement in behavioral and biomedical HIV prevention which is still a goal unsettled [3]. The viral protein gp120 causes the tight junction proteins to be disrupted and upregulation of inflammatory cytokines increased permeability of the virus [4]. Recently, though a subset of dendritic cells (DCs) has been identified, the CD11 + DCs; which are enriched in anogenital tissues in comparison to Langerhans cells. Moreover, CD11 + DCs higher levels of HIV entry receptor CCR5 can uptake higher number of viral particles and can present to CD4 + T cells more efficiently [5]. After entry, the virus replicates locally in the mucosa by infecting resident memory T cells expressing CD4 and CCR5 then spreads into the nearby lymph nodes. This phase is called the eclipse phase, following which viral RNA becomes detectable in plasma of the patients [6]. It is in the lymph nodes that HIV encounters activated CD4 + CCR5 + T cells which are targets for further infection and causes their massive depletion [7].

In the human body, the innate immune system is the first line of defense against invading pathogenic organisms. It has many components starting from the physical epithelial barriers to the molecular complement system, and cells with phagocytic and antigen presenting properties, such as granulocytes, macrophages, and DCs [8]. The immune response to HIV starts as soon as it enters the body by infecting the first cell. The robust action of the host innate immune responses against HIV in the early phase of infection is very important. It should be able to ideally prevent the major hallmarks of the infection: chronic inflammation, and viral reservoirs [9]. The innate immune defense system of the body uses pattern recognition receptors (PRR)s to identify evolutionarily conserved structures on various pathogens, which are named as pathogen-associated molecular patterns (PAMP)s [8].

2 HIV Structure

HIV belongs to the Lentivirus genus of the Retroviridae family characterized by chronic disease course involving long latency period, persistent viral replication, and central nervous system. The diameter of HIV viral particles was reported to be 100 nm. Each viral particle is surrounded by a lipoprotein-rich membrane intruded with glycoprotein heterodimer complexes made up of external surface gp120 trimers and gp41 transmembrane spanning glycoproteins [10] (Fig. 1). Due to the weak non covalent binding of gp120 and gp41, the gp120 was shed spontaneously and detected in the serum and lymphatic tissue of HIV infected patients. Further, the virus membrane and the matrix protein contain the capsid made up of polymeric core antigen (p24) and viral genome [11]. HIV genome size is made up of two identical copies of single-stranded RNA molecules with an overall genome size of 9749 nucleotides and encoding a total of nine viral proteins [1, 12]. Based upon the difference in genomic organization, HIV isolates were classified into two types, HIV-1 (most prevalent) and HIV- 2.

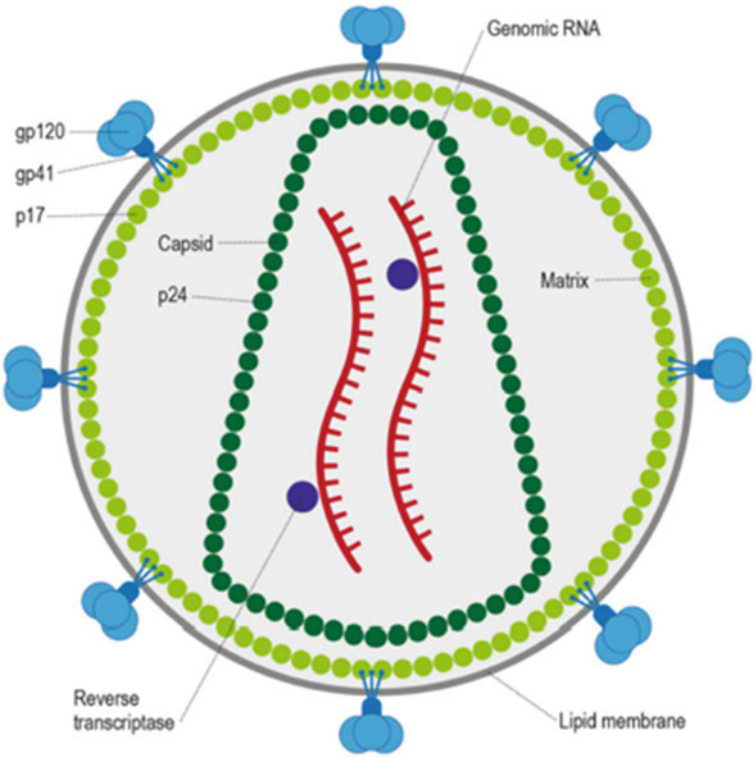

Fig. 1 Structure of HIV-1 retrovirus [10]

3 Systemic Effect of Inflammation Associated with Chronic HIV Infection

HIV infected adults are at higher risk of cardiovascular, kidney, bone, and neurologic diseases [13]. With development of ART treatment, HIV replication can be essentially inhibited. However, this does not guarantee that the patient's health will be fully restored. In fact, even effectively treated HIV-infected adults have increased risk of developing non-AIDS related co-morbidities later which may even result in early mortality [13]. Among the non-AIDS related morbidities, cardiovascular, neurocognitive, osteoporotic, kidney, and liver diseases are found to be more prominent in AIDS patients when compared to those without the HIV infection [14]. The discussion on whether the cytokine storm are overall beneficial or harmful to the host is still ongoing, it seems pertinent to state that cytokine cascades aid in up-regulation and acceleration of anti-viral immune response in host. The fact that cytokine storm leads to magnification of infection through recruiting and activating CD4 + T cells is still under investigation. It has been proposed that immunosuppressive cytokines induced by viral infection should lead to dampening of anti-viral immunity but at the same time lower inflammation and in turn reduce the pool of activated CD4 + T cells [15].

4 Materials and Methods

4.1 Materials

Major chemicals that were used in the current research include: Creatinine R1 and R2 (Transasia Biomedical Ltd.), Albumin, NED dye (Autospam^{R}), Bilirubin direct and Total (Labsystems), Leishman's stain (Fischer Scientific), PNPP reagent (IVD), Glucose reagent (Weldon Biotech), and Cholesterol Reagent. Kits for IL-6-EASIA-CE (DIA Source), 25-OH Vitamin D Total ELISA 90 (DIA Source), and Triglycerides DES kit (Transasia Biomedical Ltd) were purchased from respective manufacturers.

4.2 Study Design, Inclusion, and Exclusion Criteria

The study was conducted as a quasi-experimental study with due approval from Institutional Ethical Committee (**XXX)** dated 30-05-2019. HIV positive patients at different disease stages and naïve to HAART were duly recruited and registered in the study. Inclusion of criteria for participants were HIV seropositive, naïve ART, adults with documented gender and date of birth, no previous history of enrolling in ART clinical studies, and voluntarily ready to give a signed informed consent. The exclusion criteria include pregnant women, nursing mothers, and age less than

18 years and non-consenting HIV patients. In the present study, a total of 124 HIV patients and 40 normal healthy controls were included. Among 124 HIV patients, each disease stage had 31 participants.

The HIV status was confirmed by a positive virological test for HIV components (RNA) followed by a reconfirmation positive second test. Further, the immunological criteria used for confirmed HIV infection was CD4 count less than 350/mm^3 in blood. HIV naïve group involve patients that have not received HAART at the time of data collection for this study. Further, the patients were segregated in to four stages as per the WHO clinical classification criteria. Stage 1 includes asymptomatic patients with persistent generalized lymphadenopathy having CD4 count more than 500/mm^3 in blood. Clinical Stage 2 of HIV includes HIV patients with mild symptoms and CD4 count in the range of 350–499/mm^3 in blood. The clinical symptoms in this stage were unexplained moderate weight loss of $^<$ 10%, repetitive respiratory tract infections (sinusitis, tonsillitis, otitis media, and pharyngitis) and oral ulceration, herpes zoster, angular cheilitis, papular pruritic eruptions, seborrhoeic dermatitis, and fungal nail infections. Clinical Stage 3 represents the advanced disease stage with CD4 count in the range of 200–349/mm^3 in blood. The clinical manifestation of this stage include unexplained diarrhea and fever above 37.5 °C for more than one month, oral candidiasis and hairy leukoplakia, pulmonary tuberculosis, bacterial infections (pneumonia, empyema, pyomyositis, bone or joint infection, meningitis or bacteraemia), acute necrotizing ulcerative stomatitis, gingivitis or periodontitis, and unexplained blood cells anomalies like anaemia (<8 g/dl), neutropaenia (<0.5 × 109/litre), and/or chronic thrombocytopaenia (<50 × 109/litre). Clinical stage 4 demonstrated the most severe form of HIV with CD4 count less than 200 per mm^3 in blood. The clinical diagnosis involves identification of symptoms other than mentioned in previous disease stages like presence of HIV wasting syndrome; oesophageal candidiasis; extrapulmonary tuberculosis and cryptococcosis; Kaposi's sarcoma; cytomegalovirus infection; central nervous system toxoplasmosis; HIV associated encephalopathy, nephropathy and cardiomyopathy; non-tuberculous mycobacterial infection; progressive multifocal leukoencephalopathy; cryptosporidiosis; isosporiasis; mycosis; repetitive septicaemia; lymphoma; cervical carcinoma; and leishmaniasis.

4.3 Estimation of CD4 Count

CD4 count was estimated in patient samples for both groups. CD4 count analysis has been carried out through portable CD4 analyzer (Pima™ Analyzer, Abbott, Model number-260300003). Briefly, blood collected from patients was stored in EDTA blood collection tubes. The anticoagulated blood was stored in tubes at 20–25 °C labeled with the patient accession number or an identifiable number. Each tube contained 100 μL of patient blood with EDTA. Before performing the counting, the tubes were vortexed and inverted 5 to 10 times for adequate mixing of blood with EDTA. 25 μL of whole blood was pipette in the cartridge which was inserted in the

CD4 analyzer for test. The CD4 test cartridge contains CD4 monoclonal antibodies binded with a fluorigenic dye. These antibodies bind with the CD4 antigens were present in the blood samples, and the fluorescence signals were detected and counted by the analyzer as CD4 counts in cells/μL. The CD4 count outcomes were obtained within 20 min of sample insertion.

4.4 Estimation of Interleukin-6 (IL-6) By ELISA

IL-6 estimation was carried out through Enzyme-linked immunosorbent assay (ELISA) (Microplate Reader Model Number—Rayto, RT-6900). The assay works on the principle of Enzyme Amplified Sensitivity Immunoassay that measures the amount of the desired target bound between a matched monoclonal antibodies (MAbs). A target specific antibody is pre-coated in the wells of the supplied microplate. The standards, controls, and samples are consecutively added to the wells which bind to the immobilized antibody in the wells. A second antibody also referred to as monoclonal antibody (MAb 2) labeled with horseradish peroxidase (HRP) was then added which binds to the target-primary antibody complexes in the well. Finally, a chromogenic substrate (TMB) is added that reacts with the antibody-target-antibody complex giving rise to a recognizable signal. The intensity of the signal (absorbance) observed is directly proportional to the concentration of the target present in the sample mixture which was recorded colorimetrically by measuring the, which is proportional to the IL-6 concentration. A calibration curve was plotted, and IL-6 concentration in the serum samples was extrapolated from the calibration curve.

4.5 Assessment of Vitamin D Level in Plasma

Vitamin D status in patient blood was analyzed through assessing serum 25(OH) D levels. The measurement was done using Abbott Architect Automated Immunoassay Analyzer (Model name: i1000SR). The instrument uses chemiluminescent microparticle immunoassay (CMIA) technology. The assay works on the principle of competitive ELISA with a unique pre-treatment step performed inside the ELISA microtiter plate. The pre-treatment step used a displacement reagent that displaces the 25OH Vit D from the binding proteins. One mL blood was collected from patients and stored in EDTA blood collection tubes followed by vortexing and centrifugation at 2500 rpm. Ten microlitres of separated plasma was placed in the microtitre plates pre-coated with antigen or antibody to allow the binding of antigen or antibody present in the sample. The resultant mixture was washed followed by the addition of HRP labeled antigen or antibody conjugate and then rewashing of the resultant mixture. Next, chromognic substrate was added and the resulting reaction was measured as absorbance through automated Abbott Architect analyzer. The absorbance intensity

corresponds with the amount of Vitamin D content present in the sample and was derived through calibration curve of known concentration of standards.

4.6 Evaluation of Hormonal Parameters in Plasma Samples

Endocrine test was performed for detection of testosterone and estrogen in male and female HIV patients through immunoassay using the same instrument and principle as elaborated in previous section.

5 Results

This chapter elaborates the research outcomes of multiple variables at different disease stages both before and after six months of ART treatment. The chapter looks into the alterations in various parameters at different disease stages and compared the outcomes both with respect to healthy control and disease stages. This chapter also focused on the evaluation of ART treatment outcomes at different disease stages with respect to the naïve patients. Further, this section additionally determined that after treatment how close the multiple variables with that to the normal control values.

5.1 Demographic Studies

In the present study a total of 124 HIV patients and 40 normal healthy controls were included. Among 124 HIV patients, each disease stage had 31 participants. In terms of gender, the control group contains 20 males and females each while rest of the groups had a larger number of male participants when compared to female counterparts (Fig. 2). In Stage 1, 2, 3, and 4 the number of males was 17, 18, 18, and 17 whereas the number of female patients was 14, 13, 13, and 14 respectively. However, none of the groups had a statistically significant difference in number of male and female participants. After 6 months of ART treatment, mortality was observed in stage 4 HIV group as the total count of males and females was reduced from 17 and 14 to 10 and 5 respectively. This accounts for 58.8% and 35.7% mortality ratio among males and females in stage 4 HIV. However, no mortality was noticed in other disease stages after six months of ART treatment.

The average age of participants in control group was 36 years, whereas the average age of participants in the 4 stages of HIV range from 34 to 38 years. There was no statistically significant difference in age among the participants in all groups (Fig. 3).

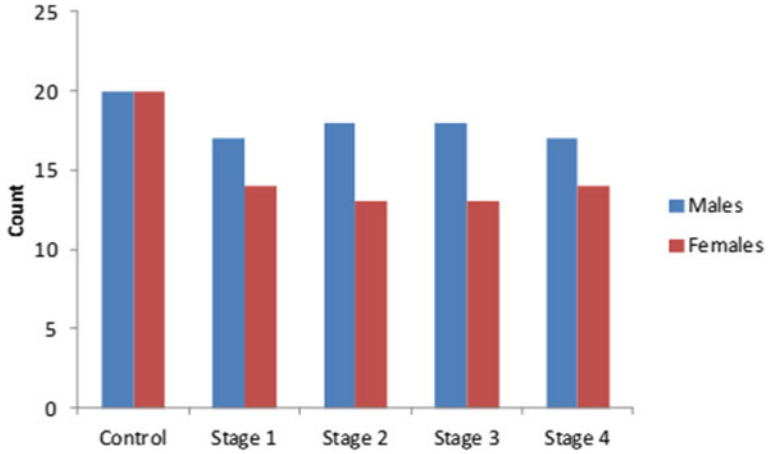

Fig. 2 Males and females count in control and naïve HIV patients. *(No statistical difference was found in Student's T test)*

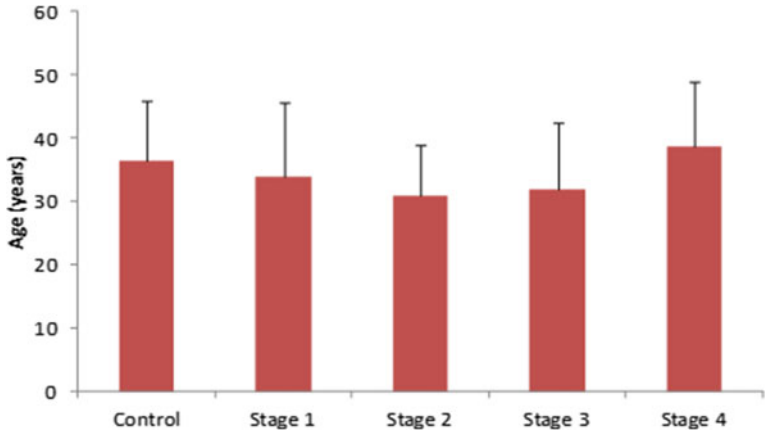

Fig. 3 Mean age of control and HIV naïve patients *(Data represented as Mean ± SD. No statistical difference was found in One Way ANOVA)*

5.2 CD4 Count

CD4 counts in the first three stages of the disease showed no statistical differences, and the average CD4 count ranged from 317 count/mm^3 to 410.52 count/mm^3 (Fig. 5.3). CD4 count was found to be significantly low in case of Stage 4 HIV patients when compared with remaining HIV groups ($P < 0.05$). HIV patients in stage 4 had an average of 61 count/mm^3 which was approximately six folds lower than stage 1–3 HIV patients (Figs. 4 and 5).

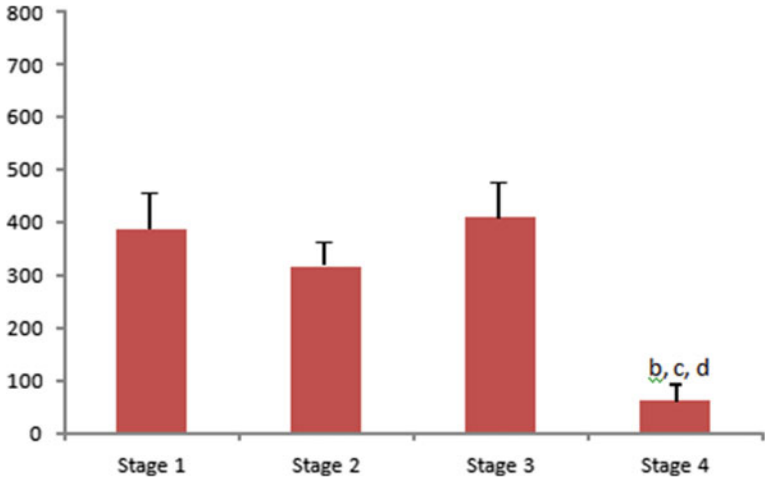

Fig. 4 CD4 status in control and HIV naïve patients groups. *Data represented as Mean ± SD. Statistical difference was obtained through One Way ANOVA followed by Posthoc Tukey's test. P < 0.05 for Stage 4 versus Stage 1(b), Stage 2 (c) and Stage 3 (d)*

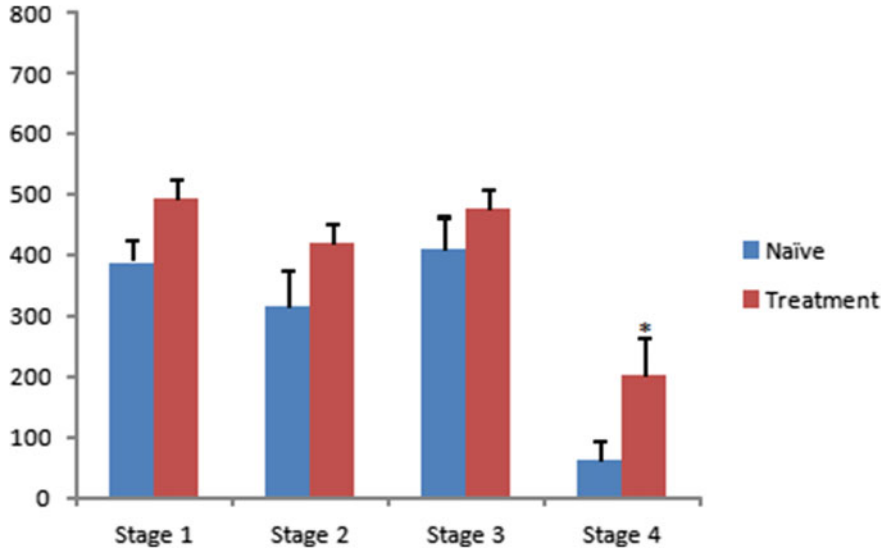

Fig. 5 CD4 status in different HIV stages post ART. *Data represented as Mean ± SD. Statistical difference was found by Student's T test. *P < 0.05 for pre vs post treatment group. Data was analyzed using One Way ANOVA followed by Post hoc Tukey test. P < 0.05 was considered as statistically significant. Level of significance was indicated by respective symbols: Stage 1 = B, Stage 2 = C, Stage 3 = D*

5.3 Major Elements in Blood Samples of Control and HIV Groups

Illustrates the status of major elements sodium, potassium, and calcium in all study participants pre and post ART treatment. A uniform trend was observed for sodium, potassium, and calcium levels among participants in the HIV disease stages 1–4. All disease stages recorded significantly lower levels of the minerals when compared to participants in the control group ($P < 0.05$). However, no statistically significant variations were noticed in all the components within the disease stages. Mineral levels were maintained similar to that of the control for all patients irrespective of the stage of their disease post ART treatment. No statistically significant variation could be detected for sodium, potassium, and calcium among the disease stages or when compared to that of the control group.

5.4 Hematological Parameters in Control and HIV Groups

Represent the outcomes of hematological parameters in control and HIV multi stages. Hemoglobin, MCV, MCH, MCHC, Eosinophils, LPCR, MPV, PDW, and PCT values were found to significantly vary for the diseased stages when compared to control. The rest of the parameters (Total RBCs, RDWA, RDW, TLC, neutrophils, lymphocytes, platelet count) did not show statistically significant variation in their values among the participants of the control group and those in the disease stages. However, inter-stage variation was observed for all parameters except RDW, TLC, and neutrophils. Hemoglobin level was found to be significantly reduced in all HIV disease stages except for stage 2 ($P < 0.05$). Hemoglobin levels significantly increases in stage 2 when compared with stage 1 ($P < 0.05$); however, a decrease was noticed in further stages. The lowest hemoglobin content was noticed among patients in the stage 4 of the disease (~8.9 g/dL), and the reduction was statistically significant when compared with stage 2 and 3 ($P < 0.05$). Hemoglobin levels were similar to that of control group post ART treatment for patients in stage 2 and stage 3. Significantly lower hemoglobin levels were observed for patients of stage 1 and stage 4 when compared to values in control group ($P < 0.05$). Lowest average hemoglobin level was recorded in case of patients in stage 4 which was also significantly lower than stage 2 and stage 3 patients ($P < 0.05$). Further, post ART for 6 months the hemoglobin content significantly elevates to 89% and 94.6% in stage 1 and stage 3 patients which was earlier decreased to 82.9% and 85.85% respectively in naïve patients with respect to control (100%).

5.5 Correlation Outcomes

Association between biochemical, hematological, minerals, IL-6, Vitamin D, and CD4 count between different disease stages as well as in efficacy of ART treatment is demonstrated in Tables 5.9, 5.10, 5.11, 5.12, 5.13, 5.14, 5.15, 5.16. In stage 1 naïve HIV group, a total of 15 significant correlations were obtained (Table 5.9). Sodium was found to be positively and negatively associated with LPCR ($r = 0.363$, $p = 0.04$) and triglycerides ($r = -0.367$, $p = 0.04$) respectively. A significant positive association was obtained between potassium and vitamin D ($r = 0.456$, $p = 0.01$). Changes in IL-6 content was positively associated with RDWA ($r = 0.371$, $p = 0.04$), total bilirubin ($r = 0.434$, $p = 0.01$), SGPT ($r = 0.566$, $p = 0.001$), and urea ($r = 0.377$, $p = 0.04$). Platelet count was positively correlated with triglycerides ($r = 0.374$, $p = 0.04$). Changes in LPCR content in stage 1 was negatively associated with direct bilirubin ($r = -0.41$, $p = 0.02$) and proteins ($r = -0.409$, $p = 0.02$). PDW was negatively associated with proteins ($r = -0.392$, $p = 0.03$) and triglycerides ($r = -0.455$, $p = 0.01$). Other negative correlations include PCT and glucose ($r = -0.467$, $p = 0.01$), RDW and direct bilirubin ($r = -0.391$, $p = 0.03$), neutrophils and uric acid ($r = -0.444$, $p = 0.01$).

Post ART, a total of 10 significant correlations were obtained in stage 1 treated patients (Table 5.10). Changes in PDW was positively correlated with SGPT ($r = 0.419$, $p = 0.02$) and ALP ($r = 0.376$, $p = 0.04$) and RDWA with SGOT ($r = 0.531$, $p = 0.002$) and SGPT ($r = 0.393$, $p = 0.03$). While, triglycerides was positively associated with platelet count ($r = 0.398$, $p = 0.03$), it was found to be negatively correlated with vitamin D ($r = -0.386$, $p = 0.03$) and hemoglobin ($r = -0.422$, $p = 0.02$). Other positive correlations include vitamin D and PCT ($r = 0.506$, $p = 0.004$), IL-6 and platelet count ($r = 0.373$, $p = 0.04$), protein and lymphocytes ($r = 0.497$, $p = 0.004$).

6 Discussion

HIV infection has emerged as one of the most devastating human pandemics with significant morbidity and mortality. However, with the advent of antiretroviral therapy (ART) the course of this pandemic is remarkably altered therefore enhancing the survival of millions of HIV positive people. Although antiretroviral therapy has transformed the HIV infection status from non-curable to treatable and manageable, complications associated with the disease course and appearance of associated co-morbid conditions still remains a concern for people living with HIV. Considering the importance of multiple physiological variables in the disease progression as well as treatment outcomes, assessment of the status of these parameters before starting the ART may provide great benefits to the clinicians in designing best treatment strategies for improved output. The present research provided comprehensive evidences about the status of various immune parameters, minerals and Vitamin D, sex hormones,

blood cells, renal, and liver enzymes in WHO based HIV clinical stages. In-addition, the study also provided evidences about the impact of HAART over these variables at each disease stage. The study also establishes the inter-relationship between these variables that will help in understanding the interplay of the complex mechanisms responsible for the disease progression.

6.1 Age, Gender, and Mortality

The average age of HIV patients in the current study from 34 to 38 years suggesting high prevalence of HIV infection in young population. These results are in corroboration with previous studies who also demonstrated the similar age group in HIV prevalent population [16, 17]. High prevalence of HIV in adults has potential impact over the socioeconomic development of the nation as this age group implicates the most productive years which gets lost due to loss of productivity and work force. Studies have shown that men seem to show higher rate of mortality on ART than women which may be due to multiple factors [18, 19]. High risk of mortality in men at later stages can also be attributed to higher frequency of tuberculosis infection [20]. It is also observed in the present study that men exhibit higher mortality ratio (58.8% and 35.7% mortality ratio) among males and females in stage 4 HIV. Men entering the ART at later stage of disease progression compared to women entering the ART earlier which is evident by high CD4 amounts according to a study reporting gender-related mortality for HIV-infected patients undergoing ART maybe the plausible explanation for higher mortality rate in men [21]. Another reason for improved life expectancy in HIV-infected women may be due to better diagnostic opportunities as they have provision for antenatal care that tests for HIV in case of pregnant women. Other factors may include behavioral and social gender differences, and also education [21].

6.2 CD4 Count in HIV Naïve and Treatment Groups

CD4 count was found to be in the range of 317 count/mm^3 to 410.52 count/mm^3 in the first three stages of the disease, while it was considerably reduced to 61 count/mm^3 in stage 4. CD4 count and CD4 percentage points to important clinical implications that influence the timing for ART treatment as shown in a previous study [22]. Extend of CD4 T cell depletion prior to ART is found to be responsible for the viral reservoir size after prolonged therapy in another study which highlights the need to evaluate the CD4 count prior to ART to predict the therapy outcomes [23]. CD4 + T cell count is observed to be significantly reduced within weeks of HIV infection followed by immune activation triggered by microbial translocation and release of pro inflammatory molecules like IL-6 in later stages. Despite ART initiation chronic immune activation and inflammation continues to persist.

6.3 IL-6 Levels in HIV Naïve and Treatment Groups

The higher IL-6 levels were seen in all the four stages of HIV infected individuals which was suppressed after six months of ART. However, in the present study we can see that the higher IL-6 levels did not show the inverse relation with CD4 levels. These results are in accordance with the previous reports demonstrating higher IL-6 levels in HIV naive individuals when compared with HIV positive individuals on ART with no association between CD4 and IL-6 levels [24]. The effectiveness of ART treatment in lowering IL-6 levels have been reported previously [25, 26].

6.4 Vitamin D Content in HIV Naïve and Treatment Groups

Vitamin D levels were found to be significantly reduced in all HIV patients irrespective of disease stage. These results are in association with previous studies demonstrating insufficient serum Vitamin D levels of less than 30 ng/mL in HIV infected individuals and deficiency of less than 20 ng/mL in 30% of HIV population [27–29]. Vitamin D insufficiency is attributed to the loss of active Vitamin D synthesis in due to the blockage of parathyroid hormone (PTH) and the hydroxylation of calcidiol in the kidney by persistent inflammatory environment in the body [30–32]. Vitamin D deficiency in HIV had wider clinical implications over both the innate and adaptive immune responses as Vitamin D receptors are present over wide range of immune cells including monocytes, dendritic cells, and lymphocytes [33–36]. Vitamin D deficiency severely suppresses the antimicrobial effects of macrophages and monocytes by negatively influencing the transcription of antimicrobial peptides like defensins (DEF) and cathelicidin (CAMP) [37].

6.5 Hematological Status in HIV Naïve and Treatment Groups

Hemoglobin level was found to be significantly reduced in all HIV stages except for stage 2, with lowest hemoglobin level seen in stage 4 (9.85 ± 1.11) that can be classified as mildly anemic. According to WHO anemia has been defined as a hemoglobin level < 13 gm/dl and < 12 gm/dl in males and females respectively. Previous studies also demonstrated similar results with normal hemoglobin levels in patients with WHO clinical stage I and reduced levels in advanced stages indicating an association between WHO staging and hemoglobin levels [38, 39]. Post ART for 6 months the hemoglobin content significantly elevates in stage 1 and stage 3 patients which were earlier decreased, respectively in naïve patients with respect to control. This observation is in concordance with reports showing a similar trend in recovery of hemoglobin post ART [40, 41]. Lowest hemoglobin content was observed in stage 4.

RBC count followed a similar trend to that of hemoglobin, with stage 4 recording the lowest count among all the stages. The low RBC count rate and possibility of anemia is linked to low CD4 count (< 200/μl) as seen in stage 4 (61 count/mm^3) in the present study, which is a consistent observation seen in several studies in literature [42, 43]. The plausible mechanism behind the prevalence of anemia in HIV-infected patients is the disruption of cytokines homeostasis in bone marrow. Persistent reduction in T-helper lymphocytes as indicated by diminishing CD4 count with disease progression is associated with deregulated B-cells proliferation and cytokines homeostasis. The disrupted homeostasis together with direct suppression of proliferation of progenitor cells in the bone marrow by HIV severely affects the process of hemopoiesis [44]. The key strength of the present research is the elaborative assessment of overall physiological status of HIV patients in complete spectrum of disease stages. Further, the study also highlights the impact of HAART in different disease stages in a small cohort. The major study limitation was the small sample size based upon which disease and the treatment impact could not be studied on gender basis and therefore warrants future research in large population.

7 Conclusion

Interesting conclusions could be deduced from the correlation outcomes observed in this study that investigated association between biochemical, hematological, minerals, IL-6, Vitamin D, and CD4 count between different disease stages as well as in efficacy of ART treatment. Triglyceride levels that exhibited negative association with vitamin D levels post ART in stage 1 HIV-infected group and stage 2 naïve HIV group may suggest the commonly observed dyslipidemia under vitamin D deficiency, that is also regarded as plausible risk factors for atherosclerosis and cardiovascular diseases associated with naïve HIV/HIV treated individuals as well as stage 3 post ART group [45–47]. Elevated IL-6 levels was observed in both the ART-naïve and the ART-experienced patients which was significantly associated with lower PCV levels, Hb levels, and MCV levels in a study of HIV positive patients in Nigerian cohort [48]. No similar correlation was seen among the above parameters in this study. However, positive correlation was seen between IL-6 and platelet count post-ART in stage 1 group and in ART-naïve group in stage 3 in the current study, whereas no significant association was seen between the platelet counts and the serum IL-6 in the Nigerian cohort study [48].

HIV infection in both naïve and treated groups is characterized by prominent disruption in immunological homeostasis that exhibit as dysregulated levels of cytokines as observed in previous studies and also accompanied by changes in CD4 levels. Low CD4 nadir is one prominent factor that is commonly observed in that may be associated with elevated IL-6 levels. Other nutrient deficiencies such as Vitamin D deficiency, imbalance in electrolytes such as Na and K levels all seems to complicate the already complex disease condition that is stuck in loop of chronic inflammation and immune exhaustion. There are also few significant dysregulations observed in

blood parameters such as low RBC count may result in prevalent anemia seen in both naïve and treated patients. These have also been linked to CD4 counts. All this emphasize the importance of monitoring CD4 levels that influence the clinical outcome of the disease very strongly.

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Studies on Bone Mineral Density (BMD) in HIV-Infected Patients Before and After ART Treatment

Vinay Malik, Amar Prakash Garg, and Tung Vir Singh Arya

Abstract Bone health status in India is grossly neglected mainly because of the unavailability and high costs of desired screening equipment for evaluation of bone mineral density (BMD). Several risk factors are responsible for limiting the study of bone health status in India. Major attention is given to communicable and non-communicable diseases. The physicians who are treating the people having HIV/AIDS (Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome) also do not know much about the bone health. Data on the prevalence of osteoporosis in HIV patients in Indian population is not fully documented; hence, this study was done to find out the prevalence of osteoporosis in HIV infected patients.

Keywords HIV · Osteoporosis · Bone mineral density · DEXA

1 Introduction

Modern therapeutic approach using Anti-Retroviral Therapy (ART) has markedly reduced the mortality and morbidity in HIV/AIDS infected patients. At present, osteoporosis is one of the most common metabolic bone disease that affects postmenopausal Caucasian women. It results in 30–40% increase of lifetime risk fracture in women in comparison to 20% in men. Osteoporosis is commonly diagnosed by assessing density of bone below (−) 2.5 times the standard deviation, while the diagnosis of osteopenia is based upon the density of bone in between −1 and −2.5 times the standard deviation [1]. Major side-effects of bone homeostasis are the impairment and reduction of bone mineral density (BMD) [2, 3] which is based upon the amount of mineral (calcium) in the bone tissue. Dual-energy X-ray absorptiometry (DEXA) is widely used to determine BMD which is commonly known as densitometry. In

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this paper, we will evaluate bone mineral density of HIV-infected patients before and after ART treatment and will match it with HIV-uninfected individuals [4–6].

2 Methods

First, the clearance from ethical committee of L. L. R. M. Medical College, Meerut, was obtained and the consent of the patients was taken by fully informing them that their personal details shall not be disclosed and will be used only for research purpose.

The patients were selected on the basis of their willingness and consent to have the supplementary tests like DXA scans and extra blood tests which were scheduled with the timings and visits of the patients. The guidelines for the diagnosis and management of osteoporosis suggested by WHO are summarized in one scientific document known as NOFSA [7]. These guidelines were followed in the present investigation. The diagnostic criteria for osteoporosis was used as BMD measurement equal to or more than 2.5 standard deviations (SD) below the young female (aged 20–29 years). A patient was diagnosed with osteopenia if he/she had a T-score between -1.0 and -2.5. A person with a T-score between 1.0 and -0.9 [7] was classified as normal. Patients suffering from heart diseases, hypogonadism, diabetes, malignancies, thyroid/parathyroid glands, chronic kidney disease, Morbus Bechterew psychiatric diseases, and PLWH with substance use and/or co-infected with viral hepatitis B and C were not included in the study. For control population vitamin D, and the bone densitometry was assessed besides the other relevant medical history points. We investigated the patients with CD4 + T lymphocyte count, HIV viral load, vitamin D levels in the serum in the form of 25(OH) Vitamin D, and Bone Mineral Density (BMD) using DEXA scan. We also measured the fracture risk in both groups of patients with FRAX tool [7]. Illustrates the status of major elements—sodium, potassium, and calcium in all study participants pre and post ART treatment. A uniform trend was observed for sodium, potassium, and calcium levels among participants in the HIV disease stages 1–4. All disease stages recorded significantly lower levels of the minerals when compared to participants in the control group ($P < 0.05$). However, no statistically significant variations were noticed in all the components within the disease stages [7].

Mineral levels were maintained similar to that of the control for all patients irrespective of the stage of their disease post ART treatment. No statistically significant variation could be detected for sodium, potassium, and calcium among the disease stages or when compared to that of the control group (Table 1).

Sodium, potassium, and calcium levels increased uniformly across all stages post ART; however, no significant difference was observed between values of pre-treatment and post treatment for potassium across all stages (Table 2). In case of sodium statistical significant increase was noticed in stage 1 alone after ART treatment while in calcium statistical significance was obtained in stage 2 and 4 when compared with naïve group [8].

Table 1 Sodium, potassium, and calcium levels in HIV patients before and after ART treatment

Parameters	Control (Mean ± SD)	Stage 1 (Mean ± SD)	Stage 2 (Mean ± SD)	Stage 3 (Mean ± SD)	Stage 4 (Mean ± SD)
Naïve patients					
Sodium (mEq/L)	142.8 ± 13.28	131.4 ± 6.74[a]	133.74 ± 3.43[a]	132.66 ± 4.08[a]	131.99 ± 4.95[a]
Potassium (mEq/L)	4.49 ± 1.01	3.33 ± 0.42[a]	3.31 ± 0.42[a]	3.31 ± 0.36[a]	3.17 ± 0.54[a]
Calcium (mEq/L)	2.37 ± 0.33	1.9 ± 0.24[a]	1.97 ± 0.11[a]	1.91 ± 0.21[a]	1.88 ± 0.16[a]
Post ART treatment					
Sodium (mEq/L)	142.8 ± 13.28	142.82 ± 4.56	141.8 ± 4.76	145.63 ± 4.76	143.44 ± 4.73
Potassium (mEq/L)	4.49 ± 1.01	4.56 ± 0.50	4.57 ± 0.47	4.70 ± 0.47	4.72 ± 0.54
Calcium (mEq/L)	2.37 ± 0.33	2.33 ± 0.25	2.35 ± 0.29	2.02 ± 0.17	2.22 ± 0.29

Data represented as Mean ± SD. Statistical variation was obtained through One Way ANOVA followed by Posthoc Tukey's test $P < 0.05$ for control (a) vs all HIV stages. No statistical differences were obtained after six months of ART treatment

3 Discussion

HIV infection has emerged as one of the most devastating human pandemics with significant morbidity and mortality. However, with the advent of antiretroviral therapy (ART) the course of this pandemic is remarkably altered therefore enhancing the survival of millions of HIV positive people. Although antiretroviral therapy has transformed the HIV infection status from non-curable to treatable and manageable, complications associated with the disease course and appearance of associated co-morbid conditions still remain a concern for people living with HIV. Considering the importance of multiple physiological variables in the disease progression as well as treatment outcomes, assessment of the status of these parameters before starting the ART may provide great benefits to the clinicians in designing best treatment strategies for improved output. The present research provided comprehensive evidences about the status of various immune parameters, minerals and Vitamin D, sex hormones, blood cells, renal and liver enzymes in WHO based HIV clinical stages. In-addition, the study also provided evidences about the impact of HAART over these variables at each disease stage. The study also establishes the inter-relationship between these variables that will help in understanding the interplay of the complex mechanisms responsible for the disease progression.

Table 2 Comparative outcomes of sodium, potassium, and calcium in HIV patients before and after ART treatment

Parameter	Stage 1 (Mean ± SD)		Stage 2 (Mean ± SD)		Stage 3 (Mean ± SD)		Stage 4 (Mean ± SD)	
	Naive	Treatment	Naive	Treatment	Naive	Treatment	Naive	Treatment
Sodium	131.4 ± 6.74	142.8 ± 4.56*	133.74 ± 3.43	141.8 ± 4.76	132.66 ± 4.08	145.63 ± 4.76	131.99 ± 4.95	143.44 ± 4.73
Potassium	3.33 ± 0.42	4.56 ± 0.50	3.31 ± 0.42	4.57 ± 0.47	3.31 ± 0.36	4.70 ± 0.47	3.17 ± 0.57	4.72 ± 0.54
Calcium	1.9 ± 0.24	2.33 ± 0.25	1.97 ± 0.11	2.35 ± 0.29*	2.20 ± 0.17	2.20 ± 0.17	1.88 ± 0.16	2.22 ± 0.29*

Data represented as Mean ± SD. Statistical variation as obtained by Student's T test. *$P < 0.05$ for pre vs post treatment group

3.1 Mineral E*lements* L*evel in HIV* N*aïve and* T*reatment* G*roups*

Electrolytes and micronutrients are essential in healthy physiological functioning. Most of the micronutrients are not generated in the body and are obtained from food intake. All disease stages recorded significantly low levels of minerals when compared to the control. Lower levels of potassium in HIV infected individuals with pre-ART may be stemmed from dilution of the extracellular space, movement of K + into cells or loss from the body or kidney. In the present study, the post ART potassium levels were increased, reaching levels comparable to that of control group. This was in accordance with a report that observed a similar trend in potassium levels post HAART (Highly Active Antiretroviral Therapy). Synonymous to the same study the sodium level were also lower in the HIV infected individuals than that of the control group before ART initiation followed by an increase in sodium levels post ART. Lower level of calcium before treatment may be due to vitamin D deficiency resulting in inadequate distribution of calcium along with inflammation induced hypocalcemia due to viral replication. Alterations in minerals and salt content pose significant negative effect over extra-cellular volume status leading to real arterial hypovolemia which can end up to serious health conditions like cirrhosis, cardiac failure, and nephrotic syndromes. Depletion of sodium content in HIV patients is also influenced by reduced potassium levels by inducing either the shift of sodium to the intracellular spaces or by release of aberrant vasopressin. The plausible reasons behind the depleted serum sodium levels in HIV infected people include occurrence of polydipsia condition and suppression of vasopressin secretion that together overcomes the renal capability of free water excretion and thus water retention. Low serum sodium level has been reported to be the most frequent electrolyte abnormality in HIV infection and AIDS indicating the multi-organ damage. Another reported cause of low serum sodium levels in the AIDS—infested people is the volume depletion secondary to vomiting/diarrhea and/or tubular disorders. Potassium acts as the main cation of the intracellular space and is reserved in the muscle tissues. Potassium levels are highly essential to maintain balance between the intracellular and the extracellular compartment. The maintenance of potassium balance in body mainly depends upon the nutrition but colonic and renal excretion also play a significant role which is regulated by aldosterone hormone. The internal balance depends upon the potassium shifts between intracellular and extracellular compartments [9]. In HIV low serum potassium levels has been reported in about 19% of patients. The primary causes of serum potassium depletion include gastrointestinal potassium losses due to diarrhea, infection, intestinal tumor, or AIDS-associated enteropathy. Further, vomiting also leads to potassium excretion directly through emesis and urinary excretion thereby inducing hypovolemia, bicarbonaturia, and consequently secondary hyper-aldosteronism. Other factors behind low serum potassium levels in HIV population include anorexia, low potassium intake, acquired tubulopathies, sarcopenia, and myopathy which results in HIV-associated wasting syndrome, hypo-calcemia, hypo-magnesemia, and hypo-phosphatemia. The present

study obtained significant correlations between reduced serum sodium levels with LPCR in stage 1 and stage 2 naïve patients indicating its role in liver damage. In case of potassium levels significant correlations were obtained with Vitamin D (in stage 1 naïve patients), triglycerides (in stage 2 naïve patients), SGOT, and urea (in stage 3 naïve patients), LPCR, indirect bilirubin, and albumin (in stage 4 naïve patients) indicating its role in renal and liver damage [10].

3.2 Biochemical Variables in HIV Naïve and Treatment Groups

Hypo-albuminemia in HIV patients at ART initiation have been linked with high mortality rate, pulmonary tuberculosis, wasting, and weight loss. Incredibly low serum albumin observed in stage 4 individuals, and the associated mortality can be thus be interlinked. Increment in serum albumin post ART is supportive of similar trend observed in other studies. Low serum albumin level before initiation of ART is also associated with increased relative hazard of death as reported in a study in a female cohort [11]. Micro-albuminuriain associated with HIV infection and ART treatment induces renal impairment both directly as well as indirectly by triggering acute tubular necrosis, renal tubular disorders, nephropathy by crystals deposit, or through pharmacologic interactions. Antiretroviral therapy mediated kidney damage may stop excretion of protein in urine. However, potential renal protective benefits of combined HAART have also been reported. Micro-albuminuria serves as an early prognostic biomarker of renal damage, diffuse endothelial dysfunction and is correlated with the increased incidence of cardiovascular morbidity. It was further suggested that the increased incidence of renal disease risk gets further elevated with the occurrence of co-morbidities hepatitis B and C, diabetes mellitus, hypertension, dyslipidemia, and also low CD4 cell counts. However, the current study obtained single positive association between albumin and potassium content in Stage 4 naïve HIV patients.

Significant increase in total protein content was observed post ART in stages 1 to 3, but this observation was contrary to a study that reported reduction in total protein levels. However, this hyper-proteinemia is similar to the findings found in some other studies with a plausible explanation of hyper-proteinemia because of spike in immunoglobulin levels [12].

4 Conclusions

HIV infected individuals are 16 times more at risk of developing low BMD than uninfected normal persons. It was found that traditional risk factors and HIV related factors do not have a correlation with this low BMD, while deficiency of vitamin D is a risk factor for low BMD in both HIV infected and uninfected individuals.

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Impact of Nationwide Lockdown During Covid-19 on Water Quality of Yamuna River in District Mathura (U. P.)

Basudev Singh and Jyoti Sharma

Abstract COVID-19 is a pandemic that affected the majority of countries of the world. After the COVID-19 outburst, the Indian Government declared the complete lockdown starting on the night of 24 March 2020. The lockdown period is in its 4th phase. In the recent year it has been very fascinating to remind that the behaviour in the environment is vastly optimistic and all layers of the earth are under the repairing mode during the lockdown. With these healing environments, the conditions of the Yamuna River water in Mathura (polluted river) have also been found to be upgrading. In this present concern, we work on the concentration of BOD, COD, pH, and other physicochemical parameters for the study, i.e. TDS, Chlorides, Alkalinity, Magnesium, Calcium, Fluoride, Sulphate, Nitrate, Hardness and Total Coliform of Yamuna River (Mathura), respectively, which was found to be reduced as compared to pre-lockdown concentration, i.e. 57, 57, 3.6, 11.7, 5.1, 7.4, 9.5, 4.2, 62.5, 14.8, 33.3, and 4.5%. In the present work, the water of Yamuna River was analysed during the lockdown phase in ITL Labs Pvt. Ltd., Delhi (India). Yamuna River showed a better quality of water during the lockdown. As per results and trend analysis, the value was reducing in this lockdown phase, which is a matter of concern. Major locations of Yamuna water sample collection are Mathura region, i.e. adjacent to the road 50 m from Adda village in Naujheel of Mathura district in Uttar Pradesh.

Keywords COVID-19 · Lockdown · Water quality · Parameters

1 Introduction

A living system cannot survive without water because it is the most essential requirement. Humans need water for many reasons, i.e. drinking, bathing, washing, food preparation, irrigation, and swimming, having complete dependence on water. Without it, we can't assume our living and sustainable environment. Nearly about 71% of Earth's surface water covers in sea and oceans, and mostly less than 1% waters

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available for drinking purposes and other basic wants. There are loads of sources of water here on earth on the basis of availability. It can be alienated in two forms, i.e. surface water and groundwater. Minute portions of groundwater are present as (1.7%) glaciers, in Antarctica and the Arctic region (1.7%), moist air, smoke (formed of water suspended in air and ice), and rainfall and snowfall (0.001%). Groundwater is an essential source of water all over the world. Groundwater is much superior to surface water due to the capability of exploiting and enhanced quality [2, 8, 15].

In the rivers, canals, wells, lakes, etc. surface water is easily reachable. For recharging these two sources of water, rainwater is the major starting place.

We drain a large quantity of water day by day because of huge construction and Industrial development. For our daily utilization of water, quality is a much essential concern. For intake, we need water having standard quality and which is potable also.

For the standard feature analysis of water, investigations have been outlying. Many studies have been carried out on polluted water that show the harmful effects on human, including cancer, indigestion, gastric problems, etc. Some research and studies show the presence of minerals in water, which is also harmful to the body while drinking as per rules.

Traditionally when we match up to the values of the superiority of water, it has been measured that the overall quality for this performance does not provide any information [4]. Thus, some modern procedures were developed. The advanced modelling techniques are used for extensive calibration and validation time and provide great knowledge about hydraulics and other groups also. However, for an immediate solution such water quality modelling is not a feasible option. For assessment and management purposes of water quality, some models should be used by [3, 9, 12, 14].

Jain and Sharma investigated the quality of surface water in eight ponds in Coimbatore and found the presence of pollutants from the expulsion of industrial and domestic waste. [6] considered the eminence of ground water in Rajasthan. Batheja et al. [1] collected the water sample from different localities from Rajasthan and evaluated the chemical and physical parameters. P R Salve et al. [11] have investigated the fluoride meditation that ranged from 0.94 to 2.81 mg/L (1.37 ± 0.56) with paramount fluoride intensity at Visalpur (2.08 mg/L) and buck potential at Adaraj (0.91 mg/L).

Probably, 33.3% of the world's population uses groundwater for drinking. The Negative impact on the environment, i.e. rapid growth industrialization and urbanization, has formed. By the leaching process of pesticides, insecticides, fertilizer residues, and heavy metals from the industrial, municipal, and agricultural waste, groundwater has been polluted. Pollutants found in water show negative effects on human health [7]. So it is essential to retain the worth of water. For the maintenance of the quality of water, it is essential to use safeguard measures and follow the techniques in the sources of surface water and groundwater (K. Keshav et al. [7])

From the start of the Year 2020 to date, the world is fighting with the deadly virus "COVID-19"; lots of changes was seen all over the world. In India, the first case of coronavirus was found on 30 January and thereafter, a lot of positive cases were

observed. 14 h controlled curfew was deployed on 22 March and after that, it was extended from 25 March to 14 April for the first time. Ganges and some other rivers also naturally became less polluted during this lockdown period in India [13].

The self-cleaning of Yamuna River is due to the cessation of all industrial and other common human activities during this period. The capacity of every property of water was based on sample collection to testing in a lab [5, 10].

In 4 phases, Lockdown is imposed. The water of Yamuna River was affected in all phases which have a high level of strictness and rules for all. However, this lockdown showed adverse effects on our economy, growth, GDP, etc. But some positive impact was also observed as it also improved the environment, surface water, and air. The new visibility of the snowcapped peaks from Jalandhar of Punjab was one such example of the positive impact of the nationwide lockdown that augmented the air quality in the region. Also, it become a very huge gift to nature and the ecosystem as it was observed that the wild animals were wandering on the streets of big cities, dolphins in River Ganga, numerous birds were seen on crowded places, i.e. cities, towns, and villages which disappeared due to environmental pollution. It was also noted that there was a sharp decrease in the noise level of day and night of all places, which is highly needed in the present time for safe natural resources and the ecosystem.

In the present study, the quantity of ambient water pollution was firstly analysed during the COVID-19 spread. The main intention of the current work is to evaluate the effect of lockdown on water quality parameters with results being statistically analysed and compared with standards. Time of sample collection and detection was from 24 March 2020 to 25 Nov 2020 for parameters like Appearance, COD, BOD, Colour, odour, Total hardness, Chloride, Alkalinity, Calcium, Magnesium, Sulphate, Nitrate, Turbidity, Total dissolved solids, etc.

2 Materials and Methods

2.1 Sample Collection

Location: Sample of Yamuna River water collected adjacent to the road 50 m from Adda village in Naujheel of Mathura district in Uttar Pradesh.

Duration: Water samples were collected from the duration of lockdown mainly March to May 2020 and then in November 2020.

Sampling Methods: We were using Cluster Sampling methods. In this method, samples were collected in which 5 were collected from each side of the river and then the remaining 10 from the mainstream of the Yamuna River randomly (from both groundwater and surface water). The sample was collected in such a way so that any extraneous matter like plastic, cloth, leaves, etc. was avoided. All samples were collected in blue cap bottles.

Sampling parameters and Reference: Different parameters were analysed such as pH, COD (mg/l), BOD, Chlorides (mg/l), Magnesium as Mg (mg/l), Calcium

as Ca (mg/l), Fluoride as F (mg/l) Sulphate as SO_4 (mg/l), Nitrate as NO_3 (mg/l), Alkalinity as CaCO3 (mg/l), Hardness as $CaCO_3$ (mg/l), TDS (PPM), and total coliforms (MPN/100 ml) for the major river Yamuna after lockdown. Water quality analysis was carried out using prescribed standard methods IS 3025.

Sampling Interval: Samples were taken at the interval of 15 days and then after 6 months durations of lockdown.

3 Result and Discussion

During lockdown, a major improvement was found in water quality as analysed in ITL lab, New Delhi. Yamuna River pH was found to be alkaline in nature (7.1–8.7). Table 1 indicates the water sample collected from Yamuna river at different phases of lockdown due to Covid-19 outbreak. In Table 2 describes the various parameters analysez and the corresponding techniques were used; whereas in Table 3 describes the analyzed data of these various parameters.

BOD varies from 7.9 to 163 mg/l in Yamuna River of Delhi, while in Mathura it was observed to be 12–60 mg/l. For the duration of the pre-lockdown 26/03, it was (28 mg/l) recorded and after that it was decreased (12 mg/l) at the end of lockdown on 25/05. At the end of year, it increased to 60 mg/l (Table 3).

Table 1 Samples collection of yamuna water during lockdown sessions

Sample No	Date of sampling	Time of sampling	Lockdown no	Description
1	26 March 2020	Evening	1 (25 March to 14 April)	No effect of lockdown on sample
2	10 April 2020	Evening	1 (25 March to 14 April)	Sample collected after 15 days of strict lockdown
3	25 April 2020	Evening	2 (15 April to 3 May)	Sample collected after a month of strict lockdown
4	10 May 2020	Evening	3 (4 May to 17 May)	Sample collected after 45 days with less strict lockdown at the end
5	25 May 2020	Evening	4 (18 May to 31 May)	Sample collected after 2 months with much less strict lockdown at the end
6	25 Nov 2020	Evening	Six months after the last sampling	Sample collected after approximately 6 months of lockdown

Table 2 Water analysis on the basis of colour and odour

Sr. no	Parameter with unit	Method of analysis	Technique used
1	Colour, Hazen	IS 3025 (Part-4)	Organoleptic
2	Odour	IS 3025 (Part-5)	Organoleptic
3	pH Value	IS 3025 (Part-11)	Potentiometric
4	Turbidity, NTU	IS 3025 (Part-10)	Photometric
5	TDS (Total Dissolved Solids), mg/l	IS 3025 (Part-16)	Gravimetric method
6	Calcium, mg/l	IS 3025 (Part-40)	By Titration
7	Chloride, mg/l	IS 3025 (Part-32)	By Titration
8	Fluoride, mg/l	IS 3025 (Part-60)	Potentiometric
9	Magnesium, mg/l	IS 3025 (Part-46)	By Titration
10	Nitrate, mg/l	IS 3025 (Part-34)	Spectrophotometric
11	Sulphate, mg/l	IS 3025 (Part-24)	Spectrophotometric
12	Alkalinity (as CaCO3), mg/l	IS 3025 (Part-23)	By Titration
13	Hardness (as CaCO3), mg/l	IS 3025 (Part-21)	By Titration
14	Total coliform Bacteria	IS 1622	Microbiological

COD varies in the range 144–220 mg/l with mid-value of 182 mg/l before and after the lockdown phase. In our research, it was found to be in between 64 and 220 mg/l during the lockdown. Before lockdown 26/03, the COD (144 mg/l) was measured and at the end of lockdown it was lowest (64 mg/l) at Adda village in Naujheelon 25/05 but in November it was increased to 220 mg/l (Table 3).

Turbidity and TDS were measured to be 4–20 NTU and 680-770 mg/l during lockdown. But at the end of the year, it increased in number 20 NTU and 730 mg/l in the Mathura region (Table 3). The concentrations of Ca, Mg, $No_{3,}$, CIF, F, and $SO_{4,}$ in between 26/03 and 2/05 in the river water were found to be in the range of 69–71, 38–42, 8–12, 74–84, 0.3–0.8, and 46–54 mg/L, respectively, but at the end of 25/11, some changes were found, respectively, i.e. 68, 39, 11, 84, 0.6, and 48 mg/l. The results show that the heavy metal and other content measured during the period of lockdown reduced as compared to before and after the lockdown in the area of Adda village in Naujheel (Mathura). Alkalinity is a measure of the water's ability to neutralize acidity (Schroede 2003). Its decrease could be due to a lack of the same in soil and bedrock through which water passes. The same can be said for magnesium and other salts. A decrease in TDS is observed due to the lack of human activity as-well-as decrease of damping of industrial waste near the river Yamuna which is also a fine indicator of decline E.coli pathoganic organismE. gifts of lockdown.

Table 3 BOD, COD and other analyses of samples by using the Indian standard method

Parameter	Unit	Result Date-Wise					
		26/03/2020	10/04/2020	25/04/2020	10/05/2020	25/05/2020	10/05/2020
Appearance	–	Brownish Yellow in colour	Yellowish in colour	Very light yellow	Very light yellow	Very light yellow	Brownish Yellow
Colour	Hazen	12	7	6	6	5	18
Odour	–	Very much unpleasant	Unpleasant	Agreeable	Agreeable	Agreeable	Very much unpleasant
(COD)	mg/l	144	78	64	72	84	220
(BOD)	mg/l	28	16	14	12	12	60
Turbidity	NTU	8	4	4	4	4	20
pH	–	8.4	8.2	8.1	8.1	8.1	8.3
(TDS)	mg/l	770	740	750	680	740	730
Calcium	mg/l	72	71	69	71	69	68
Magnesium	mg/l	42	40	44	38	40	39
Chloride	mg/l	78	82	76	74	78	84
Fluoride	ppm	0.8	0.4	0.4	0.4	0.3	0.6
Alkalinity	mg/l	376	364	366	354	348	352
Total Hardness	mg/l	352	342	352	334	336	330
Sulphate	mg/l	54	46	52	50	46	48
Nitrate	mg/l	12	8	11	9	10	11
Coliform Bacteria	–	Present	Present	Present	Present	Present	Present

*Percentage Change from Initial Value (considering initial value as 100%)

4 Conclusion

In the present research work after analysis of the result, it can be concluded that there are many changes in some of the parameters during this time. Less human activity is responsible for the good quality of water. The concentrations of various parameters studied in the present work in water of Yamuna river is found to reduce substantially during the lockdown before and after lockdown in Yamuna River. As per the present study, the concentration of BOD, COD, pH, and other physicochemical parameters, i.e. TDS, Chlorides, Alkalinity, Magnesium, Calcium, Fluoride, Sulphate, Nitrate, Hardness, and Total Coliform of Yamuna River (Mathura), respectively, reduced as compared to pre-lockdown concentrations, i.e. 57, 57, 3.6, 11.7, 5.1, 7.4, 9.5, 4.2, 62.5, 14.8, 33.3, and 4.5%. These values have been monitored using ITL Labs Pvt. Ltd., Delhi (India). In the end, we conclude that during this lockdown there is much better result showing several improved parameters of Yamuna River water in the Mathura region which in turn indicate the clean and superior quality of water.

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Performance Evaluation of Various Speech Enhancement Algorithms

Aniket Kumar

Abstract Speech is normally polluted by noises that can occur during the recording of audio signals, transmission, reception, etc. Therefore, noise removal in speech signals is a major challenge in speech improvement, recognition, communication applications, etc. The filtering technique used for noise removal depends on the type of noise polluting the audio signal. The most classical filters extensively in used, uses adaptive filtering process, which achieves clean audio approximation by passing the noise observation through an adaptive filtering. In this manuscript different algorithms such as Least Mean Square (LMS), NLMS, VLMS, BLMS, BNLMS and BVLMS have been proposed to sink noise from an audio signal. In the time domain, the signal is filtered and the filter coefficients are calculated by different adaptive algorithms.

Keywords Signal processing · LMS · BLMS · NLMS · BNLMS · Filter coefficients

1 Introduction

In communication, human speech acts as a key element. The physical characteristics of speech signals don't determine their quality, their communication situation, information competence, means to obtain the information from perspective, imitation and gesturing [1]. There is a difference between real and recorded speech, as in real speech a person is able to distinguish between speech and nearby noise and focus on speech only; hence, a human is able to filter out desired information out of a variety of nearby noises. Listening to recorded chat is a different situation. The apparatus used for recording doesn't focus on certain audio signals, as in the case of humans, impartially complete things that happen in the audio scale are recorded. As

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an effect, all recorded sounds are received as a "flat picture"; this makes the record meaningless [2–4].

The change in signal and noise is normally undeterministic, and in such situation a filter having fixed weight is not of any use therefore in such situation debuting a filter that has adaptive nature is necessary and advantageous. These filters are able to change their weight values as per the variation of the signal.

2 Noise Management

Noise management is an active or passive means of sinking sound emissions. Sound reduction using a power resource is active noise management, and by noise-isolating materials such as sound-absorbing tiles, insulation or a muffler rather than a power source is known as passive noise management [5].

In this manuscript, estimation has been made for the noise reduction method based on an adaptive filter for audio signals. The desired audio signal is restored by FIR filters, and its coefficients are expected by reducing the mean square error (MSE) among noisy and fresh signals [2, 5].

2.1 Adaptive Filters

An adaptive filter is such filter that regulates its parameters for approximating output, depending upon the conditions of its periphery. This type of filter has self-adjusting and tracking capabilities [5, 6] (Fig. 1).

$$x(n)x(n-1)x(n-3)\ldots x(n-M+2)x(n-M+1)$$

2.2 Noise Cancellation by Adaptive Filters

Adaptive noise cancellation, i.e. ANC is processed by deducting forecasted noise from a received signal, and this process is continued for updating filter weights to improved SNR shown in Fig. 2 [1]. Two types of inputs are composed in the ANC system, one is the main input and the other is noise i/p, a reference input.

$$x(n)x(n-1)x(n-3)\ldots x(n-M+2)x(n+1+M)$$

An adder block is feedback to an adaptive filter for updating filter coefficients. This Procedure will continue till we get the signal which is free of noise (or reduced noise), i.e. approximately equivalent to the source signal $s(n)$[9, 10].

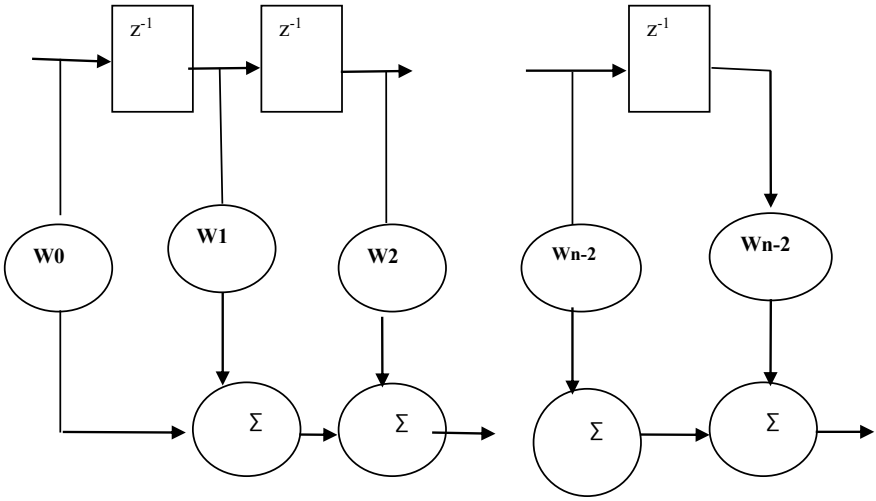

Fig. 1 Linear transversal filter [1, 7, 8]

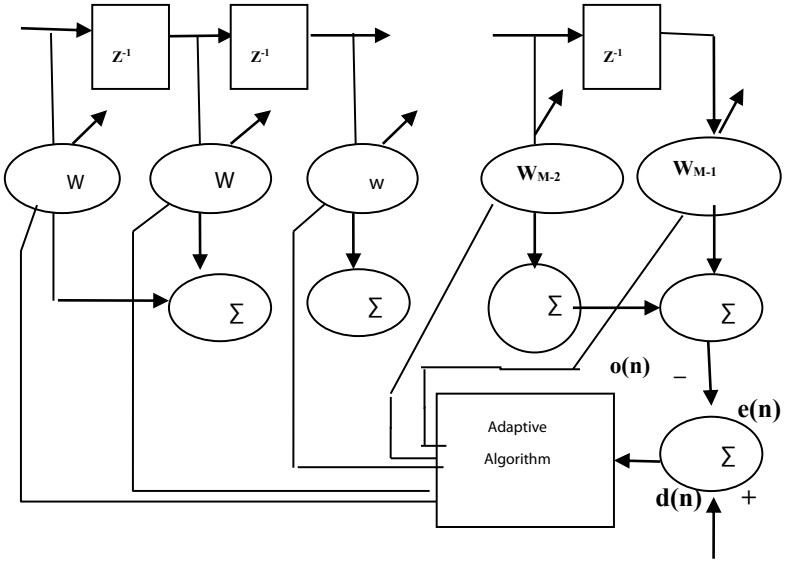

Fig. 2 Architecture of ANC filter

2.3 Adaptive Algorithm

The selected adaptive algorithms that have been coded and simulated in this manuscript are LMS, BLMS, VLMS, NLMS, BNLMS and BVLMS.

A. *LMS Algorithm*
The adaptive algorithm that is universally used in filtering is LMS. Filter coefficients are adapted by the quantity relative to the immediate approximation of the gradient of the error surface [2, 9].
The updating feature is influenced by the control of step size ***μ.*** For the performance of the LMS algorithm, the choice for a suitable value of **μ** is important [3, 4, 11].

B. *NLMS Algorithm*
In this algorithm, nature of step size depends on the function that ivolves input as well as error function, therefore a unique step size is used in a particular iteration as shown in Eq. 10 [6, 9–13].

$$o(n) = w^H(n)x(n) \tag{1}$$

$$e(n) = d(n) - x(n) \tag{2}$$

$$p(n) = e(n)x(n) \tag{3}$$

$$\mu(n+1) = \mu(n) + p(n) \tag{4}$$

$$\mu(n+1) = \begin{cases} \mu_{max} \; if \, \mu(n+1) > \mu_{max}, \\ \mu_{min} \; if \;\; \mu(n+1) < \mu_{min}, \\ \mu(n+1), \; otherwise \end{cases} \tag{5}$$

$$\hat{w}(n+1) = \hat{w}(n) + \mu(n) \cdot x(n) \cdot e(n) \tag{6}$$

C. Block Least Mean Square (BLMS) Algorithm
In the BLMS algorithm differs from the above algorithm, hear weights of filters are updated after every Lth sample (where 'L' is known as block) whereas in the above said algorithm filter weights are updated for every sample.

$$o(n) = w^H.(n).x(n) \tag{7}$$

$$e(n) = d(n) - y(n) \tag{8}$$

where w(n): weight vector; it is updated only at time instants nL [1].

$$w(n+1)BLMS = w(n) + \mu \sum_{(i=0)}^{(L-1)} \mathrm{u(nL \; + \; 1) \cdot e(nL \; + \; 1)} \tag{10}$$

3 Simulation Results

The codes of all the selected algorithms are saved as m-file, simulated in the R2019b version of MATLAB. The codes were simulated for various filter orders. As an intervention, Car noise was added to clean audio signal (यहाँ से लगभग '5' मील दूरदक्षिण-पश्चिम में कटघर गांव है "5" , i.e. yahaan se lagabhag "5" meel door dakshin-pashchim mein kataghar gaanv hai) [1, 2].

At -5 dB and 0 dB SNR, the car noise has been added to the clean signal, for the preparation of noisy version of speech signal [1–4], and the results of basic LMS algorithm for 0 dB input signal-to-noise ratio (SNR) obtained after the simulation is illustrated in Fig. 3.

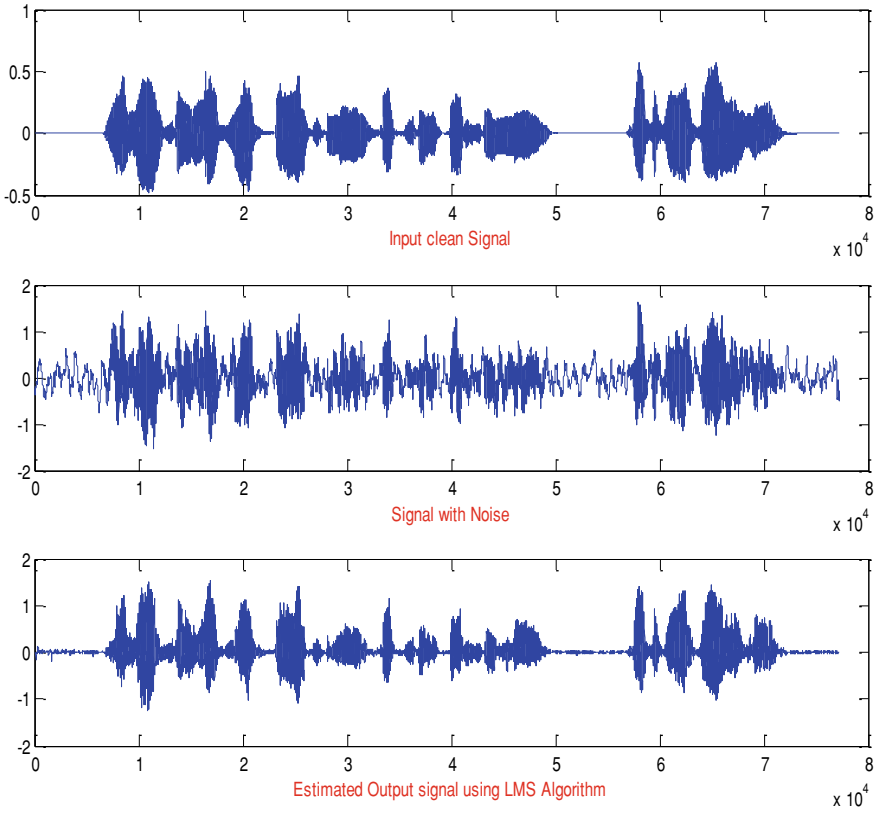

Fig. 3 Clean input signal, Car noise with signal and Estimated output signal

4 Comparative Analysis

The Performance analysis of the selected algorithm is analysed in graphical as well as in tabular form. For the given input SNR, the value of μ corresponds to maximum output SNR for the algorithm under analysis and in the block algorithm, for all types, weight is updated after every third sample of input (for block size three, output SNR is $\max^{m}$).

Table 1 shows output SNR for -5 dB input SNR, with μ = 3.5799 for filter order 10 in LMS, with μ_{max} = 2.3797 and μ_{min} = 2.3610 for filter order 20 in NLMS and with μ = 7.2460 for filter order 30 in BLMS for block size 3.

Table 2 shows MSE for -5 dB input SNR, with μ = 3.5799 for filter order 10 in LMS, with μ_{max} = 2.3797 and μ_{min} = 2.3610 for filter order 20 in NLMS, with μ = 7.2460 for filter order 30 in BLMS for block size 3, with μ = 1.8500 for filter order 40 in BNLMS for block size 3 and with μ = 1.400 for filter order 50 in LMS.

Comparative graphs are plotted using simulation tool MATLAB 2019b for Output SNR and MSE when i/p SNR is 0 dB. Figure 4 shows output SNR for filter order varying from 10 to 200 when input SNR is 0 dB for the selected algorithm.

Table 1 Shows a O/P SNRs that are obtained after simulation of selected algorithm for −5 dB input SNR

Selected algorithm	Output SNR				
	O = 10	O = 20	O = 30	O = 40	O = 50
LMS	2.8076	2.7750	2.7488	2.7277	2.6972
VLMS	2.8074	2.7748	2.7490	2.7280	2.6976
NLMS	2.8077	2.7751	2.7490	2.7280	2.6976
BLMS, B = 3	2.8294	2.8042	2.7848	2.7669	2.7403
BNLMS, B = 3	2.8294	2.8042	2.7850	2.7670	2.7404
BVLMS, B = 3	2.8295	2.8042	2.7851	2.7671	2.7408

Table 2 Shows mean square error (MSE), obtained after simulation of selected algorithm at i/p SNR (−5 dB)

Selected algorithm	MSE				
	O = 10	O = 20	O = 30	O = 40	O = 50
LMS	9.2528e–04	1.3131e–04	1.5396e–04	1.7911e–04	2.0375e–04
VLMS	9.2917e–04	1.3048e–04	1.5897e–04	1.8082e–04	2.0339e–04
NLMS	9.2161e–04	1.3115e–04	1.5510e–04	1.7929e–04	2.0209e–04
BLMS, B = 3	8.3731e–04	1.1764e–04	1.4067e–04	1.6498e–04	1.8804e–04
BNLMS, B = 3	8.3514e–04	1.1762e–04	1.4183e–04	1.6728e–04	1.8803e–04
BVLMS, B = 3	8.3238e–04	1.1858e–04	1.4252e–04	1.6442e–04	1.8824e–04

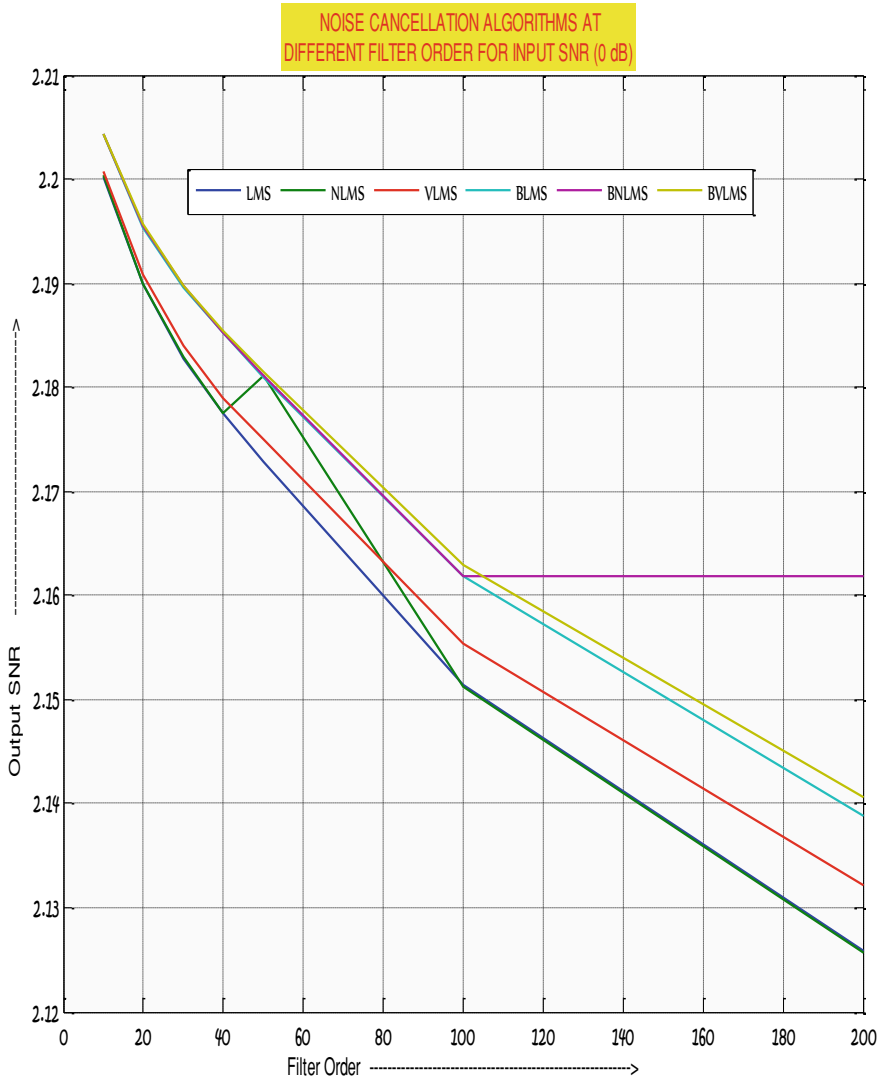

Fig. 4 SNR graphs for comparative analysis

In Fig. 5 for filter order 200 and input SNR 0 dB, value of $\mu = 0.1$ for LMS, for NLMS $\mu = 0.093$, for VLMS $\mu_{max} = 0.1$ and $\mu_{min} = 0.0084$, for BNLMS $\mu = 0.12$ and for BLMS $\mu = 0.35$, for the selected algorithms.

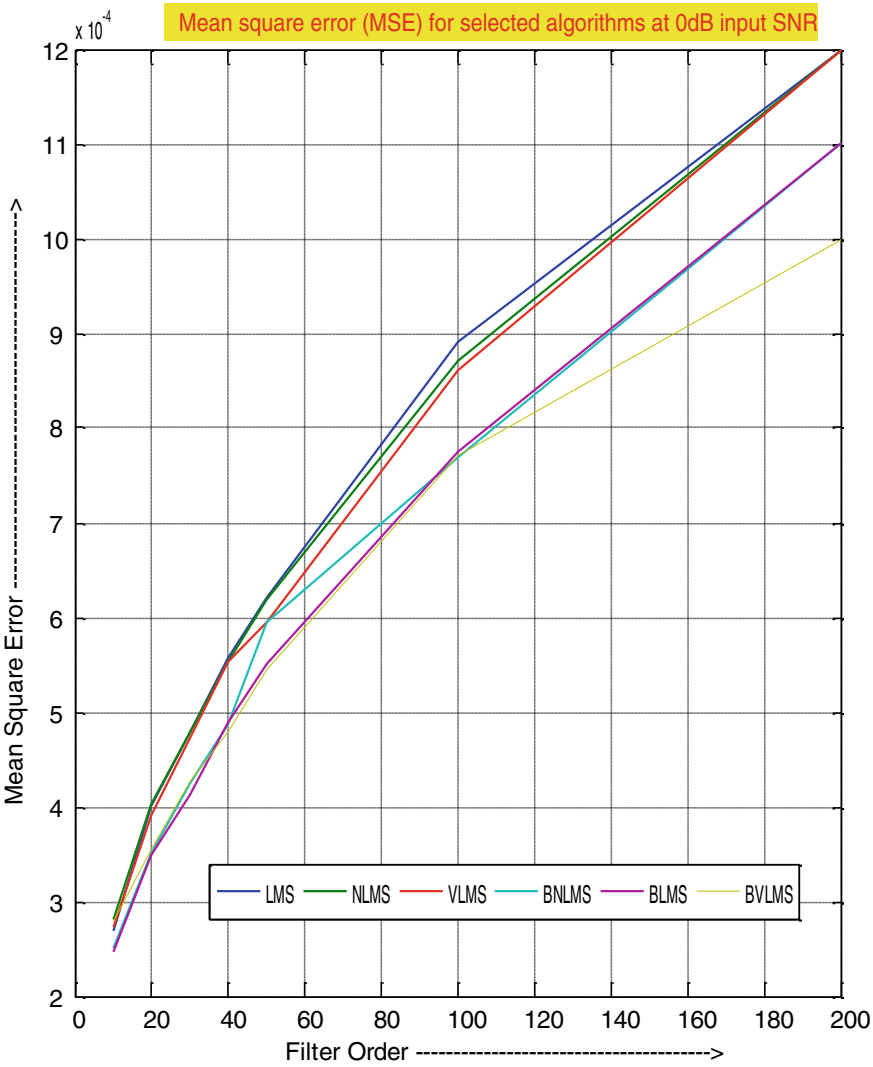

Fig. 5 MSE graphs for comparative analysis

5 Discussion

In this manuscript, the performance of the selected algorithm was verified for Hindi clean audio signal (यहाँ से लगभग '5' मील दूर दक्षिण-पश्चिम में कटघर गांव है व है, i.e. yahaan se lagabhag "5" meel door dakshin-pashchim mein kataghar gaanv hai) and car noise as an interference signal. From the comparative and analysis report (as in Tables 1 and 2) and comparative multiplier algorithm graphs (as in Figs. 4 and 5), it was concluded that with the deviation in filter order, the response of algorithms vary and also with the change in magnitude of I/P SNR, a particular algorithm is much affected. Comparative graphs and tables direct us to conclude that the response of a particular algorithm is not consistent for the entire filter order. The study also proved that output MSE and SNR are inversely allied to each other, also filter order and step size for the specific algorithm are inversely proportional to each other [14].

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Challenges and Opportunities of Internet of Things in Smart Agriculture: A Review

Jitender Kumar Singh Jadon and Rajkishor Singh

Abstract Agriculture is the basic need of any country. Almost everyone in the world is directly or indirectly concerned with agriculture. Due to increasing population, the available area for agriculture is continuously decreasing and pollution leading to decrease in the quality of products which are grown in agriculture fields. All these concerns lead the farmers to commit suicide or to leave their occupation. The integration of smart technologies with agriculture seems to improve the quality of agriculture and gives us hopes to develop it. It is also a very much needed step, as this occupation is the most lacking occupation regarding technological developments. IoT is the most advanced technology, and is nowadays available very easily to get integrated with almost all traditional and manual methods to perform tasks. In this paper, we have reviewed research work related to the integration of IoT into various agricultural tasks and operations. It has been noted that the technologies available for the artificial intelligence of Robotic machines used in Agriculture are not cheap and user friendly such that a farmer can easily operate them. A successive solution to educate the farmers in this aspect and advance the technology slowly by the use of Internet of Robotic things simultaneously is proposed in this review paper. To successfully implement this technology, the step-wise ten-year strategy is suggested to migrate to this technology in a monitored way. This plan includes education of farmers, loan distribution with monitoring and motivating farmers to use a licensed system to avoid interference.

Keywords Smart agriculture · IoT · IoT applications · Smart drones · Internet of robotic things · Smart farming

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1 Introduction

Due to the lack of knowledge and unpredictable environmental conditions, the farmers are not able to get maximum output from their crops. The farmers have to work very hard while plowing or seeding the farm or even monitoring the crops in the farm throughout their life span or during the cutting of crops or even during the extraction of seeds and their separation according to their quality. We have just discussed a small list of tasks, but there are a lot more tasks that are done by farmers that require a large effort and time involvement. In 2019, M. S. Farooq and others surveyed the role of the IoT in agriculture and found that the integration of the IoT with agriculture can improve the productivity of crops in a very innovative manner [1]. There are many pilot projects that are running in several countries which are using these IoT-based technologies. Many of these projects turn out to be a huge success. In February 2017, K. L. Krishna and others presented a paper showing the success of an IoT-based water management system which uses a wireless sensor network in lemon and vegetable fields in Thailand and improves their productivity saving a lot of water [2]. T. Wassan and others presented a precision farming low-cost model in August 2017, which monitors the soil condition for turmeric in three different fields of Taiwan and increases 40–60% production with 70% water saved [3].

The above-mentioned projects turn out to be a great success and attract interest, since many fields or operations used in farming are not yet connected with this robust technology. Muangprathub and others in January 2019 proposed a system to control the watering of crops using agriculture data analysis with the help of a Smart mobile phone with an application and a web application to monitor temperature, humidity and other variables and send notifications over a mobile app about critical values of these variables [4]. Suanpang and others proposed a prototype for monitoring the variable of agriculture which uses sensors and IoT [5]. Khoa and others proposed a multiple sensor-based model based on the Internet of Technology to control the water consumption by crops [6]. Iwendi and others proposed a system to analyze the suitability of land for agriculture for particular crops [7]. Khattab and others developed a monitoring system using IoT to control epidemic diseases by wirelessly storing the soil and environment information and showed high-quality crops in field applications [8]. Mentsiev and others presented a system to analyze crop growth and its requirements [9]. Much research is presented by many researchers since during the COVID-19 pandemic, the whole world was looking toward technology to perform their tasks without physical interaction. We are able to find a kind of research which is using a similar kind of IoT to monitor and control variables to improve open vegetable crops [10] like eggplant and tomato [11], rice, palm [12] and Columbian coffee. Similarly, a kind of research for control and monitoring systems with IoT of Greenhouse crops [13, 14]. The delivery of agriculture products is proposed as an online service. During the last years, a lot of research is done in favor of precession agriculture [15–18]. Most of this research is concentrated on similar types of work such as saving water and improving the quality of crops by condition monitoring. The research shows a promising implementation of almost all

the technologies being researched or reviewed in various papers, but when we see the practical implementation of these technologies in the field, we are able to find many challenges in addition to opportunities. In our work, we are going to see how the actual IoT-based technology works, and how it can be implemented in agriculture and discuss the challenges in its global implementation to meet today's requirements.

2 Methodology Used in IoT Technology

The concern for migrating to smart technology is in discussion since a long time. We have already discussed the success of some pilot projects in several countries. But if we want to implement IoT in agriculture, the system will look like a system as shown in Fig. 1. It will consist of almost every work done manually by the farmers to be integrated with sensors data acquisition, data processing, data analysis and actuation [1]. All these steps are required to be done using the mobile application or a computer

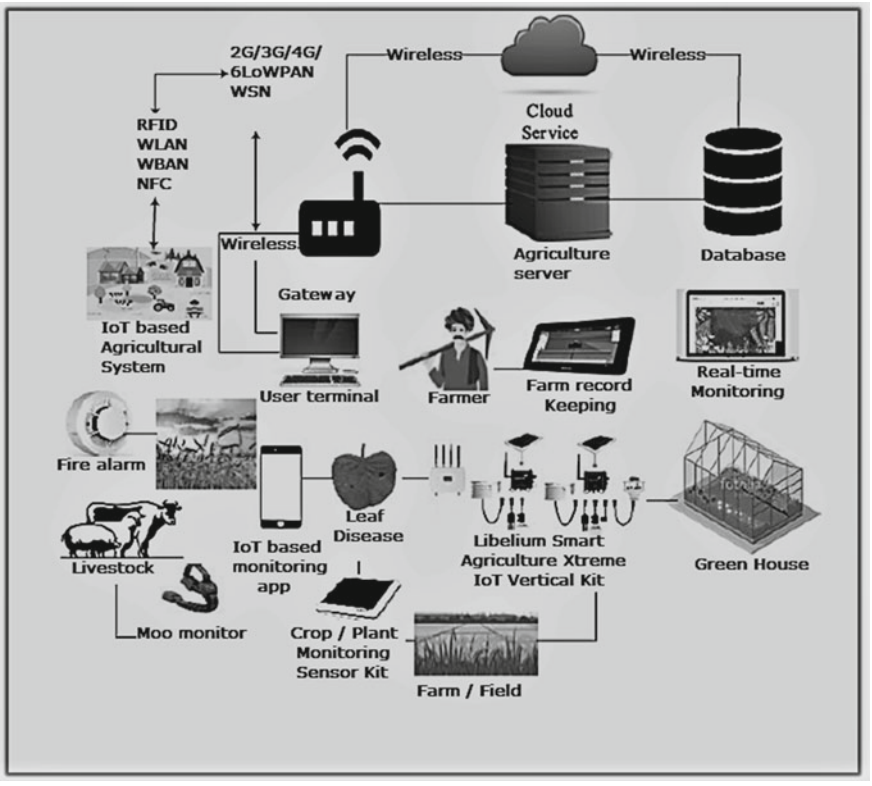

Fig. 1 IoT integrated in agriculture [1]

system which are required to be operated by a farmer from his home without being physically present at the field.

The complete system is found out to consist of several parts which are interconnected to perform the desired task in the appropriate manner to improve the quality of the crop and provide the farmers with the best output at the lowest possible cost.

The IoT technology is a very much appreciated technology which allows the farmer or the operator to work from anywhere anytime at ease. The only thing required by them is the computer or mobile system through which they can monitor and control the task. Figure 1. shows many activities along with their control technology using IoT.

Figure 2 shows the management of water in the field for which sensors are placed in different parts of the field which provides the details about moisture and sunshine through a message on a cellphone. The same data is stored on the cloud for suggestions and reference to farmers. Farmers can control the operation of the motorized valve to fill the field with water based on the data received through the message. Similarly, all other tasks are also controlled in the same manner. Various components with their use and specification are discussed here.

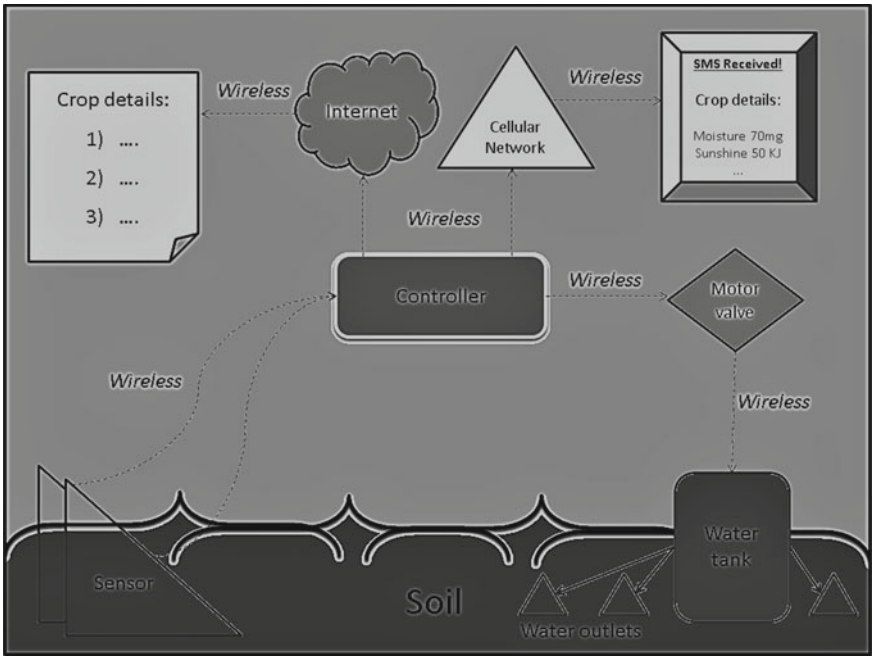

Fig. 2 Feedback control system for water management in field

2.1 Sensors

Sensors are electronic devices which reflect the change in resistance to show the real-time condition in the field. In this IoT-based agricultural system, many sensors are used for field data analysis according to the condition to monitor. These sensors include a pressure sensor, temperature sensor, moisture sensor and RFID tracker for tracking animals. Cameras can be implanted in fields to visualize the real-time field at any time. Location sensor uses GPS satellites to determine the exact position of devices used to monitor the field. Optical sensors are used to determine the soil properties; these sensors are used on monitoring devices such as drones or satellites and use light to measure these properties. Electrochemical Sensors are implanted in fields at different locations to collect soil data in the form of pH values and nutrients present in soil. Airflow sensors are used in the field to measure the permeability of air by fixing at a place in the field. Dielectric moisture sensors are used to measure the moisture content in the field [19].

2.2 Raspberry Pi

Raspberry Pi kit is used as the controller unit in IoT-based systems. As per the advancements, these kits are also advancing the latest model for this is Raspberry Pi 3 Model B +. This Raspberry Pi kit is third generation which is available for use through wireless LAN or Bluetooth. This kit is available with 64-bit CPU (BSCM2837) Quad-Core 1.2 GHz, 1 GB of RAM, wireless LAN (BCM43438) and BLE onboard, Micro SD port for loading the OS and programming data storage and micro-USB power source of 2.5 A [20]. The chromium browser of Raspberry Pi kit is updated for better performance and better hardware acceleration and is now available to use at the user end [21].

2.3 Smartphone with Compatible Application

Smartphones are available easily in the market which are compatible with the application. Advancements in technology lead us to have cheap smartphones with good specifications. The application compatible with the Raspberry Pi kit is developed and made available to download by the vendor providing the kit. To develop the app, one needs the latest version Raspbian, Node.js source code installer, Firebase tools to create an application, Pyrebase python module, Android phone, sensors and electronically controlled mechanism [22].

2.4 Electronically Controlled Mechanisms

The mechanisms which are used to minimize or eliminate the effort of farmers must be controlled electronically. Drones used for fertilizer, weedicide and pesticide spray [23–26] and mobile robot to scare the birds, and animals [27] are already available to operate electronically, but some other tasks like control of glass windows electronically and control of valve [28] to monitor water supply are still limited only to researches and very few such systems are available. The major reason is that the cost to control such a small component is very high and makes the system complicated in size.

3 Challenges in Implementing IoT Automation in Agriculture

According to the research and its increasing density, we can say that prior to artificial intelligence IoT is the best technology that we have. It may take another 30 to 40 years to get AI in almost every field, or it may be a possibility that we cannot have AI up to the intelligence level of human beings. Therefore, we are relying on this IoT technology for the next 30 to 40 years and for countries with less economy or large population like India, Brazil, Malaysia, etc. where agriculture is the major economic aspect; it may take more time. There are many challenges in implementing this system completely in agriculture that are discussed here.

3.1 Hardware Components Challenges

The development of a system requires a lot of hardware components, most of which are required to be exposed to harsh environments for most of its life. Development of such hardware which can sustain in such harsh environment is really a point of concern. The harsh environment can destroy the electronic circuit and the system will not perform or may lead to an adverse effect on the field.

3.2 Organizational Challenges

The agricultural organizations are meant to exchange information and transportation of goods. IoT brings accuracy in the delivery of these agricultural products [29]. In this respect, cloud computing provides the best services such as app development tools, efficient storage and resources. The Internet of Technology-based systems provide huge data which is required to be transferred and thus needs huge cost.

3.3 Networking Challenges

The IoT uses many networking protocols like Internet connectivity, Bluetooth and Wi-Fi. The operation of unlicensed devices using similar protocols causes interference and may cause problems in the operation of these IoT-based agriculture technology [30]. Internet connectivity and network issues are always experienced in rural areas and agricultural fields are found mostly in these rural areas.

3.4 Challenge to Educate Farmers

The IoT-based systems are very complicated and become more robust when it comes to IoT-based agriculture technology but their success depends on farms.

Farmers must be able to perform their tasks using these new technologies, but without education they are not able to do that. Spending time to learn these new technologies will cost them a huge loss in their profession. The uneducated farmers need more time to learn this technology. Therefore, to implement IoT properly it is important to educate and train the farmers.

3.5 Economic Challenge

The implementation of the IoT-based agriculture technology for a country cannot be easy or cheap, as all the farmers are not rich enough to bear the cost of implementation on their own. Many components and technologies are implemented by the government on a national scale, such as cheap availability of Internet with good signal strength and easy availability of hardware components in the local market. The budget for agriculture is mostly wasted in swiping the loan of farmers and providing more loans without proper monitoring in countries like India and Brazil. Properly monitored loans can be distributed among farmers for developing the smart farms; still, it will take a very long time to completely adopt this technology.

4 Discussion

There is a lot of research available with noticeable findings some of which have been arranged in tabular form with the noted research lapse in Table 1. The purpose of this table is to organize the major research findings to easily analyze and conclude the research lapse and propose the future scope to develop a better model for implementing IoT in Agriculture successfully.

Table 1 Main findings of some of the authors

Authors	Main findings	Research laps
Farooq et al. [1]	Provided a theoretical model to implement IoT in Agriculture covering almost every field	No discussion of any issue or challenge related to the implementation of IoT in Agriculture
Krishna et al. [2], Khoa et al. [6]	Discussed the application of IoT for water management system in lemon and vegetable fields to improve their productivity saving a lot of water	The application is done on a limited field as a pilot project. Thus, the implementation cost for a whole country is not estimated
Wasson et al. [3]	Proposed a low-cost RFID-based model for turmeric field with great success	The discussion related to its implementation for uneducated farmers is not found
Suanpang and Jamjuntr [5], Kocian et al. [13], Castaneda and Castano [14]	Implemented IoT for controlling greenhouse monitoring system for soil, moisture and others	Research is limited to greenhouse monitoring and is tested on very few crops
Iwendi et al. [7]	Proposed an IoT-based system to identify the suitability of land for particular crops	Cost analysis for such system is missing along with its suitability for uneducated farmers
Khattab et al. [8]	Proposed a system to identify plant disease in early stage to cure it with minimum damage	Cost analysis for this system is missing along with its suitability for uneducated farmers
Mentsiev et al. [9], Zinkernagel et al. [10], Palconit et al. [11]	Proposed system to monitor plant growth and its requirements to improve quality	Analysis is limited to specific vegetables, and needs more complicated system to cover all vegetables
Spoorthi et al. [23], Mogili and Deepak [24], Kadu [25], Dutta and Goswami [26]	Proposed drones used for fertilizer, weedicide and pesticide spraying in fields	Cost analysis for large-scale usage is missing
Dayoub et al. [36], Maheswaran et al. [27]	Proposed simple mobile robots to scare animals and birds in field to avoid loss to crops	Usage by uneducated farmers is not discussed also the quantity of such robots required for a large area such as city, state or country is not discussed

5 Conclusion

The IoT-based smart agriculture technology is very promising but complicated and requires a lot of hardware, software, cost and network. When it comes to pilot projects applicable to some farms or limited to small fields with some specific type of agriculture, this technology proves itself as a great success, but when the same technology is applied for all the fields of complete city, state, or country it presents many challenges like hardware compatibility and sustainability in a harsh environment, network availability and interference, education of farmers to adopt such robust technology, economical challenge as most of the farmers are poor and cannot afford this technology. To successfully implement this technology, the government has to take major steps and motivate the farmers toward this technology. The education should be moderated in order to teach the children of farmers, and farmers toward this technology. The step-wise ten-year strategy may be applied to migrate to this technology in a monitored way. The progress monitoring may lead to do moderations in the plan as and if required. This ten-year plan includes education of all farmers, loan distribution with monitoring, motivating farmers to use licensed systems to avoid interference and cyber security threat. The plan must also have to concentrate on the hardware and software developers to make them more user-friendly and sustainable in harsh environments.

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Energy-Intensive Data Compression in Order to Extend the Life Span of the Network

Nishant Kumar Pathak and Rajiv Kumar

Abstract With the advancement in technology, demand for the networked world raised every due to the fact of information sharing, supportive environment, helps in making distributed decision-making which is the main assumption of the network operation. The ad hoc network becomes popular in the real world due to instant formation, less in cost, reliability, availability and stability. The reason for the popularity of ad hoc networks is due to their instant formation within less time and without any physical barriers. In ad hoc wireless networks, difficult tasks like multi-hop communication can be performed with the help of the mobile nodes without the need for any physical and dedicated infrastructure. This paper affords a systematic evaluation of the energy-efficient clustering schemes and cell agent-based schemes used with the aid of the fact aggregation protocols in WSN.

Keywords Ad hoc · Mobile nodes · Clustering schemes · Cost · Reliability

1 Introduction

Due to the wireless nature of the mobile nodes within the ad hoc network, it's miles now mainly utilized in various areas like health center, medical, vehicle enterprises, universities and many others. Easy configuration, setup and setup capabilities are the benefits of ad hoc networks [1]. From the available series of advert hoc networks, one in all popular networks is a wireless sensor. The WSN is a mixture of the wireless sensor nodes. In this community, a group of sensor nodes can be allotted and dispersed in the community area to have a look at and record the location modifications. The sensor nodes collect the data and store the accumulated records at the crucial location. Each sensor node able to with the sense and procedure data [2]. In WSN, each senor node is prepared with a Wi-Fi radio transceiver, a small microcontroller, a strength supply and multi-kind sensors to take a look at the environmental changes like temperature, sounds, vibrations, pollutions, wind and many others [3].

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The sensor generation is turning into a favorite within the wireless networks due to its expandability and discount in its cost (Fig. 1).

Like other networks, WSNs are also totally dependent on battery assets, wireless connectivity and temporary association of nodes inside the networks; so amassed the records with the help of sensor statistics can be transported wirelessly but each sensor node within the wireless sensor network by using the battery assets. Maximum of the battery sources are consumed because of the mobility nature of the nodes [5]. Strength-green routing protocols in Wi-Fi sensor networks: A analysis. IEEE interactions surveys and tutorials, 15(2), 551–591. and last utilized in computational challenge, sensing and self-inspired topology converting operation. So, it's far critical to competently and efficiently usage of battery assets is the principle purpose to growth the existence span of the nodes. The designing of the routing protocols ought to be executed in this sort of way which decreases the electricity consumption and offers great of provider (QoS).

The manner to enhance first class services (QoS) in the WSN is clustering. In wireless sensor networks, a way off or base station offers information aggregation carriers to the quit customers. The aggregation approach decreases the transmission

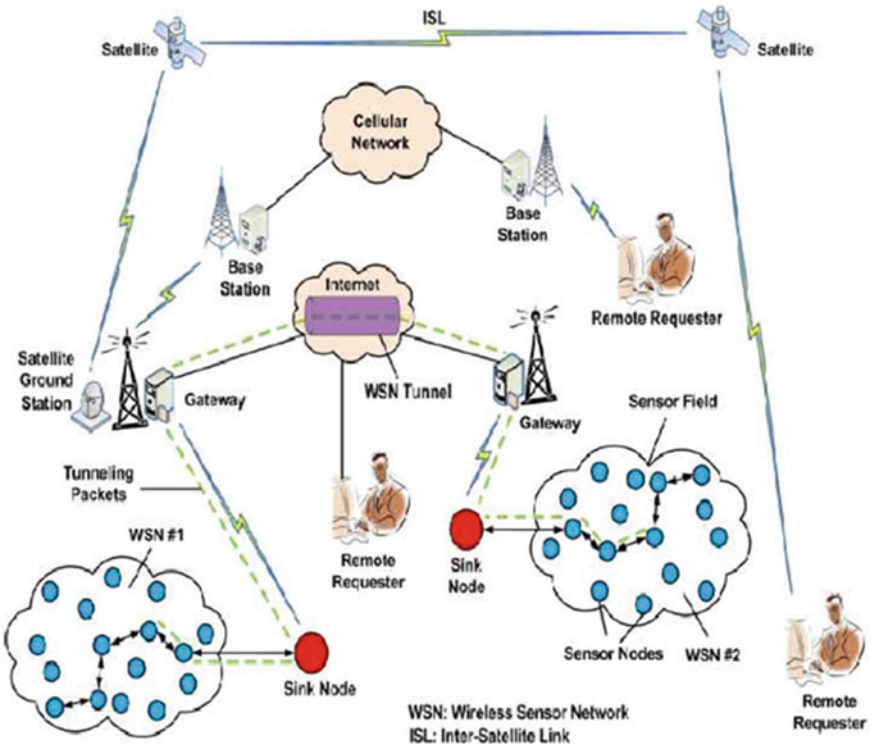

Fig. 1 Architecture of wireless sensor networks [4]

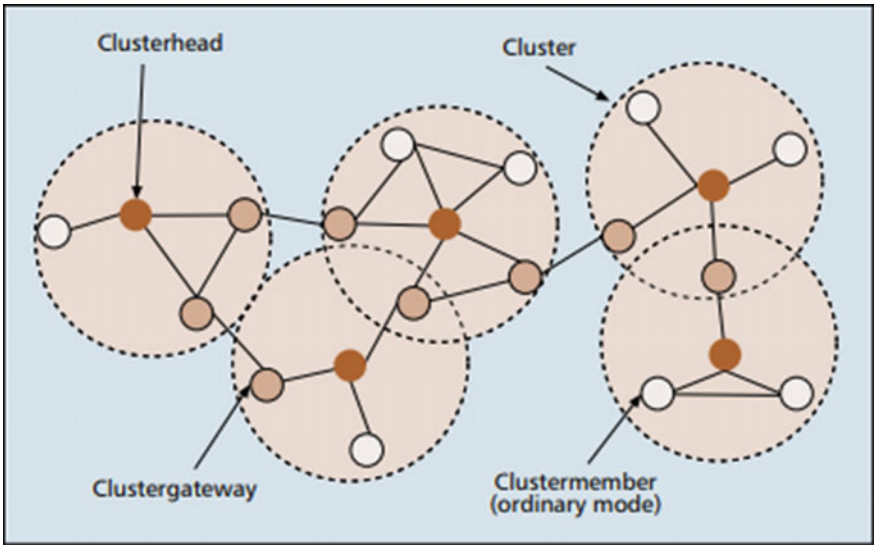

Fig. 2 Clustering in WSN [7] Yu, J. Y., & Chong, P. H. J. (2005). A survey of clustering schemes for mobile ad hoc networks. IEEE Communications Surveys & Tutorials, 7(1), 32–48

overhead, duplicity and power intake. The aggregation gadget is finished by the use of dividing the cellular nodes into small fragments which are known as clusters. The fragmentation of cell nodes in the clustering is based totally on some mechanisms. The gain of the usage of clustering within the WSN is to maintain the electricity assets and to reduce the hassle of operations [6] (Fig. 2).

In each pack together, there may be a cluster head which performs the various operations like processing, aggregation and transmission of the data to the sink node or a ways off station. Exceptional types of nodes are called member nodes who carry out the project of tracking, sensing and forwarding information to the cluster head. In quick, clustering decreases the use of electricity belongings via lessening the number of transaction inside the community. Clustering is a tier technique at the top level of the hierarchy cluster head are there and cluster member are available at lower level of the hierarchy. Every cluster is an aggregate of 3 ordinarily which can be.

(a) **Cluster Head (CHs)**: The cluster head with excessive electricity and maximum assets is chosen as a cluster head. The cluster head is responsible to switch properly timed records to the sink node.
(b) **Cluster Member** (CMs): Cluster participants (CM) can also be defined as leaf nodes. Member nodes inside the cluster are linked with each other in each different sensing variety. The records move from one cluster member to the alternative cluster member until it does not reach the cluster head.
(c) S**Gateway**: To exchange the facts over a lengthy variety, gateways are used. Gateways are used to transfer the information from one CH to a different CH.

The position of the gateway within the network impacts the overall performance and its operation.

The number one advantage of cluster side creases in intake of strength assets, clean to manipulate and statistics aggregation way is fast. The alternative benefit is simple to control due to small duration, lower delays and congestions and additionally lessen the processing time.

Clustering issues:

1. The mobility characteristic membership of node adjustments regularly inside cluster. So it's miles important to guide the mobility of CMs and CHs.
2. Cluster head behavior dynamically alternate depending on the sort of website traffic available like load chronic or intermittent.
3. Sometimes, one cluster head can be a member of a different cluster. So while designing the clusters, discover overlapping nodes and shape coordinating among them. It is essential layout difficulty to clear up the trouble of starvation or deadlock in the course of beneficial useful resource competition.
4. Distribution of the cluster participants is foremost thinking about even as forming the clusters. Cluster is a mixture of hundreds or thousands of member nodes. Fallacious load balancing of cluster contributors emerges as the purpose for the failure of cluster head.
5. Each cluster head dynamically chooses the cluster member below its sensing range.
6. The community should be fault tolerant without affecting the network functionalities. A few sensor nodes might also be blocked and lifeless because of loss of power property. The failed sensor node can be a cluster head or a cluster member. So these forms of failure do not affect regular operations and universal performance of the sensor community.

2 Related Work

Wang et al. [5] developed LCM: a link-linking method that knows how to save electricity to a wireless sensor network. The proposed process considers the node status and connection status. It uses predictive transmission number (PTX) novel compilation metrics to analyze cluster heads and gate arches to create clusters. The person who will be placed at the highest level becomes the head or the gate. Imitation effects are measured with the help of random selection and taking into account link quality and residual value in terms of packet delivery, power consumption and delivery latency, Nikolidakis, S., Kandris, D., Vergados, D., & Douligeris, C. (2013). Energy efficient routing in wireless sensor networks through balanced clustering. *Algorithms*, *6*(1), 29–42.

Kuila et al. [8] proposed the ability to integrate the strength and alignment of wireless network networks: How to make particle particles. The tunnel algorithm is designed with an efficient method of particle encoding and a multi-purpose robust

function [9]. The integration process is achieved by focusing on spatial energy management by balancing the load. Comparison of the proposed system with existing scheme outcomes depending on network life, power consumption, dead nodes and delivery of total data packets to the base station.

Tarhani et al. [10] proposed SEECH: A chain of energy-efficient energy networks in wireless sensor networks. The proposed system selects cluster heads and transmits independently and according to the suitability of the nodes. High-level nodes are set as the header and low-level nodes are set as relays. The proposed scheme compares with LEACH and TCAC procedures which have shown the development of SEECH in the long run [7].

3 Mobile Agents

A cell agent is a Wi-Fi and fast of laptop education or software program code which float the statistics from one device to some different tool autonomously and intelligently primarily based on the Wi-Fi condition of the network environment [11] Cell sellers perform the feature of record fusion and dissemination effectively in a sensor network. Chen, M., Gonzalez, S., & Leung, V. C. (2007). packages and design troubles for mobile stores in a sensor networks. IEEE Communications, 14(6), 20–26.

The gain wireless of the cell agent is rather the usage of a bit of hardware in every device for the software, a single software manipulates all of the paintings certainly by itself in the entire network (Fig. 3).

Adaptive systems (TAAS), 4(3), sixteen. when the adjustments wireless takes place in the network environment, the cellular agent skips through itself at that

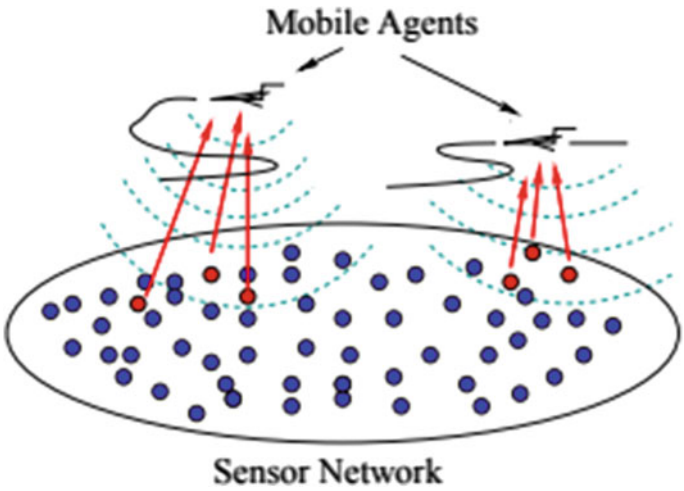

Fig. 3 Sensor networks with mobile agents

precise node and carries out the execution of duties by using itself. The blessings of the use of cellular stores close by processing of operations, dynamic technique, shared sign, expandable, scalability and reduces community transmission and delays [12]. The deployment of new software programs dynamically referred to as cellular sellers in sensor network is display to be an wi-fi green technique to address this venture. In the cellular agent-based method, the sink node releases a cell agent to the target vicinity to visit the supply nodes one by one. The sensed facts are reduced and aggregated by using the mobile agent after which switch lower lower back to the sink as described via the cellular agent. With the usage of the cellular agent-based totally method, the network isn't flooded by using way of needless messages; most effective required code is done at the goal area. To reap the better ordinary overall performance of cell dealers nodes need to be properly related with each one-of-a-kind and cluster additionally be small in length. cell dealers performs the venture of information aggregation and data filtering. In statistics aggregation, unwanted waft of packets are controlled to decrease the congestion. records filtration approach eliminate duplicity of packets. cellular retailers method also have a few drawbacks like safety and code caching.

4 Mobile Agents with Clusters

The principle aim of WSNs is minimizing electricity intake and maximizing the network life span of the community. The clustering algorithms are normally used to gather this intention. To utilize energy belongings successfully, clusters may be blended with the cellular dealers. The gain of the cell agent cluster-based algorithm, and the big quantity of sensory records can be reduced or transformed into small information factors by eliminating the duplicity and decreasing flooding.

5 Conclusion

The collection of records in WSN has to turn out to be a large challenge for the researchers around the arena. A singular taxonomic lookup on power-green clustering schemes and mobile agent-based schemes employed through the WSN protocols for record aggregation were used in the current survey. The significance of fact aggregation in useful resource-constrained WSN presentations a thorough discover about of various clustering schemes and cell agent-based schemes with middle of attention on their desires. The comparative evaluation lets the selection of suitable clustering schemes and cell agent-based schemes utilized in WSN to permit power-green aggregation of the records.

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A Fuzzy Soft Set-Theoretic New Methodology to Solve Decision-Making Problems

Shamshad Husain, Vipin Kumar Tyagi, and Mridul Kumar Gupta

Abstract A novel approach of perceiving from imperfect multi-observer data is provided in this study. During a parametric sense, the method includes constructing a comparison table for higher cognitive processes from an FSS. The notion of an FSS with Grey relational analysis is backed by a novel method. The new algorithm's evaluation grounds are diverse. The findings demonstrate that the proposed method is effective in addressing choice issues, particularly FSS decision problems.

Keywords Object identification · Comparison table · Decision-making problem · Grey theory · Choice-value

1 Introduction

Problems in economics, engineering, ecology, scientific discipline, and other fields all include confusing facts in the cosmos. According to the current research, **traditional** classical mathematics techniques may not be capable of adequately simulating key real-world situations. A mathematical approach for dealing with unclear, imprecise, or poorly defined items is known as soft pure mathematics. Through certain algorithms, we addressed some approaches for soft and **FS** in higher cognitive process issues. Molodtsov [1] detailed the applicability of **SS** theory to stability, regularization, game theory, and operational research. The notion of an **SS** was discovered by Akram et al. [2] to be a mathematical tool for controlling uncertainty in fuzzy pure mathematics. Maji et al. [3] utilized simple mathematics to solve an issue involving decision-making. They highlighted the relevance of ordering-based decision-making

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as well as the research components of it. Roy and Maji [4] proposed a novel technique for visual perception based on sloppy multi-observer data. The topic of making judgements in an uncertain environment was explored by Zou and Xiao [5]. They used a weighted average of all potential choice values of the item for a typical **SS** to calculate the choice value of an object with partial information. To deal with the supplier selection challenge, Abdul shahed et al. [6] developed a Grey-based method. To begin, linguistic variables that may be represented in grey numbers were used to define the weights and evaluations of characteristics for all options. Second, employ a grey possibility degree, which is the order in which all possibilities are ranked. Finally, an example of a supplier range problem was used to demonstrate the proposed solution. Kong et al. [7] looked at how an FSS may help with higher cognitive process issues. Multiple assessment bases were supported by the findings, which are more easily accepted and reasonable in one's mind. Kong et al. [8] looked into the issue of suboptimal choice and added a few soft settings to the parameter set. Akram et al. [9] investigated a variety of situations, ranging from rough to soft. Fatimah et al. [10] developed a unique new decision-making method based on probabilistic soft pure mathematics. They looked at a variety of methods for lowering **SS** settings. Li et al. [11] paid close attention to both academic researchers and decision-makers and discovered that the Grey model may help improve supplier selection strategy, particularly in situations where complicated sustainability settings (such as Libya) exist. Atanassov [12] proposed a novel theoretical framework for resolving decision-making problems. In these sorts of sets, they tested four different types of parameter reductions and observed that some were more efficient than others. Because of the notion of N-Soft topology in their study, Riaz et al. [13] created some fundamental operations on N-soft sets. Mohammed and Azam [14] proposed a novel method for making decisions in a highly ambiguous SS environment. Karaaslan and Deli [15] used a numerical example and a diagnostic application to evaluate the feasibility and efficacy of the suggested technique. Zhang et al. [16] presented a replacement strategy that combines quantitative logic with fuzzy pure mathematics. Ali et al. [17] expanded the notion of parameter reduction to N-soft pure mathematics. They verified its practical computation, developed related theoretical ideas, and looked into a few key points. In this paper, we explore novel techniques for resolving Grey theory problems. For the evaluation techniques, the algorithm is applicable for **SS** and unconstrained **FSS** decision issues. The method takes into account the choice-value and score-value evaluation bases, yielding complete decision outcomes. During an **FSS**-assisted Grey relational analysis, we do combined analysis using two evaluation techniques to make judgements and compute the correlation degree for each item. Because the evaluation sequence relates to a certain type of evaluation technique, this innovative algorithm might be a hybrid evaluation method for comprehensive evaluation. Furthermore, this method is objective, quantifiable, and more precise, and we can compare the results to discover which alternatives are the most effective, suboptimal, or otherwise. We offer an **FSS**-theoretic approach to solving the decision-making issue using several distinct and efficient approaches in this work. We address a quick note on the preliminaries linked to **SS** and **FSS** definitions in Sect. 2, which is focused on our topic. The essence of an **FSS** is discussed in Sect. 3,

as well as an algorithm. The choice-making issue was described and Algorithm-I was used in Sect. 4. An Algorithm for a more elegant solution is presented in Sect. 5, and then a problem utilizing the unit higher cognitive process approach supported by Grey theory is evaluated. In Sect. 6, we elaborate the results by graphical approaches and make a comparison between score values and selection values for better results.

2 Preliminaries

Notation

(i) Soft set (**SS**).
(ii) Fuzzy set (**FS**).
(iii) Parameter set (**PS).**
(iv) Fuzzy soft set **(FSS).**
(v) Fuzzy soft subset (**FSSS**).

Definition 1: A collection set of **PS** is E. Let $P(U)$ be the power set of U and $M \subset E$. An **SS** (S, M) over U with a mapping is defined by $S : M \to P(U)$.

If (S, M) **and** (T, N) **is a pair of SS over a universe** U**, then** (S, M) **is said to be a soft subset of** (T, N) **if.**

(1) $M \subset N$,
(2) $\forall \varepsilon \in M$, $S(\varepsilon)$ and $T(\varepsilon)$ have an identical approximation,

and write $(S, M)\tilde{\subset}(T, N)$.

Definition 3 If (S, M) and (T, N) are two **SS**, then "(S, M) AND (T, N)" are denoted by $(S, M) \wedge (T, N)$ and $(S, M) \wedge (T, N) = (H, M \times N)$ where "$H(\alpha, \beta) = S(\alpha) \cap T(\beta), \forall(\alpha, \beta) \in M \times N$.

Definition 4 If (S, M) and (T, N) are two **SS**, then "(S, M) OR (T, N)" is denoted by $(S, M) \vee (T, N)$ defined by $(S, M) \vee (T, N) = (O, M \times N)$, where $O(\alpha, \beta) = S(\alpha) \cup T(\beta), \forall(\alpha, \beta) \in M \times N$.

Definition 5 Here, we present an **FSS** and a few of its findings.

Let $U = \{z_1, z_2, z_3, z_4, ..., z_k\}$ be a group of k objects and a **PS** $\{M_1, M_2, ..., M_i\}$. The **PS** E may be written as $E \supseteq \{M_1 \cup M_2 \cup .... \cup M_i\}$ and M_i represent a selected property set, and every **PS** M_i represents the ith class of parameters.

Let $P(U)$ denote the **FS** of U and $M_i \subset E$. Let (S_i, M_i) be denoted by an **FSS** over U, where S_i is a mapping defined by $S_i : M_i \to P(U)$.

Definition 6 Two **FSS** (S_i, M_i) and (T_i, N_i) on the common universe U, (S_i, M_i) is said be an **FSSS** of (T_i, N_i) if

(1) $M_i \subset N_i$,
(2) $\forall \varepsilon \in M S(\varepsilon)$, maybe a **fuzzy subset** of $T_i(\varepsilon)$.
and write $(S_i, M_i)\tilde{\subset}(T_i, N_i)$.

Definition 7: Let (S, M) and (T, N) be two **FSS**, then "(S, M) AND (T, N)" is said to be **fuzzy intersection** and denoted by $(S, M) \wedge (T, N)$ defined as $(S, M) \wedge (T, N) = (H, M \times N)$, where $H(\alpha, \beta) = S(\alpha) \cap T(\beta), \forall \alpha \in M, \forall \beta \in N$.

3 FSS in Decision-Making

There are now two approaches to dealing with decision difficulties in **FSS**.

(i) The option is determined by choice value c_i, where c_i is the total of all object parameters' membership values o_i.
(ii) The decision is based on a score of S_i, where S_i denote the number of criteria with a considerably higher membership value of objects z_i.

"As a consequence, the decision is based on either the score value or the option value, or both. However, the same judgement might be reached in some cases. The following is the method for higher cognitive process issues in **FSS**".

Algorithm 1

- Put the **FSS** (S, M), (T, N), and (V, O) into the equation.
- Enter the **PS** P that the observer observed.
- Compute the corresponding resultant **FSS** (S, P) shown in tabular form.
- Compare table for the **FSS** (S, P) as the **sum of rows** (r_i) and **sum of columns** (t_i) for all objects $(z_i, \forall i)$.
- Calculate the **score** of objects $(z_i, \forall i)$.
- Final decision is $S_k = \max_i S_i$. If there are multiple values k, z_k choose one of them.

4 Application in a Decision-Making Problem

In this section, we choose an item from a set of supplied objects depending on a set of selection criteria P. Now, the aforementioned visual perception approach is based on a multi-observer input **PS** that includes **colour, size, and fuel type data**.

Example 1: Let $U = \{z_1, z_2, z_3, z_4, z_5, z_6\}$ be a set of cars in India (objects) with varying **colours, sizes, and fuel types**.

E = {white**, blue, grey, black, micro, SUV, hatchback, Sedan, CUV, Diesel, petrol, CNG, Electric}.**

Let M, N, and O denote three subsets of the **PS** E, where M represents the colour,N represents the size, and O represents the fuel type of the cars.

M = **{white, blue, grey, black} =** $\{a_1, a_2, a_3, a_4\}$.

N = **{micro, SUV, hatchback, Sedan, CUV} =** $\{b_1, b_2, b_3, b_4, b_5\}$.

The subset O represents the surface texture granularity, i.e.
O = **{Diesel, petrol, CNG, Electric}** = $\{c_1, c_2, c_3, c_4\}$.

Step I: The goal is to spot an unknown object from multi-operator fuzzy data described by FSS (S, M), (T, N) (V, O) and as previously stated.

The **FSS** (S, M) is described as follows:
$(S, M) = \{a_1 = \{z_1/.4, z_2/.4, z_3/.3, z_4/.7, z_5/.8, z_6/.8\},$

$$a_2 = \{z_1/.3, z_2/.8, z_3/.6, z_4/.1, z_5/.4, z_6/.1\},$$

$$a_3 = \{z_1/.7, z_2/.2, z_3/.9, z_4/.3, z_5/.4, z_6/.5\},$$

$$a_4 = \{z_1/.8, z_2/.7, z_3/.6, z_4/.9, z_5/.6, z_6/.4\}\}.$$

The **FSS** (T, N) is described as follows:
$(T, N) = \{b_1 = \{z_1/.5, z_2/.7, z_3/.5, z_4/.8, z_5/.7, z_6/.5\},$

$$b_2 = \{z_1/.3, z_2/.5, z_3/.3, z_4/.7, z_5/.2, z_6/.4\},$$

$$b_3 = \{z_1/.7, z_2/.2, z_3/.3, z_4/.3, z_5/.8, z_6/.7\},$$

$$b_4 = \{z_1/.5, z_2/.2, z_3/.3, z_4/.4, z_5/.7, z_6/.5\},$$

$$b_5 = \{z_1/.4, z_2/.6, z_3/.6, z_4/.5, z_5/.6, z_6/.9\}\}.$$

The **FSS** (V, O) is described as follows:
$(V, O) = \{c_1 = \{z_1/.4, z_2/.5, z_3/.6, z_4/.7, z_5/.5, z_6/.7\},$

$$c_2 = \{z_1/.5, z_2/.6, z_3/.7, z_4/.7, z_5/.5, z_6/.8\},$$

$$c_3 = \{z_1/.2, z_2/.3, z_3/.4, z_4/.6, z_5/.6, z_6/.9\},$$

$$c_4 = \{z_1/.8, z_2/.3, o_3/.4, z_4/.2, z_5/.5, z_6/.8\}\}.$$

The tabulated forms of the **FSS** (S, M), (T, N), and (V, O) are shown in Tables 1, 2, and 3, respectively.

After executing operation "**AND**" on the **FSS** for a few specific **PS** of M and N, the resultant **FSS** "(S, M) **AND** (T, N)" is obtained as follows (Table 4):

We have 20 **PS** of the shape e_{ij}, where $e_{ij} = a_i \wedge b_j$ for all $i = 1, 2, 3, 4j = 1, 2, 3, 4, 5$. Now, choose an **FSS** for the subset of the **PS** $R = \{e_{11}, e_{15}, e_{21}, e_{24}, e_{33}, e_{44}, e_{45}\}$, of 20 data **PS**, then the resultant **FSS** for "(S, M) AND (T, N)" are defined as (K, R).

Table 1 Tabular representation of **FSS** (S, M)

U	a_1	a_2	a_3	a_4
z_1	0.4	0.3	0.7	0.8
z_2	0.4	0.8	0.2	0.7
z_3	0.3	0.6	0.9	0.6
z_4	0.7	0.1	0.3	0.9
z_5	0.8	0.4	0.4	0.6
z_6	0.8	0.1	0.5	0.4

Table 2 Tabular representation of **FSS** (T, N)

U	b_1	b_2	b_3	b_4	b_5
z_1	0.5	0.3	0.7	0.5	0.4
z_2	0.7	0.5	0.2	0.2	0.6
z_3	0.5	0.3	0.3	0.3	0.6
z_4	0.8	0.7	0.3	0.4	0.5
z_5	0.7	0.2	0.8	0.7	0.6
z_6	0.5	0.4	0.7	0.5	0.9

Table 3 Tabular representation of **FSS** (V, O)

U	c_1	c_2	c_3	c_4
z_1	0.4	0.5	0.2	0.8
z_2	0.5	0.6	0.3	0.3
z_3	0.6	0.7	0.4	0.4
z_4	0.7	0.7	0.6	0.2
z_5	0.5	0.5	0.6	0.5
z_6	0.7	0.8	0.9	0.8

Table 4 Tabular representation of the resultant **FSS** $[(S, M)$ AND $(T, N) = (K, R)]$ **(Say)**

U	e_{11}	e_{15}	e_{21}	e_{24}	e_{33}	e_{44}	e_{45}
z_1	0.4	0.4	0.3	0.3	0.7	0.5	0.4
z_2	0.4	0.4	0.7	0.2	0.2	0.2	0.6
z_3	0.3	0.3	0.5	0.3	0.3	0.3	0.6
z_4	0.7	0.5	0.1	0.1	0.3	0.4	0.5
z_5	0.7	0.6	0.4	0.4	0.4	0.6	0.6
z_6	0.5	0.8	0.1	0.1	0.5	0.4	0.4

Table 5 Tabular representation of a resultant **FSS** (S, P)

U	$e_{11} \wedge c_1$	$e_{15} \wedge c_3$	$e_{21} \wedge c_2$	$e_{24} \wedge c_4$	$e_{33} \wedge c_3$	$e_{44} \wedge c_3$	$e_{45} \wedge c_4$	$c_i = \sum o_i$
z_1	0.4	0.2	0.3	0.3	0.2	0.2	0.4	2.0
z_2	0.4	0.3	0.6	0.2	0.2	0.2	0.3	2.2
z_3	0.3	0.3	0.5	0.3	0.3	0.3	0.4	2.4
z_4	0.7	0.5	0.1	0.1	0.3	0.4	0.2	2.3
z_5	0.5	0.6	0.4	0.4	0.4	0.6	0.5	**3.4**
z_6	0.5	0.8	0.1	0.1	0.5	0.4	0.4	2.8

Now the algorithm won't solve the original problem that's defined by the **FSS** as (S, M), (T, N), and (V, O).

Step-II: An observer of chosen **PS** from M, N, and O is

$$P = \{e_{11} \wedge c_1, e_{15} \wedge c_3, e_{21} \wedge c_2, e_{24} \wedge c_4, e_{33} \wedge c_3, e_{44} \wedge c_3, e_{45} \wedge c_4\}.$$

Based on these **PS**, we will decide on the available universal set U.

Step-III: The tabulated resultant **FSS** (S, P) is as follows (Table 5).

Step-IV: The **comparison table** may be a square table within which rows and columns both are labelled by the item names $z_1, z_2, z_3 \ldots\ldots\ldots\ldots z_n$ of the universe, and also the entries are c_{ij}, $i, j = 1, 2, 3, \ldots\ldots n$ given by

c_{ij} = The number of parameters that the membership value of z_i exceeds or up to the membership value of z_j (Table 6).

Step-V: The **column sum** of an item z_j is denoted by t_j and may be computed as $t_j = \sum_{i=1}^{n} c_{ij}$.

Similarly, the **row sum** of an object z_i is marked by r_i and might be calculated using the formula $r_i = \sum_{j=1}^{n} c_{ij}$.

An object with a score of $z_i S_i$ is also given a score of $S_i = r_i - t_i$.

Step-VI: The recognition method is used, and it is based on a set of multi-observer input parameters. As illustrated in Tables 5 and 7, the process entails creating a comparison table from the generated **FSS**, with the best decision being taken based

Table 6 Tabular representation of Comparison table of objects

	z_1	z_2	z_3	z_4	z_5	z_6
z_1	7	5	3	3	0	3
z_2	5	7	3	3	1	2
z_3	5	5	7	4	1	3
z_4	4	4	4	7	6	4
z_5	7	6	6	6	7	5
z_6	5	5	5	6	3	7

Table 7 Tabular representations of resultant score $S_i = r_i - t_i$

	$row - sum\ (r_i)$	$column - sum\ (t_i)$	$Score\ (S_i)$
z_1	21	33	−12
z_2	21	32	−11
z_3	25	28	−3
z_4	29	29	0
z_5	37	18	**19**
z_6	31	24	7

on the highest score. As indicated in the above score Table 7, z_5 has the highest score of nineteen, thus the decision is in favour of selecting z_5.

5 Decision-Making Problem with Grey Theory

Julong [18] proposed Grey systems theory, or simply Grey theory, in 1982. Grey systems are those that have partial, inadequate, or unclear information. Generating methods are essential ideas in this theory because they allow for the creation or transfer of disorganized or deficient raw data into a regular series for subsequent analysis and decision-making. This sort of approach can sometimes result in a dual object value and/or negative results. As a result, due to some physical quantities, theoretical approaches to decision-making issues in real-life face some difficulties. As a consequence, we offer the following approach based on grey theory for improved results.

Algorithm II Step-1: Input such as the choice value series of evaluation criteria $\{c_1, c_2, ...c_n\}$ and the score sequence $\{s_1, s_2, ...s_n\}$ were c_i and s_i and are linked to z_i.

Step-II: Grey relation generating functions.

Based on the original behavioural sequence, the sequence operator is used to normalize the data. The outcomes of normalization c_i can be expressed as $c_i\prime$, i.e.

$$c\prime_i = \frac{c_i - Min\{c_1, c_2.....c_n\}}{Max\{c_1, c_2.....c_n\} - Min\{c_1, c_2.....c_n\}}$$

$$s\prime_i = \frac{s_i - Min\{s_1, s_2.....s_n\}}{Max\{s_1, s_2.....s_n\} - Min\{s_1, s_2.....s_n\}}$$

Step-III: Reorder sequences $\{c\prime_1, s\prime_1\}$, ...$\{c\prime_n, s\prime_n\}$, where $\{c\prime_i, s\prime_i\}$ is associated with an object o_i.

Step-IV: Difference information.

The mother sequence may be thought of as the normalized sequences of pricing characteristics, and the difference Δx_i between the mother sequence and the sequence of other influencing variables can be expressed as follows:

$c_{\max} = Max\{c\prime_i,\ i = 1, 2, ...n\}\quad \Delta c_i\prime = |c_{Max} - c_i\prime|$

$s_{\max} = Max\{s\prime_i,\ i = 1, 2, ...n\}'\ \Delta s_i\prime = |s_{Max} - s_i\prime|$

$$\Delta_{\max} = Max\{c_i\prime, s_i\prime,\quad i = 1, 2.....n\}$$
$$\Delta_{\min} = Min\{c_i\prime, s_i\prime,\quad i = 1, 2.....n\}$$

Step-V: The degree of correlation $\gamma(c, c_i)$ and $\gamma(s, s_i)$ can be written as follows. From Step IV, Grey relative coefficients

$$\gamma(c, c_i) = \frac{\Delta_{\min} + \delta \times \Delta_{\max}}{\Delta c_i\prime + \delta \times \Delta_{\max}}$$

and

$$\gamma(s, s_i) = \frac{\Delta_{\min} + \delta \times \Delta_{\max}}{\Delta s_i\prime + \delta \times \Delta_{\max}},$$

where $\delta \in [0, 1][0, 1]$, as the distinguishing coefficient is expanded or compressed the range of the grey relational coefficient. In particular, we choose $\delta = 0.5$.

Step-VI: Grey relational grade $\gamma(z_i) = \{\alpha \times \gamma(c, c_i) + \beta(s, s_i)\}$, where α, β is the weight of evaluation factor $\alpha + \beta = 1$. We choose $\alpha = \beta = 0.5$.

Step-VII: Make a decision z_k, where $z_k = \max \gamma(z_k)$.

If we get more than one object having the maximum value, then the optimal selection is made based on Grey's theory in a reverse manner.

Now, using the above algorithm on Example 1 as follows.

Step-I.

The choice-value sequence.

$\{c_1, c_2, ...c_6\} = \{2.0,\ 2.2,\ 2.4,\ 2.3,\ 3.4,\ 2.8\}$ and the source sequences

$$\{s_1, s_2, ...s_6\} = \{-12,\ -11,\ -3,\ 0,\ 19,\ 7\}$$

Step-II

$$\min\{c_1, c_2, ...c_6\} = 2.0$$

$$\min\{s_1, s_2, ...s_6\} = -12$$

$$c\prime_1 = \frac{c_1 - Min\{c_1, c_2.....c_n\}}{Max\{c_1, c_2.....c_n\} - Min\{c_1, c_2.....c_n\}} = 0$$

$c\prime_2 = 0.1428$, $c\prime_3 = 0.2857$, $c\prime_4 = 0.2142$, $c\prime_5 = 1$, $c\prime_6 = 0.5714$

$$s'_1 = \frac{s_1 - Min\{s_1, s_2.....s_n\}}{Max\{s_1, s_2.....s_n\} - Min\{s_1, s_2.....c_n\}} = 0$$

$s'_2 = 0.0322$, $s'_3 = 0.2903$, $s'_4 = 0.3870$, $s'_5 = 1$, $s'_6 = 0.6129$.

Step-III

$(c'_1, s'_1) = \{0, 0\}$, $(c'_2, s'_2) = \{0.1428, 0.0322\}$, $(c'_3, s'_3) = \{0.2857, 0.2903\}$, $(c'_4, s'_4) = \{0.2142, 0.3870\}$, $(c'_5, s'_5) = \{1, 1\}$, $(c'_6, s'_6) = \{0.5714, 0.6129\}$.

Step-IV

$c_{\max} = 1$, $s_{\max} = 1$, $\Delta_{\max} = 1$, $\Delta_{\min} = 0$, $\Delta c'_1 = 1$, $\Delta c'_2 = 0.8572$, $\Delta c'_3 = 0.7143$,$\Delta c'_4 = 0.7858$, $\Delta c'_5 = 0$, $\Delta c'_6 = 0.4286$.

$\Delta s'_1 = 1$, $\Delta s'_2 = 0.9678$, $\Delta s'_3 = 0.7097$, $\Delta s'_4 = 0.6130$, $\Delta s'_5 = 0$, $\Delta s'_6 = 0.3871$.

Step-V

$\gamma(c, c_1) = 0.333$, $\gamma(c, c_2) = 0.369$, $\gamma(c, c_3) = 0.4117$, $\gamma(c, c_4) = 0.3882$, $\gamma(c, c_5) = 1$, $\gamma(c, c_6) = 0.538$.

$\gamma(s, s_1) = 0.333$, $\gamma(s, s_2) = 0.3406$, $\gamma(s, s_3) = 0.4133$, $\gamma(s, s_4) = 0.4492$, $\gamma(s, s_5) = 1$, $\gamma(s, s_6) = 0.538$.

Step-VI

$\gamma(z_1) = 0.333$, $\gamma(z_2) = 0.3548$, $\gamma(z_3) = 0.4125$, $\gamma(z_4) = 0.4186$, $\gamma(z_5) = 1$, $\gamma(z_6) = 0.4625$.

Step-VII

According to the grey optimal solution (choice-value) is z_5, because $z_5 = \max \gamma(z_i)$ therefore $z_5 = 1$, the maximum value of all objects is z_5 (final decision).

6 Graphical Representation of All Methods

See Figs. 1, 2, 3 and 4.

7 Conclusion

In his pioneering research, **Molodtsov** introduced soft pure mathematics as a universal mathematical tool for dealing with uncertain, fuzzy, or imprecise things. The use of **FS** pure mathematics to the problem of visual perception is described. The popularity method is based on a data set with a large number of observer input factors. The method may include creating a comparison table from the resulting **FSS**, and the judgement is based on the highest score generated from the Comparison Table. Use the Grey theory for various evaluation bases to choose the **FSS** decision-making problem. Results are shown graphically and procure a comparison between score values and selection values for better results.

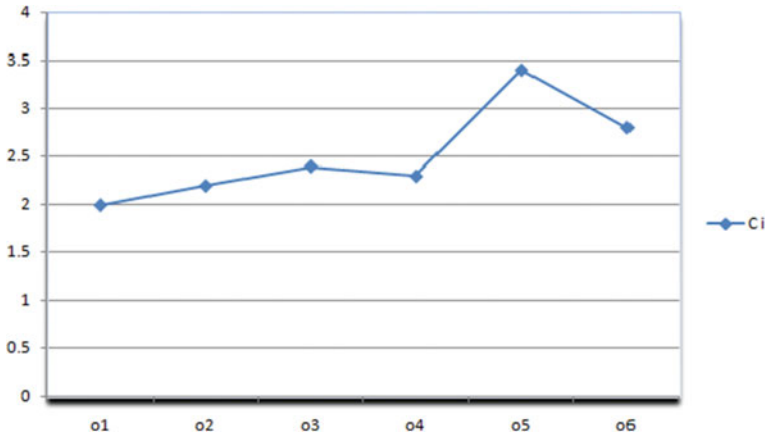

Fig. 1 Graph of resultant fuzzy soft set (S, P)

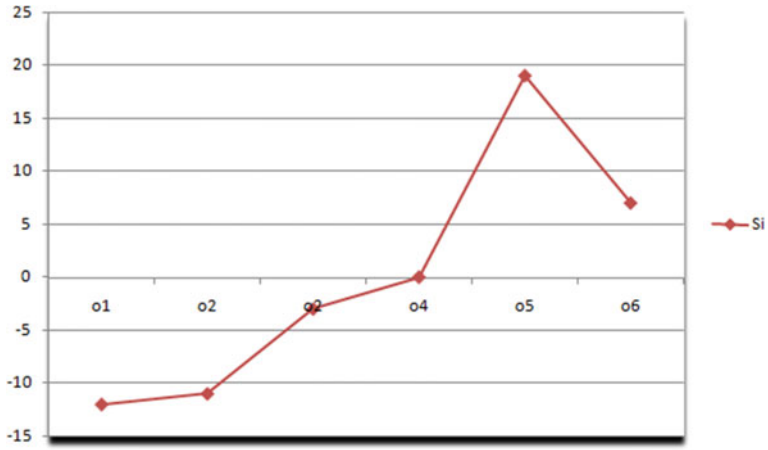

Fig. 2 Graph of resultant score $S_i = r_i - t_i$

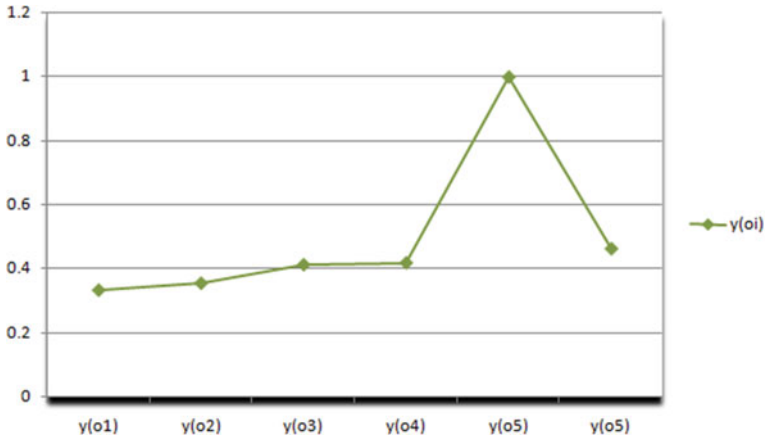

Fig. 3 Graph of resultant grey choice valve $\gamma(z_i)$

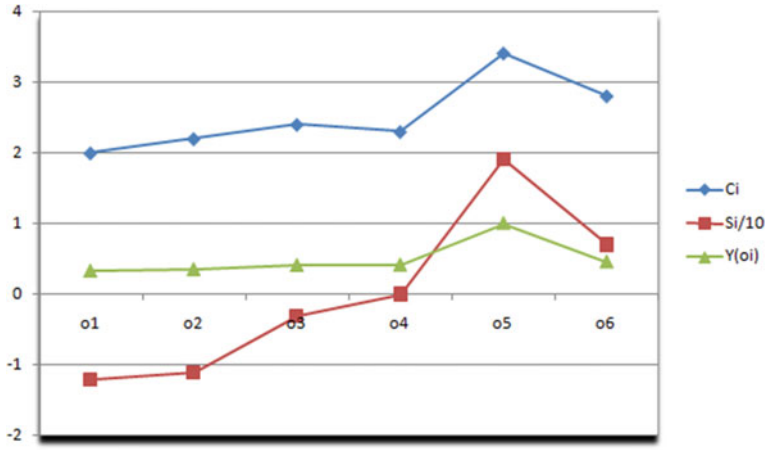

Fig. 4 Comparison between (S, P),S_i, and $\gamma(z_i)$

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Repatriated Migrants in Re-engineering Supply Chain of Agricultural Produce of Rural Odisha

Sanjaya Kumar Sahoo and Sukanta Chandra Swain

Abstract Agricultural produce does not get the apt recognition so far as the pricing and match between the supply and demand forces of it are concerned. In fact, the supply chain of the agricultural produce in India, particularly in the state of Odisha, is very weak. The supply chain of agricultural produce, i.e. the flow of agricultural produce from the farmers to the end-users, i.e. consumers, is not a smooth one for which the farmers receive a very less price, whereas the consumers pay exorbitant prices for the agricultural produce. Sometimes, the farmers fail to sell their produce owing to the unavailability of buyers, particularly for perishable produce during harvesting season. It happens for two things: (1) because the supply chain of agricultural produce is not scientific, and (2) because the farmers don't have enough man-hours during harvesting season to sell their products directly to the consumers in the local markets. However, the insertion of some productive manpower in the existing supply chain of the agricultural produce may solve the purpose. The current pandemic owing to Covid-19 has caused an inflow of out-migrant people to their native places, i.e. repatriated migrants or returnee migrants. Since those returnee migrants are having the threat of life in migrated place for the on-going pandemic, their inclusion in the supply chain of agricultural produce may solve the problems of pricing and mismatch of demand and supply forces of agricultural produce. Against this backdrop, this paper is to design a framework to make use of the repatriated migrants in upgrading the supply chain of the agricultural produce. The methodology adopted for this paper is content analysis from the existing literature and secondary data.

Keywords Repatriated migrants · Supply chain · Agricultural produce · Pricing · Rural · Odisha

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1 Introduction

In the primary sector, there are a large number of small and marginal farmers cultivating in the countryside land of India. They are unable to sell the products directly to the consumers because of the exorbitant transportation cost as compared to the scale of their produce. There are a large number of intermediaries who have a contract with the farmers to purchase the product throughout the year at a very low price. But they are selling the product at a very high price to the end-users or wholesalers. Consequently, the producers, i.e. farmers sell the product at a very less price and the consumers purchase the product at a very high price. This gap has been widened further because of the Covid-19 pandemic.

The transaction with the lack of quality assessment, limited e-transaction and optimum illiterate intermediaries led to hindrances in the physical movement of the Agricultural Supply Chain in our country. This problem collaborated with the social distance measures of the Government because of the Covid-19 pandemic situation. Proper quality assessment at the grass-roots level enables to purchase of the product directly from the farmer retailers by minimizing the number of intermediaries, reducing spoilage, minimizing marketing cost, reducing quality deterioration, providing proper information and offering better convincible price to both consumer and producer. So a proper network is necessary to minimize those crises.

The Odisha state of India is one of the agrarian states where 70% of the population is dependent on agriculture. Even though agriculture contributes nearly 26% of the Gross State Domestic Product, the majority of the population dependent on agriculture has low per capita income. So necessary steps are required to uplift the agricultural sector for the economic development of the state. Out of the total geographical area of 155.711 lakh hectares available in Odisha, 64.09 lakh hectares are used for cultivation purposes. Of the total area meant for the cultivation purpose, 40.17 lakh hectares have acidic soil, 4.00 lakh hectares have salinity and about 3.00 lakh hectares suffer from waterlogging. The average size of the landholding in the state is 1.25 hectares. Of the total farmers, 83% are small and marginal farmers. As per 2007–08, total food grain production in the state is 92.13 lakh tonnes which contributes 4.06 percentage of the national food grain production.

As per the statement of the Minister of Labour and Employee's State Insurance, Susanta Singh, 853,777 migrants returned to Odisha after the lockdown imposed in the country since March 2020. Maximum migrants came from Gujarat, Karnataka, Tamil Nadu, Telengana, Andhra Pradesh, Kerala and Maharashtra. Of the total migrants returned, nearly about 4 lakhs came only to Ganjam districts. So the paper tries to explore how these returnee migrants would be employed in the Agricultural Supply Chain sector for the continuation of the economic growth of the state.

2 Review of Literature

Sharma et al. highlighted the different risk and their mitigation measures associated with the Agricultural Supply Chain. The study is conducted using Fuzzy Linguistic Quantifier Order Weighted Aggregation. The paper finds different risks like demand risk, supply risk, financial risk, management and operational risk, etc. that are associated with the Agricultural Supply Chain. So different policy measures like Industry 4.0 technologies and supply chain collaboration are necessary for a sustainable future [1].

Boyabatlı explores how the investment in the agriculture sector is made to use input into commodity and a by-product. The paper used the multi-period model for studying the optimal one-time processing and decision about the storage capacity in the condition of the uncertainty of input and output spot prices and production yield. Here, optimal decision and perform sensitivity analysis are done to find how the processor's optimal capacity and profitability are influenced by the spot price uncertainty. Taking the case of the palm industry, performance capacity investment policy is analyzed. The study finds that average yield is preferred to maximum yield if the yield uncertainty is not taken into consideration in capacity planning. When the capacity investment cost is high, average yield performance is good, otherwise, it leads to loss of profit. When spot price uncertainty is not taken into consideration, it leads to a significant loss of profit. Further, when by-product revenue is ignored in capacity planning, it reduces the processor's profit [2].

Haley et al. shows that the pandemic Covid-19 reshaped the Canadian society impacting the pre-existing social inequities. It negatively affected the homeless people, low-wage workers, older, racial minorities, and disabled residents in general and migrant people in particular. The paper highlights that in Canada through the Temporary Foreign Worker Program, 50,000 migrant workers came into the agricultural stream. These migrant workers are 10% of the agricultural workers in Canada. These people face the problem of health crisis, isolation, lack of access to field sanitation, overcrowded living conditions, inability to switch employers and lack of access to immigration pathways. So, priority should be given to providing them health, worker protection, permanent residency, etc. [3].

3 Objectives and Methodology

1. To investigate the potential risk associated with Agricultural Supply Chain.
2. To explore how the repatriated migrants can be utilized for mitigating the threat that lies in the product of the Agricultural Supply Chain.

The methodology adopted for this paper is content analysis from the existing literature and secondary data.

4 Potential Risk Associated with Agricultural Supply Chain

4.1 Agricultural Supply Chain

Agricultural supply chain includes all the activities like actors, organizations, information, technology, services and resources in the process of producing the agricultural product for the consumer. It encompasses the agricultural upstream and downstream sector from the process of supplying agricultural input to the production, post-harvest handling, processing, transportation, marketing, distribution and retailing. It consists of support services like market information, Research and Development, etc. It includes various types of enterprises starting from smallholders, cooperatives, startup companies and farmers' organizations to multinational entrepreneurs.

The composition of the supply chain varies among different types of products and geographies. Normally, there are four stages of the agricultural supply chain. They are Production, Aggregation, Processing and Distribution. Similarly, it includes several types of enterprises. The on-firm enterprises include agricultural production and near-farm basic processing. They comprise the farms of small to large families, farmers' organizations, cooperatives and private enterprises and further, companies that directly or indirectly involve in investing in land and managing farms. The downstream enterprise comprises the aggregation, processing, distribution and marketing of the agricultural food products among trades, wholesales, transportation companies, manufacturers of food, feed and beverages, textiles and biofuel producers, retailers and supermarkets. The cross-cutting enterprises involve input suppliers, Research and Development institutions, Educational institutions and extension services, market information providers and control and certification bodies. Financial enterprises comprise all the Financial institutions that are involved in the supply chain which are Asset owners, Asset managers, Bilateral or multi-lateral development banks, Financial services providers like Commercial Banks, commodity traders, etc.

The major actors of the value chain in Odisha are as follows:

(i) The seed supply is conducted by RRTTS, CHES, ICRISAT, OSSC, NRRI, CTCRI, KVK, private dealer, sale center in block, private party, seedling from Horticulture nursery, local market and farmers.
(ii) The Fertilizer supply is done by RMC, MARKFED, Private Input Dealers and farmers.
(iii) The Pesticides are supplied by sale center in block, private trader, input dealer and farmers.
(iv) Credit is provided by Banks, Society, NBFC, Cooperatives, PACS/LAMPS, farmers and Money Lenders.
(v) Product is sold by Middleman, Farmer, Wholesalers, Rice millers, Exporter and Consumers.

4.2 Different Types of Risk in the ASC

The entrepreneurs of the supply chain may face different types of risk depending on their focus. Different types of cross-cutting risks they face are Human rights, Labor rights, Food security and nutrition, Health, Access to natural resources, Governance, Environmental protection and sustainable use of resources and Technology and innovation. More specific risks are Animal welfare and Tenure rights. In addition to that, different types of risks that affect the Agricultural Supply Chain are supply side, demand side, logistic and infrastructural, policy and regulations, financial, biological and environmental, management and operation, weather-related and political.

(i) Supply-side risk is the quality problem of the product, payment default by the supplier toward transportation, wage, etc. shortage of the product and underperformance of the logistic providers.
(ii) Demand-side risk is the imperfect and inadequate information on demand, uncertain and unanticipated demand, change in the food safety requirements and transportation issues.
(iii) Logistics and Infrastructural risks are insufficient road infrastructure, increase in fuel costs, inadequate transportation infrastructure, labor shortage, labor conflict and dispute, unavailability of infrastructure, etc.
(iv) Policy and regulatory risks are the unstable fiscal, tax and monetary policy, uncertain market and trade policy, unsure legal policies and enforcements, undetermined land and tenurial policy.
(v) Financial risks are the unavailability of financial support, unsettled credit issues, unresolved interest and exchange rate policies and detaining financial support.
(vi) Biological and environmental risks are the attacks of the pest and disease, yield loss, inadequate sanitization and illness and contamination affected by food safety.
(vii) Management and operational risks are degradation of the processed food product, poor management, etc. planning error, forecast error and outdated inputs.
(viii) Weather-related risks are deficit or excess rainfall, drought, flood, winds, cyclone, etc.
(ix) Political risks are political instability, trade restrictions, volatility in political empowerment and legislation risk.

The major constraints in Odisha about Agricultural Supply Chain are the following:

(i) Large-scale production.
(ii) Lack of information about marketing.
(iii) Unavailability of storage facility at the village level.
(iv) Inadequate transport facility in the rural area.
(v) Lack of producer training.
(vi) Lack of financial facilities.

(vii) An adequate infrastructure facility is not available.
(viii) A large number of intermediates.

4.3 Reappraise (Due Diligence)

The adverse impact can be mitigated by the process of identifying, assessing, mitigating, preventing and accounting for the risk related to the supply chain. The entrepreneurs need to identify the risk by taking the factual information and then evaluate it by taking the available laws, policy, tools, etc. Here, the due diligence is affected by several factors like size and nature of the entrepreneurs, content and location of its operations, nature of the product, etc. As per the OECD due diligence guidelines, there are five steps for due diligence:

1. To establish strong enterprise management systems for responsible supply chains.
2. To identify, assess and prioritize the risks associated with the supply chain.
3. To design and implement a strategy to respond to the identified risk in the supply chain.
4. To verify supply chain due diligence.
5. To report on supply chain due diligence.

We know that one enterprise covers different stages of the supply chain by coordinating different departments to implement due diligence. The following collaboration is necessary among the industry for due diligence:

(i) Cooperation among the industry is necessary to support and advance adherence to international standards.
(ii) Cost-sharing among the industry for specific due diligence tasks.
(iii) Coordination among the industry members who share the same supplies.
(iv) Coordination among the upstream and downstream enterprises.

Further, cooperation among the international and civil society organizations is necessary for the above said purpose.

4.4 Covid-19 Impact on ASC and Immigrant Employment

Almost all the countries of the world imposed restrictions on internal and international trade which affected the farm trade negatively. All the countries of the world adopted the non-pharmaceutical measure of shut-down to reduce the spread of the coronavirus. This ultimately put a strain on the agricultural supply chain of the food produced as there is a complex interaction among the farmer's agricultural inputs, processing plants and retailers shipping. As the shipping industry slows down, it disrupts the supply chain. This depreciated the exchange rate and energy

and commodity prices. It leads to the complex in the global food supply chain and ultimately risk mitigation measures become proactive for Agricultural Supply Chain management. As per the report of the WTO, global merchandise trade reduced in between 13 and 32 percentages in 2020.

Risk in the Agricultural Supply Chain arises because of the Supply Chain coordination or supply chain disruptions. The health statuses of the people engaged in the Agricultural Supply Chain are at risk due to the spread of Covid-19. So different supply-side risks like labor shortage, transport disruptions and demand-side risks like consumer panic buying behavior, change in consumption pattern affects the Agricultural Supply Chain. This ultimately affects the sustainable production and consumption of the Agricultural product and hence food security. As food is the basic necessity, the Government is taking so many steps for the smooth and continuous supply of the product.

1. Government of India is providing free Mid-day Meals to school children, free meals to hospitalized patients, nutritious food to conceive and lactating mothers, children, etc. As the food supply is halted, these people become vulnerable. The repatriated migrants may be engaged to deliver the food to the students, conceive and lactating mother and their children. It will benefit in three ways, i.e. reducing the spread of the virus, regular supply of nutritious food and protection of the livelihood of the repatriated migrants. Along with food supply, protective kits and medicine can be supplied by engaging these people. Here, food assistance can be used in an emergency manner for the social protection programs.
2. As the lockdown and shut-down are imposed in the country, farmers are unable to purchase the farming input and also unable to sell whatever is produced. The Government needs to establish a collection center to collect the agricultural product where repatriated migrants will be engaged. This will benefit the farmer, repatriated migrants and also the consumer. Even if they are small farmers, they will be able to sell their product at one government-recognized place and price. The repatriated migrants who are wondering about their livelihood would get engagement. The consumer will get the product at a justifiable price. Government needs to open the shops those that are selling the agricultural input. To reduce the mobility of the people, repatriated migrants will be engaged for the home delivery of the input. E-commerce channels need to be opened where small and large farmers will be included to purchase and sell the agricultural input and product.
3. Agricultural food is divided into staple commodities (wheat, corn, maize, oilseeds and soybeans) and the high-value commodities (fruits, fisheries and vegetables). Generally, the staple commodities are capital intensive commodities and the shortage of the labor supply has less impact on the production of it. On the other way, as high-value commodities is a labor-intensive commodity; most of the migrant labor will be engaged in this field.
4. Due to the pandemic coronavirus, the food price rises in most of the country which depends on the imported product and because of the reduction of their domestic currency in relation to dollar.

5 Repatriated Migrants in Agricultural Supply Chain

5.1 Utilization of Repatriated Migrants

As per the report of the International Labour Organization, about 2.7 billion people or 81% of the total global workforce are affected by the Covid-19 pandemic situation. Without the effective mitigating Government policy for these migrant labor, nearly 49 million people worldwide will be in extreme poverty and ultimately in hunger. In India out of the 450 million migrant workers in the informal sector, nearly 30% are in the vulnerable group. When lockdown is imposed, these vulnerable migrant workers planned to go back to their native village for getting regular meals, engage in the agricultural sector and involve in the social protection programmes of the government. In the remotest part of India, Government and IFAD work to improve the lives and livelihoods of these migrant worker. In Odisha, the NGOs, Government Workers and Project staff provide cooked meals to vulnerable population such as the poor, pregnant women and migrants. Further, these people create awareness among these vulnerable people on sanitation, health and social distancing. Several plans have been made to engage these migrants in the form of livelihood collectives, SHGs, Producer groups, farmer's organizations or in any other way for the socioeconomic integration of the migrants.

In the Covid-19 pandemic situation, providing employment to the repatriated migrants in the agricultural sector is highly needed. It needs to assess the quality of the repatriated migrants and according to their necessity in this field, they will be provided employment. For the smooth continuation of the economic growth, repatriated migrants will be employed in this field. The Government needs to respond to the problem of the repatriated migrants and needs to provide them employment in the labor-saving technology product like agriculture.

(i) The repatriated migrant can provide better skills to agriculture and by producing agricultural crops they can create earning opportunities.
(ii) Since most of the agricultural production is seasonal in nature, the farmers get themselves employed in that period and remain unemployed in the rest of the period. The repatriated migrants can diversify the agricultural activity by producing different types of products in different seasons and ultimately selling them.
(iii) Most of the repatriated migrants are having no agricultural field. So Government needs to take appropriate steps for providing them with land on a rent basis and imparting training to them to produce varieties of products according to the climate and necessity of the consumer.
(iv) The Government needs to arrange to form an association of the repatriated migrants who are engaged in the agricultural sector and seek suggestions from them, and after that provide them loans for the commercialization of the agricultural sector.

(v) As inconsistency related to the employment of the repatriated migrants exists in agriculture. Government needs to frame appropriate policy. The policy will be made in such a way that the agricultural sector will be productive to provide higher wages and safer jobs as per their skill.

The employment of the repatriated migrants needs scrutiny among the management by the Government, repatriated migrants, farmers, land owners and the available land for cultivation. The Government needs to manage while employing the repatriated migrants in the agricultural sector in different ways, i.e. in the process of the agricultural production, in assessing the quality of the product, in packaging the product, in transporting the product and selling the product. The challenges of the repatriated migrants need to be identified like working in a different atmosphere, seeking training to work in the agricultural field, renting of the land, etc. The farmers need to equip themselves to diversify the agricultural product by employing the repatriated migrants. The agricultural field needs to be utilized as per its availability.

The issues and challenges of providing employment to the repatriated migrants in the Agricultural Supply Chain need the following attention:

(i) First, collect the data and to assess the different programs where the migrants will be employed in the process of the Agricultural Supply Chain. Assessment needs to be made to test the labor market how the repatriated migrants can be employed, wage systems and their interaction with the tax and social welfare systems.
(ii) Assess the skill of the migrants in which section of the Agricultural Supply Chain he can be employed.
(iii) Determine the amount of remittance he had sent, in what way this remittance amount was utilized for the betterment of the family. Now, what wage should be provided to that person, so that it will not deteriorate the quality of the maintenance of the family.
(iv) Cost and benefit analysis needs to be done while the repatriated migrants are in the process of different schemes of the Agricultural Supply Chain.
(v) The Government needs to guarantee for providing 18 days of work in a month. The Government should form employer cooperatives to maximize work opportunities for migrant workers.
(vi) The program for the smooth continuation of the Agricultural Supply Chain should have multiple objectives, i.e. employment of the repatriated migrants, promotion of the agricultural activity and reducing the spread of coronavirus.

Besides the above-mentioned procedures, the Government needs to encourage the companies to invest their Corporate Social Responsibility Fund in this sector for providing employment to the repatriated migrants. The scheme should be named as "Corporate Social Responsibility in providing employment to the repatriated migrants". The program should have the following objectives:

(i) Train the repatriated migrants on Agricultural Supply Chain activity.
(ii) Prepare pre- and/or post-orientation training for these labor.
(iii) Plan to support supply chain mapping for the required purposes.

(iv) The company should provide an international standard certificate to the trainer.

In the process of employment, priority needs to be taken for protecting the rights of the migrant worker, enhancing the transparency and accountability in the process of recruitment, promoting the employer pay principle, strengthening the public policies, regulations and enforcement mechanisms. Further awareness for capacity building among the people needs to be created, voice of the repatriated migrants should be protected, recruitment policy should be followed and certificate must be provided to the volunteers. Government through the volunteers needs to assess the interest, skill and future plan of the repatriated migrants.

6 Suggestions

The implementation of different policies related to the Agricultural Supply Chain needs two approaches—one for durable agricultural produce and another for perishable agricultural produce.

6.1 Durable Agricultural Produce

(i) Agricultural Supply Chain to be made through Warehouse

The Ideal method of selling the storable commodity is through Government recognized negotiable warehouse receipt (NWR) linked with e-NAM. The farmer needs to take the product to the warehouse, assess the quality of the product and then offer to sell the product at a convenient price when required. Here, the advanced technology like registration system through mobile app needs to be done and to get the slot when to meet the NWR official for negotiation purpose to avoid the crowding. Through this, the farmers of the remote area will directly sell their products without the help of the intermediary. The function of this needs a mission mode approach.

(ii) Introduction of the compulsory Quality Assessment

Particularly the commodity that is exported to long distance needs quality assessment at Agricultural Produce Market Committee for as many commodities as possible. After the quality assessment is done, the officer concerned needs to issue a certificate indicating the quality and quantity of the product. Then that will be offered for the sale through e-NAM when the farmer needs to sell. This will help to purchase the product from the remotest part of the country by assessing the quality and reducing the intermediary. Here, the advanced technology like a mobile app can be used for the registration purpose to book the slot when to brought into APMC by avoiding overcrowding and maintaining social distance.

(iii) Farmer Union

Farmer Union and cooperatives can collect the product from the farmers, assess the quality, pack it and then offer it for sale through their own portal to the consumer. Large Farmer Union can reach out to distance retailers, consumers and e-commerce companies.

(iv) E-commerce

Government needs to develop e-commerce to directly purchase the product from the farmer and sell it to the consumer.

All the above-mentioned activities need huge employment in various categories like assessing the quality, purchasing the product, selling the product, home delivery to consumer, packaging the product and transporting the product. The skill of the repatriated migrants will be mapped and will be engaged thereon, which will solve the paradoxical situation like labor shortage, in this field on the one hand and surplus of the labor because of the returnee migrants to their native place. So, it will save the lives and livelihood of the farmer and migrant labor.

6.2 Perishable Commodity

Generally, perishable commodities are sold in the nearby centers. Here, the Government needs to form an organization by taking the farmers and e-commerce companies for the effective production and smooth selling of all the products. The organization needs to develop software for matching the demand and supply of the perishable product. The selling of the product through e-commerce urgently needs a broadband connection in the remotest area of the country. Once this activity is completed, the volunteers from the agricultural graduate and diploma holder will be engaged to train the farmer, repatriated migrants to get employment in this field. This can be done by following the social distance and safety measures.

6.3 Technological Aid for Re-engineering Agricultural Supply Chain

To overhaul the existing supply chain of agricultural produce, technological aid is a must. Technology is there to upgrade the system, but the problem lies with how to make the best use of it. Since the repatriated migrated workers have some sort of skills to work with technology and as such, they have the mindset not to work in a filthy environment, gaining the knowhow to adopt the technology is not a difficult task for them. By using the information and communication technology, they can learn the technique to effectively adopt modern technology. They can develop a network through social networking sites which may help to stretch the reachability

of the agricultural produce. Moreover, the Internet of Things can facilitate safety measures for storing the products in a better way. Through e-commerce and cooperative societies, the farmers can be motivated to produce more as the marketing of their product will be taken care of well. Moreover, financing the agricultural sector can be done digitally for which the farmers need to have knowledge on usage of digital technology. This facilitation can be made available to the farmers by an organization working in different layers of the supply chain.

7 Conclusions

The Sustainable Development Goals are to end hunger by achieving food security and improved motivation and ensuring sustainable consumption and production can be achieved through effective management of the Agricultural Supply Chain. So the main task is to identify the potential risk associated with it in the Covid-19 pandemic situation and take effective measures and resolve it. Similarly, Sustainable Development Goals will be nullified unless and until problems of the repatriated migrants are solved. So, different policy measures need to be taken to engage these repatriated migrants for the effective management of the Agricultural Supply Chain. By re-engineering the agricultural supply chain, both the producers and consumers of agricultural produce will be benefited. In the process, job opportunities can be created for the repatriated migrants. Although the agricultural sector of Odisha has the potential to accommodate the repatriated migrants effectively, it may not take place automatically. Intervention from the government side is required. In fact, government has already started using technology in different activities of the rural economy. However, concerted efforts are required in this direction to have the desired result.

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A Comparative Study on the Identification of Informative Tweets Using Deep Neural Networks During Crisis

T. Ramya and J. Anita Christaline

Abstract The social media platform Twitter is considered as a vital source of information during the time of crisis events which shares a variety of information about injured or dead people, infrastructure damage, affected people needs, and missing or found people, among others. The information shared on social media is either textual messages or images. Informative tweets are helpful to the victims and humanitarian organizations that require details. So identifying the informative tweets from crisis-related data collected from Twitter is a challenging task, and we are in need of specialized machine learning algorithms for automatic identification. This review article gives an overview about crisis-related dataset, classification of tweets, preprocessing methods, methodology, and machine learning algorithms used in their study. This article also gives an overview of a few works of the author related to classifying useful images shared during a crisis on Twitter. The classifying algorithms of Naive Bayes and SVM are analyzed in this article. By using different algorithms for various datasets, a comparative study has been done. The performance of datasets collected during various crisis events is collected and compared using the parameters AUC, precision, recall, and F1-score.

Keywords Twitter · Algorithms · Disaster · AUC · Recall

1 Introduction

Twitter is a micro-blogging site in which users can post and interact through messages known as tweets. Tweets are visible to everyone by default. The senders can send messages only to their followers; they also mute others with whom they do not want

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to interact and block them from viewing their tweets. Twitter acts as a source of news provider at the time of crisis. It provides timely access for information seekers during a disaster. Twitter provides details about disaster events much faster than other news providers. These details are available in future for reference. In Twitter, Retweet feature is used to republish a post hence the information can be shared with more people. Hence, Twitter acts as a vital source of information sharing during crisis events. Since the varied tweets are broadcasted rapidly using classifiers, extracting the needed information alone is a challenging task. The authors study about the tweets collected during various crisis events and found that all crisis-related social tweets are related to one of the following categories like affected people, infrastructures and utility damage, caution and advice, sympathy and emotional support, donations and volunteer, and other useful information. However, automatically classifying tools for extracting useful information is largely unavailable [1]. In this review article, we compared different classifiers used by the authors to classify the tweets, performance evaluation and also investigate information extracted for an Identification of Informative Tweets Using Deep Neural Networks during crisis events [2]. The following section describes crisis-related dataset, classification of tweets, preprocessing methods, methodology, and machine learning algorithms used in their study.

2 Crisis-Related Dataset

The collection of data from social media is an important task to create models for automatic detection of particular tasks. Researchers have scraped tweets based on hurricanes, floods, earthquakes, wildfires, etc. from Twitter and made the data available for public use. Images posted during four natural disasters Typhoon Ruby, Hurricane Matthew, Ecuador Earthquake, and Nepal Earthquake were used for evaluation [3]. Nearly 3518 images were selected and a Damage severity assessment was done and classified the images into three categories severe, mild, and no damage. Twitter datasets collected during the 2015 Nepal Earthquake (NEQ) and the 2013 Queensland Floods (QFL) of nearly 21,703 tweets were taken and classified into relevant and non-relevant data. They consist of both labeled and unlabelled data from related events [4]. Crisis MMD datasets consist of data related to seven natural disasters Hurricane Harvey 2017, Hurricane Maria 2017, California Wildfires 2017, Mexico Earthquake 2017, California Wildfires 2017, Iraq-Iran Earthquake 2017, and Sri Lanka Floods 2017 with 3.5million tweets and 176,000 images. In this paper, the author focused on both textual content and labeled images to extract useful information hence it is useful for many humanitarian organizations to plan for relief operations [5, 6]. Crisis NLP dataset which consists of data related to various crisis events is taken and CNN with word embedding model is used for the classification of textual content from Twitter during a crisis and achieves the best performance compared to other models [7]. CrisisLexT26 dataset which consists of crisis-related events from 2012 to 2013 was taken and performs identification of different information categories using the

CNN model [8]. The dataset collected from Twitter's API using the hashtag #Joplin, #sandy was used to identify useful textual content using a model based on conditional random fields and achieves a 90% detection rate [9]. The authors collected the data from Twitter based on the event Hurricane Florence 2018 which provides a detailed picture about the affected people, areas, and utilities damage [10].

3 Preprocessing Methods

Preprocessing is required for data collected from Twitter since tweets consist of misspelled, incomplete, and grammatical error sentences. To preprocess the input data, CNN with a pre-trained word vector model developed by Kim is used for sentence-level classification tasks [8–11]. Lovins stemmer was used to remove errors [12]. Feature selection methods of unigrams and bigrams are used for classification tasks. The author used an approach of the jieba segmentation package for automatically detecting Chinese text from the Twitter dataset [13]. The CSAE—Convolutional Sparse Auto-Encoder is used to extract the Chinese text [14]. The preprocessing steps of Stemming, Stop word Removal, and Spell Check are used during the stemming process [15].

4 Methodology

The various methods used for the automatic detection of crisis-related messages on Twitter are shown in the figure.

5 Machine Learning Algorithms

Supervised learning is the machine learning algorithm which consists of a trained dataset which maps the input variables and predicts the output variable. A semi-supervised learning approach based on self-training-based and graph-based experiments done for the datasets collected from Twitter. The graph-based semi-supervised learning algorithm achieves better results in terms of F1-score [4]. The machine learning classifiers SVM (TF-IDF) and SVM (Word2Vec) are used for identifying the tweets related to crisis events [1]. A Transformer-based machine learning technique called Bidirectional Encoder Representations from Transformers (BERT) is used for natural language processing (NLP) [16]. Domain adaptation with the Naive Bayes classifier algorithm is used to classify the tweets from labeled and unlabelled data [17]. To evaluate the Crisis2Vec dataset, a linear model of Logistic Regression and a non-linear model of LSTM—Long Short-Term Memory are used to evaluate the performance [6]. An innovative AI technology called a knowledge graph (KG)

covers Opportunities, Challenges, and Implementation of COVID-19 KGs in industry and academia [18]. Text steganalysis model based on CNN framework is used for better identification of short text [19]. An unsupervised machine learning approach of a convolutional sparse auto-encoder (CSAE) is used to pre-train the CNN model for extracting the Chinese text from images and also achieves better results [14]. A supervised network of CTR—candidate text region generation method is based on text-aware saliency detection to predict the initial location of the text [20]. Naive Bayes text classification algorithm is used to identify the text based on opinion [11] (Table 1).

Table 1 Various methods on the classification of text and images

Method	Author	Crisis event	Remarks
Image4Act	Firoj Alam (2017)	Cyclone Debbie (2017)	Focused on imagery content posted on Twitter to help humanitarian organizations to perform relief operations
Manual Annotations using Crowdsourcing	Firoj Alam (2018)	Hurricane Harvey 2017 Hurricane Maria 2017 California Wildfires 2017 Mexico Earthquake 2017	Focused on multimodal dataset which includes textual as well as imagery content
Word embeddings	Reem ALRashdi (2018)	Crisis NLP dataset	Bidirectional Long Short-Term Memory *(Bi-LSTM)* with word embedding is used for detecting crisis-related information
CRISIS EVENT EXTRACTION SERVICE (CREES)	Grégoire Burel (2018)	CrisisLexT26 dataset	CREES is a web API that automatically classifies the crisis-related textual content
Sem-CNN model	Gregoire Burel (2017)	CrisisLexT26 dataset	CNN Model with semantics of words is used for text classification
Model based on conditional random fields	Muhammad Imran (2013)	Joplin 2011 Sandy 2012	Achieves low detection rate in identifying relevant information

(continued)

Table 1 (continued)

Method	Author	Crisis event	Remarks
Artificial Intelligence for Disaster Response (AIDR)	Muhammad Imran (2014)	Earthquake in Pakistan 2013	AIDR is a open-source platform which combines human and machine intelligence and achieves a classification quality of 80%
Word2vec	Muhammad Imran (2016)	Twitter corpora—52 million crisis-related tweets collected from 19 crisis events	A language model is trained to identify OOV—Out of vocabulary words. Misspellings with one edit can be predicted
NMF—non-negative matrix factorization topic modeling	JensKersten (2020)	Hurricane Florence 2018	NMF is an effective tool to identify crisis-related topics
Domain adaptation approach	Hongmin Li (2017)	CrisisLexT6 dataset consists of about 10,000 labeled tweets collected from six disasters events is evaluated	This method classifies unlabelled target data along with source labeled data of the event

6 Evaluation Metrics

The performance of each model has been evaluated using AUC, precision, recall, and F1-score. It is shown in Table 2.

7 Comparison Chart

The figure shows the comparison chart of various parameters like F1-score, Precision, Recall, and Accuracy of various algorithms like crowdsourcing, CNN crisis embedding, BiLSTM crisis embedding, Sem CNN model, TLex embedding, Markov chain algorithm, and SVM algorithm. The graph shows that F1-score is high for TLex embedding algorithm, Precision and Recall are high for the Random Forest algorithm, and accuracy is high for Image 4 act methodology compared to other algorithms.

The Graphical Representation of F1-score of different algorithms is depicted in Fig. 1a. The graph shows that TLex algorithm has a better F1-score in comparison with other algorithms.

The Graphical Representation of Precision of different algorithms is shown in Fig. 1b. The graph shows that the Random Forest algorithm which is implemented

Table 2 Evaluation metrics of various methods

Author name and year	Dataset	Class definition	Performance measurement parameters
FirojAlam (2017)	Cyclone Debbie (2017)	Crowdsourcing task used to classify an image based on severe damage mild damage, no damage	Relevancy Evaluation AUC = 0.98 Precision scores = 0.67
Firoj Alam (2018)	Nepal Earthquake 2015	Relevant non-relevant	AUC = 66.49 Precision (P) = 67.48 Recall (R) = 65.90 F-measure (F1) = 65.92
ReemALRashdi (2018)	CrisisNLP dataset	Affected individuals, donation needs, volunteering services, infrastructure and utilities, sympathy and support, relevant and irrelevant	**CNN** Crisis embedding F1-score = 61.38 GloVe embedding F1-score = 59.87 **Bi-LSTM** Crisis embedding F1-score = 60.88 GloVe embedding F1-score = 62.04
Gregoire Burel (2017)	CrisisLexT26 dataset	Related/Unrelated Event Types Information Types	**SVM-Related/Unrelated** Precision (P) = 0.870 Recall (R) = 0.738 F-measure (F1) = 0.785 **SVM-Event Types** Precision (P) = 0.997 Recall (R) = 0.616 F-measure (F1) = 0.997
			SVM-Information Types Precision (P) = 0.642 Recall (R) = 0.604 F-measure (F1) = 0.616
Muhammad Imran (2013)	Joplin 2011 Sandy 2012	Personal Informative Other	Detected tweets = 52 Detection rate = 49% Hit ratio = 90%
Marc-Andre Kaufhold (2020)	European floods dataset 2013	O—Off-topic, R—On-topic, relevant to situational awareness N—On-topic, irrelevant to situational awareness	**Random Forest algorithm** Precision (P) = 98.3% Recall (R) = 80.4% Accuracy = 91.3%

(continued)

Table 2 (continued)

Author name and year	Dataset	Class definition	Performance measurement parameters
Juan Wen (2019)	COCO dataset	Short text detection, long text detection	**TLex embedding algorithm** Accuracy = 0.94 False Negative Rate = 0.07 Precision = 0.96 F1-score = 0.94 **Markov Chain-based method** Accuracy = 0.84 False Negative Rate = 0.22 Precision = 0.89 F1-score = 0.83

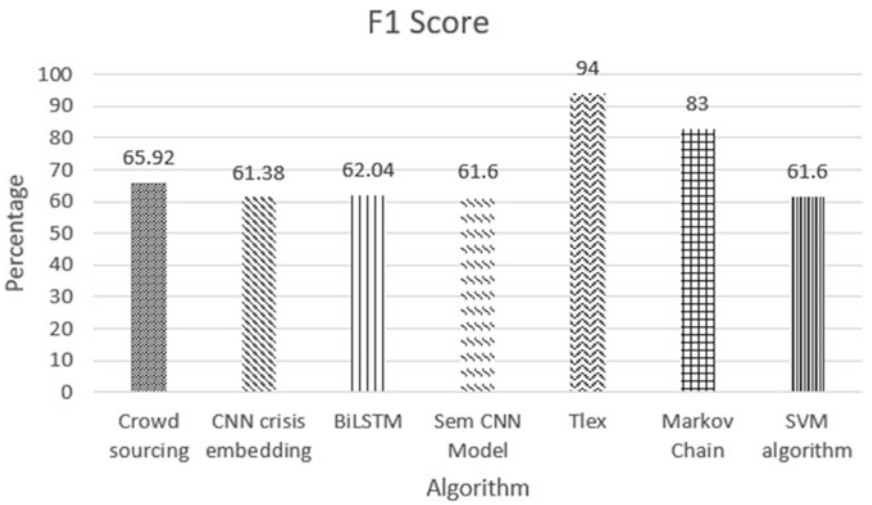

Fig. 1a Graphical representation of F1-score of different algorithms

using the European flood dataset has a high Precision Score in comparison with other algorithms.

The Graphical Representation of the Recall score of different algorithms is shown in Fig. 1c. From the figure, it is identified that the Random Forest algorithm has a better Recall Score and classified the datasets into relevant and irrelevant.

The Graphical Representation of Accuracy of different algorithms is depicted in Fig. 1d. The graph shows that an Image 4 act algorithm has the highest accuracy when compared to other algorithms.

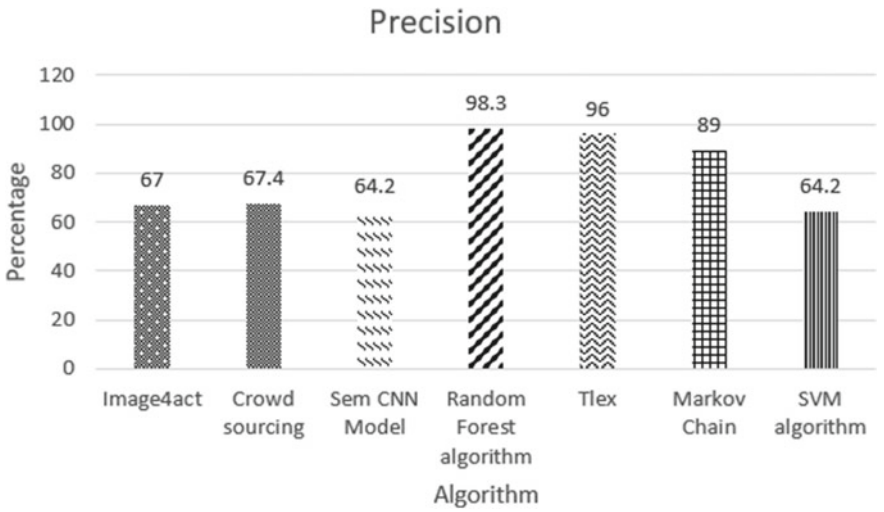

Fig. 1b Graphical representation of precision score of different algorithms

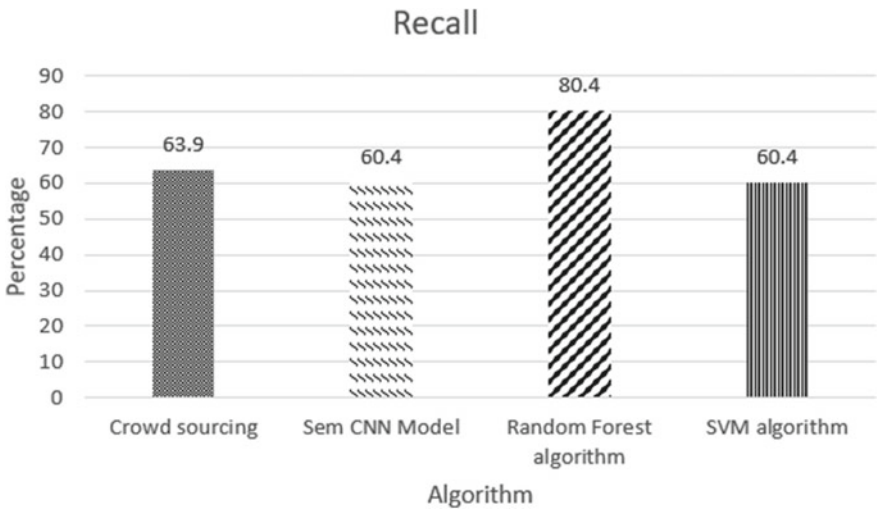

Fig. 1c Graphical representation of recall score of different algorithms

8 Conclusion

This work has detailed the classification of tweets, datasets, preprocessing methods, and machine learning algorithms used in their study. The performance of each model is evaluated using the parameters AUC, precision, recall, and F1-score is discussed. The classifying algorithms of Naive Bayes and SVM are analyzed and it shows that

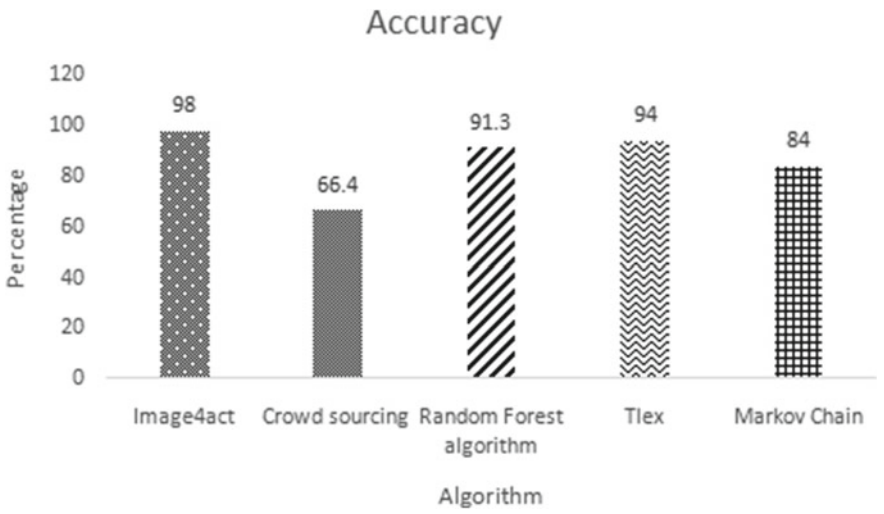

Fig. 1d Graphical representation of accuracy of different algorithms

SVM outperformed compared with other classifiers. This article gives a brief review of the existing publication works which focused on detecting the related, relevant, event types, information types, tweets, and a few works based on detecting images related to crisis events from Twitter and detecting informative textual content from images, detecting Chinese text, etc. The evaluation metrics of various algorithms were analyzed in the graph. From the chart, it is found that the TLex algorithm which is implemented using the COCO dataset has a high F1-score of 94%. The Random Forest algorithm which is implemented using the European dataset has high precision and recall scores of 98.3 and 80.4 percent. An Image 4 act algorithm which is focused on predicting images related to disaster posted on Twitter achieves the highest accuracy of 98% compared to other algorithms. Hence, a detailed analysis related to methodology, algorithms, datasets used, and evaluation metrics of various methods has been analyzed in this review article. The Future directions of the research may focus on the evaluation of other machine learning algorithms with improved evaluation metrics.

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Real-Time Implementation of Caption Generation System Using LSTMS and WEB API

M. Shunmugathammal, V. Kamatchi Sundari, and Manikenti Gnana Prakash

Abstract Automatic captioning for images brings together the latest advances in computer vision research. This paper will explore sentence-based unidirectional matching of images and their descriptions. The proposed image captioning model is accomplished by generating novel captions of any image using deep learning techniques. This proposed model is evaluated based on image retrieval and sentence generation. During the image retrieval phase, the objects in the image are detected using a Convolutional Neural Network's pre-trained model like InceptionV3. After the objects have been detected using CNN, a syntactically and semantically proper caption for the image is generated utilizing a Recurrent Neural Network with Long Short-Term Memory (LSTM) and its attention mechanism in the sentence production phase. The efficiency of the proposed work is assessed using the Flickr8k dataset. The proposed model produces significant results when compared to the existing blue metric algorithm and other state-of-the-art techniques.

Keywords Captioning model · Image retrieval · Sentence generation · Recurrent neural network · Convolutional neural network · Long Short-Term Memory (LSTM)

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1 Introduction

Caption Generation is one of the interesting and centralized areas of Artificial Intelligence which has many challenges to pass on. Image description provides the process of describing the content from an image. The idea is based on the detection of objects and what actions are in the input image.

On seeing Fig. 1, some of you might say "Two men on top of a hill", some say "A man riding a bike". Surely, the captions mentioned above are applicable for the figure, and there could be a couple more. Yet, the point I need to make is, it's so natural for us, as individuals, to simply have a look at an image and portray it in a proper language. Indeed, even a 5-year-old could do this effortlessly. Yet, would you be able to compose a PC program that accepts a picture as information and produces an applicable subtitle as yield?

This problem could be solved by caption generation. For doing this, bottom-up and top-down approaches are two main approaches to image description. Bottom-up approaches generate contents in an input image, and then combine them into a caption. Top-down approaches generate a semantic representation of an input image where a deep CNN is used to generate a vectorized representation of an image that is given as an input to LSTM to generate the caption. Image description could have many benefits. It enables community administrators to monitor interactions and analysts to formulate business strategies. This proposed model is helpful for the person who is vision impaired.

Fig. 1 Sample picture

2 Previous Works

Since the birth of the Internet and its widespread acceptance as a means for sharing images [1, 2, 4], the problem of image captioning and sophisticated solutions has emerged. There are many proposed solutions to this problem which are replacing the previous solutions every single day. Wang et al. [1] proposed a system which uses multimodel neural networks to generate novel descriptions of the image by providing suitable descriptions for the image.

Soh [2] employed an ImageNet-based database, which is a large-scale collection of figures built on the WordNet structure's core. This model uses ImageNet to generate sentence descriptions from the images. Jia et al. [3] proposed an attention-based model, which generates captions of the images based on the region of interest. This model generates the captions based on the region the image is surrounded by. Ding et al. [5] proposed a multi-modal recurrent neural network-based model, which generates the descriptions of the image by detecting the objects and converting them to sentences, which is almost similar to the human visual system. After thorough training, Qu et al. [6] introduced a model based on a convolutional neural network which was used in machine translation and image fusion to generate inscriptions about the images. Chen et al. [7] proposed a model that uses natural language processing and computer vision to give rise to natural inscriptions of a picture depending on word processing and keyword retrieval strategies that assure that the resulting sentence will perfectly describe the target image in the vast majority of cases. Researchers from several disciplines have proposed a variety of methods and strategies [8–11]. Arthi et al. [9] proposed object detection with computer vision with real-time analysis using the YOLO technique.

3 Proposed Model

3.1 Transfer Learning

In this proposed model shown in Fig. 2, transfer learning is used to create pre-trained models in solving machine learning problems. It is the way to store knowledge in that model gained by solving a problem and use it later to solve another problem. In this model, a pre-trained model is used with transfer learning to make the new model learn things from the existing knowledge. Training a model takes more time and other processes could be involved with it; this could be avoided by using json format for saving. With this new saving in json format, training would not be necessary again and again.

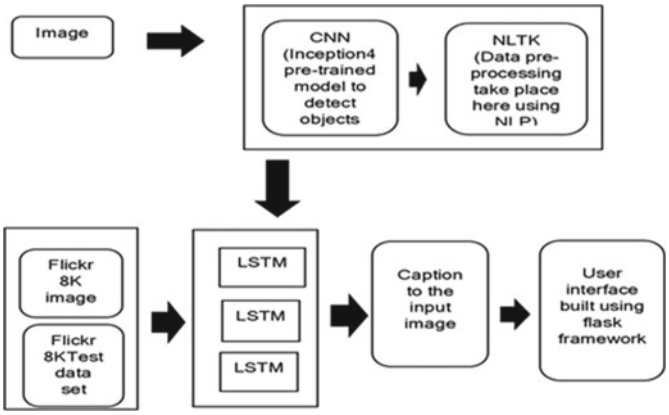

Fig. 2 Proposed model

3.2 Feature Extraction

During this phase, objects in the pictures were discovered. It extracts the features from the image using a Convolutional Neural Network (CNN). A pre-trained model would be employed like InceptionV4 which could be a Convolutional Neural Network for the task of object detection. Each and every object in the image is detected in this phase. The objects were also marked with their names.

3.3 Probabilistic Model

The objects detected in the image were sent through the Natural Language Processing (NLP)-based probabilistic model, which removes unnecessary features from the image. It processes only the features which are relevant and meaningful with the context of the image and ignores the odd ones which are irrelevant. It also removes the stop words which are repeated and have the same meaning.

3.4 Long Short-Term Memory (LSTMs)

This step combines the object detection and probabilistic model phases to build inscriptions for the image. The output of the previous phases is input into a Long Short-Term Memory (LSTM), which is a type of Recurrent Neural Network (RNN), to construct the captions. It allows RNN to continue to learn over multiple steps by maintaining a consistent error by preserving errors that can be backpropagated through layers and time. Captions were produced in this phase.

Different layers in LSTMs generate multiple captions from the image. The captions generated from the top layers of the LSTMs were ranked based on the captions which were supported by more numbers of LSTM layers. The caption which gets the top rank will be treated as the final caption. Different layers of LSTM generate their own captions. The caption which is supported by a greater number of LSTMs will be taken as the final caption.

3.5 Model Training

During the phase of training, an image dataset could be provided as well as the captions of these images to the model. The inception model which is pre-trained could detect all the feasible objects present in the image. After observing the image, the LSTM component is used to predict each and every word from it. To each and every caption, starting and ending symbols too could be added to recognize the sentence. If any stop word is approached in the sentence, it stops sentence formation and marks as the end of the string. The loss function could be calculated by using Eq. (1). 'I' stands for the input image, while 'S' stands for the generated caption in Eq. (1). In the process of training, the loss function needs to be minimized. After training the dataset with the RNN-based Long Short-Term Memory (LSTM), the descriptions of the trained images were stored in a separate text file.

$$L(I, S) = -\sum_{t=1}^{N} \log p_t(S_t) \tag{1}$$

3.6 Model Deployment

Finally, the aim of the project is to deploy the caption generation model in the form of web application. Flask Rest API is used here, which is a web framework of Python to deploy the working model. Flask is one of the popular Python Web development frameworks to develop and deploy models into web applications. To design the interface of the web application, html, css, and bootstrap are used.

Fig. 3 Flicker8K dataset

4 Implementation and Results

4.1 Dataset

Choosing the dataset to train a new model is a bit challenging. There was more than one dataset to fulfill this purpose which includes MS-COCO dataset (containing 180 k images), Flickr30k (containing 30 k images), Flickr8k (shown in Fig. 3) (containing 8 k images), but Flickr8k could be chosen to train and test this model. Because the new system is linked with time and sources, 6,000 pictures were used for training, 1,000 for validation, and 1,000 for testing.

4.2 Pre-Processing for Caption

Each image includes five inscriptions (captions). The major function presented here is the Clean () function, which extracts all of the captions and cleans them up:

1. Eliminating punctuation marks;
2. Removing words with numbers in them;
3. Changing all of the captions to lowercase;
4. Tokenization could be applied to the dataset and a fixed vocabulary size of 8,464 is used here to exclude special tokens (such as '%t', '$', '#', and so on).

4.3 Image Pre-Processing

Any image could not be fed directly to this model; for that, some pre-processing techniques should be applied before feeding it to our model. The following 3 steps are essential for pre-processing:

1. Reduce the size of each image to 299*299 pixels for the exception model and 224*224 pixels for the VGG-16.
2. Make it flat.
3. Image pixel scaling (normalization).

4.4 Hardware and Software

The Python programming language was used to implement the model. The deep learning model was implemented using Keras 2.0. TensorFlow is a Google-developed deep learning library that is used as a posterior for the Keras framework for building and training deep neural networks. Google Colab was used to train the neural network. To implement this model, two neural networks were trained on the Nvidia GeForce 1050 Graphics Processing Unit: one is Convolutional Neural Network and the other is Long Short-Term Memory. Transfer learning uses pre-trained models to deal with complex object detection tasks. This model is trained using the Flickr8k dataset which generates sequences using CNN and LSTM which is used to generate captions from the input image. The image features are preloaded in order to deploy the image captioning model in real time. The following 4 APIs are used as an interface to deploy our model. 1. Flask Rest API, 2. Keras Tokenizer API, 3. Keras VGG-16 API, and 4. Keras Xception API. First, the VGG net model allocates probabilities to all of the items that could be present in the picture. The model converts the image into a word vector. This word vector is fed into LSTM cells, which subsequently create a phrase out of it. Figure 4 depicts the image of caption generator.

Figure 5 depicts the created sentences. Generated sentence is "man in blue jumping up into water" while actual human-generated sentence is "The man wearing blue shorts is jumping into the water".

5 Evaluation

During the evaluation of this new model, many obstacles were encountered. The first issue is a difference in convolutional feature extractor selection. VGG-16 and Xception models were employed for identical decoder architectures. These two models were trained to do image codification on 1000 different classes of images using the ImageNet dataset. However, the primary goal is to obtain a fixed-length informative vector for each input image rather than to classify it. This is referred to as automatic

Fig. 4 Image of caption generator

Fig. 5 Output image

feature engineering. As a result, the last Softmax layer could be deleted from the two models, and each image could be extracted as a 2048-length vector (bottleneck features) from the preceding layer. The second challenge is a single model versus ensemble comparison. While others have shown performance boosts by using association, results of the proposed model report a single model performance. The proposed model was compared against a number of existing models, and in every case, the new prototype outperformed the others. The proposed model is tested with 100 images of four different varieties includes people's faces, location-specific images, animal images, and other objects. The proposed model outperformed other models in all four cases.

6 Conclusion

For the captioning of images, a deep learning approach was used in this work. Keras' sequential API was merged with TensorFlow as a backend to generate a deep learning architecture that determines objects and captions for images using several neural networks such as Convolution Neural Networks (CNN) along with Long Short-Term Memory (LSTM). To deploy our model as a web application, Flask is used, which is a powerful Python web framework. Results could be improved to a great extent by a lot of modifications which include the following 3 parameters: 1. Making use of a vast dataset. 2. Performing additional hyper-parameter tuning (group normalization, group size, the quantity of layers, the quantity of units, learning rate, dropout rate, etc.). 3 To learn about overfitting, and use the cross-validation set.

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Smart Segregation Bins for Cities Using Internet of Things (IoT)

K. Srisabarimani, R. Arthi, S. Soundarya, A. Akshaya, M. Mahitha, and Sruthi Sudheer

Abstract Waste management includes various activities like the collection of waste, treatment of waste, and other such actions which if neglected will become a threat to the environment. Among these, one such significant activity is the segregation of waste. Though people tend to use the manual segregation of waste using different colors of dustbin, the sustainability of this process does not last for a much longer time. In this paper, the first half of the operation concentrates on segregation of wastes which is performed with the help of sensors and few other components, whereas the second half of the operation involves monitoring the real time updates of the dustbin which is implemented using IoT. We have used IR sensor, Ultrasonic sensor, and capacitive sensor to sense the presence of the waste, measure the level of the waste, and identify the presence of plastics, respectively. Components like an air blower, a microcontroller, rotating disk, servo motor are used to perform the action of segregation. With the help of a cloud server system, all the data of the dustbin will be stored, and using the Wi-Fi module, these data can be monitored. Even though we tend to segregate the wastes into plastic and reusable wastes, the collection of wastes from the garbage bin will be done manually because we do not want our technology to affect the work of daily laborers and eventually lead to unemployment. Keeping all these factors in mind, we have proposed this idea which will help definitely pave a way for the betterment of the society.

Keywords Ultrasonic sensor · Air blower · Arduino Uno · The internet of things · The waste management control room

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1 Introduction

A sophisticated method of waste management has an adverse effect on human health and the environment. Almost every street in India has a minimum of one dustbin in each corner where all the waste is dumped together. Even though people throw the waste inside the dustbin, quiet later after continuous dumping of waste inside the bin, it gets overflowed which would eventually result in air pollution and many other environmental issues. The segregation of the waste is so complicated that it requires more space and time. This smart segregation bin tends to separate waste into two categories—plastic waste and reusable waste. It comprises of few sensors which will be attached to either side of the bin. With the help of the sensors and air blower, the types of wastes can be categorized. The ultrasonic sensors are also installed with which the level of wastes dumped can be determined. Every dustbin has its own ID tags which contain all the information about that particular bin. When the garbage is about to overflow, it will give an alert message to the data center of the waste management control room where the level of both sides of the bin and the temperature are being indicated, using the Internet of things (IoT) through a microcontroller which is the Arduino Uno that has stored all the details regarding the bin within it. Then necessary action to collect the garbage will be taken by tracking the location through ID tags attached to each smart bin. The SMART SEGREGATION BINS indeed makes the city smart as it has many advantages which will ultimately increase the betterment of the society.

The segregation of plastic waste and reusable waste provides a sophisticated method of waste management that has an adverse effect on human health and the environment. The project contains a few sensors which will be attached to either side of the bin through which the types of waste will be categorized. It has been found that 50% of Indian residents face the problem of improper waste collection and management. This method helps to control waste management, which will pave ways for making smart cities much more efficient and clean. It also helps to create a healthy environment by reducing health risks and hazards that affect mankind. Proper waste management helps us to improve the quality of waste as well as reduce the emission of greenhouse gases. So, when they collect the waste, they are usually retrieved for redistribution, recycling, and reusing of wastes, thereby reducing pollution and other health hazards.

By implementing this method, proper waste management can be taken into account and thus utilization of resources will also increase. The smart bin is an efficient and hygienic waste disposal and segregation system which will eventually help in waste optimization.

2 Related Works

A system has a belt that is driven by dc-motor to carry the waste to the dustbins with help of sensors [1]. The metal detectors are used to separate the metallic wastes which are collected to the separate bins. Likewise, the dry and wet wastes are also collected in separate bins. The segregation method implemented is effective and helpful to the municipality for the separation of metallic waste, dry waste, and wet waste. This segregation is carried on with the help of sensors.

A smart waste bin based on the Internet of Things (IoT) [2] and the corresponding real prototype. The detail about waste in the garbage is collected and the details are transmitted over the internet. With this, the real-time status can also be viewed using any tools available online by the citizens and checks the status of availability of bins that are around different areas of the city.

A system that claims to sort the waste into wet, metallic, and dry wastes using an automatic waste sorter and a robotic waste delivery system [3]. Right after the IR sensor detects the existence of the waste, the robotic arm collects those wastes and using AWS, the sorting process is done. With the help of sensors and a robotic arm, the results of the experiment carried out are successful.

An alert system to the user about overfull of waste and manages the system and provide fully automated smart bin [4]. It also predicts if waste is wet or dry. It is efficient and saves time, helps in waste collection and management.

A mechanical arrangement for dry waste and wet waste are separated and collected into a container [5]. The dry wastes are detected using IR sensor and wet wastes are detected using moisture sensor. The percentage of waste available in the bins are represented graphically is uploaded to the application which can be viewed by the user who have account to the application. The user can access the application by using the username and password created.

A system developed by using raspberry pi contains a blower, a conveyor, and the sensors like moisture sensor, IR sensor, and capacitive proximity sensor to separate dry and wet waste [6].

The waste is separated into metallic and non-metallic waste. The experiment analysis comprises of 3 stages, where in stage 1—the detection of metallic and non-metallic wastes observed using inductive proximity sensor. In stage 2—wet and dry wastes are observed and in stage 3—the isolation process takes place.

A system to use a parallel resonance impedance system along with few sensors in order to segregate the wastes automatically [7]. The experiment is carried out successfully and using IoT the type of waste and the quantity of waste is monitored.

A methodology that uses a capacitive sensor and inductive sensor [8]. The sensor checks the waste materials and segregates metallic and non-metallic wastes which are controlled by Raspberry pi and Think Speak web. The wastes are separated and composed in varying containers that ensures the industries that waste are segregated successfully in an effective manner and waste can be recycled. The entire process is carried on using Raspberry pi.

The system composed of ARM 7 microcontroller [9], sensors, and the IoT Technology, detects the level of dirt, once it reaches the threshold level, it sends a message to the Municipal/Government authority person with the location of that waste bins using Global Positioning System (GPS).

A container consisting of an Arduino Nano board and an ultrasonic sensor is used to sense the fullness level of the bins. The SMS alert was sent using the GSM module, which was operated using a solar panel and powered by a Lithium battery. This provides effective trash management on a small scale over various locations.

A system would be able to monitor the solid waste collection, process, and segregate dry and wet waste [11]. The waste segregator segregates the waste into three major classes: plastic, organic, and metallic using Arduino successfully.

A system to segregate the wastes into three categories—metallic, wet and dry at the disposal level itself [12]. With the help of an inductive proximity sensor, the conveyor belt and a high speed blower, the wastes are been separated automatically. The experiment is done by using household waste and the test results show positive sign in segregating the waste. The localization algorithms like Multilateration (MLAT) method, K-nearest neighbor (KNN), and Minimum Mean Square Error (MMSE) method with RSS for Wi-Fi [13]. This algorithm provides a correlation between the original data stored in the database and the location of the estimated bin with high accuracy and less error.

This approach provides a range of the network that is connected in the model by reducing traffic using LoRa and power that is consumed by the device [14], [15]. This approach discussed about low energy harvesting [16].

3 Proposed Work

The main aim of the work is to segregate the wastes into plastic and reusable automatically as shown in Fig. 1. A disk is kept at the top of the bin in which there is a slight opening in the plastic side through which the plastic waste enters the other side of the bin when the air blower is turned ON. The Capacitive sensor also senses the presence of plastic waste. Initially, the wastes are dumped into the dustbin. Sensing the presence of the object, the IR sensor turns the Air blower ON with the help of the microcontroller. According to researches, the density of plastic is comparatively less than that of reusable waste. So the air blower blows the plastic wastes to the other side of the bin. The Biodegradable waste is pushed down on the same side with the help of the servo motor, which, in turn, rotates the disk. This way both the plastic and the reusable wastes are separated. Ultrasonic sensors are used to measure the level of the waste on both sides sends an alert message when the bin is about to overflow through the microcontroller to the waste management control room where the temperature, levels of plastic waste, and the biodegradable waste of the bin is being monitored during IoT.

The necessary action to collect the garbage will be taken by tracking the location through ID tags attached to each smart bin.

In Fig. 2, to monitor the real time updates of the dustbin, we have used a cloud server system where all the data regarding the bin will be stored and using the Wi-Fi module these data can be accessed. We have created a web page where the database will be displayed. All the action is performed by IoT.

In Fig. 3, Arduino is the microcontroller for our operation. To this microcontroller, all the sensors as well as other components are attached. The IR sensor is used to sense the presence of the waste once it is thrown inside the bin. The two ultrasonic sensors kept on either side of the bin is used to measure the level of waste on both plastic and reusable side. In order to get better results, a capacitive sensor is used to detect the plastics inside the waste. To regulate the power supply from Arduino to servo motor, a motor driver is used so that the disk is made to rotate which will be helpful for reusable waste segregation.

In Fig. 4, initially, when the waste is thrown inside the bin, the presence of waste is sensed by an IR sensor. It will instruct the microcontroller which will turn on the

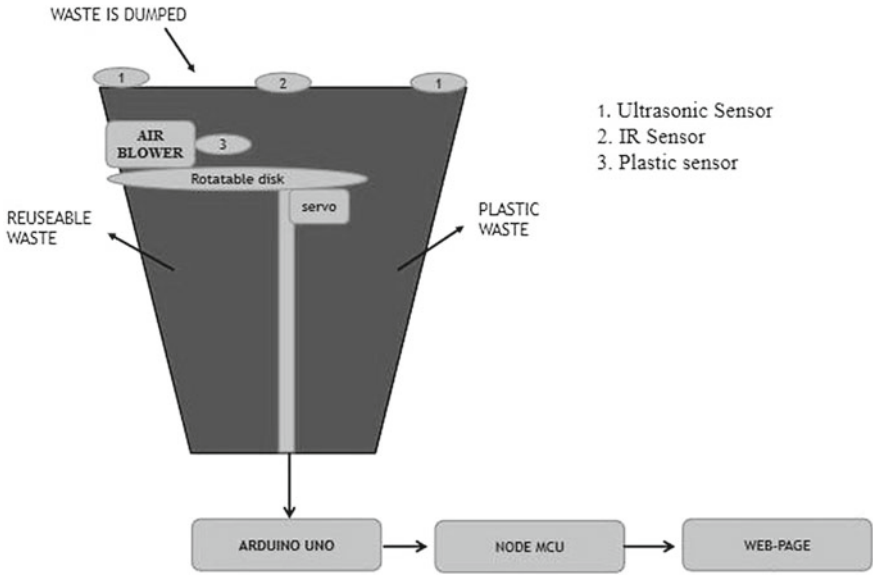
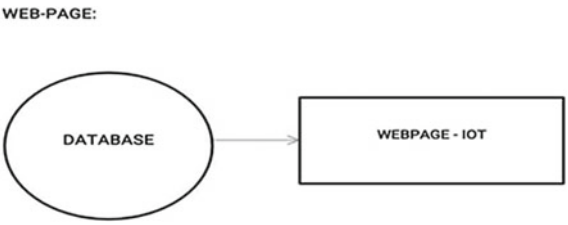


Fig. 1 The Design of smart segregation bin

Fig. 2 Web-page



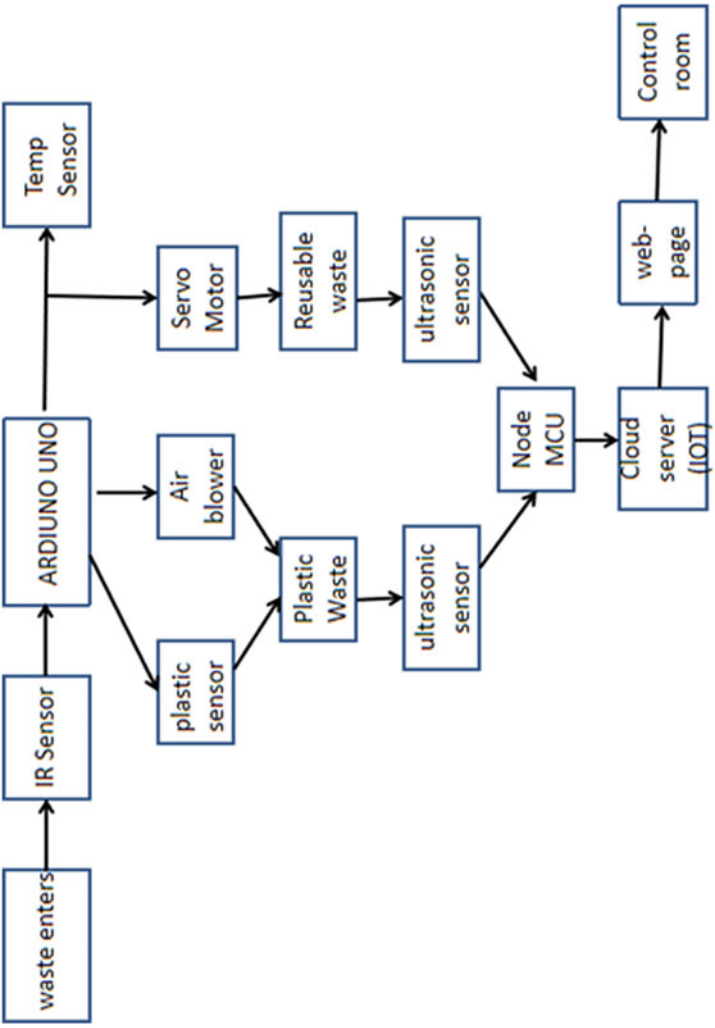


Fig. 3 The block diagram of smart segregation bins

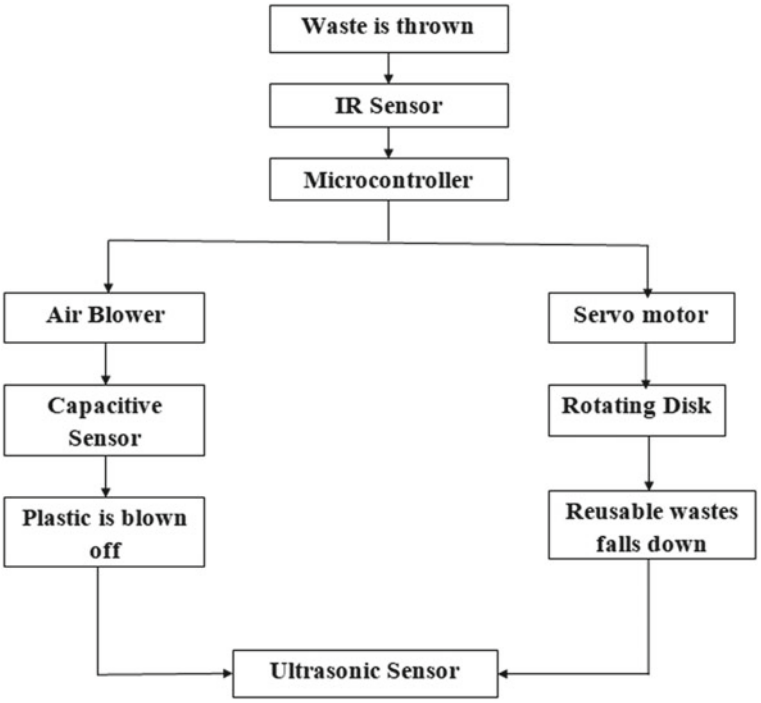


Fig. 4 The workflow of smart segregation bins

air blower which will blow off the plastic wastes to the other side of the bin since the density of plastic wastes is considerably less than that of reusable waste. According to the global survey, the density of plastic waste is found to be around 180 kg/m^3 and the density of reusable waste is around 459.35 ^{kg}/m^3 it will be easy to blow off plastic waste to the other side of the bin.

The capacitive sensor is used to sense the presence of the plastic, therefore, along with the air blower, the capacitive sensor also gives better results in segregating plastics from reusable wastes. The microcontroller will turn on the servo motor which will make the disk like structure to rotate. Once it begins to rotate, the remaining wastes which are the reusable wastes are made to push downwards so that they fall inside the bin. Likewise, the process is carried out until the waste on both sides is about to overflow.

Ultrasonic sensors are kept to measure the level of wastes on both sides. When it is about to overflow, an alert message is sent so that the waste can be collected from the garbage bin. Also, all information about the bin will be stored in the cloud server system, and using the Wi-Fi module, the real-time status of the bin can be monitored.

4 Result and Discussions

In Fig. 5, the circuit connections we have made for our project. It is clearly shown that the wires of the sensors and the rest of the other components are connected to the Arduino microcontroller. We use a relay switch to enhance the performance. Toward the downside, we have etched node MCU over the PCB board.

In Fig. 6., the connection of components that we have used in our project. To the top, the two ultrasonic sensors have been fixed. These two ultrasonic sensors detect the level of waste on either side of the bin. Exactly opposite to that is the infrared sensor which is used to sense the presence of waste once it is thrown in the bin. Besides is the temperature sensor, which is used to measure the temperature of the bin. Along the side is the air blower with the plastic sensor. This air blower is used to make the plastic waste fall off the other side of the bin when it is turned on, and in order to get better results, we have also used the plastic sensor. To the side of the rotating disk is the servomotor with which the disk is made to rotate.

In Fig. 7, the outlook of the prototype where sensors are attached to the sides. The plastic waste is separated from the reusable wastes using the air blower and in order

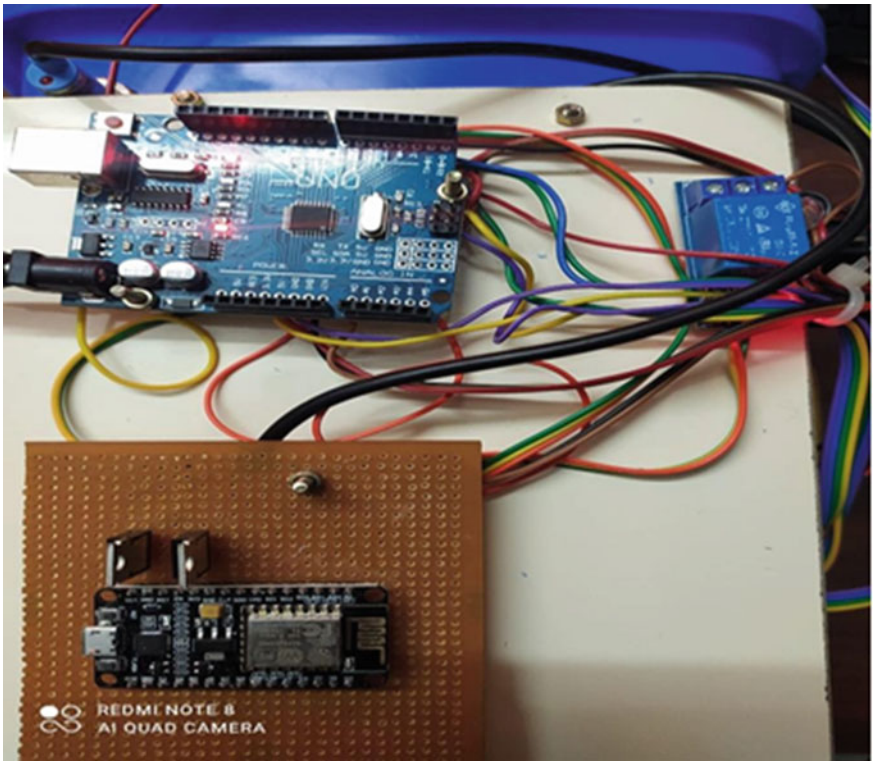


Fig. 5 Model Circuit

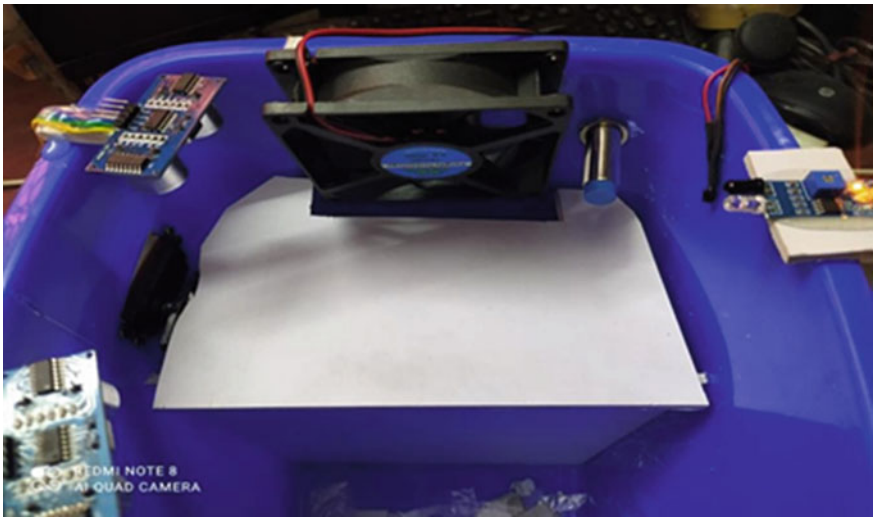


Fig. 6 Working model

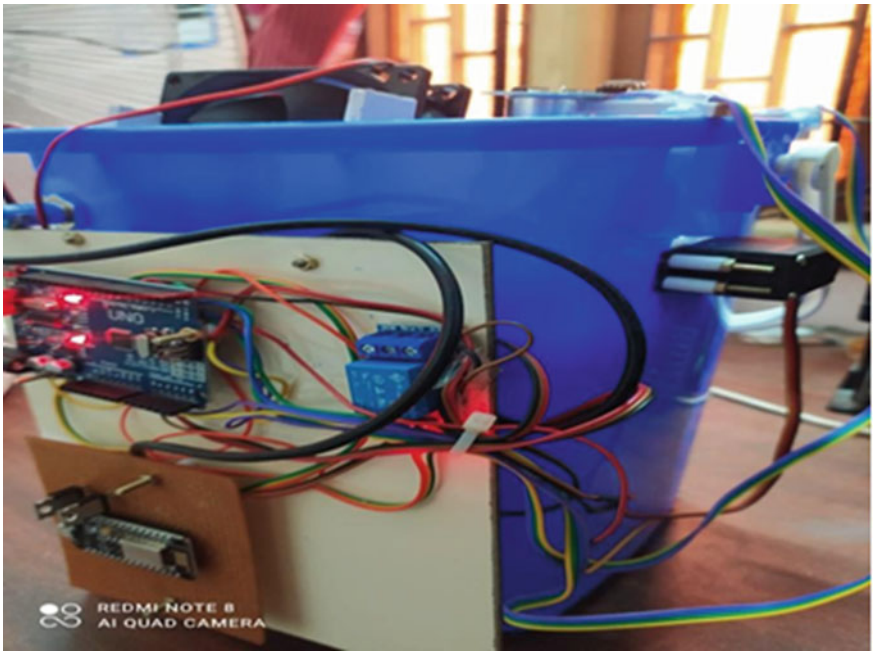


Fig. 7 Final outlet

to get more efficient results, the capacitive sensor comes into action which will sense the presence of the plastic. By this method, the plastic wastes will be separated from the reusable wastes. Then remains there usable wastes. The circular disk on top will rotate once the servo motor is turned on. There is a circular disk-like structure placed that contains the reusable wastes. When the servo motor is turned on, this disk-like structure is made to rotate, and is made to push downwards so that all the remaining reusable waste falls down inside the bin.

5 Experimental Explanation

In Fig. 8, we are performing the experiment by taking few plastic wrappers for plastic wastes and a wooden broken pencil and a vegetable to represent reusable waste. When the power supply is turned on, these wastes are placed on the rotating disk and the IR sensor senses the presence of these wastes. Then it will instruct the air blower to turn on through the Arduino Microcontroller.

In Fig. 9, the air blower blows off the plastic wastes to the plastic side of the bin since the density of plastic waste is considerably less than that of reusable waste, what

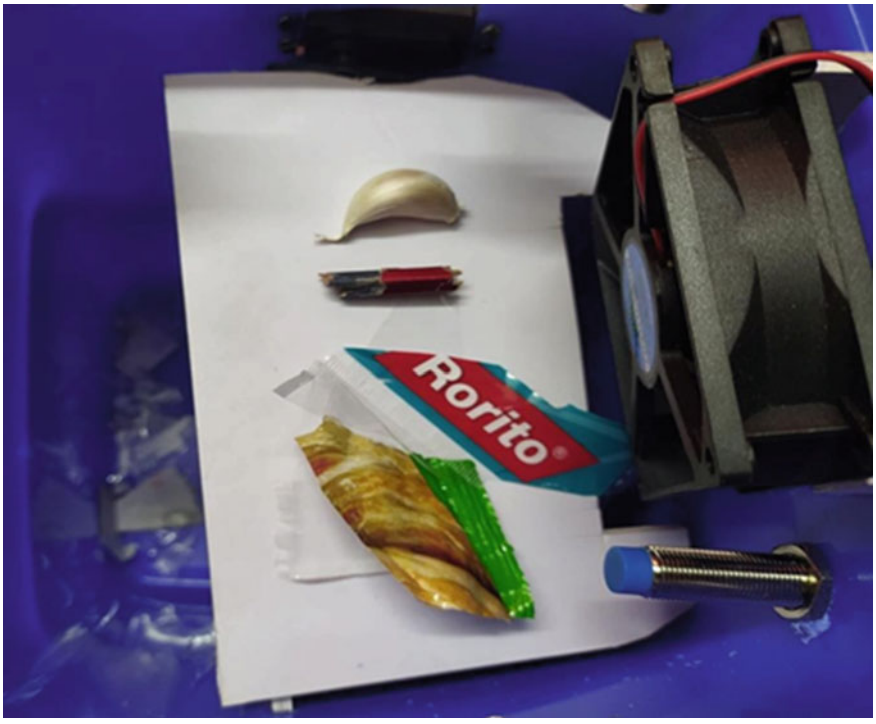


Fig. 8 Throwing the waste

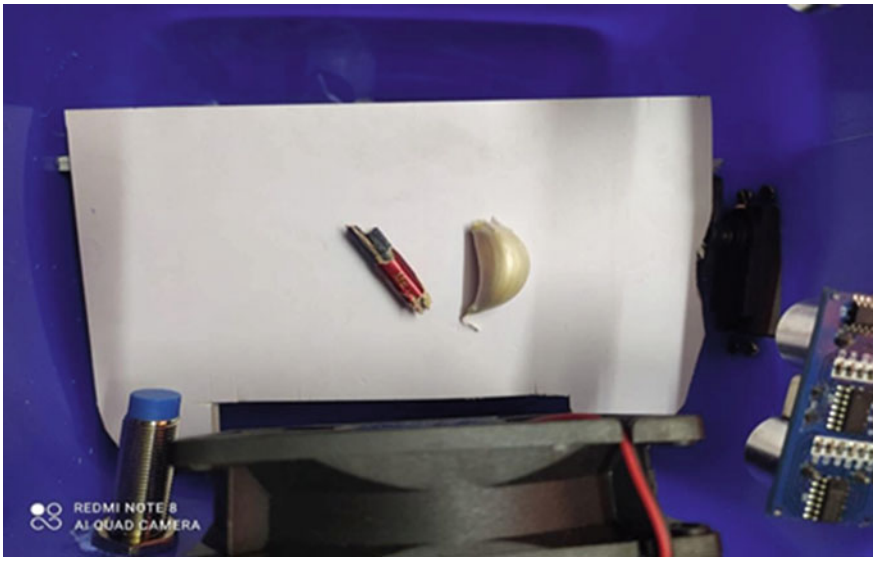


Fig. 9 Remaining reusable waste

remains on the top of the disk is the reusable wastes. After few seconds, the servo motor turns on which makes this disk to push itself downwards and the remaining reusable wastes are made to fall on the reusable side of the bin.

In Fig. 10, the final output of the first half of the project where the wastes are segregated into plastic and reusable waste and are made to fall on its respective sides of the bin using sensors and few components.

Figure 11 shows the outlook of the web page through which all the data collected by the cloud server system and which are accessed by the Wi-Fi module can be monitored. The information such as the temperature of the bin measured by a temperature sensor, the garbage level on either side of the bin is detected by the ultrasonic sensor and the date which shows when the last time the experiment has been performed was monitored.

In Fig. 12, the history button is clicked the results of previously performed experiments will be displayed. When the waste is about to overflow, with the alert message sent by the ultrasonic sensor the wastes from the waste management control room, the municipality will call for laborers to collect the waste from the garbage bin. This way not only the segregation of wastes is performed, but also we have made sure that the employment of daily labors is not affected.

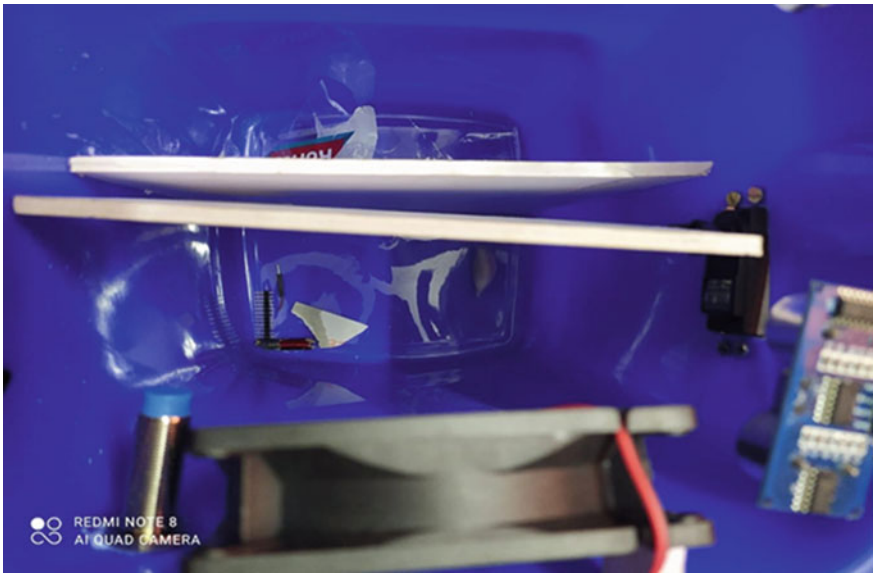


Fig. 10 Final output

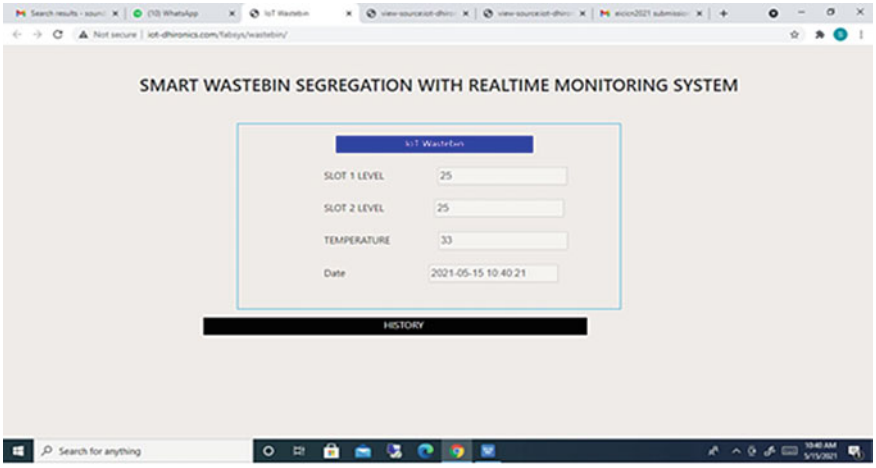


Fig. 11 The real time monitoring system output

6 Future Work

Every project has a scope of improvement. Perhaps the most pressing issue of parting of the waste is when they are disposed of instantaneously. The smart bin can be improvised further which would include the separation of wastes such as paper and

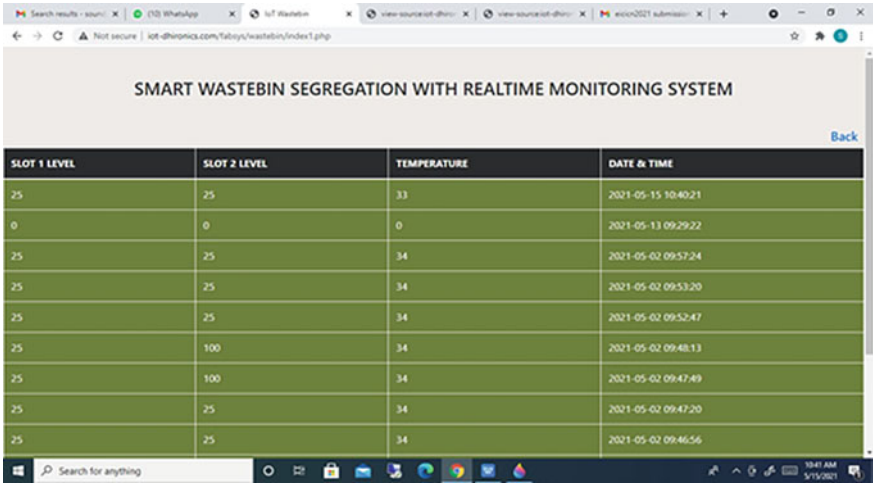


Fig. 12 The real time monitoring system output after segregation

plastic, safe segregation of biomedical waste generated at home, a compact and aesthetic Mechanical design.

7 Conclusion

The smart bins have various features such as durability, affordability, and accuracy. The Smart Dustbin can have a lot of contribution toward the clean neat and hygienic environment in the construction of a smart city. The advantages of the smart bins are: saves time for the segregation of waste; helps to keep our environment clean and green from the bad odor of wastes to improve the health of the environment to keep cities clean; reduces air pollution in the society. The cost of Infrastructure, operating, and maintenance will be reduced. The smart waste management process to the city will enhance the smart city. There few drawbacks in the system are, it requires a large number of bins for collecting the separated waste for the population in the city. The initial cost is expensive when compared to other methods. It also requires a well-structured hardware system.

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Deep Q Network-Based Spectrum Sensing for Cognitive Radio

N. Mahesh Kumar and Phanikumar Polasi

Abstract Cognitive radio network is considered as an ideal answer to the spectrum utilization problem of the current era. In cognitive radio, spectrum sensing has created new opportunities, as it senses the primary users' unused licensed spectrum and hands it over to the secondary users. The secondary users can utilize this spectrum without creating interference to primary users. Conventional energy detectors are used to achieve signal detection, through supervised learning, but it needs huge training data to achieve better detection performance. In this paper, a deep reinforced learning spectrum sensing (DRLSS) algorithm is proposed. DRLSS is an unsupervised deep learning method that does not depend on a large amount of training data sets.

Keywords Cognitive radio networks · Deep Q Network · Spectrum sensing · Deep reinforced learning

1 Introduction

Radio frequency spectrum is the most scarce resource in today's world, as more and more applications are in need of this resource. Cognitive radio network (CRN) has emerged as an answer to the spectrum scarcity problem [1]. A cognitive radio network identifies two types of users: Primary users (PU's) and Secondary users (SU's). PU's are authorized users licensed to use the allocated channel. SU's are unauthorized users who are allowed to use the channel opportunistically without interfering with PU's [2]. Secondary users have to sense the spectrum reliably to find out whether it is used by the primary user. In the absence of primary users, secondary users can utilize the spectrum effectively [3]. When the primary users start their activity, the secondary users have to vacate and hand over the spectrum to primary users.

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Spectrum sensing is a fundamental task of CR where the existence of a primary user is identified in the geographical area. Once the spectrum is sensed, efficient use of the spectrum is important to maximize the throughput of the cognitive radio. Many spectrum sensing models have been used over the years. Estimator correlator detector (ECD) [4], which is generated from the log likelihood ratio, can be used when we have information related to signal and noise distribution. However, in practical cases, information of the distribution of signal is hard to achieve, and therefore, semi-blind spectrum detection algorithms such as the energy detector (ED) [5, 6], the maximum eigenvalue detector (MED) [7] and the signal-based algorithm of the Generalized Likelihood Ratio (GLRT) test eigenvalue subspace (SSE) [8] have been proposed. The semi-blind algorithms depend on noise power information for sensing the spectrum. The noise uncertainty problem of semi-blind algorithms can be overcome by using totally blind methods such as blindly combined energy detection (BCED) [9] and covariance absolute value detection (CAV) [10]. Although model-driven approaches provide better detection, the drawback is they aren't designed for the real environment.

Deep learning (DL) technology can be extended to CRN as it can extract the features intelligently from various environments using deep neural network. DL technology has made a mark in spectrum sensing. Shan et al. [11] have proposed a k-nearest neighbor algorithm and Lee et al. [12] have designed a convolutional neural network. The majority of deep learning algorithms in use today are supervised learning algorithms. The higher performance of supervised learning-based spectrum sensing algorithms is inextricably linked to training on a large amount of labelled training data matching to each sample of the signal. It would be difficult to collect a substantial amount of training data since it would necessitate a significant amount of communication between the SU and the PU. Additionally, the SU needs to obtain a fresh workout data set if the SU's or PU's overall location makes obtaining a large amount of labelled workout data, which is required for detection algorithms, impossible.

Mnih et al. [13] made an important development by combining deep learning with reinforcement learning (RL) to overcome the drawbacks of dimensionality. The deep RL has attracted great attention from the research community. In this paper, we propose a deep reinforced learning algorithm named deep reinforced learning spectrum sensing (DRLSS). The proposed DRLSS algorithm works in an entirely different way from supervised learning models. It doesn't need any labels for clustering process, instead it uses a learning process to find the channel state. The proposed DRLSS algorithm works by making an agent learn the environment through exploration and exploitation. Recently, Deep Q Network (DQN) has received wide acceptance as single agent algorithm of DRL. DQN has firm contact with convolutional neural network (CNN) to directly interpret the graphical representation of the input state from the environment.

The rest of the paper is arranged as follows. Section 2 involves related work. Section 3 presents the problem formulation. The proposed DRLSS algorithms are discussed in Sect. 4. Simulation results are given in Sect. 5. Conclusions are drawn in Sect. 6.

2 Related Work

The spectrum sensing in CRNs generally result from the PUs activities, the change in position of secondary users and the spectrum divided among them. In this section, we will discuss the advantages and disadvantages of existing algorithms in spectrum sensing.

A. Narrowband Sensing

Secondary users in narrowband sensing basically feel the spectrum to determine if it is idle or not. Two distinct architectures are used to accomplish this task: single radio and dual radio [14]. In the first one, a single radio chain was used to handle both data and CR features for transmission. In addition, a specific time window has been set aside for spectrum sensing. This model's features include its ease of use, low power consumption, and low cost. One channel is allotted for transmission of data and reception, while the other is allotted to spectrum monitoring in a dual-radio sensing architecture. The high power consumption and increasing hardware costs are the model's biggest drawbacks.

B. Wideband Spectrum Sensing

Wideband aims to detect frequency bands that are larger than the coherence bandwidth [15]. Two approaches are available in wideband sensing. The first method assumes that the desired spectrum may be sampled at an ordinary Nyquist rate. The drawback of this model is the high computational complexity and high sampling rates. The second method relies on sub-Nyquist techniques, in which we extract a wideband signal directly from a regular ADC and use it for digital signal processing. The major drawback of this model is the spectrum reconstruction.

C. Cooperative Spectrum Sensing

Line of sight communication and buried terminal difficulties are addressed through cooperative sensing [16] [17]. Because receivers can detect faint signals, CR receivers impose a tight sensitivity requirement and implementation complexity. The sensing performance is improved by taking advantage of the spatial diversity of distributed CR users. There are two types of cooperative sensing models: centralized and distributed. The sensing process is controlled by a fusion centre or master node in a centralized approach. Secondary users in the distributed cooperative sensing paradigm exchange data among themselves rather than reporting to a central fusion centre.

3 Problem Formulation

Deep learning has been considered the most important development in the field of wireless communication, signal processing, image processing, and natural language processing. There are numerous areas where deep learning has excelled in capability

and performance of humans. Most deep learning algorithms that are used belong to the supervised learning model. In supervised learning models, the performances rely entirely on the proper training with a large amount of labelled training data. For collecting training data, the secondary user has to constantly communicate with the primary user to acquire detail about each signal sample. Gaining a huge amount of training data is a difficult process which is also the drawback of this model. The unsupervised deep learning model depends on data unlabeled to revamp the parameters of neural networks (NN).

Deep Reinforced learning is assured to transform the field of wireless communication and enable CRNs to move towards advanced methods for spectrum sensing and monitoring. Deep learning enables reinforcement learning (RL) to identify problems that were previously untraceable. DRL contains fixed states (s_i, representing environment and agent), actions (a_i) by the agent, probability (p_a) of shifting from the existing state to the next with action a_i, and reward $R_a(s_i, s_{i+1})$ $\mathrm{R_a(s_i, s_{i+1})}$ related with moving to the next state with action a. Main aim is to maximize and balance the present reward (R) and upcoming reward (γ, $\max\left[Q\left(s^{'}, d^{'}\right)\right]$) by forecasting action defined as $Q(s, a)$. γ represents finite discount factor. $Q(s, a)$ is the summation of present and upcoming reward as

$$Q(s, a) = R + \gamma.\max\left[Q\left(s^{'}, a^{'}\right)\right]$$

4 Proposed Algorithm

The proposed deep reinforced learning spectrum sensing algorithm (DRLSS) uses the Deep Q network model to learn the environment using agent function. Q-Learning [18] estimates directly the value of Q in each action of each state. The expected discounted reward is estimated using the Q value. For each state, the policy applied can be chosen with the highest Q value. Deep Reinforcement Learning (DRL) joins Deep Learning (DL) with Reinforcement Learning (RL), making it suitable for handling large state spaces and sophisticated computations. To approximate the action-value function that calculates the Q values of the primary user's availability using partial channel observations, we employ Deep Q Network (DQN) [19, 20]. DQN is used for dynamic spectrum sensing and dealing with instabilities in the spectrum environment. The DQN action-value function is offered online to help users make decisions without prior understanding of system dynamics and low computing complexity. The agent interaction with discrete-time environment obtains reward r relating to each state action shown in Fig. 1.

In Q learning, a DQN deep neural network is utilized to replace the look up table and deliver Q values for each state action combination. The neural network allows DQN to deal with dimensionality issues caused by vast system state spaces,

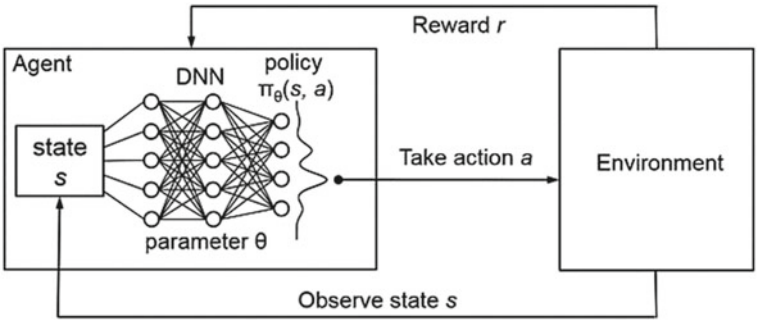

Fig. 1 Deep Q network—single agent

which were previously untraceable with Q-Q value Learning's table. The process of spectrum sensing using DQN is given in the algorithm.

Algorithm: Deep reinforced learning spectrum sensing algorithm

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1. Initialize actions by the agent a_i
2 Initialize network Q with reward R;
3. Initialize target network Q with weight $\Theta^{Q1} \leftarrow \Theta^{Q}$
4 Initialize channel environment;
5 **for** *i* = a ,1; *episodes* **do**
6 Randomly select state *S* from the channel environment;
7 Execute action a_i in emulator and observe reward r_t
8 **for** t=1,T **do**
9 select action a to sense spectrum
10 **End for**
11 According to *a*, obtain next state *St*+1 and reward *R* from the channel environment;
12 Update parameters
15 Assign *St*+1 to *S*
16 **End for**
17 Do Train the DQN to sense the spectrum
18. **for** t = 1, 2; do
Perform actions to receive rewards from trained DQN. Calculate the reward accumulated.
19 **If** the reward accumulated > given threshold
20 **Then**
21 Re-train DQN to sense the spectrum
22 **End If**
23 **End for**
25 **End**

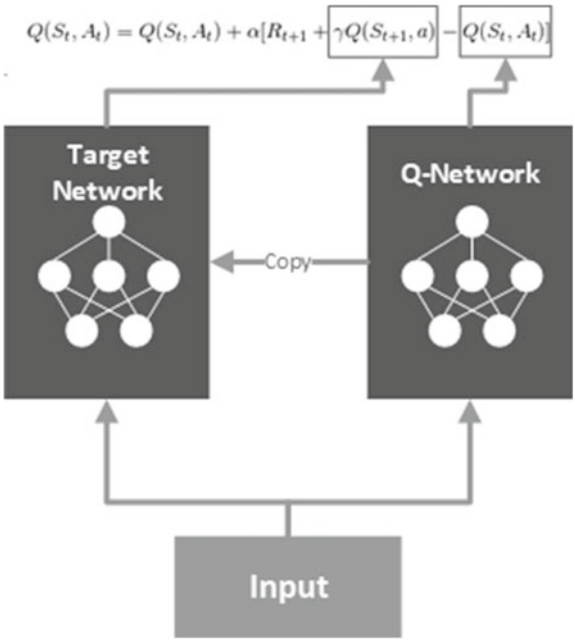

Fig. 2 DRLSS learning with TF

The agent in the DRLSS algorithm must keep track of prior encounters in local memory. Because the agent lacks labels, it must rely on the value function. Because the target varies with each repetition, the agent has two neural networks. In the state of S_t, the first network, dubbed Q network, will calculate the Q value. In the state s_{t+1}, the target network, which is the second network, calculates the Q value. The action values Q are recovered from the current state s_t by the Q network $(S_{t,a})$. To calculate $Q(S_{t+1},a)$, the target network will use the following state S_{t+1}. This is shown in Fig. 2.

5 Simulation Results

In the simulation, we have taken three PUs and ten SUs. To ensure unpredictability, SUs are made to move slowly, and half of the SUs are randomly placed in the nearest horizontal blocks during initialization. An evaluation is done in terms of Receiver Operating Characteristics (ROC) by comparing the proposed DRLSS method with the existing CM-CNN and BCED algorithm. The BCED is the blind energy detection model which doesn't depend on any information of signal or noise. The CM-CNN algorithm also doesn't need any prior information, it has the powerful capacity of extracting features. The ROC curve in Fig. 3 shows the superiority of the DRLSS algorithm with reference to the CM-CNN and BCED method. For the training, phase number of primary user samples and their activities are collected and features are

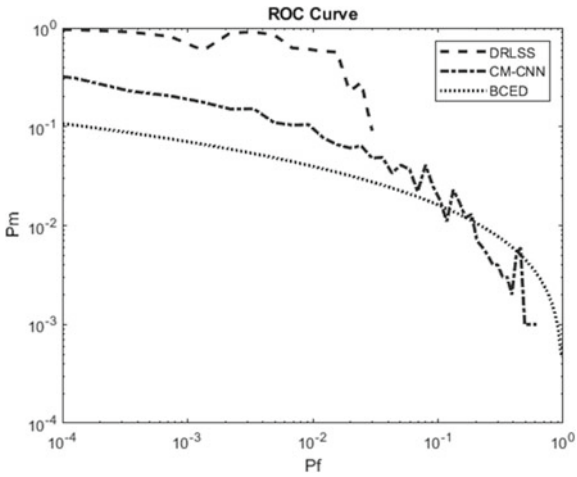

Fig. 3 ROC curve

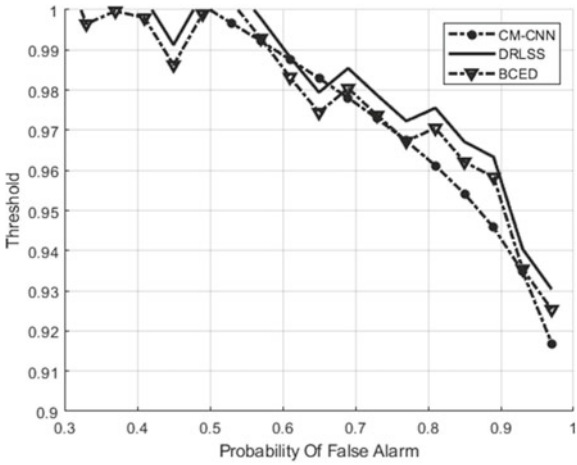

Fig. 4 Probability of false alarm

extracted. In Fig. 4, the false alarm probability versus the threshold of the proposed method and the existing method is shown.

6 Conclusion

We have examined the performance of the proposed Deep reinforced learning spectrum sensing (DRLSS) algorithm with the existing benchmark algorithms. The DRLSS algorithm doesn't need any prior information about the primary user and the spectrum. With the smaller amount of labelled training data, the DRLSS algorithm has shown superior performance compared to the benchmark algorithms.

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Power Quality Enhancement in Transmission System Using Proposed Switched Capacitor Multilevel Inverter-Based Static Synchronous Compensator

G. Ramya, P. Suresh, and B. Manimaran

Abstract Power quality enhancement in transmission system proposes the new structure of Switched Capacitor Multilevel Inverter (SCMLI)-based Static Synchronous Compensator (STATCOM) to improve the power quality. SCMLI can generate voltage sources with the least number of components for symmetric and asymmetric values. The proposed system consists of a DC converter with a switched capacitor to operate as a self-balancing device using an asymmetrical binary algorithm. Switched Capacitor Multilevel Inverter can generate 21 level Multilevel output from DC source. This scheme is applied to STATCOM for improving compensation ability, suppression of harmonics, and reactive power control under non-linear load conditions. Proposed SCMLI-based STATCOM is employed in both single and three phase transmission system and is simulated using MATLAB Simulink and verified with PIC controller-based hardware implementation.

Keywords Static Synchronous Compensator (STATCOM) · Switched capacitor multilevel inverter · Cascaded H Bridge · Power quality

1 Introduction

In recent years, a lot of revolution has occurred in the field of power electronics. All these advancements in this field have been evolved to improve the efficiency, reduce the complexity, and also to reduce the cost. One such major change that has happened in the converter or inverter field is the introduction of multilevel inverter [1–3]. Early inverters had only two output voltage or current levels 0 or ± Vdc. Since

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only two output levels, they were called two-level inverters. But to obtain quality output voltage or current waveform, they required high switching frequency along with various Pulse Width Modulation (PWM) techniques [4–6]. This disadvantage possessed a limitation to inverter to high power and high voltage application. To overcome these problems, multilevel inverters have evolved. The multilevel inverter has given a big boost in the power industry. This multilevel structure allows inverter to obtain high voltages with low harmonics [7–10]. The effect of the lower order harmonics can be eliminated with an increase in output voltage levels. This structure of the multilevel inverter produces a near sinusoidal voltage from different levels of DC voltage, which may be obtained from the capacitor connected across the DC voltage source [11, 12]. Generally, the multilevel inverters were classified into, Diode clamped multilevel inverter, Flying capacitor multilevel inverter, and Cascaded H-bridge multilevel inverter [8, 13, 14]. All the above introduced multilevel inverter topologies have certain limitations like complex circuits, requiring high number of power switches and high cost due to a lot of switches, capacitors, and diodes [15–17]. To overcome all these limitations, a new topology of multilevel inverter has been presented here. This new topology can be implemented with a 21 level waveform and can be extended to obtain any number of levels of output waveform. To obtain a smooth waveform with reduced lower order harmonics. A 21 multilevel inverter is introduced in this paper. This new topology is simulated using MATLAB/Simulink simulation software and simulation results prove that the design ideas work as expected.

2 System Description

A STATCOM is a power semiconductor switching device that includes either IGBT or GTO, a coupling transformer, a controller, and an energy storage device. The working principle of STATCOM is similar to that of the working of a synchronous machine. The synchronous machine provides leading and lagging currents when they are overexcited and under-excited, respectively. Similarly, based on the requirement, STATCOM can absorb or inject reactive power. Power quality issues occur in the AC system when STATCOM is linked to PCC of the power networks. The controller compares all the necessary currents and voltages using commands and executes the feedback control to generate switching pulses for driving the converter. Figure 1 shows a schematic representation of the proposed SCMLI-based STATCOM. By applying DC input voltage to VSC of a STATCOM system, three-phase AC output voltage is obtained. Coupling transformer reactance links the three-phase STATCOM AC output with a grid system. STATCOM can efficiently control the reactive power between the grid and STATCOM by altering the magnitude and phase of STATCOM output voltage.

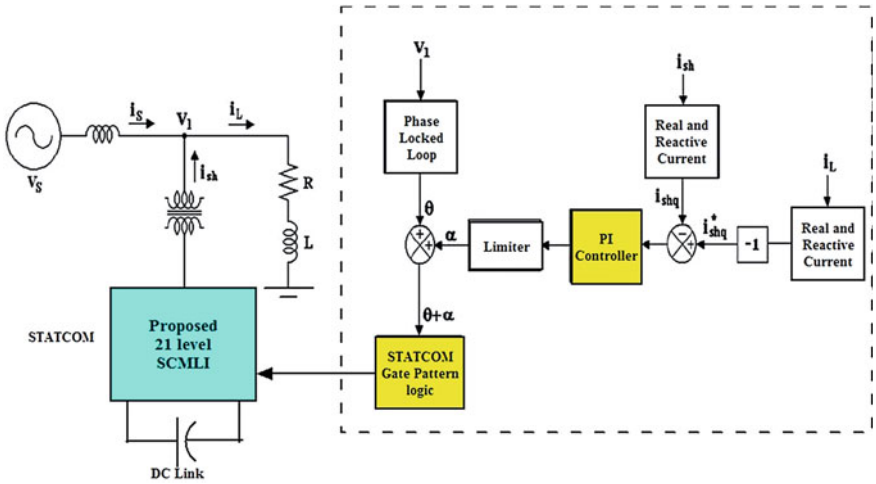

Fig. 1 Schematic diagram of proposed SCMLI based STATCOM

2.1 Exchange of Reactive Power

STATCOM output voltage of variable amplitude controls the exchange of STATCOM output voltage and source voltage.

The

reactive power Q supplied by the STATCOM is given by

$$Q = \frac{(V_i - V_S) * V_S}{X} \tag{1}$$

where

V_s denotes the source voltage,

V_i is the STATCOM output voltage,

X denotes the impedance of the STATCOM system.

Case 1:

When the magnitude of AC system voltage *Vs* and STATCOM output voltage *Vi* are equal, STATCOM does not operate. It does not absorb or generate reactive power. The no load operation of the STATCOM system is depicted in Fig. 2.

Case 2:

When the magnitude of STATCOM output voltage *Vi* is less than source voltage *Vs* produces the lagging current resulting in the inductive operation of the STATCOM system. The inductive operation of the STATCOM system is depicted in Fig. 3.

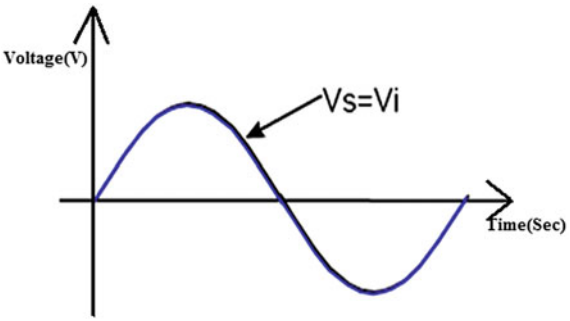

Fig. 2 No load operation of the STATCOM system

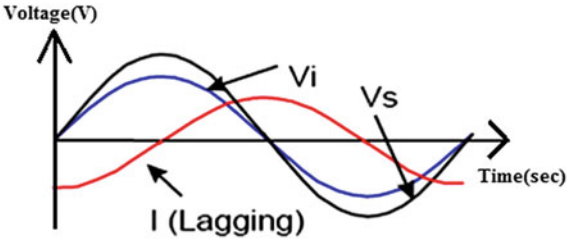

Fig. 3 Inductive operation of the STATCOM system

Case 3:

When the magnitude of source voltage *Vs* is less than STATCOM output voltage *Vi* produces the leading current resulting in capacitive operation of the STATCOM system. The capacitive operation of the STATCOM system is depicted in Fig. 4.

The schematic diagram of the proposed 21 level SCMLI-based STATCOM system is depicted in Fig. 5 and the different switching states to obtain the 21 level output is given in Table 1.

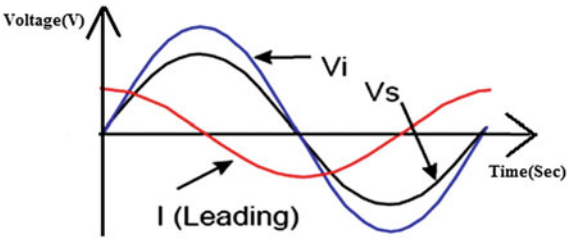

Fig. 4 Capacitive operation of the STATCOM system

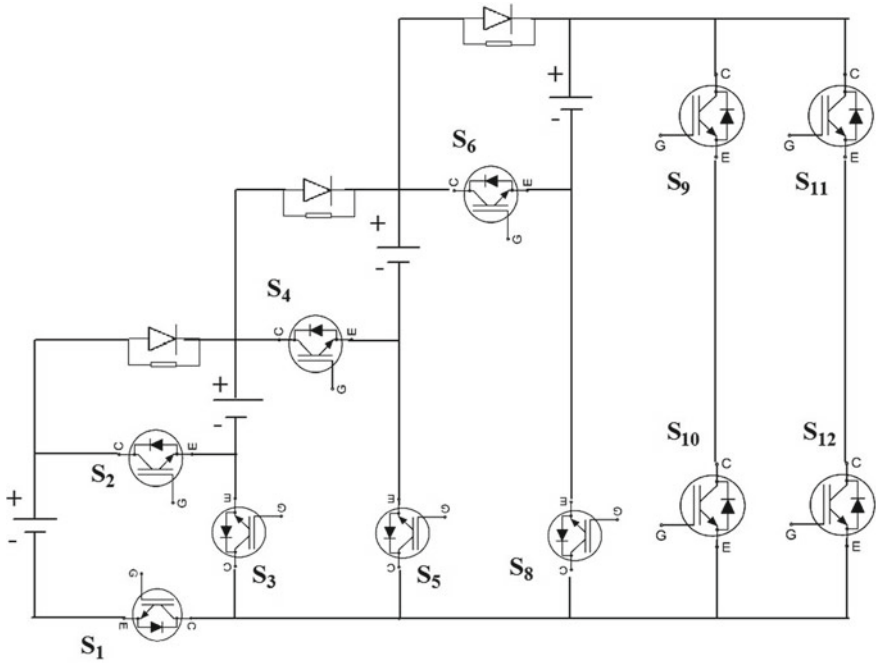

Fig. 5 Circuit diagram of proposed 21 level SCMLI

Table 1 Switching states of proposed SCMLI

S. No	Output Voltage Level	S1	S2	S3	S4	S5	S6	S7
1	0	Off	Off	Off	Off	Off	Off	Off
2	$+ V_{dc}$	On	Off	Off	Off	Off	Off	Off
3	$+ 2V_{dc}$	Off	Off	On	Off	Off	Off	Off
4	$+ 3V_{dc}$	Off	Off	Off	Off	On	Off	Off
5	$+ 4V_{dc}$	Off	Off	Off	Off	Off	Off	On
6	$+ 5V_{dc}$	On	Off	Off	Off	Off	On	Off
7	$+ 6V_{dc}$	Off	On	Off	Off	Off	On	Off
8	$+ 7V_{dc}$	Off	Off	Off	Off	On	On	Off
9	$+ 8V_{dc}$	On	Off	Off	On	Off	On	Off
10	$+ 9V_{dc}$	Off	Off	On	On	Off	On	Off
11	$+ 10V_{dc}$	On	On	Off	On	Off	On	Off

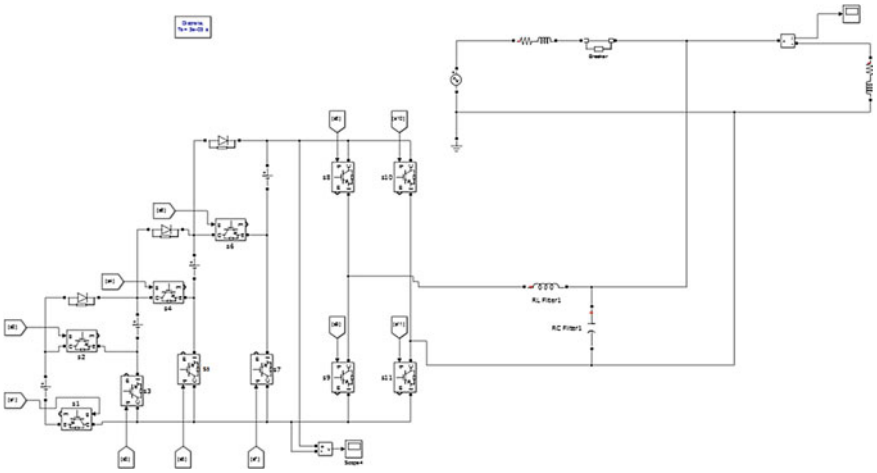

Fig. 6 Simulink diagram of proposed SCMLI-Based STATCOM for Single Phase Transmission Line

3 Simulation and Discussion

The Simulink circuit diagram of the proposed SCMLI-based STATCOM for Single Phase Transmission Line is depicted in Fig. 6 and the Switching pulse is given to Proposed SCMLI Switched from switches S1 to S11 is shown in Fig. 7.

Twenty-one level output voltage obtained across the inverter is depicted in Fig. 8. Due to the addition of a second load, voltage sag occurs from 0.5 to 0.7 s and it is compensated by SCMLI-based STATCOM systems as shown in Figs. 9 and 10, respectively. Twenty-one level inverter output voltage is employed to inject reactive power to compensate the voltage sag during the unbalance load conditions.

The Simulink circuit diagram of the proposed SCMLI-based STATCOM for three-phase transmission line is depicted in Figs. 11 and 12 depicts the output voltage waveform from 21 level inverter for three-phase transmission line.

The output voltage after compensation using SCMLI-based STATCOM is shown in Fig. 13 and the frequency spectrum analysis of 21 level inverter output is depicted in Fig. 14 with THD of 1.25% which follows the IEEE standard.

4 Hardware Results

The hardware results are presented in this section. Figure 15 shows the Prototype model of the proposed 21 level inverter and its 21 level inverter output is shown in Fig. 16.

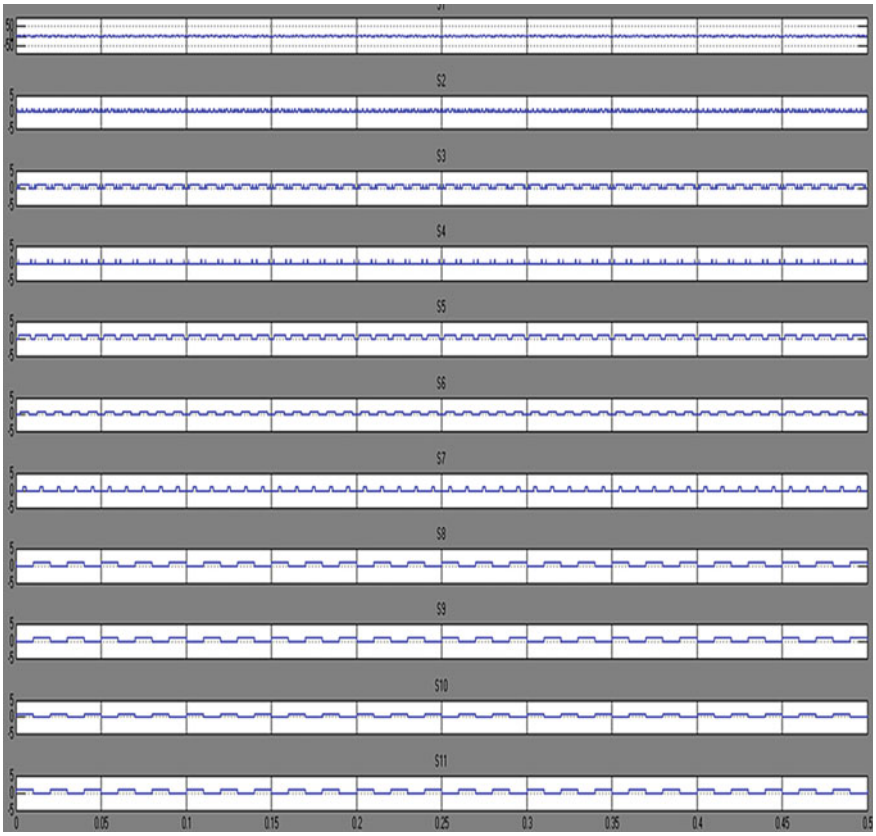

Fig. 7 Switching pulse is given to proposed SCMLI Switched from S_1-S_{11}

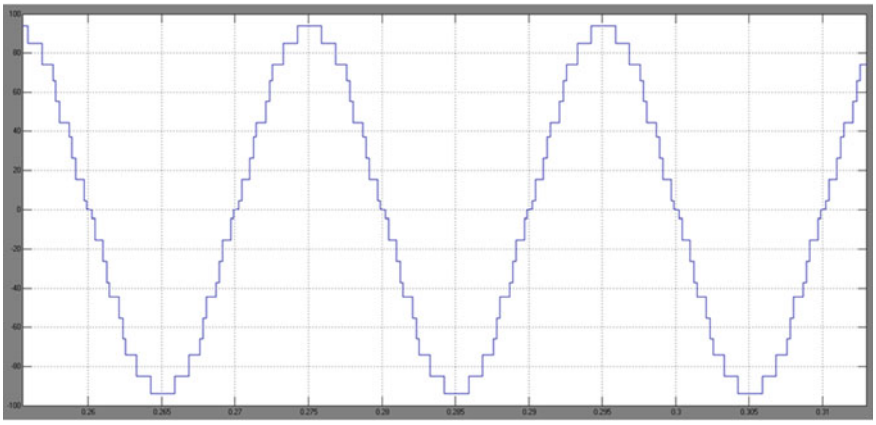

Fig. 8 Output Voltage Waveform of 21 level Inverter

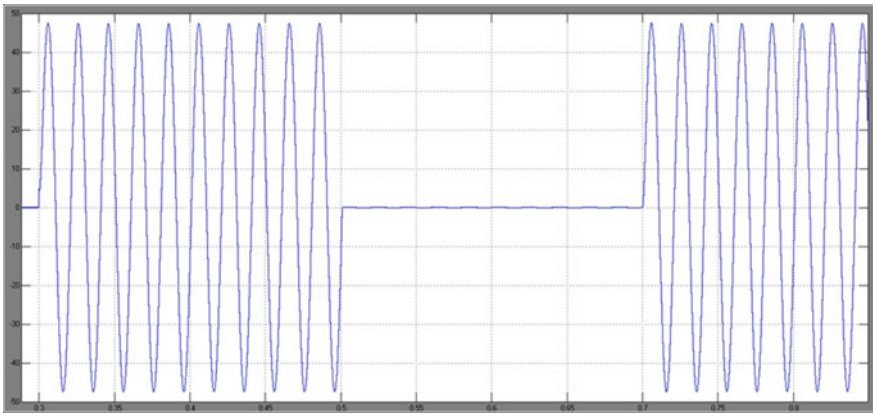

Fig. 9 Voltage sag occurs between 0.5 s to 0.7 s

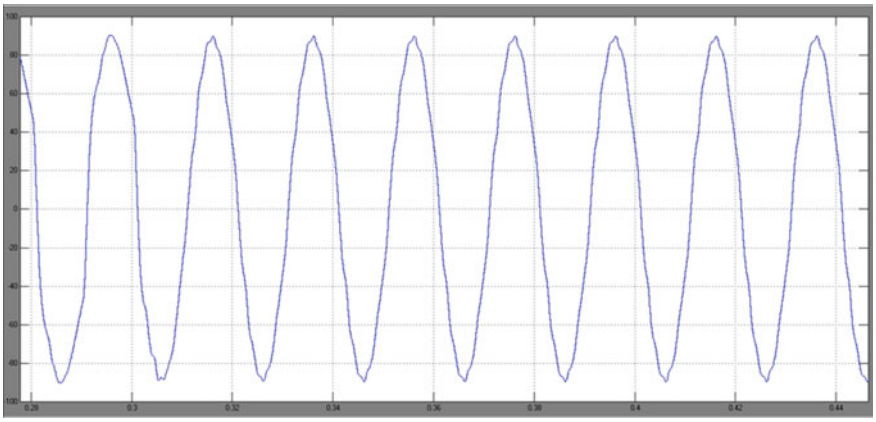

Fig. 10 Voltage sag compensation between 0.5 s to 0.7 s using proposed SCMLI Based STATCOM

5 Conclusion

The proposed 21 level SCMLI-based STATCOM system is simulated in both single-phase and three-phase systems using MATLAB Simulink. SCMLI is a new structure and it is designed with a lesser number of switches without using the H-bridge to generate the 21 level output voltage. DC converter in the proposed system that can operate switched capacitor as a self-balancing device using an asymmetrical binary algorithm. Voltage sag occurs from 0.5 to 0.7 s, due to the addition of load was compensated by SCMLI-based STATCOM system. The number of levels in SCMLI can be increased by reconfiguring the SCMLI circuit. The THD of 21 level inverter output is 1.25%, which follows the IEEE standard of less than 3%. The output of 21 level SCMLI is verified with PIC controller-based hardware implementation.

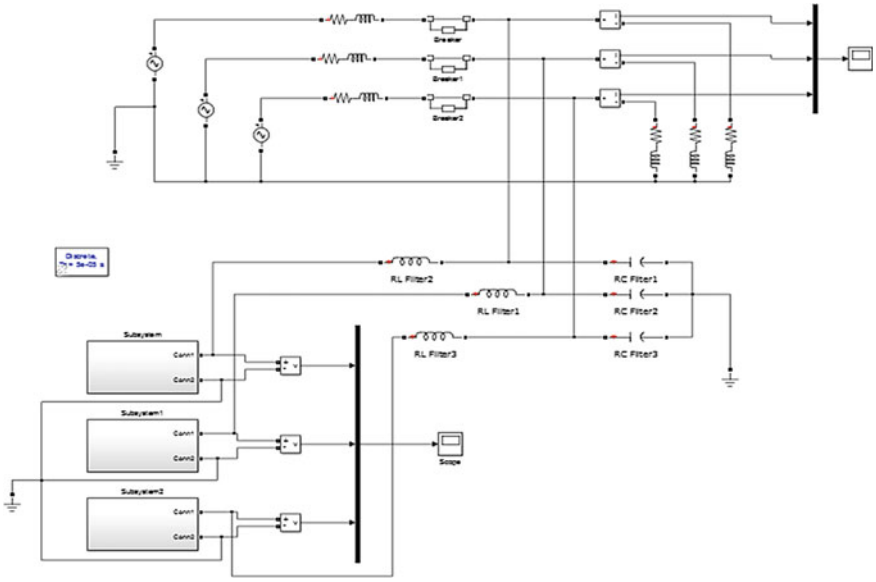

Fig. 11 Simulink diagram of proposed SCMLI-based STATCOM for three-phase transmission line

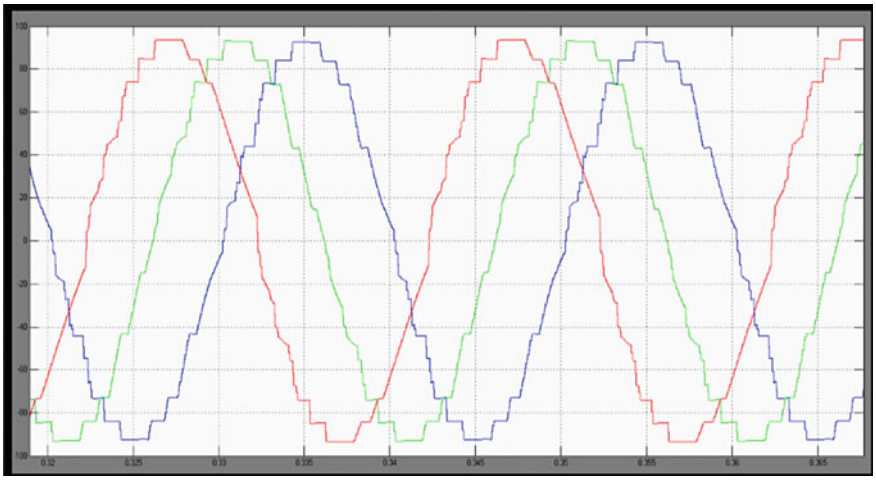

Fig. 12 Output voltage waveform from 21 level Inverter for three-phase transmission line

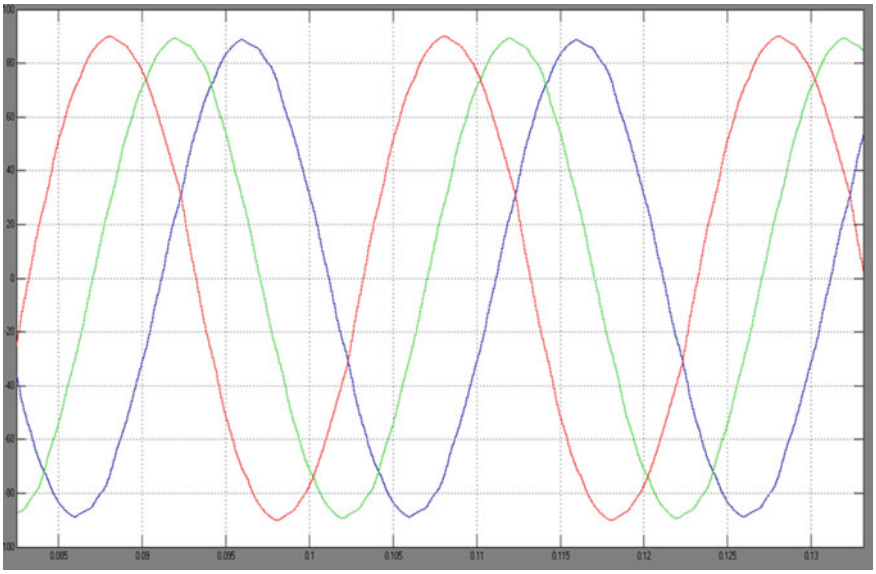

Fig. 13 Output voltage after compensation using SCMLI-based STATCOM

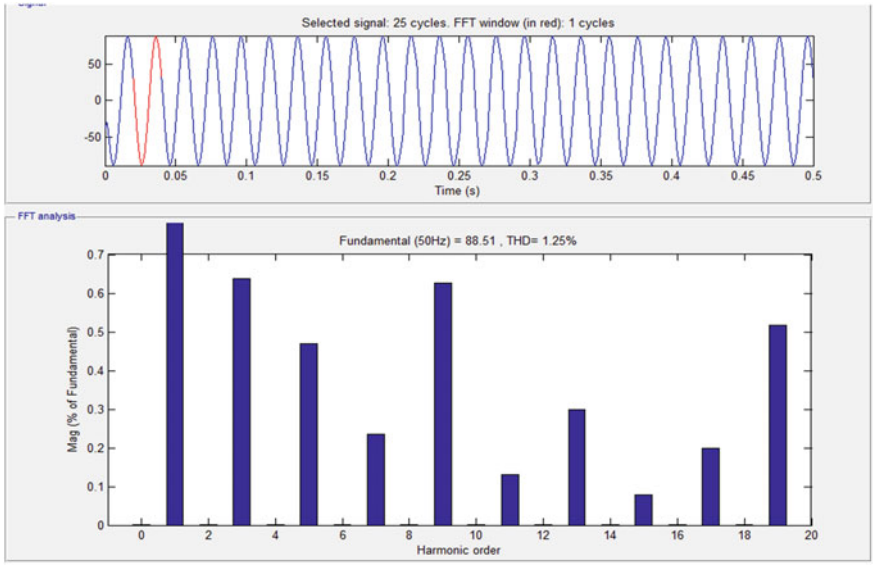

Fig. 14 Frequency spectrum analysis of 21 level inverter

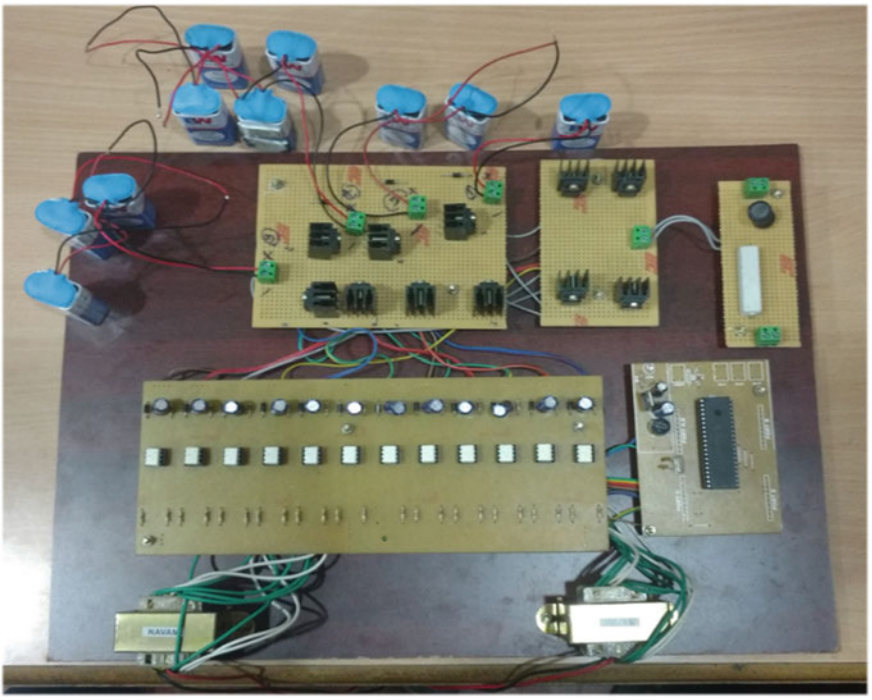

Fig. 15 Prototype model of proposed 21 level inverter

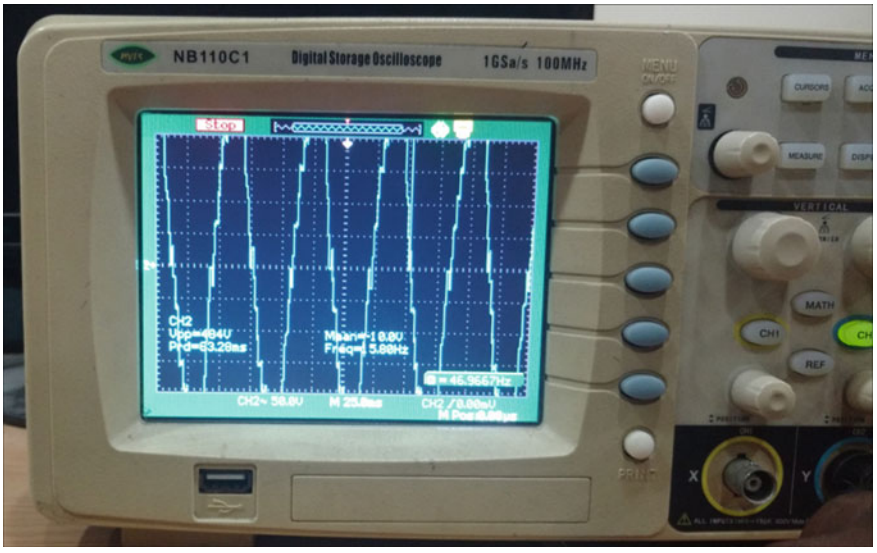

Fig. 16 Prototype output voltage of proposed 21 level inverter

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An Approach for an Intelligent Lithium-Ion Battery Management System with Active Balancing

Thealfaqar A. Abdul-jabbar, Adel A. Obed, and Ahmed J. Abid

Abstract Lithium-ion batteries (Li-ion) are the first choice in applications that require energy storage devices because of their high capacity, high energy density, long life cycle, no effect memory, and low self-discharge capability. Li-ion of necessity must be controlled pending operation to be in a safe position and get the best performance, so it must be utilized battery management system (BMS). BMS functionality monitors, controls, and protects the battery pack from over-discharge, active balancing cells, and over-temperature. This paper proposed the charging method built on the fuzzy logic controller (FLC) to set the reference charging current through *SoC* of cells, also designed discharge controller via FLC to maintain discharge under limiting manufacturing rate with high protection for the battery string. The simulation results illustrate that protection features were the best performance. The proposed charging and discharging methods maintain the battery life cycle because, in charging, the temperature increase impacts the performance; this method change charge current value and in discharge also the effect of rising temperature reduce battery life cycle, this method has given discharge current depending on SoC and T_{MAX} in the pack.

Keywords Active balancing · Battery charging · Battery management system · Fuzzy logic controller · Switched capacitor

1 Introduction

Recent trends in energy storage systems have led to a proliferation of studies on batteries because of the significant component of renewable energy enforcement, rapid evolution employment of electric vehicles, and augmented reliance on portable devices [1, 2]. Lithium-ion is the preferred type of battery with high capacity, high energy density, long life cycle, no effect memory, and low self-discharge capability [3, 4]. Li-ion is non-linear during utilization when charge or discharge process also

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different manufacturing capacity or internal resistance should control and monitor to meet highest performance and safety operation because prone to explosion [5, 6].

Battery Management System (BMS) is substantial in Li-ion battery systems to assure the pack's excellent and safe functionality and grow the usable capacity [7]. The BMS fulfill various tasks measuring the voltage, current, temperature for each cell, voltage of battery pack, estimation the state of charge (SOC) and the state of health (SOH) of battery, controlling the charge/discharge operation, and protecting the cells from over-charge, over-discharge and over-temperature [8]. Series pack of batteries is vastly used. Typically, the series pack is charged and discharged as a unit, and there is a slight imbalance voltage in the battery cells during charge and discharge because cells in the pack are not equal, and they cannot supply the same processing during operation [9]. Balancing between cells is the pivotal functionality of BMS to the safety of the battery pack and life cycle of cells. The classification of cell balancing is divided into two categories: passive balancing and active balancing. The passive methods transmit the surplus charge from the full cell through the resistor component and dissipate energy in the form of heat. This technique is more dependable and uses fewer components, which reduces the total cost, and is adequate for low-power employment. The active methods expel charge from fuller energy cells and convey it to the lower energy cells. This method conserves the energy in the battery pack, increasing the system's efficiency and fetching little time to balance amid the cells than the passive method. Hence, active cell balancing is fit for high-power applications [10].

A considerable amount of literature has been published on BMS, charging method, and fuzzy logic in the Battery system, and these studies aim to increase performance and maintain the battery pack. The authors in [11] optimal traditional charging method constant current-constant voltage (CC-CV) was applied depending on PSO to meet minimum error with a reference value. The control of discharge using flyback converter with discontinuous current mode (DCM) to balance cells, this paper did not focus on protection from overtemperature. In [12], BMS implantation for control $LifePO_4$ the pack was connected 1P15S, BMS here was control CC-CV charging method and passive balancing without focused on battery temperature protection. This research proposed a string of a combination of Nickel, Manganese, and Cobalt battery (NMC) 1P6S, which implemented passive balancing and focused on thermal management by adding a heat sink to reduce the impact of passive balancing in [13]. The survey discussed in [14] displays Li-ion string 1P4S proposed, which applied passive balancing, CC-CV charging, and SoC estimation by coulomb counting method; this survey is not focused on over-temperature and over-discharge. The lead–acid battery was enforced [15] to apply the three-stage charging method, including CC, CV, and float modes. In [16], the focus is on the enforcement of passive balancing, and the other protection required was neglected. The authors designed the CC-CV charging method and passive balancing for Li-ion pack 1P4S, and the other protection desired were ignored, which is illustrated in [17]. The optimized passive balancing was demonstrated in [18], where resistors were added in parallel with the balancing resistor to minimize the balancing time, was tested on NMC battery pack

1P3S. The paper [19] designed the charge control for Li-ion batteries with the imitative CC-CV method and concentrated on protecting the battery from overcharge and over-discharge using FL depending on SoC to control charge or discharge mode.

This paper has four key aims. Firstly, the multi-stage charging method depends on FLC, which uses SoC inputs to control charging current because of T increase with the charging process. Secondly, FLC is applied to control the discharge of battery predicate on SoC and T to maintain battery life and keep safety operation. Thirdly, implementation of active balancing method depending on the capacitor. Finally, designed over-temperature, over-discharge protection.

This paper is organized as follows. Section 2 discusses the balancing architecture, andthe proposed system debate is discussed in Sect. 3. The control strategy of charging and discharging is described in Sect. 4. Section 5 illustrates the simulated results. Finally, the conclusion of this work is in the last section.

2 Switched Capacitor

In SC, no bulky magnetic component is utilized in a based cell balancing system, and solely a couple of complementary signals are desired to control the circuit. The SC has integral benefits of smaller size, lower cost, more straightforward control, and higher qualifications than passive balancing [20]. The SC consists of 2 N switches and N-1 capacitors when the pack N of the cell. The capacitor is appointed to transfer energy between two adjacent cells. Figure 1a explains the SC diagram, and Fig. 1b the path of transfer energy when $V_{B11} > V_{B12} > V_{B13} > V_{B14} > V_{B15}$. It can function in both charging and discharging operations.

3 Design Methodology

The proposed system implicates a PV array, Boost converter, bidirectional converter, battery pack, and BMS, illustrated in Fig. 2. This system implements charge control, discharge control, active balancing, protects the battery from over-discharge and over-temperature. Li-ion model in MATLAB.

3.1 PV and Boost Converter

The PV array supplies the system DC voltage, of which the PV string is 1S1P. A dc-dc converter was utilized as a power interface between the PV panel, load, and bidirectional converter to charge or discharge the battery. The DC/DC converter connects/ disconnects the solar panel from the load based on PWM signals. The boost converter raises the voltage to maintain the voltage required battery and load.

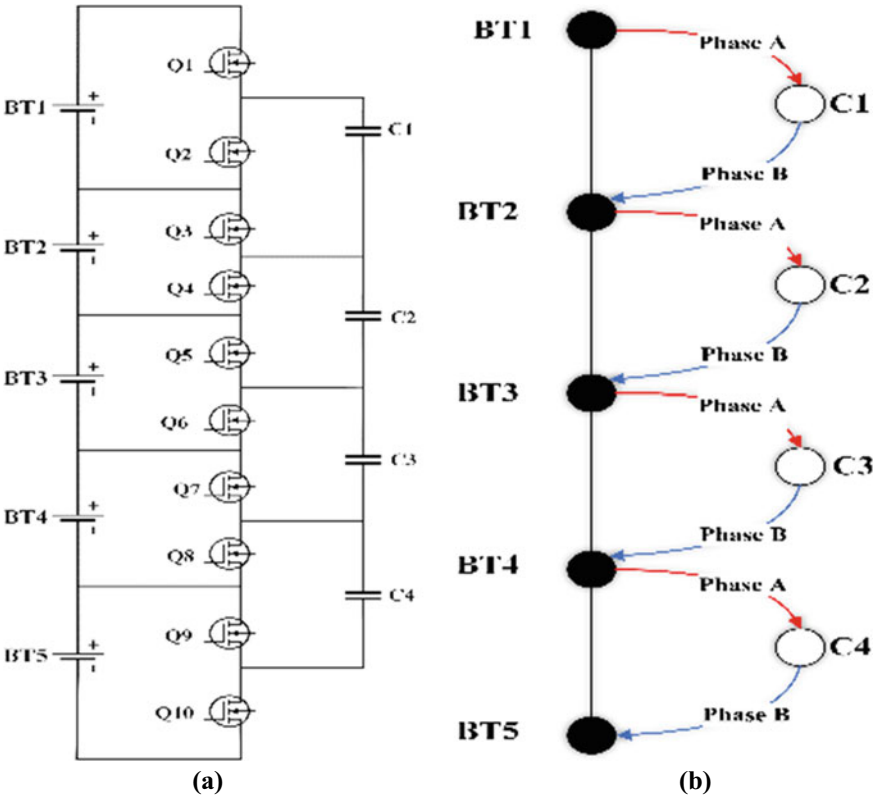

Fig.1 The SC **a** circuit **b** path of energy

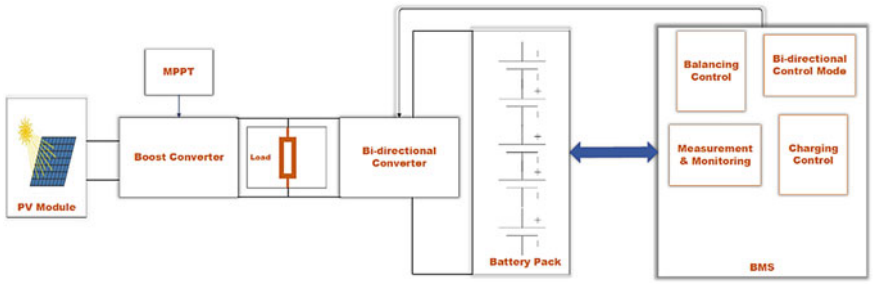

Fig. 2 The proposed system

This equation described the design of the boost converter from Eqs. (1)–(4), for more datum; refer [21].

Table 1 The parameters of PV, boost converter, BDC, Li-ion battery

PV		Boost converter		BDC		Li-ion battery	
V_{OC}	36.3 V	V_{in}	29 V	V_{in}	40 V	V_{Nominal}	3.4 V
V_{MAX}	29 V	V_{out}	40 V	c_o	200*10^{-6} F	V_{Max}	4.125 V
I_{SC}	7.84 A	I_{in}	7 A	L	$100 * 10^{-3}$ H	$V_{cut-off}$	2.55 V
I_{MAX}	7.35 A	L	$2 * 10^{-3}$ H	C_i	20*10^{-6} F	$Cap._{rated}$	4.4 Ah
P_{MAX}	213.15 W	c_{out}	1000*10^{-6} F			$Cap._{Max}$	4.5 Ah
		C_{in}	100*10^{-6} F				

$$D = 1 - \frac{V_{IN}}{V_{OUT}} \tag{1}$$

$$\Delta iL = 10\% \text{ of } I_{IN} \tag{2}$$

$$L = \frac{DTs \times V_{IN}}{\Delta iL} \tag{3}$$

$$C_{OUT} = \frac{Io \times D}{f \times \Delta vo} \tag{4}$$

In Eq. 1, V_{IN} = voltage of PV, V_{OUT}= output voltage of boost converter, and D = duty cycle. In Eq. 2, I_{IN}= input current and ΔiL = inductor ripple current. In Eq. 3, L = inductor, and in Eq. 4 where C_{OUT}= output capacitance and Δvo = desired output voltage ripple. Table 1 illustrates the parameters of PV and boost converter. The maximum point of the production of V and I perform the maximum power point (MPP) P_{MAX} of the PV module, this point reconciled to the MPP whose arranges are V_{MPP}, I_{MPP} to optimal employ of the electrical energy available at the terminals of the PV generator can contribute to curtailment of the system's gross cost. The maximum power point tracking (MPPT) controller is consumed to supply the load at P_{MAX} of PV modules competent to produce at given atmospheric conditions [22]. The MPPT algorithm depends on FLC applied in this paper, which is presented in [23].

3.2 Bidirectional Converter

The bidirectional converter (BDC) outputs DC voltage by filtering the time ratio of opening and closing of the switch transistor. With the technical progress of integrated circuits, BDCs are moving toward integrated evolution and miniaturization. The BDC converter fundamentally uses PWM and combines it with power electronic technology. DC/DC switching power is a pretty efficient power supply type, and it has become a fasten of concern in the development of DC power supply. The BDC

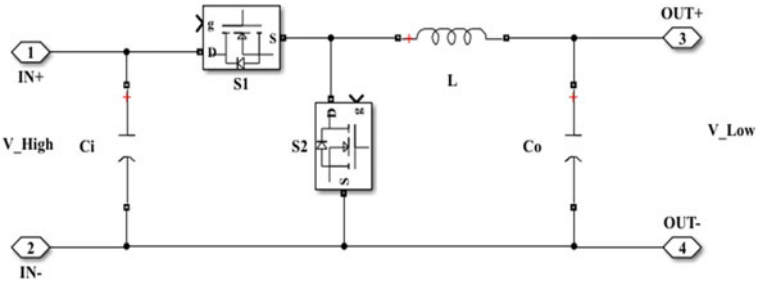

Fig. 3 The BDC circuit

works in two modes; boost mode is applied when the controllable switch S2 is in a turn-on state, and buck mode is applied when the controllable switch S1 is in turn-on state. The BDC links the battery pack with the PV system and controls battery charging and discharging, shown in Fig. 3.

3.3 Battery Management System

In this part, BMS tasks to monitor each battery's voltage, current, and temperature, also protects each cell from over-discharge, over-temperature, and balance between cells. The BMS has over one circuit, and it will elucidate each part in detail.

3.3.1 Over-Discharge and Over-Temperature Circuit Protection

Li-ion battery sensitive to increase the voltage, the circuit protection from over-discharge to maintain the battery life cycle, when cells in the pack arrive 10% SoC the discharge is stopped and the load supply from PV only. Figure 4a indicates the over-discharge circuits.

The effectiveness of increased temperature through the charging and discharging process exposes cells to a decrease in the life cycle and exposes them to an explosion. According to the manufacturing datasheet, the maximum temperature at which batteries can be charged and discharged is variable, but usually, the maximum temperature for Li-ion batteries ranges from 50 °C to 60 °C. The circuit stops the system when any cell in the pack reaches 55 °C. The over-temperature circuit is explained in Fig. 4b.

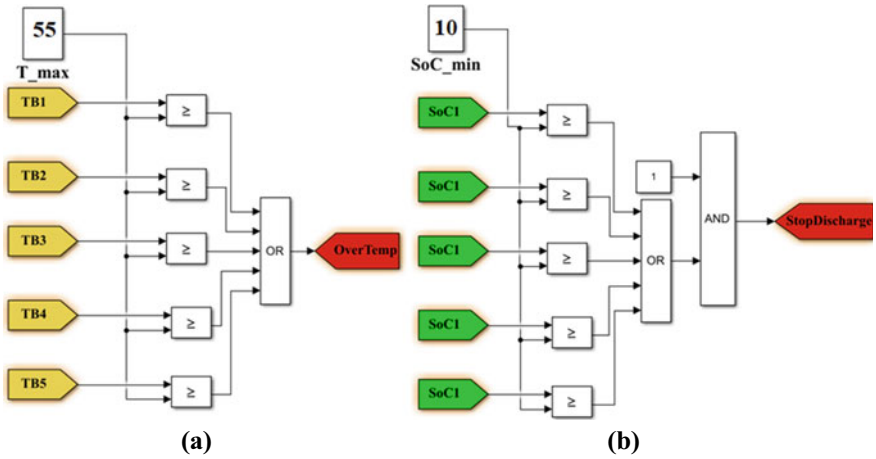

Fig. 4 The protection Circuit **a** Over temperature **b** Over discharge

3.3.2 Balancing Circuit

In this method, two cases are rotated continuously, and in the beginning case, all the capacitor is set in shunt with cell from the upper switch, which the capacitor is set to the cell voltage, transmitting energy from the cell above-mentioned. Once the capacitor has reached cell voltage V_{u_i}, the stored charge Q_{u_i} for the i-capacitor is

$$Q_{c_i} = C_i V_{\mathrm{u}_i} \tag{5}$$

where C_i is the capacitance of the i-capacitor.

In the second case, the capacitors are set in parallel switched lower, transporting energy from this one in request to reach this new voltage. Subsequent periods of this operation, two cells are balanced any switching cycle, the i-capacitor relocates the current I_{C_i} from the max charged adjacent cell to the min charged adjacent cell according to

$$I_{\mathrm{c}_i} = C_i \left(V_{\mathrm{u}_i} - V_{\mathrm{l}_i}\right) f_{\mathrm{SW}} \tag{6}$$

where V_{l_i} is the min cell voltage of the i-capacitor, and f_{SW} is the switching frequency. Therefore, the capacitor pursues similar resistance and the equivalent resistance R_C is

$$R_{\mathrm{C}} = \frac{V_{\mathrm{u}_i} - V_{\mathrm{l}_i}}{I_i} = \frac{1}{f_{\mathrm{SW}} C_i} \tag{7}$$

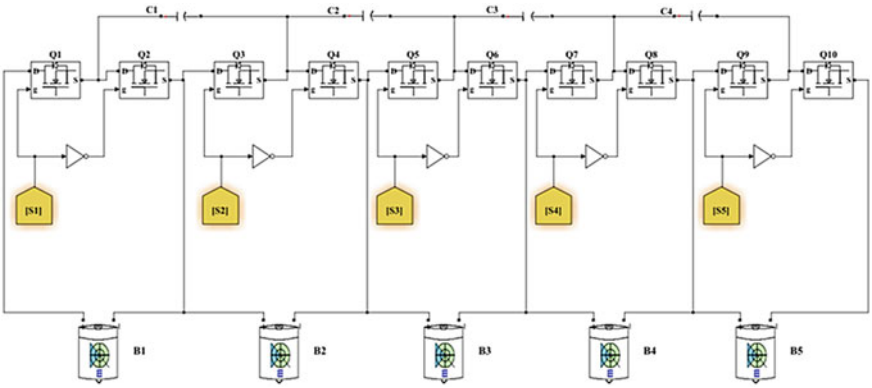

Fig. 5 The SC circuit

When taking the on-resistance of the switches R_{SW} The overall resistance for the i-capacitor R_{SWi} is

$$R_{\mathrm{SW}_i} = \frac{1}{f_{\mathrm{SW}} C_i} + 2\frac{R_{\mathrm{SW}}}{D} \tag{8}$$

where D is the duty cycle, the efficiency regression per capacitor follows [20]. Figure 5 illustrates SC simulated circuit, where C = 10mF, $f_{SW} = 10KHz$.

4 Control Strategy

Fuzzy logic controller (FLC) was first suggested by Lotfi A. Zadeh of the University of California at Berkeley, in a 1965 paper. The FLC is a computational intelligence technique processing the human experience into an advanced control method. Diverse the binary system, the FLC is eligible for item issues in unclear and heuristic paths. FLC application is extended as uncomplicated, necessitates no mathematical modeling data, and can beat the system's nonlinearity. The FLC is divided into four parts, namely, fuzzification, Rule Base, Inference, and Defuzzification. This section of paper supplies a brief description of the proposed charging with the FLC method, Discharge control, and control mode in BDC.

4.1 Charging Control

As previously pronounced, the battery life cycle and performance count on the temperature of the battery. Also, the temperature must be stable against the high

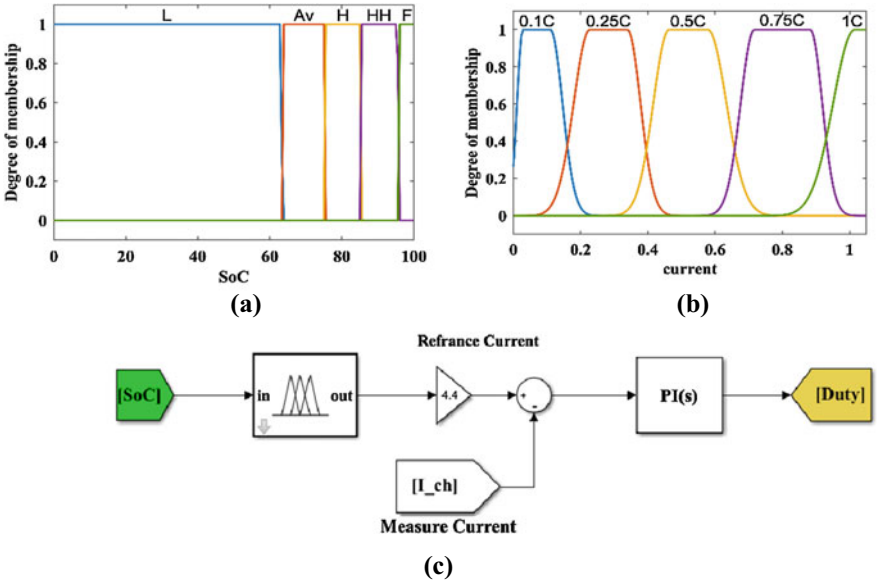

Fig. 6 The Charging **a** SoC MF, **b** Current MF, and **c** Control Circuit

charging current because of excessed temperature where the safety area is lost during the charging process. The FLC proposed a multi-stage charging current to regulate the current to reduce the effect of rising temperature during the charging process. FLC has one input SoC of the battery, and the output is the charge current $I_{Charging}$. The FLC is exercised here to set the reference current for the charging process relying on the *SoC* in a battery. The input SoC is between (0–100) and the output current between (0–1C). The Mamdani FIS used is illustrated in Fig. 6a, b.

To manage the charging process after obtaining the reference charging current from the output FLC, we use the Propositional Integral controller (PI) to change the value of duty to reduce the difference between the reference and the measurement current. The PI tuned utilization of the trial and error method with minimum steady-state error. The circuit of charging is expounded in Fig. 6c.

4.2 Discharge Control

As the charging process necessity current control to maintain the battery pack's performance, discharge process poverty to control draw current duo to the datasheet of battery limiting charging and discharging current. The FLC applied to discharge operation depends on two inputs; SoC of the pack and $\boldsymbol{T}_{\boldsymbol{MAX}}$, which produces the duty cycle output of FLC. When the discharge current exceeds the battery's capacity, the system will shut down to preserve the life cycle of the battery. The range of inputs

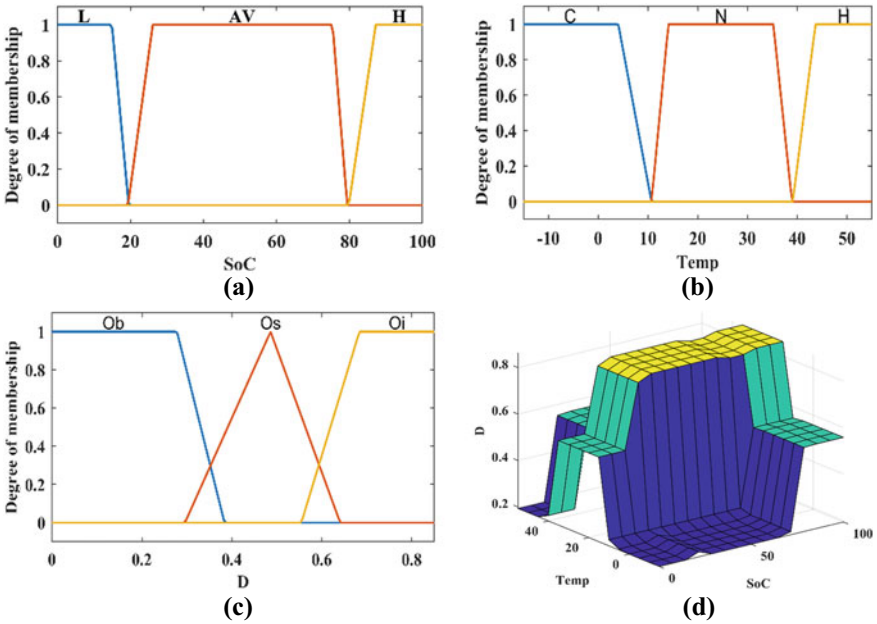

Fig. 7 Discharge Control **a** SoC MF, **b** Temp MF, **c** D MF, and **d** Surface

where $\boldsymbol{SoC} = 0\boldsymbol{to}100$ and $\boldsymbol{T}_{\boldsymbol{MAX}} = -15\boldsymbol{to}55$ and output D = 0 to 0.85. Figure 7 illustrates the discharge Mamdani FIS used and the surface of FLC.

4.3 Control Mode of BDC

Figure 8 shows that this flowchart to control the BDC works in Buck or Boost mode depending on the *SoC* of cells in the battery string and power availability, which

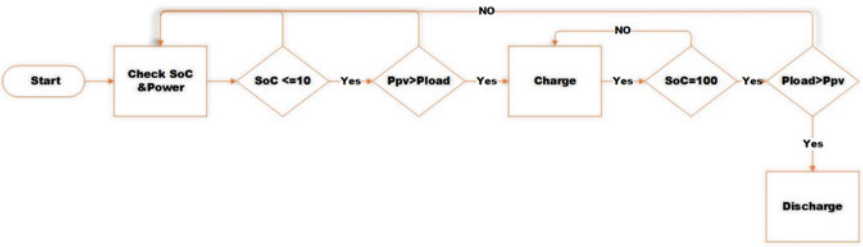

Fig. 8 The Control Mode Flowchart

priority to supply load. If $SoC \leq 10$ and $P_{PV} > P_{Load}$, the buck mode activated (charging mode), when $SoCMIN = 100$, the boost mode activated (discharge mode).

5 Result and Discussion

This section of the paper demonstrates how the response and performance of FLC determines the charging and discharging process and the proposed methods to protect the battery.

5.1 Charge and Discharge Current

As mentioned above, meanwhile the charging operation, the temperature growing which affecting the battery performance. Therefore, the proposed charging method was designed to achieve various charging currents, depending on SoC. The charging current is equal to 1C when the SoC is between 0–65%, this represents the first charging stage. The current equals 0.75C when the SOC is between 65–75, this represents the second stage of the charging. When SoC is between 75–85%, the charge current is equal to 0.5C, this represents the third charging stage. When SoC is between 85–95%, the current is similar to 0.25C, representing the fourth stage of charging. The final stage of charge starts when SoC is between 95–100%, here, the current is equal to 0.1C. Figure 9a illustrates the charging process.

The proposed discharging method was designed to achieve several discharging current, depending on the availability of SoC andT_{MAX}, the battery pack used FLC to change the duty cycle and maintain the discharge current with the desired current value. Figure 9b shows the discharge current with different values depending on SoC and T_{MAX}, which does not exceed the 1C design discharge value.

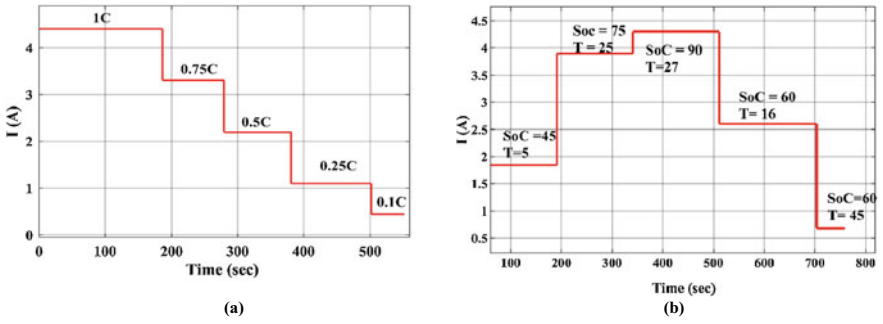

Fig. 9 The Current in **a** Charge mode **b** Discharge mode

5.2 Protection Features

Protection Features: Lithium batteries are dangerous and cause explosions, so protection is done for the battery pack to get maximum performance. The different materials manufactured and used of cells, some of the cells during the charging process amount to the maximum point before the other cells in the string, and it is the difference between the voltages of the cells. Cell equalizer must be implemented for the first protection feature. Figure 10a shows the application of SC between adjusted cells, which transfer energy between cells 1 and 2. The SC balancing manifests a preference in energy loss over passive balance, but the equalization is slow when the difference voltage becomes small. The end of balancing when the difference of voltage cell becomes 20 mV.

Over discharge and exceeding the permissible limit several times affect the life cycles of the battery, so the maximum value was particular to be discharged upon arrival $SoC = 10\%$. Figure 10b revelations how to protect against over-discharge. The values between points (a) and (b) appear discharge stopped, and the charging process did not start because of the power of source not more than the load required power, when charging start should $P_{pv} > P_{load}$.

Over-Temperature protection pending charge or discharge process illustrated in Fig. 10c and d, when any cell in the pack reaches $T_{MAX} = 55$ the system shutdown.

6 Conclusion

This study modeled and designed BMS with the proposed charging method based on FLC and discharging method setup on FLC completed in MATLAB/Simulink environment 2020a. The circuit is sophisticated, along with the Li-ion battery model, charging control circuit, discharge control circuit, boost converter model, PV array, and BDC. From the simulation results, the system attains changing of charging current counting SoC, which provides safe reign for operation owing of reducing the charging current, the proposed method provides fast charge to SoC = 65%, In the other stages, the current decreases, which reduces the increase in temperature during charging. The selection of PI values explained excellent results with little difference from the reference, and this could be improved by utilizing the optimization technique for the PI tune. The range of discharge rate should consider maintaining the battery pack, control of discharge based on FLC depending on SoC and $\boldsymbol{T_{MAX}}$ of string which provides safe discharge and maintains the life cycle of the battery. The battery protection feature validated from where overcharge, over-discharge, over-temperature, and cell balancing. The application of SC balancing shows reliability and flexibility, so when an increased N of cells time balance becomes long, this method is preferred with low and medium voltage. In high voltage, systems must use a modified SC method to achieve.

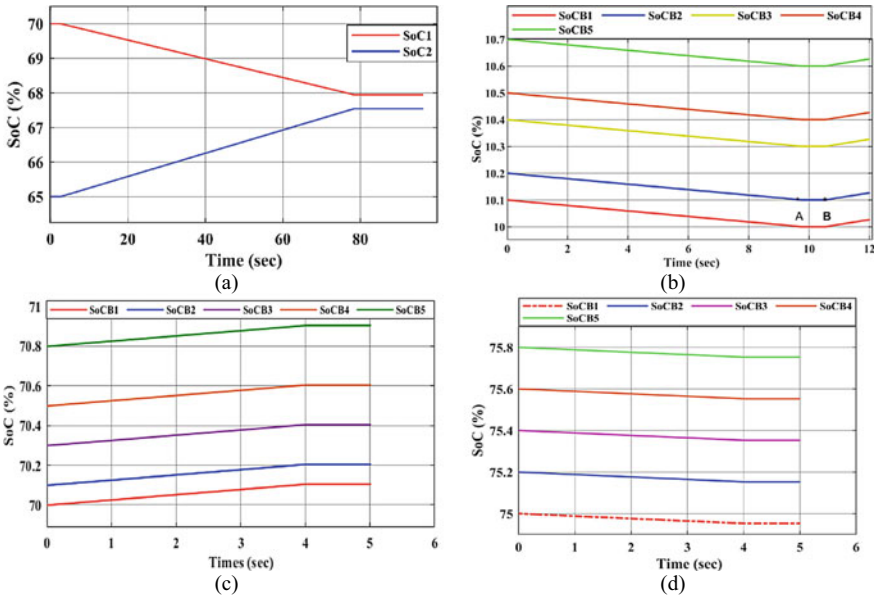

Fig. 10 **a** The Overcharge Protection, **b** The Over-discharge Protection, **c** The Over-Temperature Protection in Charge Mode, and **d** The Over-Temperature Protection in Discharge Mode

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Hybridization of Artificial Potential Field and D* Algorithm for Mobile Robot of Path Planning in Dynamic Environment

Noor Alhuda F. Abbas, Omar Alniemi, and Janan Farag Yonan

Abstract Robot path planning has been paid much interest by many researchers to be utilized in many industrial applications. In order to attain accurate robot movements, the path planning methods are improved. In this paper, the artificial potential field has been enhanced to find the robot path that follows the dynamic goal and avoids the dynamic obstacle. The D* algorithm cost is utilized to add to the attractive potential equations, taking into consideration the dynamically changing goal point and robot environment. The essential functions of the prospered D*-based potential field method are solving the artificial potential field problems in generating the potential area and path, as well as obtaining the best path that achieves the whole motion criteria, especially the minimum distance. Simulation results of the implementation of the proposed D*-based artificial potential field demonstrate that the proposed method has promising potential for efficient robot path planning in following the dynamic goal and avoiding the dynamic obstacles with achieving the minimum distance and overcoming the potential field problems.

Keywords Path planning · Artificial potential field · D* algorithm · Dynamic environment

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1 Introduction

Path planning of robots is a significant research field to attain robot automation. Robot path planning is considered as the quantity's foundation of tasks of the robot. It is improved to implement in several industrial applications for carrying out particular tasks repeatedly based upon predetermined movements and specifically located objects. Especially the tasks that are most dangerous tasks for humans. In the field of mobile robot application, path planning is concerned with generating the set of movements that should satisfy the motion criteria, which is represented by a path with minimum time, minimum traveling distance, minimum consumed energy, and ensuring obstacle avoidance. The planned path may be optimal or near-optimal depending on the satisfaction of all or most of the planning criteria. However, path planning with minimum traveling distance is the most exemplary case [1–4].

The path can be planned offline or online based on the completely available information of the static or moving robot environment. In online path planning, the path is partially planned depending on updated available information related to the dynamic environment until achieved the given goal. Many challenges that can appear in online planning, represented by robot environment complexity, guaranteed completeness of path, and achieving optimality path.

The artificial potential field (APF) method is essentially used for planning an acceptable path for a variety of robot types. The robot path is subject to the artificial potential force, which has two main companies' forces, which comprise: attractive force and repulsive force. Moreover, The APF suffers from the main problems in best path planning, the local minimum problem, and avoided colliding with obstacles [5–8].

In this paper, the hybridization algorithm is proposed to plan the shortest and free collision robot path in the dynamic environment and goal. The proposed method depends on the enhancement of the (APF) by integrating with the D* algorithm to find the optimal path that navigates within dynamic obstacles and follows the dynamic goal. The D* algorithm cost is utilized to enhance the attractive potential field that guides the robot's movements toward the dynamic goal [9, 10].

2 Proposed D*-Based Artificial Potential Field

Finding the minimum distance path of the robot can be considered as the essential field that tends to find the shortest route from the start point to the goal point by avoiding all the dynamic obstacles. The hybridization of the D* algorithm with the artificial potential field (APF) is proposed to find the shortest path from the static start points until reaching the dynamic goal. The D* algorithm is utilized to obtain the exact distance between all points of the dynamic environment to the goal point. The APF is applied to find the shortest robot path from the static start point to the

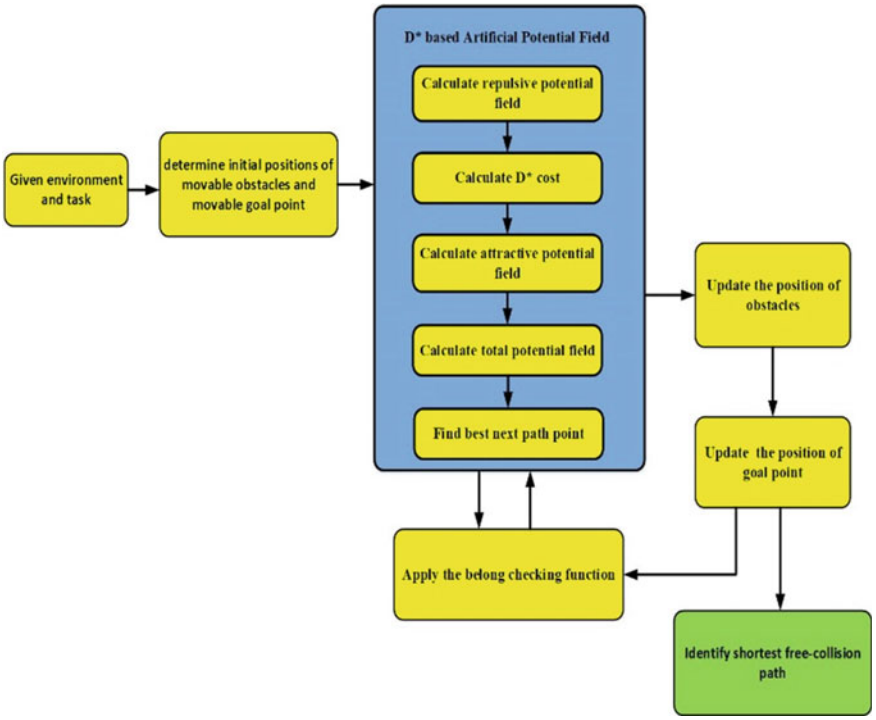

Fig. 1 The block diagram of the proposed D*-Based APF method

following dynamic goal point. Figure 1 illustrates the block diagram of the D*-based APF proposed method. The proposed method of D*-based APF (D*APF) is initialized with determining the static start position and initial position of the dynamic goal point. subsequently, the repulsive potential field is calculated according to the following equation:

$$U_{rep}(q) = \sum_i U_{repi}(q) \tag{1}$$

where $U_{repi}(q)$ indicates the repulsive potential, which is calculated depending on the obstacle i that influences the environment of the robot. The function is

$$U_{rep}(q) = \begin{cases} \frac{1}{2}\eta\left(\frac{1}{d(q,q_{obs})} - \frac{1}{d_0}\right)^2 d(q,q_{goal})^n & if\, d(q,q_{obs}) < d_0 \\ 0 & if\, d(q,q_{obs}) > d_0 \end{cases} \tag{2}$$

Where q indicates the current position of the robot, while q_{obs} represents the position of the obstacle.d_0 represents the influence distance of the obstacle, $d(q, q_{obs})$ is the distance between the robot position and the obstacle position. The adjustable constant is η, which indicates the proportional coefficient of the repulsive potential

field function. Moreover, depending on the negative gradient of repulsive potential fields function, the repulsive force can be obtained according to

$$F_{rep}(q) = -\nabla U_{rep} \tag{3}$$

After that, the D* algorithm is applied to calculate the exact distance between the points of the dynamic environment and the dynamic goal. The cost of the D* algorithm is added to the modified attractive potential field that is calculated according to the following equation:

$$U_{att}(q) = \frac{1}{2}\zeta d^2(q, q_{goal}) \tag{4}$$

where ζ represent the proportional coefficient of the attractive potential field function, $d(q, q_{goal})$ is the D* cost that indicates the exact distance between the robot position and the (q_{goal}) goal position. The attractive force is obtained depending on the negative gradient of the attractive potential field according to the equation:

$$F_{att}(q) = -\nabla U_{att}(q) = -\zeta d(q, q_{goal}) \tag{5}$$

The influence of the hybridization between the D* cost and attractive potential field is demonstrated in Fig. 2.

Accordingly, the whole potential field can be calculated depending on the combining the attractive potential U_{att} and a repulsive potential U_{rep}:

$$U(q) = U_{att}(q) + U_{rep}(q) \tag{6}$$

As soon as the total potential field is calculated, the best next movement of the robot position is planned, the validation of free collision with the obstacle is taken into consideration. Subsequently, the obstacles positions and goal positions are updated.

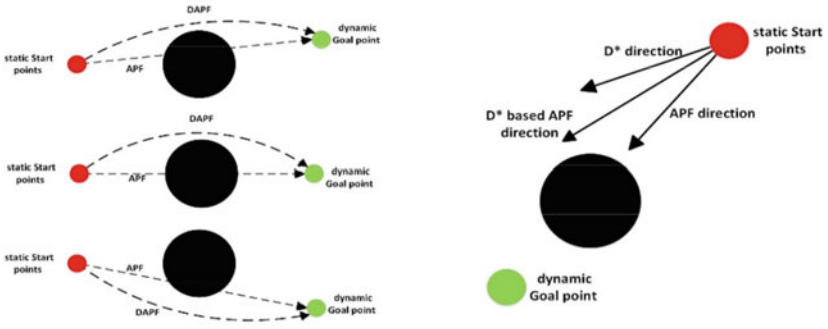

Fig. 2 The influence of the hybridization between the D* cost and attractive potential field is illustrated in the figure

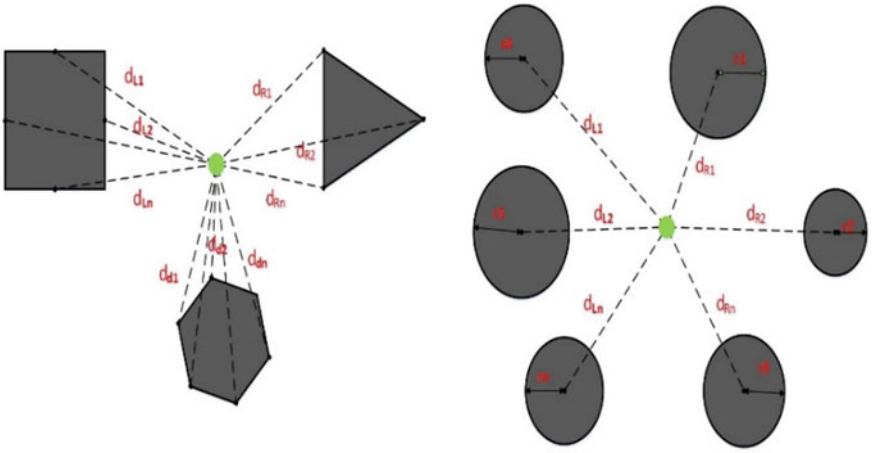

Fig. 3 Checking the distances between the robot and the obstacles

However, the updated obstacle position and goal position is randomly within the environment limitation and without colliding among them.

The formulation of the collision checking function varies depending on the obstacle shape (polygon, circle). In the circular obstacle case, the collision checking function is based on the center point and radius of the circle as in Eq. (13). While in the case of the polygonal obstacle, the collision checking function depends on polygon vertex points. Figure 3 shows the two circles and geometric polygon model with the robot checking the distances between the robot and the obstacles. The following equations represent distances between the robot and obstacles.

$$d_{L1} = \sqrt{(x_p - x_c)^2 + (y_p - y_c)^2} \tag{7}$$

$$d_{L2} = \sqrt{(x_p - x_c)^2 + (y_p - y_c)^2} \tag{8}$$

$$d_{Ln} = \sqrt{(x_p - x_c)^2 + (y_p - y_c)^2} \tag{9}$$

$$d_{R1} = \sqrt{(x_p - x_c)^2 + (y_p - y_c)^2} \tag{10}$$

$$d_{R2} = \sqrt{(x_p - x_c)^2 + (y_p - y_c)^2} \tag{11}$$

$$d_{Rn} = \sqrt{(x_p - x_c)^2 + (y_p - y_c)^2} \tag{12}$$

While the verification equation of collision is as follows:

$$v = \max\left(1 - \frac{d_L}{r}, 0\right) \forall d_L \in (d_{L1}, d_{L2}, \ldots d_{Ln}, d_{R1}, d_{R2}, \ldots d_{Rn}\}, r \in \{r_1, r_2, \ldots r_n\} \tag{13}$$

where (d_{L1}, d_{L2}, d_{Ln}) represent the distances between the points of the robot and center of the left circular obstacle (x_c, y_c), and (d_{R1}, d_{R2}, d_{Rn}) represent the distances between the points of the robot and center of the right-left circular obstacle (x_c, y_c). Also, v represents the verification value of the collision checking function. The processes of the D* cost calculating, total potential field summing, and best next robot movement finding with free collision with dynamic obstacles are iteratively done following the dynamic goal. This process is terminated as soon as the robot reaches the dynamic goal or attains the minimum distance between the planned path point and goal point.

3 Results

Computer modeling simulates the test implementation of the proposed D*-based APF algorithm for path planning of the mobile robot in a dynamic environment. In this paper, the 2-D difficulties of dynamic mobile robot environments are suggested to test the proposed method. However, the suggested environments have x–y dimensions that are limited from (0 to 10) cm and contain dynamic obstacles. The path has to be planned from the static start points and follow the dynamic goal point, based on the modified potential area.

However, the artificial potential area is essentially influenced by changing the coefficient variables of the attractive and the repulsive equations, Table 1 illustrates the influence of changing of variable values on the shortest path planning.

Figure 4 represents the tested run of the suggested mobile robot environment containing dynamic obstacles. In Fig. 4a, the red circle represents the dynamic obstacles, the yellow start represents the static start point, while the green point represents the initial position to the dynamic goal point. Figures 4b, c, and d demonstrate the modified attractive potential field area, the repulsive potential field area, the total potential field, respectively. Figure 5 demonstrates the comparison between the basic

Table 1 The influence of changing of variable values on the shortest path planning

Test number	ζ	η	τ	D* based APF
1	10,000	1	10,000	12.458
2	30,000	3	15,000	12.587
3	60,000	5	20,000	11.5483
4	70,000	7	30,000	11.5796
5	90,000	9	50,000	15.2596

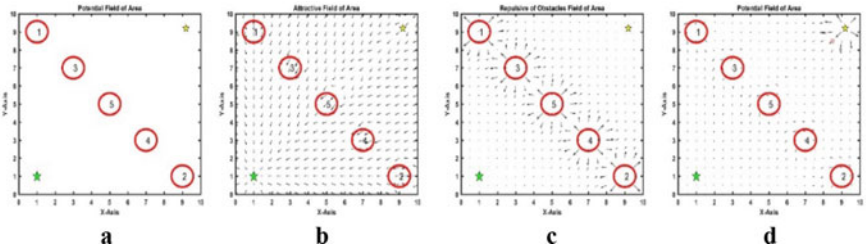

Fig. 4 Suggested tested environment, **a** The modified attractive potential field area, **b** The repulsive potential field area, and **c** The total potential field

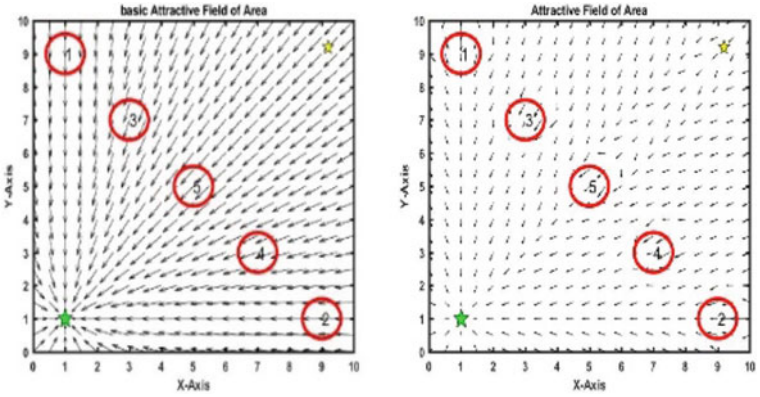

Fig. 5 Comparison between the basic attractive potential field and modified D*-Based attractive potential field forces

attractive potential field and modified D*-based attractive potential field forces.

The modified D*-based algorithm test to find the path in the dynamic environment. the robot path has to be planned from the static point (9, 9) to follow the dynamic goal point that is initialized from the point (1, 1) until reaches to the final position of the goal point (1, 1.4) with the distance equal to 17.26794. Figure 6 represents the sequences of movements of path planning of the first tested run, the green line illustrates the planned path. The modified method is also tested with the second run, where the path has been planned from the static start point (9, 9) to follow the dynamic goal point from the initial robot position (1, 1) to the desired robot position (1, 1.4), with a distance equal to 13.39292. Figure 7 represents the sequences of movements of path planning of the second tested run. The modified method is also tested with the third run, where the path has been planned from the static start point (9, 9) to follow the dynamic goal point from the initial robot position (1, 1) to the desired final robot position (2, 1.4), with a distance equal to 10.69238. Figure 8 represents the sequences of movements of path planning of the third tested run.

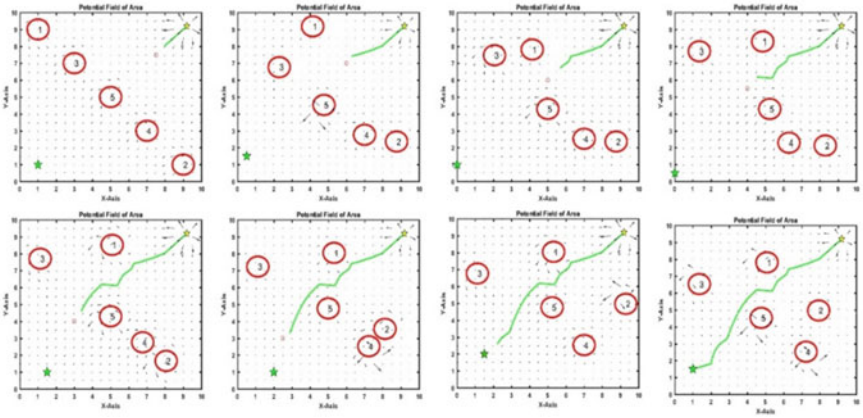

Fig. 6 Sequences of movements of path planning of the first tested run

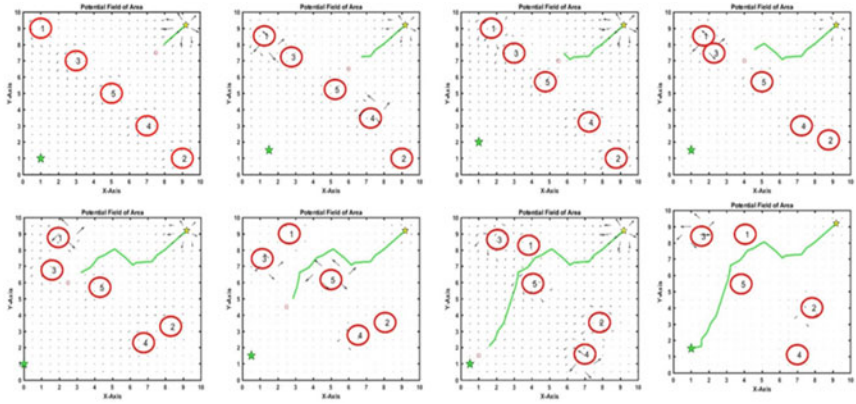

Fig. 7 Sequences of movements of path planning of the second tested run

The modified method is also tested with the fourth run, where the path has been planned from the static start point (9, 9) to follow the dynamic goal point from the initial position (1, 1) to the final position (4.5, 4.4), with a distance equal to 8.8284. Figure 9 represents the sequences of movements of path planning of the fourth tested run.

Table 2 explains the comparison between the basic D* algorithm, basic artificial potential field, and the modified D*-based APF, which are the results of all test cases that are implemented on the suggested dynamic environments.

Simulation results and modeling of the robot path planning illustrate the efficiency performance of the proposed method of D*-based APF in finding the shortest path from the static start points to the moving goal point, with guaranteed free collision of dynamic obstacles.

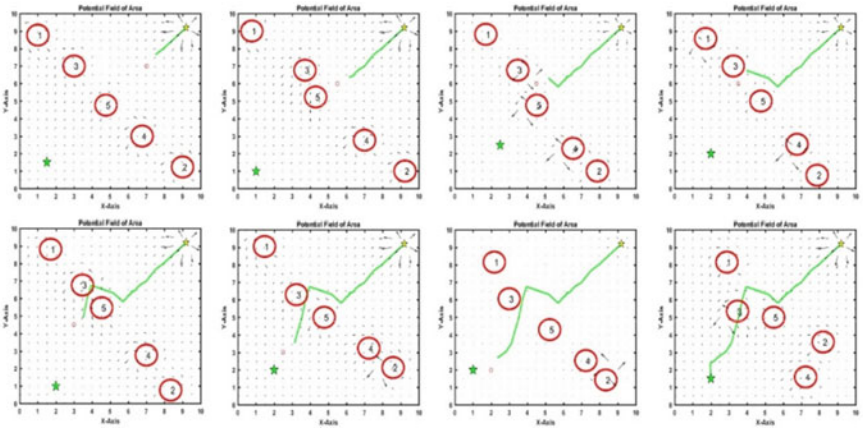

Fig. 8 Sequences of movements of path planning of the third tested run

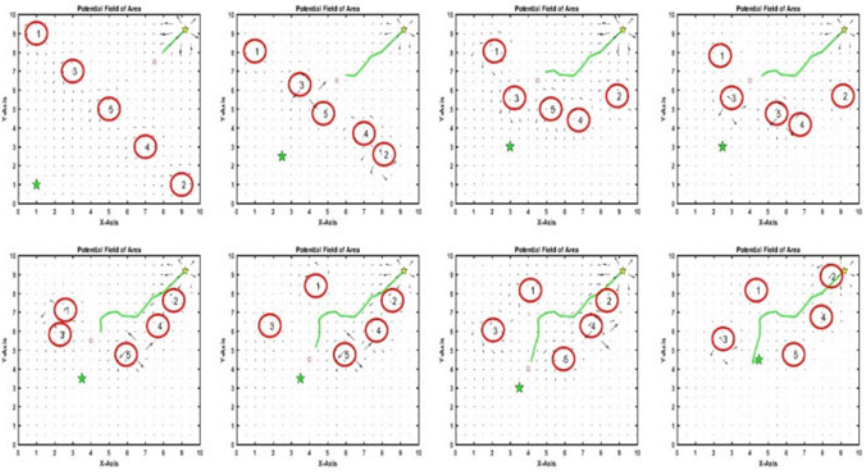

Fig. 9 Sequences of movements of path planning of the fourth tested run

Table 2 The comparison between the modified D*-based APF and the basic algorithms

Test number	Test point		D* algorithm cost	Basic artificial potential field	D*-Based artificial potential field
	Start point	Initialgoal point			
1	9,9	1,1	11.2426	12.3678	10.5462
2	9,9	1,1	23.2848	24.1493	18.5557
3	9,9	1,1	11.3238	12.9831	11.377
4	9,9	1,1	16.7848	16.3875	14.7028
5	9,9	1,1	29.5716	29.9273	27.1758

4 Conclusion

In this paper, the hybrid algorithm of D*-based Artificial potential field (D*APF) is proposed for robot path planning that follows the dynamic goal within environments containing dynamic obstacles. The D* algorithm is utilized to solve the assumption-based path planning problem, taking into consideration the dynamic change of the robot environment. Based on the D* cost, which indicates the exact distance between the environment points and the dynamic goal, the attractive potential field has been modified. The modified D*-based APF method makes the robot navigate within the environment to plan the path with the minimum distance from the static start point and follow the dynamic goal and avoid the dynamic obstacles. The modified D*-based APF method efficiently solves the main problems that face the APF by avoiding the dynamic obstacles, completely removing the local minimum problem, and achieving the minimum path distance. The experimental results of the modified D*-based APF illustrate the efficiency of the proposed method in achieving and satisfying the complete motion criteria of the robot that plan the path within the dynamic environment. The future work includes the implementation of the proposed method by hybrid with the optimization algorithms to enhance the robot motion in multiple stochastic environment dimensions (3D) include static and dynamic obstacles as well as the dynamic goal.

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Human Factors and Workplace Well-Being: An Empirical Analysis in Construction Work

Sasmita Samanta and Jyotiranjan Gochhayat

Abstract The construction sector workplace is different from other workplaces and complex in nature. Such workplaces are unorganized and have poor workplace well-being with various safety and health issues, dissatisfaction among workers, and poor quality of work life. Human factors such as job stress, safety orientation of the workers, work engagement, worker's agility, and spirituality at workplace are the potential factors contributing largely to an unsafe work environment leading to poor workplace well-being. This study aims to explore the potential role of human factors in workplace well-being at construction sites. Primary data were collected through questionnaire surveys from workers working on construction sites. The data were analyzed with the help of the statistical tool SPSS AMOS 22. The results indicated that human factors such as safety orientation, spirituality at work, work engagement, and workers' agility significantly predict workplace well-being at construction sites. This study will help the workers to enhance their well-being at work. It will help the supervisors, managers and contractors to devise strategies for their workplace.

Keywords Workplace well-being · Human factors · Spirituality · Safety orientation · Agility

1 Introduction

The construction sector workplace is different from other workplaces and complex in nature. [13]. It was found that most of the workers in Indian construction sites are migrated from rural areas [5] with no or little education and having a goal to earn for sustaining their livelihood. Such workplaces are unorganized and may lead to poor workplace well-being with various safety and health issues, dissatisfaction

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among workers, and poor quality of work life. It is observed that workers' safety behaviour accounts for more than 80% of incidents (http://www.behavioural-safety.com/articles/BSMS0). Furthermore, [3] predicts that 80–95% of all accidents and injuries are largely due to human factors such as unsafe action and behaviour. Beyond safety and health, other dimensions of workplace well-being are likely to get impacted by the human factors at the workplace. Though the significance of human factors in workplace well-being has been increasing, the research on the influence of such human factors is counted. Hence, this study aims to explore the potential role of human factors in workplace well-being at construction sites.

2 Review of Literature

Workplace well-being refers to the concept of making the workers safe, healthy, and satisfied with the various dimensions of the working environment. Workplace well-being is crucial in individual productivity as well as the organizational outcome. Poor workplace well-being will lead to demotivation, dissatisfaction, and a sense of inferiority and undervalued. Sustained poor workplace well-being is dangerous for a workplace to sustain and grow. The study suggests that 88%, 10%, and 2% of the reasons for the accidents are related to unsafe acts, unsafe environment, and unpredicted factors, respectively [4]. However, human factors such as job stress, safety orientation of the workers, work engagement, worker's agility, and spirituality at workplace can also contribute largely to an unsafe work environment leading to poor workplace well-being.

Job stress which results out of the characteristics of the job and the work environment is likely to affect the workers' well-being. Work in construction sites are often with job characteristics such as the need to ever vigilant and ready, higher consequences of the errors, the need to comply with time frame, and working under pressure [9]. Such complex dynamics induce stress, which is potent to affect workers' workplace well-being. Job demands from jobs at construction sites are high, whereas the control over the kind and nature of jobs by the individual workers is low. Job Demand–Control (JDC) model indicates that work where demand of tasks are high while providing lower autonomy to workers to perform the job independently results in stress [1]. These stressors are fatal for workers' well-being [10]. In most of the construction sites, it is observed that there is poor safety orientation where workers remain indifferent towards potential risk at workplace even they get a sense of it. Workers in desperate need of job, and with little safety awareness, often do not bother to compromise their safety for financial gain. Such a lack of appropriate safety orientation is a major cause of injuries and accidents [5, 10]. Furthermore, though the need forces the workers to work in such an environment, they often feel unsafe and dissatisfied with their work activities leading to poor workplace well-being. Hence, it is proposed that:

H1: Higher the job stress, lower will be the workplace well-being.

H2: Higher safety orientation will lead to higher workplace well-being.

Spirituality at work can also be a factor in substantiating workplace well-being. Spirituality at work can be defined as individuals' contentedness and intrinsic satisfaction with their work activities. Spirituality at work is not about individuals' acceptance of a particular faith or belief system. It is about being faithful and true to one's work and intended outcome [7]. Thus, spirituality at work with the inner life, meaningful work, is a factor in greater workplace well-being. Similarly, workers with higher work engagement get involved with their work activities at a deeper level with higher attachment to the work as well as the outcomes [9]. When people engage themself with a particular task, they get involved with the role they are about to perform. Individuals with higher engagement exhibit high level of energy, experience positive emotions [6, 9], and a sense of actualization and completeness [8]. Accordingly, we propose the following hypotheses:

H3: Spirituality at work contributes to higher workplace well-being.

H4: Work engagement of workers has positive influence over worker's well-being.

Similarly, a worker's agility at workplace is a potential factor in deciding the workplace well-being. Agility refers to an individual's flexibility to respond to uncertainties easily [9]. An agile worker is quick, open to change, ready to accommodate, and can absorb pressure [2]. They exhibit an open mindset for continuous learning, improvement, and development. Accordingly, an agile workforce will be able to manage any kind of crisis, uncertainty, and unfavourable situation effectively [9] contributing to workplace well-being. Hence, it is proposed that.

H5: Workers' agility predicts workforce well-being positively.

On the basis of the proposed hypotheses, the following conceptual framework is developed for investigation (Fig. 1).

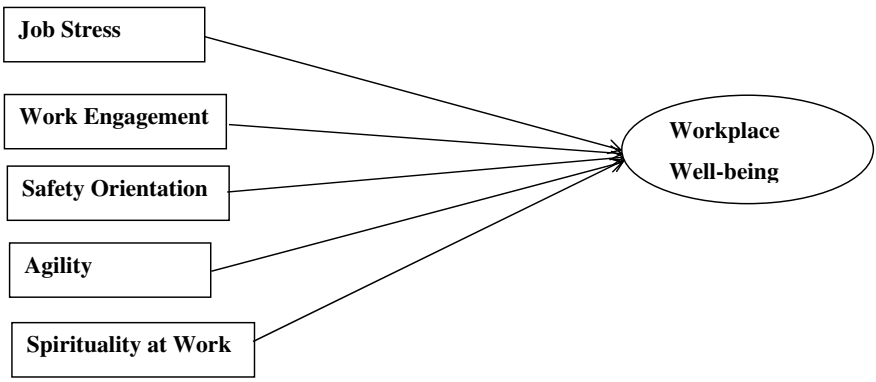

Fig. 1 Conceptual framework for investigation

3 Methodology

A questionnaire was designed to collect responses from various workers working in the construction site of Odisha through a questionnaire survey. The questionnaire was designed in English, and two research assistants were engaged to collect responses from the workers by asking the information in a language understood by the workers, and helping them understand the question for getting the right response.

4 Participants

Data were collected from workers working in various construction sites at different locations of Odisha. In the process, A total of 379 responses were collected. 36 responses were dropped for incompleteness. Rest 343 responses were taken for analysis. Respondents were from various age groups. While the youngest respondent is of 18 years, whereas the oldest respondent is of 60 years with a mean age of 40.7. Out of the 343 respondents, 243 (71%) were Men and 100 (29%) were women. Out of all the workers, 291 were having mother tongue as Odia, 31 with Bengali, 11 with Santali, and 10 are with Hindi as their mother tongue. Most of the workers were bilingual as 327 people can speak Hindi, 302 people can speak Odia, and 79 people can speak Bengali.

5 Measures

The questionnaire for data collection included questions on demographic details, and scales to measure job stress, work engagement, safety orientation, agility, spirituality at work, and workplace well-being. To measure the variables, scales on workplace well-being, agility, and work engagement were taken from existing standard scales, whereas scales on safety orientation, job stress, and spirituality at work were developed by the authors. The items on agility, work engagement, safety orientation, job stress, and spirituality at work are on a 5-point Likert scale. The response range for safety orientation, job stress, and spirituality at work was 1: Strongly Disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly agree and for work engagement and agility was 1 = Never, 2 = Rarely, 3 = Occasionally, 4 = Often, 5 = Always.

Safety orientation and Spirituality of workers at work were measured through 5 items each developed by the authors. To measure job stress, 9 items were developed. Work engagement was measured through a short version of the Utrecht Work Engagement Scale (UWES-9, [11]. The scale had 9 items. To measure agility, 39 items from the Workforce Agility scale [12] were taken. The scale was reduced to 19 items to suit the context of exploration. The negative items were reverse coded and

the responses to scales were averaged with respect to the number of items on each scale and used as observed variables for statistical analysis. To measure workplace well-being, 9 items were developed on work satisfaction, feeling safe and accidents and near misses. The items on work satisfaction and feeling safe were on a 5-point Likert scale with a response range of 1: Strongly Disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly agree. The items on accidents and near misses were dichotomous with response range as Yes and No. No was coded as 1 and Yes was coded as 0. Accordingly, higher score represents lower number of accidents and near misses and vice versa. Workplace well-being was used as a latent variable with reflective indicators representing work satisfaction, feeling safe, and accidents and near misses.

6 Analysis, Result, and Discussion

The descriptive statistics and Person co-relation of the variables are presented in Table 1. The correlation among variables does not indicate towards a prominent pattern of association between the human factors and workplace well-being. Safety orientation is positively associated with the number of accidents and feeling safe. Spirituality at work correlates with the number of accidents. Work engagement is associated with work satisfaction, and workers' agility is associated with the number of accidents and feeling safe. These correlations indicate that the studied human factors might have a significant influence on workplace well-being. Job stress is negatively associated with feeling safe and does not relate to the number of accidents and work satisfaction, indicating that job stress might not have a linear relationship with workplace well-being (Table 1).

Table 1 Correlation statistics among studied variable

	Mean	SD	JOS	SAR	SPR	WE	AGI	ACC	FES	WS
JOS	3.10	0.40	1	−0.04	0.22**	0.14**	0.11	0.06	-0.17**	0.02
SAR	2.61	0.53		1	0.16**	−0.27**	0.06	0.37**	0.13*	0.03
SPR	1.84	0.64			1	−0.19**	0.24**	0.29**	0.10	−0.05
WE	3.75	0.85				1	−0.010	−0.04	0.03	0.35**
AGI	3.01	0.55					1	0.29**	0.16**	0.09
ACC	2.22	0.83						1	0.05	0.26**
FES	3.99	1.07							1	0.28**
WS	3.54	1.035								1

**Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

Note JOS: Job Stress; SPR: Spirituality at Work, SAR: Safety Orientation, WE: Work Engagement, AGI: Agility, ACC: Accidents, FES: Feeling Safe, WS: Work Satisfaction, SD: Standard Deviation

The correlation statistics among the studied variables did not give any clear results. Furthermore, such associations do not represent a causal relationship. Accordingly, the conceptual model was examined with the help of structural equation modelling (Fig. 2). The results of the structural equation modelling is presented in Table 2.

The results indicate that safety orientation, spirituality at work, work engagement of workers and their agility are significantly predicting workplace well-being positively. When the safety orientation of the workers increases, it decreases the number of accidents and hazards. Spirituality at work and work engagement help the workers to have a positive attitude and orientation towards the work with a focus on work as well as contentedness. The focus on work and contentedness contribute to reducing

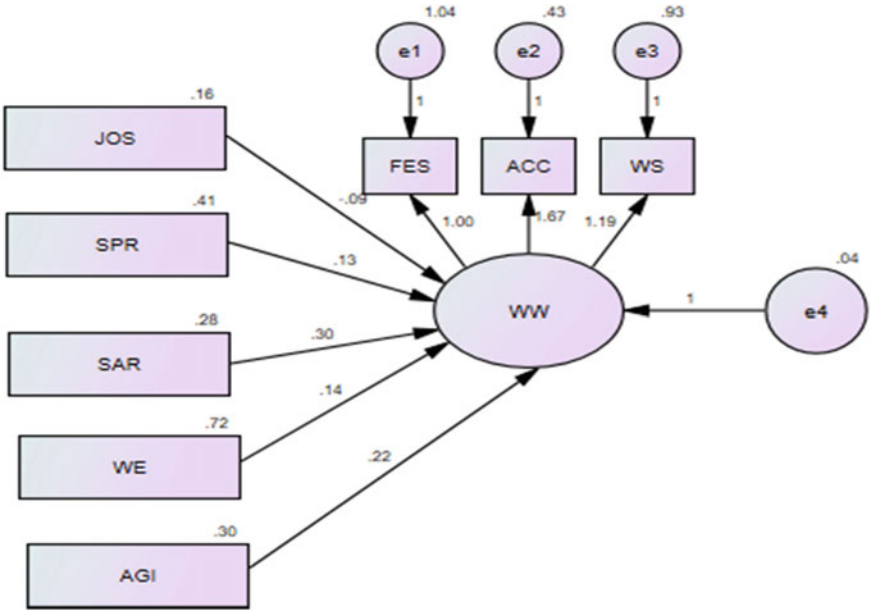

Fig. 2 Structural equation modelling with un-standardized estimates

Table 2 Hypotheses testing through structural equation modelling

Path	B	SEB	β	CR	*p*	Inference	Fit indices
JOS - - > WW	−0.087	0.055	−0.109	−1.57	0.12	Refutes H1	χ^2/df = 10.2, GFI = 0.87, AGFI = 0.86
SAR - - > WW	0.304	0.072	0.506	4.204	0.001	Supports H2	
SPR - - > WW	0.131	0.042	0.263	3.125	0.002	Supports H3	
WE - - > WW	0.139	0.037	0.37	3.743	0.001	Supports H4	
AGI- - > WW	0.221	0.058	0.381	3.794	0.001	Supports H5	

Note JOS: Job Stress; SPR: Spirituality at Work, SAR: Safety Orientation, WE: Work Engagement, AGI: Agility; *B*: Un-standardized beta; SEB: Standard error of beta; *β: S*tandardized beta; CR: Critical ratio; *p*: Level of Significance

unsafe acts and helps in enhancing work satisfaction. Workers' agility increases the ability of the workers to avoid and face any uncertainties and accidents at workplace. It reduces the probability of hazardous occurrences. Furthermore, it builds confidence among the workers that makes the workers feel safe at the work activities. Accordingly, safety orientation, spirituality, work engagement, and workers' agility help in reducing the number of accidents, make the workers feel safe and satisfied in their work environment leading to enhanced workplace well-being. These findings support our hypotheses H2, H3, H4, and H5. However, it was observed from the analysis that job stress failed to predict workplace well-being significantly. This refutes our hypothesis H1. Though job stress failed to predict workplace well-being linearly, it might have a non-linear relationship with workplace well-being.

7 Conclusion

The study examined the influence of human factors on workplace well-being at unorganized workplaces such as construction sites. The correlation statistics and structural equation modelling results indicated that human factors such as safety orientation, spirituality at work, work engagement, and workers' agility are crucial factors for enhancing workplace well-being at construction sites. In order to increase the workplace well-being at the construction sites, the workers need to change their attitude towards ensuring safety. Workers need to focus on enhancing their engagement with the work activities and building agility and spirituality at work. The managers, supervisors, and contractors of the construction work have larger responsibility to guide, motivate, and orient the workers in line with the findings to have enhanced well-being at work. This study will help the workers to enhance their well-being at work. It will help the supervisors, managers, and contractors to devise strategies for their workplace.

Conflicts of Interest/Competing Interests The authors have no conflicts of interest to declare that are relevant to the contents of this article.

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