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Special Issue on Artificial Intelligence for Smart Cities and Industries:

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INTRODUCTION TO THE SPECIAL ISSUE ON ARTIFICIAL INTELLIGENCE FOR SMART CITIES AND INDUSTRIES

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Smart Cities and Artificial Intelligence offers an intensive evaluation of how the smart city establishments are made at different scales through automated thinking headways, for instance, geospatial information, data examination, data portrayal, clever related things, and quick natural frameworks handiness. Progressing propels in electronic thinking attract us closer to making a persistent reproduced model of human-made and trademark structures, from urban regions to transportation establishments to utility frameworks. This continuous living model empowers us to all the bound to manage and improve these working structures, making them dynamically watchful. Keen Cities and Artificial Intelligence gives a multidisciplinary, joined procedure, using speculative and applied bits of information, for the evaluation of savvy city situations. This special issue shows how the mechanized and physical universes are associated inside this organic framework, and how nonstop data arrangement is changing the possibility of our urban as well as industrial condition. It gives a fresh sweeping perspective on the natural framework designing, advances, and parts that include the masterminding and execution of sharp city and industry establishments. This special issue also shows how the computerized and physical universes are connected inside this biological system, and how continuous information assortment is changing the idea of our urban and industry condition. It gives a crisp all-encompassing viewpoint on the biological system engineering, advances, and parts that involve the arranging and execution of keen city and industry foundations. After following double blind peer review for all the submitted manuscripts across the globe, and after the rigorous review process, revision and based on final recommendations of the reviewers and editorial team, finally 17 manuscripts have been accepted for publication. A brief about each accepted manuscript for this Special Issue is as underneath.

The first manuscript is entitled on "Research on Construction Cost Estimation Based on Artificial Intelligence Technology" by Ghafoor et al.. This paper determines the application of grey system theory, to optimize the estimation model using Back Propagation (BP) neural network. The viability of the method established in this paper, is tested by collecting the engineering cost data in Zhengzhou city and comparing between the standard BP neural network and the Gray BP neural network methods. The results show that the average error of the Gray system theory optimized BP neural network model designed in this paper is 2.33%. The Gray BP neural network model helpful for quickly estimate the project cost, with high accuracy rate.

The second manuscript is entitled on "An IoT and Blockchain Approach for the Smart Water Management System in Agriculture" by Ghafoor et al.. In this article, IoT based smart water management system is designed for the agriculture which ensures the effectiveness of the agriculture water management. A system is implemented for the agriculture water management through the real time data collection. The obtained result shows the data, that updates the water monitoring interface with the varying number of hours.

The third manuscript is entitled on "Design and Research on the Intelligent System of Urban Rail Transit Project Based on BIM+GIS" by Pljonkin et al.. The urban rail transit projects are linear projects, they not only span long lines, multiple regions, involve multiple disciplines, and are difficult to coordinate, but also have complex surrounding environments and high safety requirements. Therefore, their needs for integrated

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construction and operation applications are more concentrated. To solve the problems of data isolation, single display form, abnormal situation notification and delayed processing in urban rail transit construction monitoring, combined with GIS+BIM technology, a complete set of construction monitoring information management process and data organization plan is proposed, and the development is oriented.

Tomar et al. contributes fourth article entitled "An IoT and Blockchain Approach for Food Traceability System in Agriculture". In this paper, food quality problems are discussed, and the food traceability system is proposed which is based on the Internet of Things (IoT) and blockchain technique for agricultural products. The consortium blockchain is utilizing as the basic network and the traceability system can achieve more reliable and trustable devices.

Zhou et al. contributes fifth article entitled "Design and Application of College Online Education Platform Based on WEBRTC". In this paper, a media server cluster load balancing algorithm based on consistency hash algorithm and genetic algorithm is proposed. This paper is focused on designing and practical implementation of a fusion communication platform combined with WebRTC and related technologies to deliver online education system in colleges and universities. The media server cluster load balancing strategy proposed in this paper can ensure the cluster overall load balancing. At the same time, the node weight can be dynamically adjusted according to the real-time state of the clusters. The outcomes obtained justifies the efficiency and practicability of the proposed methodology.

Ikbal et al. contributes sixth article entitled "Research on Data Security Detection Algorithm in IoT Based on K-Means". In this paper, an efficient data intrusion detection algorithm based on K-means clustering is proposed. Also, this paper proposes a network node control method based on traffic constraints to improve the security level of the network. Simulation experiments show that compared with traditional password-based intrusion detection methods; the proposed method has a higher detection level and is suitable for data security protection on the Internet of Things.

Lin et al. contributes seventh article entitled "Network Virus and Computer Network Security Detection Technology Optimization". In this paper, the structural model of network security detection and monitoring system is established in a proactive way. The function of each component is described, and the design model is introduced to conduct comprehensive and effective automatic security detection on the client. Each layer of the network is used to find and avoid the system from being attacked. The observed example shows that the flow rate of information in and out of the network is relatively stable, with few changes, and the rate of change is close to zero per unit time.

Yang et al. contributes eighth article entitled "A Detailed Study on GPS and GIS Enabled Agricultural Equipment Field Position Monitoring System for Smart Farming". In this paper, the nonlinear programming method has been adopted to study the agricultural machinery operation, optimal allocation, and scale management. This paper investigates the crop planting area, mechanization level, production situation, and technological process of corn planting mode. The results show that in the corn production, 11.195 million yuan of maize production value has been optimized.

Mi et al. contributes ninth article entitled "Design of Intelligent Building Scheduling System for Internet of Things and Cloud Computing". In this paper, an improved ant colony algorithm is presented to remove the shortcomings of the existing ant colony algorithm with slow speed and fall into local optimum. The improved ant colony algorithm is transplanted into cloud computing environment. The advantages of fast computing and high-speed storage of cloud computing can realize the real-time resource scheduling of building equipment. The experimental results present that the improved ant colony algorithm can obviously improve the efficiency of resource scheduling in cloud computing environment.

Sharma et al. contributes tenth article entitled "Research on TCP Performance Model and Transport Agent Architecture in Broadband Wireless Network". This paper proposes an improved scheme of TCP proxy acknowledgement based on Automatic Repeat Request (ARQ), which improves throughput, reduces delay, and saves uplink bandwidth of wireless link. The substantial improvement is observed during the experimentation as processing efficiency of protocol. The observed results revealed that overall processing time for each packet is approximately equals to one fourth of the transfer control protocol and the reduction of 59% is also observed in the utility of resources.

Paul et al. contributes eleventh article entitled "Research on Multi-Agent Systems in a Smart Small Grid for

Resource Apportionment and Planning". The energy saving system is presented in this paper which also adapts to the inhabitant's preferences apart from environmental conditions consideration. The energy consumption of 40% is obtained and in the inhabitants' behaviour pattern, the algorithm was specialized. The 16.89% of reduction is obtained by the existing system and it was focused to obtain the agreement between the system and users for user preference satisfaction and the energy optimization is also performed at the same time.

Srivastava et al. contributes twelfth article entitled "Study and Research on IoT and Big Data Analysis for Smart City Development". In this paper, a complete system of various types of IoT-based smart systems like smart home, vehicular networking, and smart parking etc., is proposed for data generation. The Hadoop ecosystem is utilized for the implementation of the proposed system. The evaluation of the system is done in terms of throughput and processing time. The proposed technique is 20% to 65% better than the existing techniques in terms of time required for processing. In terms of obtained throughput, the proposed technique outperforms the existing technique by 20% to 60%.

Mohan et al. contributes thirteenth article entitled "Cloud Based Resource Scheduling Methodology for Data-Intensive Smart Cities and Industrial Applications". This article presents an effective and time prioritization based smart resource management platform employing the Cuckoo Search based Optimized Resource Allocation (CSO-RA) methodology. The proposed (CSO-RA) system is compared with the current methodologies like particle swarm optimization (PSO), ant colony optimization (ACO) and genetic algorithm (GA) based optimization methodologies and the viability of the proposed framework is established. The percentage of optimality observed for CSO-RA algorithm is 97% and overall resource deployment rate of 28% is achieved using CSO-RA method which is comparatively much better than PSO, GA and ACO conventional algorithms.

Balyan et al. contributes fourteenth article entitled "Research on Mobile User Interface for Robot Arm Remote Control in Industrial Application". This article proposed system includes various modules like a robot arm, a controller module, and a remote mobile operating application for visualizing the robot arm angles having real time applicability. Augmented reality (AR) is utilized for robot control WIFI communication and the robot angle information is obtained for varying real time environment. The simulation results are obtained for various assessment indicators and effectual outcomes are achieved with 98.03% accuracy value and 0. 185, 0.180 of error and loss values for training phase. The accuracy value of 97.65% is achieved for testing phase with corresponding 0.209 and 0.190 minimum error and loss values. The proposed platform provides the feasible and reliable outcomes in the real time environment for real time manufacturing industry applications.

Kumar et al. contributes fifteenth article entitled "A Cluster Based Intelligent Method to Manage Load of Controllers in SDN-IoT Networks for Smart Cities". This paper proposes Grey Wolf Optimization Affinity Propagation (GWOAP) Algorithm to balance the traffic load of controller an intelligent cluster based when deploying the multiple controllers in SDN-IoT enabled smart city networks. The proposed algorithm is simulated and the experimental results able to calculates the minimum overall communication cost in comparison with Genetic Algorithm (GA), Particle Swarm Optimization (PSO) and Affinity Propagation (AP). The proposed GWOAP better balance the IoT enabled smart switches among clusters and node equalization is balanced for each controller in deployed topology. By using the proposed methodology, the traffic load of IoT enabled devices in smart city networks intelligently better balance among controllers.

Ziyad et al. contributes sixteenth article entitled "Novel emergency rapid response to epileptic Seizures for patients in self-driving cars". In the proposed framework, on receiving a seizure alert from wearable device of the patient, the car is stopped, and an alert is sent to the patient's family as well as registered hospital. The proposed framework is an attempt to the future applications, especially in context to the smart healthcare facilities. We hope that the quality research work published in this special issue will be helpful to upcoming research works and to the community at large.

Agarwal et al. contributes seventeenth article entitled "Enhanced secure ATM authentication using NFC Technology and IRIS verification". This manuscript covers a solution to the existing PIN based authentication problems in ATM cards. In contrast to standard architecture, the proposed solution incorporates NFC enabled smartphones as a substitute for physical card and Iris based authentication for PIN.


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RESEARCH ON CONSTRUCTION COST ESTIMATION BASED ON ARTIFICIAL INTELLIGENCE TECHNOLOGY

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Abstract. For the prediction of economic expenses involved in construction industry, cost estimation has become an important aspect of construction management for the prediction of economic expenses and successful completion of the construction work. Cost analysis is crucial and require expertise for accurate and comprehensive estimation. In order to effectively improve the accuracy of construction project cost, this paper establishes an estimation model based on gray BP neural network. It combines the MATLAB toolbox for program design, and learns and tests the input and output of training samples. This article determines the application of grey system theory to optimize the estimation model of Back Propagation (BP) neural network. The viability of the method established in this article, is tested by collecting the engineering cost data in Zhengzhou city and comparing between the standard BP neural network and the gray BP neural network methods. The results show that the average error of the gray system theory optimized BP neural network model designed in this paper is 2.33%. The gray BP neural network model studied in this paper can not only quickly estimate the project cost, but also has high accuracy rate. The outcomes obtained establishes a model with scientific and reasonable construction project cost estimation.

Key words: Construction management; BP neural network; artificial intelligence; engineering cost; Zhengzhou city.

AMS subject classifications. 68T07

1. Introduction.

Construction industry has built as a vital developing sector all around the world. This sector plays an effectual part in economic development of the worldwide economy. Construction industry occupies a large share in the national economy of China as well, especially since the formation of the technological reforms. The share of the construction industry in the national economy has been increasing, and it has a vital role in the process of my country's economic development. The core of the construction industry is construction engineering; therefore, the management of construction engineering has high practical significance [1]. While dealing with the challenges in the construction projects, information technology (IT) equipped with intelligence has emerged as an important aspect for the improvement of technological performance. Intelligent IT techniques are useful in combating the challenges like the selection of qualified contractors for handing the construction projects, prediction of project performance and risk estimation at different construction phases [2,3]. The recent technological development has enabled the civil engineers to consider the Artificial Intelligence (AI) scenarios for handling the ambiguous challenges faced by then [4-6].

Cost estimation is the foremost step in a construction project as it is helpful in predicting the economic expenses involved to accomplish the construction work [7,8]. The cost assessment is a knowledge intensive task, which is important for ensuring the successful completion of the project [9]. Cost analysis is crucial and require expertise for accurate and comprehensive estimation. The manual estimation is unable to achieve high degree of accuracy and precision in this field, however, inaccurate estimation may lead to construction delay and many other worse scenarios [10-12]. The various factors responsible for switching from the manual construction management towards the AI assisted construction mechanism are depicted in Figure 1.1. The investment perspective of construction project management includes various aspects like preliminary investment estimation, plan design expansion design and construction drawing design stage design budget, project budget in the bidding

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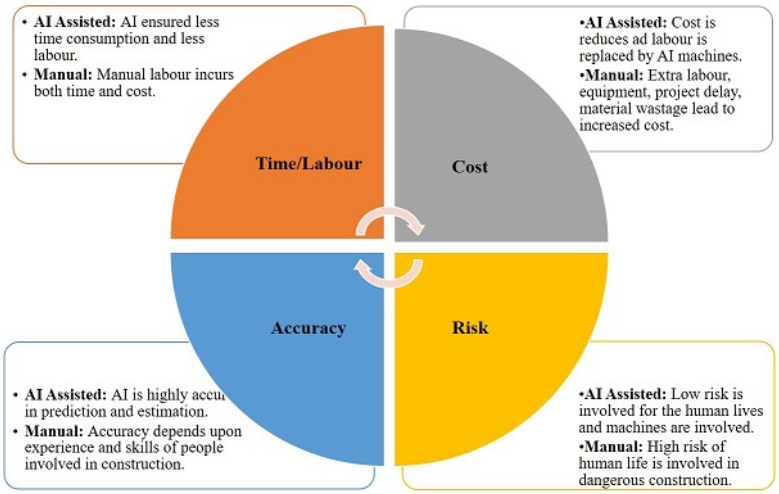

FIG. 1.1. *Differentiating features for AI assisted versus manual construction mechanism*

stage, project settlement and project final accounts after completion, etc. The focus of construction project management is the investment estimation of construction cost. The investment estimate of the construction cost directly determines the profitability of a project. The cost of construction and installation engineering, that is, the cost of construction engineering, occupies an important position in the investment estimation of construction projects. Therefore, the prediction of construction project cost is of great significance. The project cost system is a very complex task. The traditional manual method of preparing project budgets often results in some miscalculations and omissions. At the same time, the accuracy of the data has also been greatly affected, which will have a great impact on the country. Economic property has a great impact. With the continuous development and change of my country's construction market, the requirements for project budgeting work are also constantly increasing. Therefore, the traditional budget method can no longer meet the actual project budget needs, and computer technology must be used to control the intelligent project cost budget to improve the accuracy of the budget [13,14]. Thus, the researchers are encouraged to invest in finding the intelligent solutions for handling the situation of cost estimation.

The research on construction cost estimation based on artificial intelligence technology in this article is of great significance. This article deals with the effective improvement in the construction project cost while improving its accuracy. It established an estimation model based on gray BP neural network, and combines the MATLAB toolbox for program designing. The learning of the neural network takes place and the input and output of the training samples are tested. The novelty of this article lies in determining the application of grey system theory to optimize the estimation model of BP neural network. The feasibility of the proposed method is tested by collecting the engineering cost data in Zhengzhou city and a comparison is done between the standard BP neural network and the gray BP neural network methods. The comparison reveals that the gray BP neural network model utilized in this article not only quickly estimate the project cost, but also provides high accuracy. The remaining article is structures as: literature review is presented in section 2 of the article followed by the research methods briefed in section 3. Section 4 presents the results and discussion of different prediction models and the final conclusion is detailed in section 5.

2. Literature Review. The study of project cost forecasting models, not only need to have a clear understanding of influencing factors, but also need to have a comprehensive understanding of the current widely used forecasting models. There are many studies on the influencing factors of construction costs. From the comprehensive perspective of the literature published by scholars, they mainly focus on the following aspects.

The construction cost estimation is mainly dependent upon different factors like labor employment, material, equipment, etc. and there are several estimation techniques available in the literature [15-19]. These literature suggests that the cost estimation tenders are required to be prepared precisely over the specific period,

so as to make the modernized cost estimation self-sufficient. The traditional methods were not upto the mark as they fail to utilize the knowledge of the past projects to tackle the problems in the current scenario. As the actual cost information of the past projects was not known, thus, this leads to slow estimation which are highly inaccurate and tends to variability.

The advancement in the technology led to the initiation of artificial intelligence (AI) based methods for the investigation of multiple as well as non-linear relationships between the construction cost and design parameters, utilizing complex methods and large data volume [20]. Through the applicability of AI platform, fairly accurate cost estimation is possible while using limited amount of information. These machine learning aspects uses the knowledge based and evolutionary hybrid systems for cost estimation [21]. These methods identify the pattern relationships in between the past tender data, thereby reducing the estimation sensitivity and provides the better outcomes. A study performed by Hyari, et al. [22] utilizes the data-driven approach for cost estimation and the influential features are determined using the expert advice on the available data. This study does not provide the actual influence insight of variables on cost estimation and does not reveal the relative importance of variable for cost estimation. Petruseva, et al. [23] utilized the support vector machine (SVM) based approach for the prediction of bidding price in cost estimation. Evaluation on the basis of 54 reports suggests that the SVM based approach provides a better bidding price prediction comparative to the other models. Kim, et al. [24] used various machine learning approaches like SVM, regression and artificial neural network (ANN) for the construction of a school building at the reliable cost. The regression based construction cost estimation was compared to the SVM based method to observe the superiority of machine learning based method in terms of prediction accuracy [25]. Ajayi and Oyedele [26] utilized the concept of structural equation modelling for the cost estimation of construction waste. This paper discusses the scenario of effective cost reduction while reducing the construction waste. Matel, et al. [27] presented the ANN based approach for the estimation of cost in engineering service sector. This method uses the heuristic approach for performance improvement of the model and the approach provides relatively precise cost estimation comparative to the other analogous works. Elmousalami [28] studied the practices and procedures of cost identification using the computation intelligence techniques. The study reviewed various aspect of construction cost on the basis of various paradigms like fuzzy logic, AI, SVM, genetic algorithm, evolutionary programming, etc. AI provides the exceptional performance among all the models used for this approach.

Nguyen, et al. summarized existing research on the application of AI to forecast the performance of several building resources (for example, concrete, wood, steel, and composite materials). It also discusses methods for predicting the fire flame redundancy of certain structural components using AI-based mechanisms. The end of this review provides insights on the advantages of AI technology, its challenges, and recommendations for developing AI technology for evaluating the fire performance and flame redundancy of building materials. An inclusive overview of the current research in the area of fire protection engineering and materials science is presented in this review, which enable the researchers to discover the future perspective of AI [29]. There is an inevitable advent of artificial intelligence in various aspects like engineering industry, construction mechanism, etc. In this context, the technological advent has undergone tremendous expansion, which affects the employment opportunities of Chinese labour forces. The crucial impact of employment on the engineering and construction industry was reviewed by Guang, et al., exploring the perspective of machine learning and intellectual transformation of individuals [30].

This article presents a grey system theory based perspective to determine its application and optimize the estimation model of BP neural network. Through the collection of engineering cost data in Zhengzhou, a training sample set is formed for simulation for establishment of a reliable method for cost estimation. Finally, through example analysis, the prediction accuracy of the grey system. Standard BP neural network method and grey BP neural network method are compared and tested for its prediction accuracy.

3. Research Methods.

3.1. BP neural network model construction. Back-Propagation network, abbreviated as BP network, is a very widely used multi-layered feedforward neural network that propagates the errors in the backward direction. The three layers of this network includes the input, hidden and the output layer as depicted in Figure 3.1.

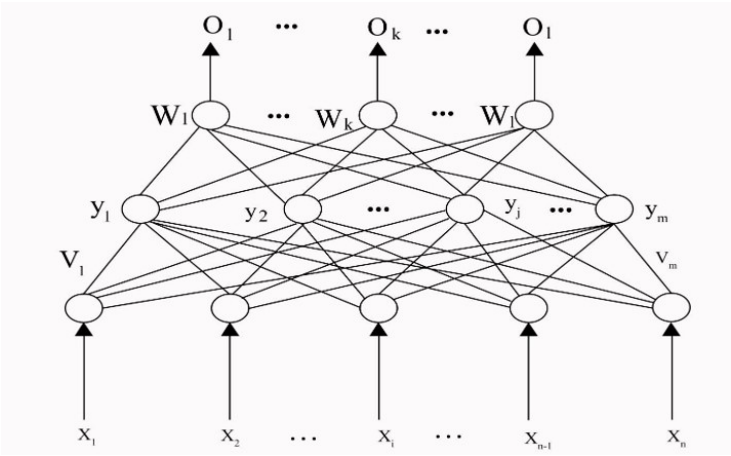

FIG. 3.1. *BP neural network model*

In the three-layer perceptron, the input vector is

$$Xi = (Xi_1, Xi_2, ...Xi_n)^T \tag{3.1}$$

The variable of the hidden layer is denoted as

$$Yi = (Yi_1, Yi_2, ...Yi_m)^T \tag{3.2}$$

The variable of the output layer is denoted as

$$Oi = (Oi_1, Oi_2, ...Oi_l)^T \tag{3.3}$$

The expected vector of the output layer is denoted as

$$Di = (Di_1, Di_2, ...Di_l)^T \tag{3.4}$$

The weight matrix between the training sample from the input layer to the hidden layer is represented by Vj,

$$Vj = (Vj_1, Vj_2, ...Vj_m)^T \tag{3.5}$$

where V_j represents the column weight vector that corresponds to the jth neuron in the hidden layer; the weight matrix between the sample from the hidden and the output layer is represented by W,

$$Wk = (Wk_1, Wk_2, ...Wk_l)^T \tag{3.6}$$

The column vector Wk represents the weight vector indicating the kth neuron in the output layer [31].

3.2. Grey Theory. After more than 30 years of development of grey system theory, the structural system of this subject has been basically established. Mainly use grey equations, grey algebra systems, grey matrices, etc. as the theoretical system, grey sequence generation as the method system, grey correlation as the analysis system, and grey model (GM) as the model system to solve "small samples" and " Poor information" and inexperienced uncertain information problems, through data analysis to explore the laws of things [32].

The GM (1,1) model is currently the most significantly used predictor model. Among them, the two "1" respectively represent a first-order equation and a variable. The main idea of grey prediction is: accumulate the original number sequence one or more times to generate a new number sequence, and it is a first-order linear differential equation showing a certain regularity. The steps for the modeling of GM (1,1) are described below.

Let the variable be

$$x^0 = (x^0(1), x^0(2), , x^0(n)) \tag{3.7}$$

As a set of original data, accumulate it once to generate a new accumulative sequence (Accumulated Generating Operator abbreviated as AGO), uses:

$$x^1 = (x^1(1), x^1(2), , x^1(n)) \tag{3.8}$$

among them

$$x^1(k) = \sigma(i=1)^k x^0(i) = x^1(k-1) + x^0(k) \tag{3.9}$$

then, Series of mean:

$$z^1(k) = 0.5x^1(k) + 0.5x^1(k-1)z^1 = (z^1(1), z^1(2), , z^1(n)) \tag{3.10}$$

That is, the grey differential equation model of GM(1,1) which is presented in the following equations:

$$x^0(k) + az^1(k) = b \tag{3.11}$$

(2) Smoothness inspection

$$\rho^k = (x^0(k))/(x^0(k-1)) \tag{3.12}$$

The judgment condition is: when

$$k > 3\, if \rho^k < 0.5 \text{ then } \ x^0 \text{ Meet the smoothness test} \tag{3.13}$$

(3) Exponential law test

$$\sigma^k(k) = (x^1(k))/(x^1(k-1)) \tag{3.14}$$

The judgment condition is: when

$$k > 3, 1 < \sigma^1(k) < 1.5 \text{ o'clock}, x^1 \tag{3.15}$$

Satisfying the exponential law for the establishment of GM(1,1) model.

(4) The equation should be seen as a continuous function of time and it should satisfy

$$((dx^1)/dt) + ax^1 = b \tag{3.16}$$

Then it is the GM(1,1) prediction model, where a and b are undetermined coefficients.

(5) Remember

$$a^{'} = (a, b)^T \tag{3.17}$$

According to the method of least squares

$$a^{'} = ((B^T B)^{-1})B^T Y \tag{3.18}$$

among them

$$B = [[(-z^1(2)][1][(x^0(2)], [(-z^1(3)][1][(x^0(3)], [(-z^1(n)][1][(x^0(n)]] \tag{3.19}$$

At this time, the time response function of (3-1) is

$$x^1(t) = (x^1(t_0) - b/a)e^{-a(t-t_0)} + b/a \tag{3.20}$$

Let $t = k + 1$, then the equation becomes

$$x \perp^1 (k+1) = (x^0(1) - b/a)e^{-ak} + b/a \tag{3.21}$$

The prediction equation and its reduction value is given by,

$$x \perp^0 (k+1) = a^1 x \perp^1 (k+1) = x \perp^1 (k+1) - x \perp^1 (k) = (1-e^a)(x^0(1) - b/a)e^{-ak} \tag{3.22}$$

(6) After using the prediction formula to calculate the predicted value, the predicted value must be tested for residual error, that is, the predicted value is compared with the actual value to see whether the overall meets the accuracy requirements. Remember that the residual sequence value is:

$$\beta(k) = x^0(k) - x \perp^0 (k) \tag{3.23}$$

The relative error is:

$$\varepsilon(k) = (\beta(k))/(x^0(k)) \tag{3.24}$$

The average relative error is:

$$\varepsilon(k_1) = 1/n(\sigma(k=1)^n |E(k)| \tag{3.25}$$

The model accuracy is shown below:

$$P = (1-\varepsilon)100\% \tag{3.26}$$

In general, the accuracy of the model is greater than 80%, and in the case of high requirements, the accuracy of the model is greater than 90%.

3.3. Cost estimation model based on grey BP neural network.

3.3.1. Selection of characteristic factors. After analysing the estimated cost and actual cost of many projects, this paper chooses the most common residential projects as the research object, collects multiple residential projects in Zhengzhou, and selects 40 sets of data as the project samples. And through the analysis of the cost composition of the residential project and the parameter changes of the building structure, the 8 main factors affecting the project cost were finally determined: foundation type, structure type, total number of layers of the project, exterior wall decoration, door and window engineering, Interior wall decoration, floor and floor practices, and the location of the project. After quantifying these factors, the grey system processing is used as the input variable of the BP neural network cost control model, and the final unit cost of the entire project is used as the output variable [33].

3.3.2. Quantitative processing of eigenvectors affecting project cost. Use X1≈X8 to represent the 8 major factors as the input vector of the network model, and use O to represent the final project cost as the output vector. The quantification outcomes are depicted in Table 3.1.

3.3.3. Introduction to MATLAB. MATLAB was developed in the 1970s and was written by Cleve Moler and his colleagues. It was originally designed as an interface program between EISPACK and LINPACK, mainly for the combination of matrices and laboratories, to analyze values, and use programming languages to process large amounts of data efficiently, with high efficiency, good interactivity, and expansion. Strong ability, good portability, easy to learn for users, and faster and more convenient to use. With the development of MATLAB, it is now more suitable for modeling and simulation training.

The MATLAB toolbox provides a fast and efficient platform for research and development of different modules in various fields, utilizing the available toolboxes.Its content covers a wide range, covering signal processing and image processing. Many fields such as processing, economics, mathematics and engineering. Using the MATLAB toolbox can greatly reduce the complexity of programming, and the complete program can be used as a template. Open the toolbox and just enter the actual data and some parameters [34].

Many new results of neural networks are included in the MATLAB toolbox, such as self-organizing networks, perceptron models, feedback networks, adaptive filtering, adaptive training, BP networks, radial basis function networks, etc. [35, 36]. These toolboxes can quickly Realizing the modeling and solving of the problem provides convenience for users, greatly saves programming time, and users can optimize network design more [37].

TABLE 3.1
Engineering feature vector quantization index

Serial number	Influencing factors	Quantitative Indicators
X_1	Basic Type	1-Full house foundation 2-Prefabricated pile foundation 3-Belt foundation
X_2	Structure Type	1-frame structure 2-frame-shear structure 3-shear wall structure 4-brick-concrete structure
X_3	Total number of layers of the project	1- Multi-story 2-Middle-high 3-High 4-Super high-rise
X_4	Exterior wall decoration	1-Exterior wall paint 2-Ceramic tile 3-Stone wall
X_5	Door and window type	1-Plastic steel window wooden door 2-Plastic steel window ordinary anti-theft door
X_6	Interior wall decoration	1-Rough surface 2-Cement mortar 3-Paint 4-Mixed mortar
X_7	Floor practice	1-Cement mortar floor 2-Fine stone concrete floor 3-Floor tiles
X_8	Project location	1-Second ring inner 2-Second ring outer third ring inner 3-third ring outer fourth ring inner 4-fourth ring outer

TABLE 4.1
The original number of sample samples

Category	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	Output(yuan/m^2)
1	1	3	3	3	3	2	1	3	1443.65
2	1	3	3	3	3	4	2	3	1562.21
3	1	2	2	3	2	1	2	3	1243.57
4	1	3	3	3	4	3	1	3	1687.43
5	1	3	4	3	4	3	2	3	1898.16

3.3.4. Grey system's processing of data. Based on the establishment of a sample database of residential projects in Zhengzhou, this paper has determined the main influencing factors of 8 projects, and selected 40 sets of sample data, of which 30 sets are used as training samples and 10 sets are used as test samples. The sample is subjected to a grey accumulation, and MATLAB is utilized to model and simulate the data. Finally, the test data is justified, and the error meets the requirements, which proves that it is feasible to optimize the BP neural network with grey system theory in reality.

4. Results and Discussion.

4.1. Project Overview. Initially a comparative investigation of various projects is done in terms of different factors and after this comparison, the most common residential projects Zhengzhou city, China is selected for this work. The quantitative data is depicted in Table 4.1.

It is expressed in Table 4.1, that the project includes a set of data which is subdivided into different categories. After quantification of various factors affecting the project cost like foundation type, structure type, project location, etc. the grey system processing is used as the input variable of the three different cost control prediction models, and the final unit cost of the entire project is obtained.

4.2. Comparison of the three models. A comparative analysis of three different prediction models is done. The models utilized for the study are grey prediction model, standard BP neural network model and the grey BP neural network model.

4.2.1. GM(1,1) grey prediction model. The predicted value of the grey prediction model cost is observed for various samples which is shown in Table 4.2.

TABLE 4.2
Analysis of actual versus predicted values of samples

Serial number	Actual value	Predictive value	Relative error (%)
1	1443.65	1244.67	13.78
2	1562.21	1371.31	12.22
3	1243.57	1510.85	21.49
4	1687.43	1664.58	-1.35
5	1898.16	1833.95	-3.38

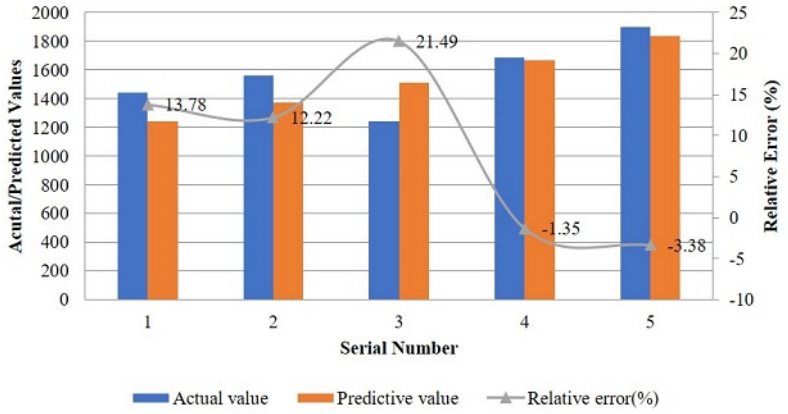

FIG. 4.1. *Graphical comparative analysis of actual values, predicted values and relative error for grey prediction model*

TABLE 4.3
Normalized data of example samples

No.	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	Output
1	0.0000	1.0000	0.5000	0.0000	0.5000	0.3333	0.0000	0.0000	0.3057
2	0.0000	1.0000	0.5000	0.0000	0.5000	1.0000	1.0000	0.0000	0.4868
3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
4	0.0000	1.0000	0.5000	0.0000	1.0000	0.6667	0.0000	0.0000	0.6781
5	0.0000	1.0000	1.0000	0.0000	1.0000	0.6667	1.0000	0.0000	1.0000

It is evident from the table that the average relative error of the model is 10.44%, and the accuracy of the model obtained is 89.56%. Although it meets the general requirements of accuracy, the predicted value is not accurate enough, and the error fluctuates greatly, which cannot meet the accuracy requirements of cost estimation. It is graphically represented in respect of actual value, prediction value and relative error in Figure 4.1.

4.2.2. Training of standard BP neural network. The standard BP neural network is also trained for the selected samples and the data of example samples is normalized initially. The normalized data of the example sample is depicted in Table 4.3.

This normalized sample data is utilized for the training of BP neural network. MATLAB software is used to process the data and the output value obtained is compared with the actual value as shown in Table 4.4.

The outcomes observed for the standard BP neural network model are depicted in Table 4.4 and are graphically presented in terms of actual value, predicted value and the relative error (percentage) in Figure 4.2. From the graphical comparison, it is revealed that the relative error obtained by using the BP neural network-based method provides much reduced value of relative error comparative to the grey prediction model. The relative error has decreased from 10.44% to 3.64% which validates the accurate prediction of standard BP

TABLE 4.4
Analysis of actual versus predicted values of samples

Serial number	Actual value	Predictive value	Relative error (%)
1	1443.65	1510.45	4.63
2	1562.21	1623.29	3.91
3	1243.57	1202.91	-3.27
4	1687.43	1627.02	-3.58
5	1898.16	1951.69	2.82

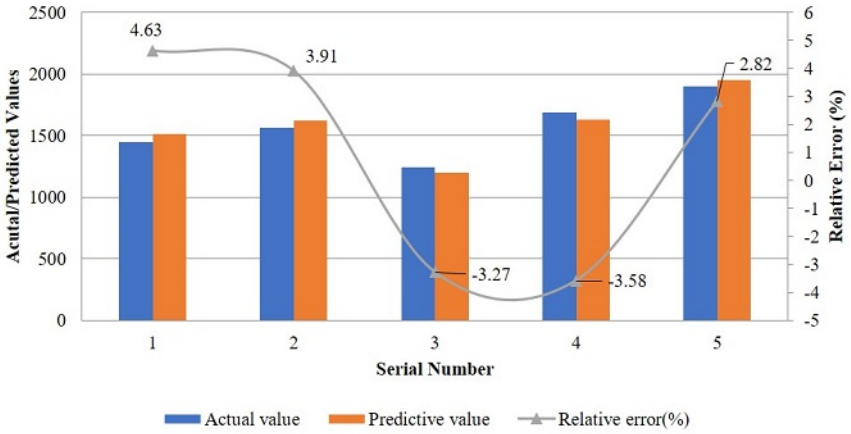

FIG. 4.2. *Graphical comparative analysis of actual values, predicted values and relative error for standard BP neural network model*

neural network-based method.

4.2.3. Training of grey BP neural network. For training the grey BP neural network model, grey one-time accumulation processing is performed on the example samples which is shown in Table 4.5.

The outcomes obtained after grey one-time accumulation processing are then normalized in order to obtain the normalized input and output vectors for further processing. The samples were normalized, as depicted in Table 4.6.

MATLAB software is used to process the normalized data, and then the obtained data is de-normalized followed by the grey one-time accumulative subtraction to obtain the predicted value. The obtained data is shown in Table 4.7 and the graphical presentation is depicted in Figure 4.3.

The comparison reveals that the mean relative error is further reduced from 3.64% in case of standard BP neural network based method to 2.33% for grey BP neural network model establishing its feasibility for cost prediction and estimation.

It is evident from Table 4.3 to Table 4.8 that the standard BP neural network method and the BP neural network method optimized by grey system theory have certain errors. The error of the grey BP neural network model is smaller than the error of the GM (1,1) prediction model and the standard BP neural network model, and the prediction accuracy is relatively high. It has a particular ideal set reference value for the early prediction of the project cost. This comparison is clearly depicted in Table 4.8.

The prediction results are compared and error mean values of the GM (1,1) model, BP neural network model, and grey BP neural network model respectively, is depcited in Table 4.8.

This article selects representative buildings, quantifies the characteristics of buildings, then processes quantitative data using GM (1,1) prediction model, standard BP neural network method and BP neural network method optimized by grey system theory, and trains and tests the actual samples in combination with MATLAB toolbox, obtains prediction values, and calculates the error mean of 10.44%, 3.64% and 2.33%, respectively.

TABLE 4.5
The sample values of the examples accumulated once in grey

Category	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	Output
1	1	3	3	3	3	2	1	3	1443.65
2	2	6	6	6	6	6	3	6	3005.86
3	3	8	8	9	8	7	5	9	4249.43
4	4	11	11	12	12	10	6	12	5936.86
5	5	14	15	15	16	13	8	15	7835.02
Sequence minimum	1	3	3	3	3	2	1	3	1443.65
Sequence maximum	5	14	15	15	16	13	8	15	7835.02

TABLE 4.6
Normalized data of example samples for grey BP Neural Network

No.	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	Output
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.2500	0.2727	0.2500	0.2500	0.2308	0.3636	0.2857	0.2500	0.2444
3	0.5000	0.4545	0.4167	0.5000	0.3846	0.4545	0.5714	0.5000	0.4390
4	0.7500	0.7272	0.6667	0.7500	0.6923	0.7272	0.7143	0.7500	0.7030
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

TABLE 4.7
Comparison of actual values and predicted values of samples

Serial number	Actual value	Predictive value	Relative error (%)
1	1443.65	1405.29	-2.65
2	1562.21	1531.28	-1.98
3	1243.57	1272.67	2.34
4	1687.43	1723.03	2.11
5	1898.16	1947.13	2.58

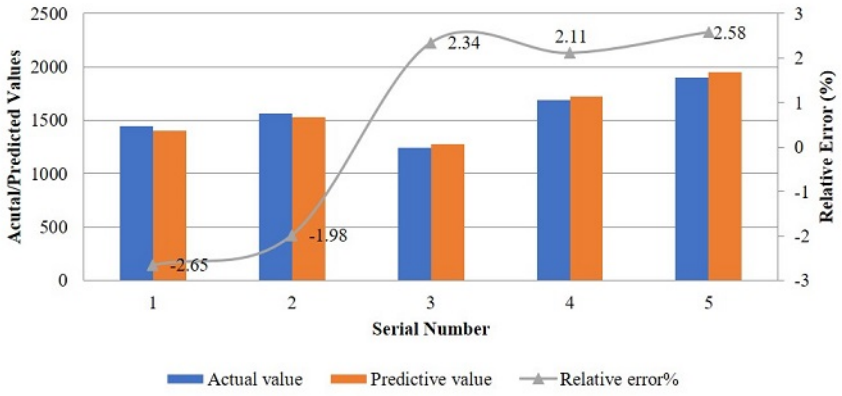

FIG. 4.3. *Graphical comparative analysis of actual values, predicted values and relative error for grey BP neural network model*

Finally, the three algorithms are compared to show that the improved BP neural network method is better than the GM (1,1) prediction model and the standard BP neural network method.

5. Conclusion. This article analyzes the advantages and disadvantages of BP neural network, puts for-

TABLE 4.8
Comparison of three algorithms

Serial number	Actual value	GM(1,1)	BP Neural Network	grey BP Neural Network
1	1443.65	1443.65	1510.45	1405.29
2	1562.21	1371.31	1623.29	1531.282
3	1243.57	1510.85	1202.91	1272.67
4	1687.43	1664.58	1627.02	1723.03
5	1898.16	1833.95	1951.69	1947.13

ward the use of gray system theory and analyzes its advantages and disadvantages, comprehensively utilizing the advantages of both. This article determines the application of grey system theory to optimize the estimation model of BP neural network. The feasibility of this method in cost estimation is verified by collecting engineering cost data from Zhengzhou City to form a training sample set for simulation training, and through case analysis, the comparison is done for the prediction accuracy of gray system theory, the standard BP neural network method and gray BP neural network method. This paper, combined with the GM (1,1) model, standard BP neural network model and gray BP neural network model in gray system theory, establishes an estimation model for the Sunshine City project in Zhengzhou. The analysis verifies that the gray BP neural network model can not only estimate the engineering cost quickly, but also has high precision, making it a scientific and reasonable construction cost estimation model. The future perspectives of this article which are still needed to be explored are; analysis of various influencing factors of project cost like requirement of a large amount of project examples for verification, the selection of factors affecting the project cost needs to be further studied in the future part of this work. The future scope of application of this method is to require the location of the project to be estimated to have similar project examples, so that the total project cost estimated by these data should be consistent with the previous forecast results.

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AN IOT AND BLOCKCHAIN APPROACH FOR THE SMART WATER MANAGEMENT SYSTEM IN AGRICULTURE

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Abstract. In all the smart applications, evolution of the Internet of Things (IOT) is utilized as a complete matured technology and in the future internet generations, established itself. Block-chain is also the blooming technique like Internet of things in which the distributed ledger which enhances the security contained in the each node of the block-chain. In the block-chain network, any fault transaction is not done by the illegal users. The block-chain is combined with the Internet of Things for the improvement of real time application performance. IOT based smart water management system is designed in this paper for the agriculture which ensures the effectiveness of the agriculture water management. The remote monitoring with the IOT is used for this purpose. By linking with 2D modelling, the control and management of the agriculture water were performed. Finally, a system is implemented for the agriculture water management through the real time data collection. The obtained result shows the data that updates the water monitoring interface with the varying number of hours. The IoT technology and remote monitoring technology is utilized to the existing water management infrastructure. For water resources management and water supply, this is the very efficient technology.

Key words: Internet of Things, Block-chain technology, 2D modelling, Fault transaction, water management system

AMS subject classifications. 68M11

1. Introduction. The use of water resources and quality of service is optimized by the smart water management in supply systems. The integration of multiple technologies, storing and analyzing data from different sources in real-time is enabled by the Internet of Things (IoT). All operational scenarios in IoT-based systems can be difficult to anticipate and to establish how managers should act in each situation. The operational processes through conventional workflows are modelled which are based on the fixed flows. To deal with water systems, the flexibility provided by declarative processes can be an adequate solution. The execution of every activity is allowed by the declarative paradigm and it ensures that the policies of management will be executed.

The implementation of the monitoring framework is illustrated in the Fig 1.1. First of all, in the water supply system, installations of sensors are done for data collection. Then CEP technology is used for the data execution for recurring patterns of water loss identification. On occurrence of water loss, alarms are triggered. The one or more tasks are executing the water management agents. In the control panel, enabling and disabling of tasks is done by a declarative business process.

In the agricultural activities, the agricultural water is a vital element however due to changes in conditions like an increase in the cost of water management for supply and deepening of climate change phenomenon, a lot of inconveniences is experienced by the farmers. For agricultural water use and management, management of water demand has been increased.

IOT infrastructure is focussed to demonstrate and evaluation of the some implementation possibilities. The sensors generate the copious amounts of data which are analyzed by the innovative strategies addressed by other works. Patterns like water leakages are identified by the big data technologies and the adequate response time in the context of water systems is not presented. The analysis must produce the required results in real time

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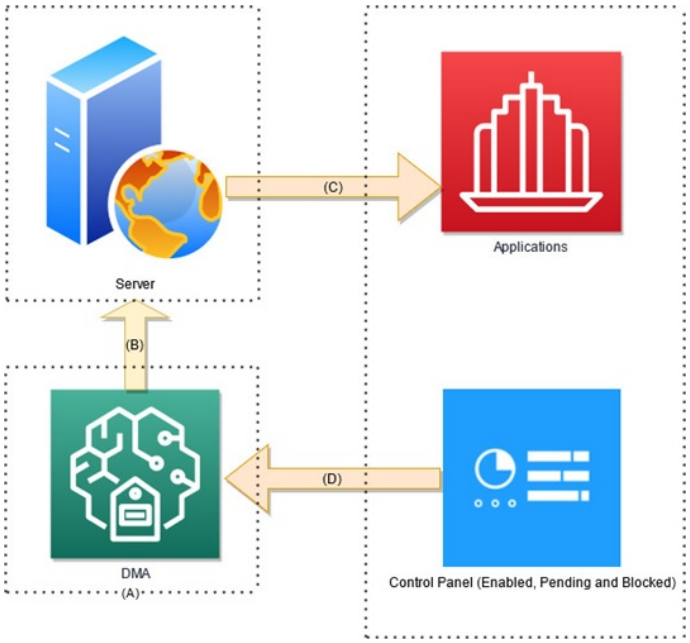

FIG. 1.1. *The monitoring framework*

in the scenario of real time otherwise to handle issues in the water supply systems; it may be late to handle the water supply system issues.

So, there is a requirement of effective mechanisms for the undesirable incident prevention and to operate and control these systems. To deal with unpredictable situations, the flexibility is required by the dynamic behaviour of water supply systems. The water management companies define and maintain the strict control to respect the operational and strategic policies. The various communication technologies and the other solutions are integrated by the wireless network infrastructure (IoT) for the people and object interaction. For the development of distinct applications, this is the remarkable technology for the smart cities. By focusing on engineering aspects and to reflect socioeconomic characteristics, agricultural water demand and supply is failed to analyze. For increase the supply, supply side is focussed by the agricultural water management. For the demand management, the patterns of internal water use are changes due to increase in water demand in the non-agricultural sector. To changes in internal and external conditions related to agricultural water, existing agricultural water supply has the limitations in the agricultural water utilization and management. The main focus is on increasing water supply by the management policies like upgrading infrastructure and installing additional facilities. The scarcity or opportunity is not reflected by costs of agricultural water and the management policies. By considering the realistic part of agricultural environment, agricultural water management is difficult to reform and improve. The design of a smart agricultural water management system is shown in Fig 1.2.

Numbers of nodes are consisted by the block-chain having distributed ledgers to allow the access and a ledger single edition is updated along with shared control maintenance. A distributed ledger contained in the Blockchain can record transactions between the nodes. The existence of third party is immediately avoided by the block-chain technology. The data is successfully released from the ledger by the blockchain technology progressing from centralized systems to a decentralized and network system is then distributed. It can also be used in business network. The Blockchain Elements are shown in Fig 1.3.

This paper is structured as follows. Many existing techniques are discussed in section 2. Research methodolgy is detailed in section 3. Discussion of experimental results obtained is presented in section 4 and section 5 concludes the paper.

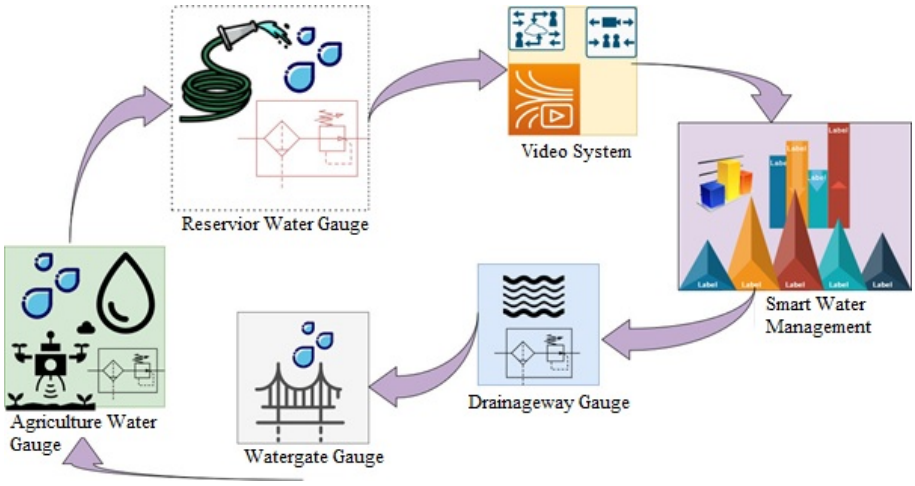

FIG. 1.2. *Smart agriculture water management system*

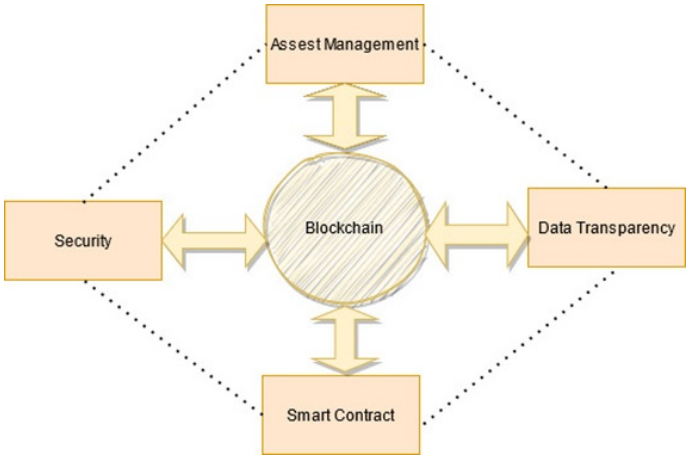

FIG. 1.3. *Blockchain Elements*

2. Literature Review. For the interaction between people and things/objects, the Internet of Things (IoT) is a wireless network infrastructure to integrate various communication technologies. For the development of distinct applications, distinct applications for the so-called smart cities are opened by the remarkable technology. For monitoring and controlling water supply systems, IoT is used in the context of water management. The high quality water demand is increased by the climate change with the increase in the world's population and for that new water strategies are created [18]. In this paper the author utilized the Internet of Things (IoT) technique and process the large amount of dataset which is produced by the sensors of IOT. The dynamic behaviour of water supply systems is too rigid to express by the traditional processes. A powerful, efficient, and flexible architecture is created by the IoT, CEP, and declarative processes for management of water supply system. The first solution is REFlex for supply systems combination. The REFlex Water architecture is detailed in this paper. The REFlex Water utilization is expanding to water supply system sectors.

The technicalization of agriculture progress and the informationization, IT technology of the agricultural ecosystem is increasing continuously [19]. There is great demand for agriculture water in rural areas so stable agricultural water supply is necessary. The smart agricultural water management system is designed and implemented for the effective management of agricultural water utilizing IoT based remote monitoring technology. For the management of agricultural water, a system is implemented through real-time data collection and

analysis. The presented technique can efficiently manage the management of agricultural reservoirs and large river reservoirs.

A new topology of sensor nodes is presented by the author based on the highly efficient components. The water level, temperature and humidity are utilized [20]. The system main circuit board optimization is done by integrating layers and software optimization implementation . The IOT Block-chain is the emerging technique in which the distributed ledger is contained in the block-chain which enhances the security and data transparency [21]. In real time, blockchain is merged with the Internet of Thing. Author in this paper attempted to survey the core details of features of blockchain. The designed architecture is proposed in this paper for Smart Agriculture and ended up with some new architectural framework by merging the IOT and the blockChain. In this paper, authors' details how the blockchain technology can help to utilized the water more effectively in the network [22]. In the water management system with the water ultimate goal, the presented architecture serves as the basis for blockchain helps inbuilding transparency. To create a smart water management system is the main objective using blockchain technology. While contributing to environmental sustainability and for increasing crop yield, smart management of freshwater is utilized for the precision irrigation in agriculture [23]. For water management applications, the IoT is the natural thing even though the different technologies essential for making it work seamlessly. An IoT-based smart water management platform is developed by the SWAMP project for precision irrigation in agriculture. The SWAMP architecture, platform is presented by the author for IoT applications. Specially designed configurations of some components are required to provide adequate performance and utilizing less computational resources.

Water management affects the agriculture as a large amount of water is used [24-26]. To ensure the availability of water for food production and consumption, global warming is considered. The low-cost sensors are offered by the manufacturers for irrigation management and agriculture monitoring. For agriculture irrigation systems, the commercial sensors are very expensive for agriculture irrigation systems.

The advanced techniques can be applied in the development of these systems development and regarding smart irrigation systems is presented by the authors. Regarding water quantity and quality, soil characteristics and weather conditions, the different parameters are determined for irrigation systems monitoring. The most utilized nodes and wireless technologies are detailed by the author in this paper. The provenance of food can be tracked by the blockchain technology [28-31]. The applications of blockchain technology are examined by the author in food supply chains, agricultural insurance and smart farming. The challenges of recording transactions are discussed which are made by smallholder farmers and the ecosystem for utilizing the block-chain technology is created in the food sector [31-34]. For precision irrigation, The IoT-based systems are mostly theoretical and with the limited proof of concept experiences. They do not address the deployment of system for reliability facilitating and streamlining the deployment of new systems. The advanced features are provided by the water management and there is no need of the isolated initiatives connection to the existing architecture.

Contribution: A smart water management system based on the IOT and Block Based Chain is designed and implemented for the agriculture. It ensures the complete system is highly effective for the agriculture water management. The IoT sensor network technology is utilized with the remote monitoring for this purpose. By linking with 2D modelling, the control and management of the agriculture water were performed. Finally, a system is implemented for the agriculture water management through the real time data collection.

3. Research Methodology.

3.1. Integrated management system. In the agriculture sector, an efficient water management is very important and in this paper, we designed such a smart agricultural water management system. The IoT technology and remote monitoring technology is utilized to the existing water management infrastructure. For water resources management and water supply, this is the very efficient technology.

In the floods and droughts, there are natural changes in the recent years and in the rural area, disasters are according. To secure agricultural water and to cope with the damage of crops, a reservoir is installed which solves all these problems. During floods, there are damages by the river overflow and to prevent it flow to the reservoir is by passed to lower the level of the river. The sensor monitoring network system is essential for all this. The optimal supply of agricultural water is identified by the sensor monitoring for the water supply and management. For crop growth, the optimal amount of water is found for the excessive consumption of agricultural water supply.

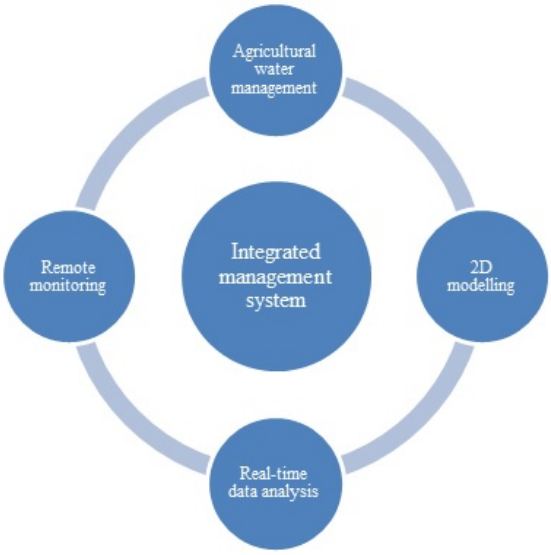

FIG. 3.1. *Four modules of an integrated management system*

The reservoir at all times is monitored by the water level sensor reservoir. If the rainwater supply is not smooth then the river water can be utilized for agriculture. The various problems in the exiting water management system are solved by the smart water management system and also an effective agricultural water system manages more efficiently. Four modules are finally utilized and integrated into an integrated management system such as agricultural water management, 2D modelling, real-time data analysis, and finally the remote monitoring as shown in Fig 3.1. The first module is responsible for the agricultural water management and the operation status of agricultural water related waterway is analyzed, and agricultural water related devices are also controlled. The structural safety of the development system is secured by the second module and the smart drainage system performance is analysed. The real - time data analysis is the third module for the designing of DB integrated system for remote monitoring. A smart drainage system and quality of water management function is finally developed by the remote monitoring module. The maintenance management system is finally developed and integrated with control systems and remote monitoring.

The agricultural water demand has the important characteristics as it requires the amount of agricultural water which is determined by the various factors like soil, climate and crops agriculture. As an important determinant of agricultural productivity stability and agricultural productivity, stable supply of agricultural water has been regarded.

The declarative notation is described and depicted in Fig 3.2. The sequence of activities is not defined here as it is declarative notation and all the activities are the rectangles. There is a chain response for the obligation of immediate execution and it is just one kind of rule. In this rule, the next activity to be executed is the activity at the end of the rule whenever the source activity is performed. The next activity is turning on all the pumps after reaching the minimum level. It will be turn on the next pump when the output flow. The set of interconnected hydraulic components are denoted by the water supply system for the water collection from the lakes and the water treatment procedures are applied for water distribution to the final consumers.

Following elements are included in water supply system:

1) Water source: Found in environment.
2) Water pumps: Set of equipments and installations for water collection from lakes.
3) Water transmissions: Raw water transportation to the water treatment facilities.

3.2. Implementation of the Proposed Technique . An innovative method is proposed in this paper to eliminate the water stress i.e., Blockchain Technology. Initially, water token is generated by the blockchain and then transaction of water is done as water shared among 10 households. The different transactions functions

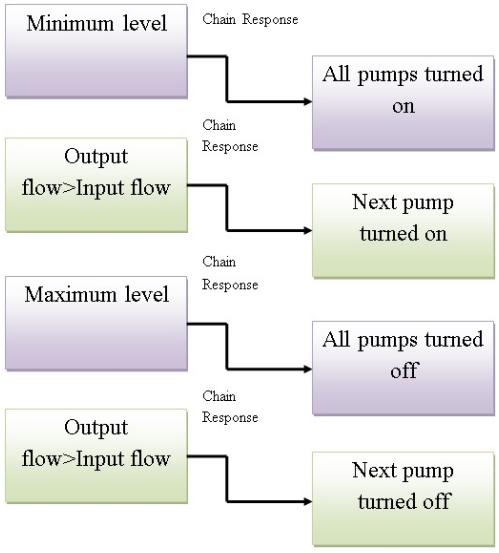

FIG. 3.2. *Water Supply Process*

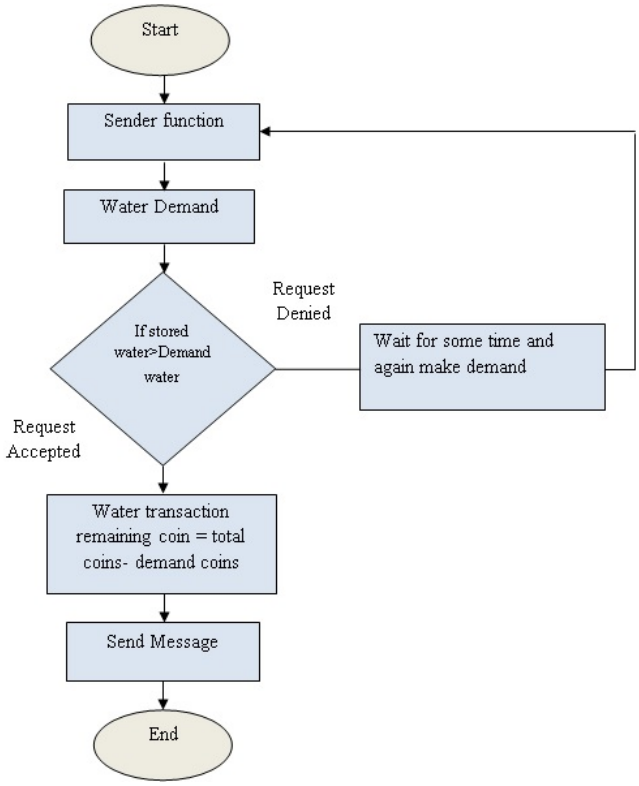

FIG. 3.3. *Process of transaction in Sender's Side*

are consisted in the smart contract as shown in Fig 3.3 and Fig 3.4. All transactions were written in solidity and run on Ethereum as platform. For water demand, the process of transactions is depicted in this Fig 3.3 which is occurring at sender's side. Any household can occur the demand and if it is accepted than it pass the transaction otherwise user have to wait for some time for the demand. The process of transaction occurring at

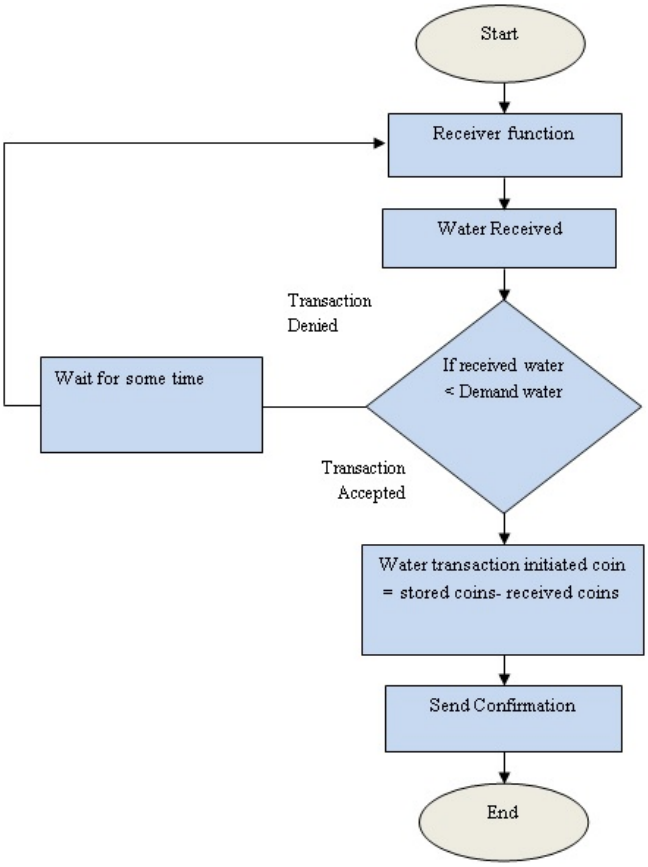

FIG. 3.4. *Process of transaction in receiver's Side*

receiver side is depicted in Fig 3.4. The acceptance of water demand request is shown in the figure. If demand coin equals to receive coins, transaction pass when water received from any household otherwise user have to wait for another time to make another demand.

4. Results and Discussion.

4.1. Water Monitoring Interface . In this section, a solution for intelligent water management and the water architecture is evaluated and analyse the performance. The event processing and the declarative processes are utilized for this purpose. The practical use of water management system which is installed in the city is evaluated and demonstrated in this section. The declarative business processes in the context of water distribution systems having varying merits which are also discussed here. The imperative process modelling language is utilized for the traditional workflow management systems which are helpful for the standardized and modelling static systems. However, an adequate response is not provided when the chaotic and dynamic processes are utilized.

A team of highly skilled and experienced professionals are required by the system for the water management. The unexpected situations are adapted by the professionals which accur in this scenario. Over water management policies, flexibility, and maintain control are offered by the declarative processes.

Table 4.1 represents the data that updates the water monitoring interface and it is also represented graphically. Flow of water through pump 1 is shown in Fig 4.1 and the water flow from the pump 2 is presented in Fig 4.2.

The raw water sources, pump, pipes, stations, tanks and all other components are in the same layer (Physical) which also contains water meters, IOT devices to measure the pressure and volume in pipes and

TABLE 4.1
Data that updates the water monitoring interface

Time (Hours)	Pump 1 Flow (lps)	Pump 2 Flow (lps)	Tank Level (m)
00.00	17.98	10.00	180.00
01.00	21.07	0.00	180.00
02.00	19.87	0.00	180.00
03.00	13.78	0.00	180.03
04.00	23.87	0.00	180.08
05.00	18.94	0.00	180.00
06.00	21.45	10.64	180.00
07.00	13.87	-3.12	180.05
08.00	22.43	4.98	180.09
09.00	8.67	17.32	180.02
10.00	14.67	23.78	180.00

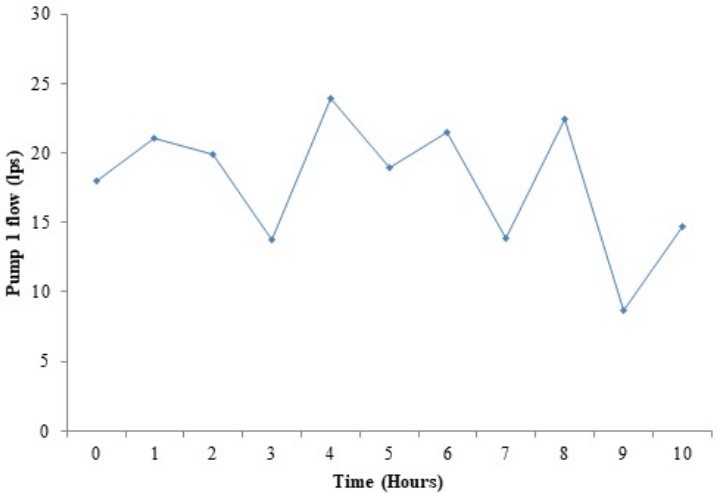

FIG. 4.1. *Flow of water through pump 1*

water tank respectively. Network sensors and actuators are connected to a gateway. The middleware layer provides the storage, analysis, processing, and orchestrating services and the communication between the two layers and also in IOT infrastructure of sensors and actuators.

To test the performance of the IOT devices, the benchmark tool CoAPBench is utilized. The confirmation requests are sending by the system and then waiting for the response before the next request. The IOT device is connected with the blockchain and it receive the request, fetches the information and response is returned to the IOT devices.

To check whether the plants are irrigated or not, sensed data is transmitted to server in four, five times in a day and the threshold values of temperature, humidity and moisture are checked with these values for the comparison. The user got the notification when the plants watering condition is fulfilled. Experiments are done and the results are obtained which are tabulated in Table 4.2. For more clear vision, it is also shown graphically in Fig 4.3.

Maximum of security is ensured by the water management system based on the blockchain in water supply system. Here some of the security issues are listed:

i. IoT devices are checked regularly and carried out the outputs.

ii. Proper paring of Public/ private key.

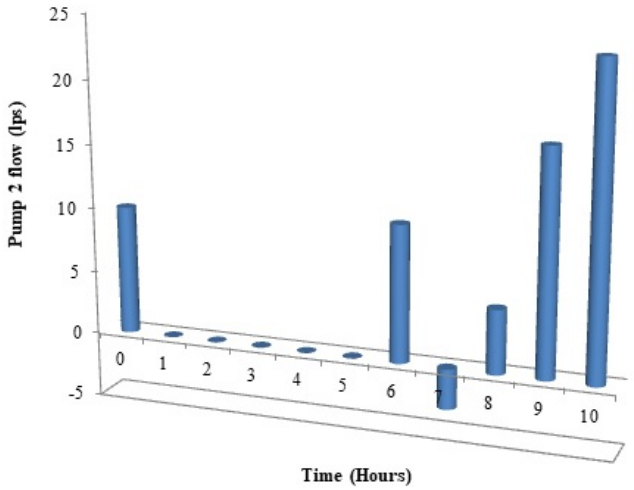

FIG. 4.2. *Flow of water through pump 2*

TABLE 4.2
Water management results for 6 experiments

Sr. No.	Moisture (voltage)	Humidity (Percentage)	Temperature (° C)	Time (Minutes)
1	High	7.34	2.32	2.30
2	High	5.21	2.76	1.55
3	High	3.67	1.89	4.25
4	High	12.32	7.65	8.40
5	High	15.54	9.45	2.10
6	High	12	5.56	1.23

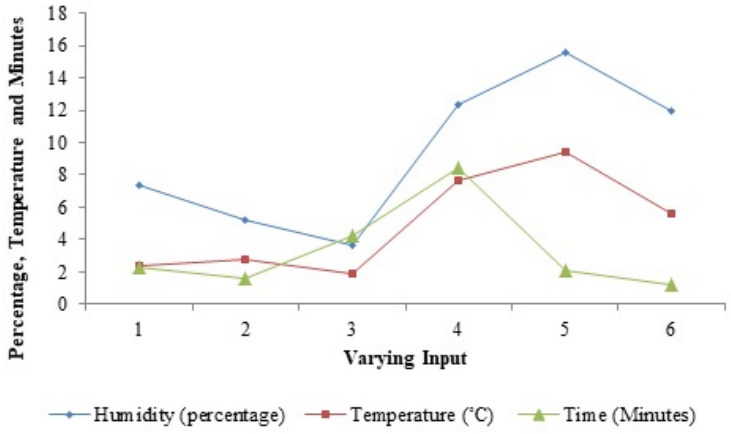

FIG. 4.3. *Water management results in terms of humidity, temperature and time*

iii. Digital signature security is ensured by the system.
iv. Regularly inspection of consumer feedback.

TABLE 4.3
Comparison of the proposed technique with existing technique

Sr. No.	Existing Technique [19] Humidity (Percentage)	Existing Technique [19] Time (Minutes)	Proposed Technique Humidity (Percentage)	Proposed Technique Time (Minutes)
1	8.78	3.20	7.34	2.30
2	5.89	2.54	5.21	1.55
3	4.56	5.24	3.67	4.25
4	13.78	9.35	12.32	8.40
5	16.43	3.54	15.54	2.10
6	13.56	3.65	12	1.23

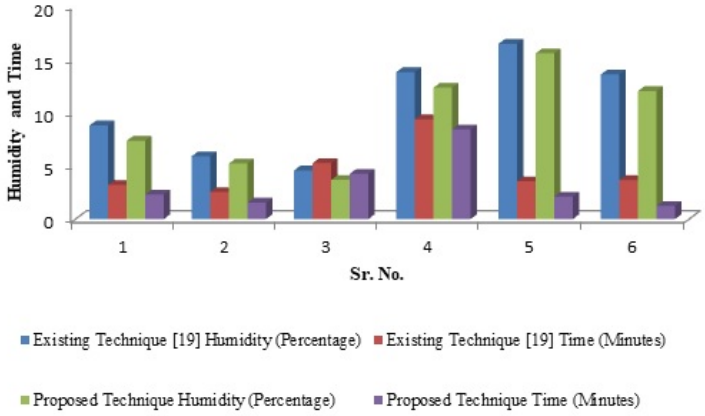

FIG. 4.4. *Comparison of the proposed technique with existing technique*

4.2. Comparison of the Proposed Technique with the Existing Technique. The comparison of the results obtained by the proposed technique is done with the existing technique for the validation purpose. This comparison shows the improvement of the proposed technique. The threshold values of temperature and time are checked and compared with the state-of-the art technique as tabulated in Table 4.3.

For better visualization and analysis, the comparison values in terms of humidity and time are also represented graphically as shown in Fig 4.4. It is clear from the figure that the humidity and time is less by the proposed technique.

The percentage improvement of the proposed technique is also calculated and the improvement of the proposed technique is shown in terms of the humidity (percentage) and time (minutes). The percentage improvement of the proposed technique is tabulated in Table 4.4.

For proper validation and analysis purpose, the visual graphical represented is presented in Fig 4.5. The percentage improvement over existing technique is shown graphically in terms of humidity and time.

It is clear from the figure that the proposed technique is better in terms of humidity of time. On an average the presented technique is 14.5% better than the existing technique in terms of humidity and the improvement of 67.5% is shown over the existing technique in terms of time.

5. Conclusion. The block-chain technology and IoT based technique with its features are detailed briefly. In the context of water systems management, the combination of these technologies is a powerful tool. It is very efficient and cost effective technique to control and monitor the real time aspects of water distribution. IOT based smart water management system is designed in this paper for the agriculture which ensures the effectiveness of the agriculture water management. The remote monitoring with the IOT is used for this

TABLE 4.4
The proposed technique improvement over existing technique

Sr. No.	Percentage improvement In terms of Humidity (Percentage)	Percentage improvement In terms of Time (Minutes)
1	19.62	39.13
2	13.05	63.87
3	24.25	23.29
4	11.85	11.31
5	5.73	68.57
6	13.00	196.75

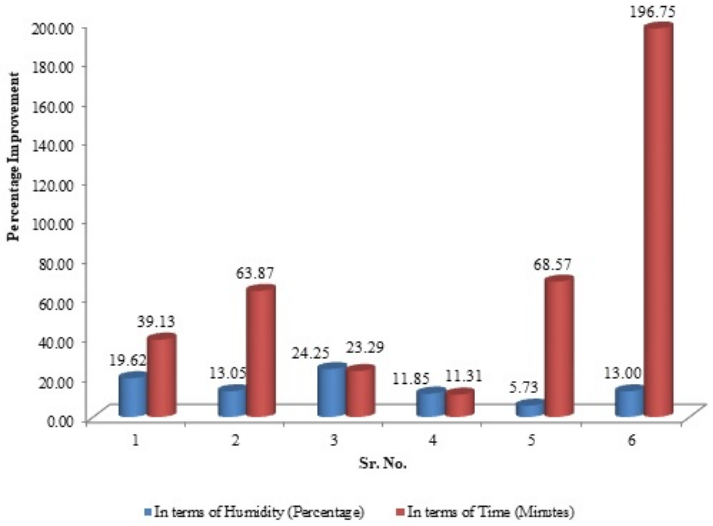

FIG. 4.5. *Percentage improvement of the proposed technique*

purpose. By linking with 2D modelling, the control and management of the agriculture water were performed. Finally, a system is implemented for the agriculture water management through the real time data collection. The obtained result shows the data that updates the water monitoring interface with the varying number of hours. The IoT technology and remote monitoring technology is utilized to the existing water management infrastructure. For water resources management and water supply, this is the very efficient technology.In future, IoT , blockchain and neural network based water management technique can be designed for the effective results.

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DESIGN AND RESEARCH ON THE INTELLIGENT SYSTEM OF URBAN RAIL TRANSIT PROJECT BASED ON BIM+GIS

YAN LIU*, MOHD ASIF SHAH†, ANTON PLJONKIN‡, MOHAMMAD ASIF IKBAL§, AND MOHAMMAD SHABAZ¶

Abstract. Building Information Modeling (BIM) technology has been widely used in the construction industry, especially in the field of civil construction. BIM standards, basic software and management platforms are relatively mature. The urban rail transit projects are linear projects, they not only span long lines, multiple regions, involve multiple disciplines, and are difficult to coordinate, but also have complex surrounding environments and high safety requirements. Therefore, their needs for integrated construction and operation applications are more concentrated. In order to solve the problems of data isolation, single display form, abnormal situation notification and delayed processing in urban rail transit construction monitoring, combined with GIS+BIM technology, a complete set of construction monitoring information management process and data organization plan is proposed, and the development is oriented. The construction monitoring system of project construction management focuses on solving the problems of the integration, display, early warning and secondary early warning of construction monitoring data.The system realizes the functions of input, storage, processing, three-dimensional display and early warning of measuring point information and daily measurement information. It is integrated with the GIS+BIM management and control platform, and the project is carried out in the construction project of Qingdao Rail Transit Line 8. Application, interact with functions such as model browsing, schedule control, engineering quantity management, video monitoring, etc., to improve the management efficiency and safety quality level of on-site construction.The mainstream GIS and BIM data based research on construction monitoring data standards promote the in-depth integration of construction monitoring data and improve the data entry and association efficiency.

Key words: Building Information Modeling, Urban rail transit; construction monitoring; GIS; integration; linear projects; multiple regions.

AMS subject classifications. 94-10

1. Introduction.

Concealed projects such as urban rail transit, underground complexes, and underground pipe corridors are very different from above-ground projects due to their construction conditions and construction methods. Construction units need to understand construction monitoring data in a timely manner during the construction process, such as: surface deformation, structural settlement, structure Horizontal displacement, supporting internal forces, etc [1]. At present, BIM technology has been widely used in the construction industry in my country, especially in the field of civil construction. BIM standards, basic software and management platforms are relatively mature. Because urban rail transit projects are linear projects, they not only span long lines, multiple regions, involve multiple disciplines, and are difficult to coordinate, but also have complex surrounding environments and high safety requirements. Therefore, their needs for integrated construction and operation applications are more concentrated as shown in Figure 1.1. However, at this stage, there are still many problems in the application of BIM technology in urban rail transit projects:

1. The basic BIM software for urban rail transit projects is not yet mature and has not formed a unified data standard.
2. The construction of urban rail transit projects involves many environmental factors and conditions. Complex, traditional BIM technology cannot integrate all data information.
3. The large amount of BIM model data, model lightweight technology and mobile internet technology are backward, which limits its convenient application in design and construction.

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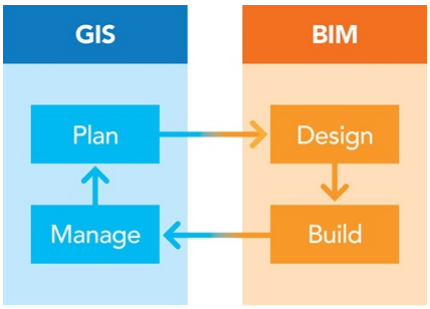

FIG. 1.1. *Integration of BIM and GIS*

There are three modules in the simulation model of urban rail transit safety vulnerabilities. The first unit: urban track traffic can respond to interference in time and perform corresponding adjustments and adaptation. Module 2: Urban rail transit can be restored to a completely normal state to implement some interference. Module 3: Urban track traffic can be completed within a limited self-recovery and adjustment time, and the vulnerable state after the period of disturbance can restore normal state in time. Most of the existing construction monitoring systems focus on solving the problems of data organization and business process, lack of association with other information in construction, and do not put forward the complete process of data input, calculation, display, early warning, message push, early warning processing and so on [2, 3].The main problems are:

1. The data entry is cumbersome, and the paper data or Excel tables used on site cannot be seamlessly connected with the system, resulting in the system data entry is not timely.
2. The system display and data query are mostly two-dimensional drawings and data charts. Mainly, it has high technical requirements for system users and is not intuitive enough.
3. The data (such as: wrong data, measurement points that are again for early warning after an early warning, etc.) are not specially processed on the construction site [4,5].

The existing construction monitoring system has not fully played its role in construction safety management. Based on scholars' research on GIS, BIM, and construction monitoring information technology, a reliable and efficient construction monitoring system should have the following characteristics:

1. High integration of construction monitoring data and progress data, surrounding buildings, geological data, etc.
2. Data The diversification of queries.
3. The multi-angle and intuitiveness of data display.
4. The processing of abnormal data and the immediacy of pushing early warning messages.

The important modes of urban commuter transport are urban rail transit that can operate at higher speeds than buses typically utilized in traditional transport systems. The unexpected disruptions are caused by the urban rail transit line emergencies which lead to interrupted operations and passenger delays. Unexpected service disruptions of varying degrees are caused by the variety of random events ranging from train malfunctions to bomb threats and power failures [6, 7]. The longer disruptions are caused by the serious emergencies whereas the short disruptions are caused by the minor events. The rail transit system reliability is ensured by the evacuation for emergency plan. The interactive collaboration between the different professionals is the BIM methodology's fundamental feature to insert, extract, and modify the model information. A single virtual model is recreated in the iterative process which contains the series of additional or complementary information of the elements of the dimensional structure, costs, safety and decommissioning.

The organization of the paper is as follows. Section 2 provides an overview of the exhaustive literature survey followed by a methodology adopted in section 3. A detailed discussion of obtained results is in section 4. Finally, section 5 concludes the paper.

2. Literature Review. In order to overcome the vulnerability of large passenger flow effects, WANG, L. et al. proposed improvement method based on large passenger vulnerability and applied five-year passenger

flow technology. There are three modules in the simulation model of urban rail transit safety vulnerabilities. The first unit: urban track traffic can respond to interference in time and perform corresponding adjustments and adaptation. Module 2: Urban rail transit can be restored to a completely normal state to implement some interference. Module 3: Urban track traffic can be completed within a limited self-recovery and adjustment time, and the vulnerable state after the period of disturbance can restore normal state in time [8].

Many City Rail Transit (URT) systems use DC traction power systems. Since the impedance and incomplete ground insulation of the running track, a portion of the traction current is inevitable to flow from the track into the ground, resulting in stray current. This type of current will produce huge safety hazards in the URT system and nearby metal structures. Yao, C. et al. explores different resistors in each of the power supplies under each power supply section below the bilateral power supply. Then, the defect of the current discharge method was identified in the context of stray current protection. In order to solve these defects, a reverse chemical neural network (bpnn) is used to construct the discharge flow prediction model. On this basis, a smart current monitoring system is established for the URT. Finally, the author simulates the effect of each factor on the stray current and verifies the reliability and stability of the proposed monitoring system. Compared with the predicted value and the actual value, the prediction agreement is very good [9, 10].

Based on GIS and BIM technology, combined with the actual needs of the project site, this paper establishes a comprehensive project construction management and control system, which integrates construction monitoring and progress management, engineering quantity management, video monitoring, shield monitoring and other modules, in order to realize the convenience of construction monitoring data. Processing, diversified inquiries, multi-angle display, rapid warning, improve the level and efficiency of project quality and safety management [11].

The alleviation of urban traffic congestion is an efficient way with the development of urban roads. The site space, complex resource allocation and tight schedule are limited [12]. These technical problems are solved by the BIM technology, three-dimensional visualization and parameterization. Throughout the lifecycle of BIM technology, BIM technology is innovatively researched in the context of the metro rail transit project. The optimum construction scheme of the shield machine is determined by the model information file which is imported for 4D simulation. The engineering quality and construction efficiency of the subway rail transit project is improved by the BIM technology. In this paper, author develops a project on Building Information Model (BIM)-based monitoring system for monitoring data integration and visualization for risk assessments [13]. A construction project and a comprehensive model are established by utilizing the BIM technology. The intelligent building components are composed into it which includes the parametric rules for each object. The construction project team is provided by the system with ongoing project. The possible blind spots when attempting to achieve risk assessments are identified by the construction project teams and further enable the adoption of mitigation measures to reduce risk levels.In the context of transportation infrastructure, BIM technology utilization is slow although in building industry, it has been widely adopted [14]. BIM for other non-building civil infrastructure is now adopting in industry and academia. Author in this paper implement the BIM technology in in an infrastructure design project. The focus of the paper is also on specific road elements modeling from guardrails and retaining walls etc. by utilizing the Revit and Subassembly Composer and the interoperability is also analyzed among BIM-based tools. In this paper, the unfavorable effects are caused by the deep excavations in urban areas on ground stability [15]. The environmental impact is required to evaluate and monitor during deep excavation construction processes. All the monitoring instruments are setup by the construction project team for controlling and monitoring the environmental status during the construction of retaining walls. The Building Information Model (BIM)-based monitoring system is developed in this paper by the author for monitoring data integration and visualization. The transit-based evacuations under emergency scenarios are focused by the author in this paper on single rail line under emergency scenarios. The stranded passenger's evaluation is done by the model which determines the vehicles and routes. The optimization model is proposed in this paper for maximizing the total number of stranded passengers within the given time window [16]. The validation of the proposed model and optimization model is done. The proposed control method effectiveness is evaluated and the stranded passengers at stations are analyzed under different numbers of vehicles. The routing arrangements are provided by the proposed model to maximize the number of passengers.

2.1. Contribution. Present the technique to solve the problems of data isolation, single display form,

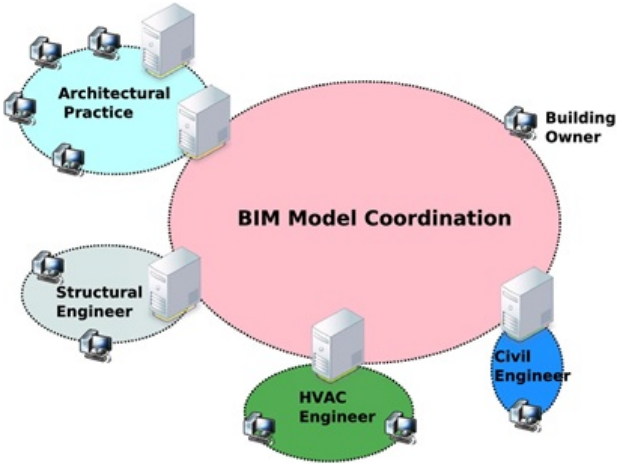

Fig. 3.1. *BIM model*

abnormal situation notification and delayed processing in urban rail transit construction monitoring, combined with GIS+BIM technology. A complete set of construction monitoring information management process and data organization plan is proposed, and the development is oriented. The construction monitoring system of project construction management focuses on solving the problems of the integration, display, early warning and secondary early warning of construction monitoring data. The system realizes the functions of input, storage, processing, three-dimensional display and early warning of measuring point information and daily measurement information.

3. System Design.

3.1. System Architecture. The system mainly serves the construction party and meets the application requirements including: three-dimensional display, historical data query, data import and export, monitoring and early warning, early warning processing and secondary early warning. The system uses a layered architecture, and the data uses a centralized storage method [17, 18]. BIM data services, high-definition terrain services, and monitoring-related data services are provided by the central server. The basic terrain services use the Sky Map of the National Geographic Information Public Service Platform. The BIM model is shown in Figure 3.1.

3.2. The correlation of monitoring data with GIS and BIM data. In the development of digital tunnels to smart tunnels, the comprehensive interconnection and deep integration of data and systems are important manifestations.The interrelationship of monitoring points, structural components, and surrounding environments will greatly increase the convenience and diversity of data query and display. Monitoring points can be broadly divided into structural monitoring, surface monitoring and environmental monitoring according to their spatial location [19, 20]. Among them, structural monitoring points are associated with components, and surface monitoring is associated with the ground. Environmental monitoring is mainly associated with GIS data through user-specified three-dimensional coordinates [21-24]. The incorporation of site data in BIM environment is shown in Figure 3.2.

When the user enters the measuring point for the first time, the type of measuring point, monitoring items and plane coordinate values (X, Y) are specified. For structural monitoring points, the system has a built-in relationship table to realize the association between different monitoring items and component types [25]. The monitoring points are orthographically projected in the vertical direction according to the plane coordinates, looking for components under this type, and determining a unique associated component. And get the component GUID number and the Z coordinate of the monitoring point; for surface monitoring, the system will project the measuring point to the surface to obtain the Z coordinate; For environmental monitoring, the user must manually specify the Z coordinate of the measuring point. Surface monitoring and environmental

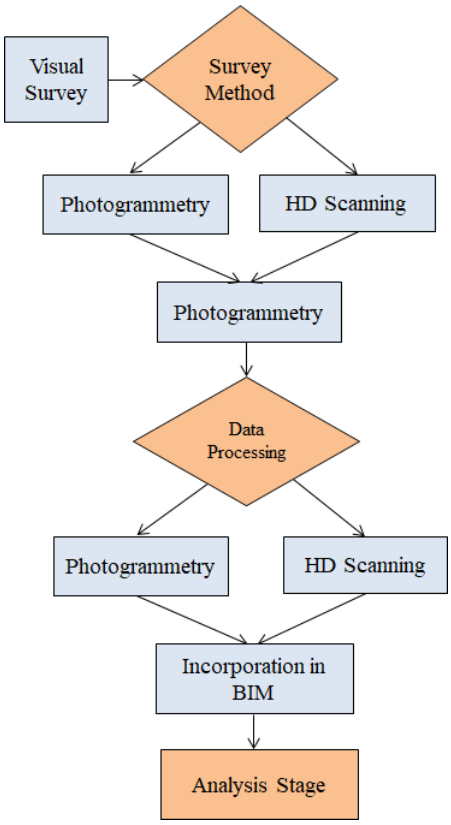

FIG. 3.2. *The incorporation of site data in BIM environment*

monitoring points are not related to components [26, 27].

4. Results and discussion with function application system. The function application and entrance are mainly set according to the working habits of the engineering personnel, which are more redundant and complicated. Only the core functions are explained below.

4.1. Data Entry. Because engineering monitoring personnel have a large amount of data processing work every day, the system should provide simple and quick entry mode when designing data entry modules, and provide the monitoring personnel with intuitive and referable data inspection results. All data entry in this system supports single-line entry and imported Excel table entry. The user customizes the system entry template according to the on-site data table format to achieve the purpose of seamless connection between on-site data and the system [28, 29]. After entering daily data, a temporary interface for data inspection is provided. The inspection content includes whether the measured value and the rate of change exceed the limit, whether the corresponding monitoring point exists, whether there is an early warning for the measuring point, etc. The user can directly review and edit the data in the temporary interface. The monitoring data entry check is shown in Table 4.1.

4.2. Early warning and handling. In the existing construction monitoring and early warning, there are mainly the following problems:

1. The single prediction is mainly based on the measured value.
2. The monitoring and early warning in the actual construction is a complex and cyclical process. After the monitoring data exceeds the limit, it is also accompanied by early warning processing.
3. More than 50% of the monitoring data in all regions of the country are in a state of exceeding the control value, and the early warning processing is seriously lagging behind [30, 31]. Combining industry

TABLE 4.1
Monitoring data entry check

Line number	Repeated measuring points	Test group	Measuring point	Measured value	Cumulative change state	Rate change status
1	normal	2	4	9	normal	normal
2	normal	2	4	3	normal	normal
3	normal	2	4	12	normal	normal
4	normal	2	4	11	normal	normal
5	normal	2	4	7	normal	normal
6	normal	2	4	8	normal	normal
7	normal	2	4	12	normal	normal

TABLE 4.2
Early warning rules

Warning status	Monitoring value size
Yellow warning	The cumulative value and rate both reach 70% of the limit, or a certain value reaches 85% of the limit
Orange warning	The cumulative value and rate both reach 85% of the limit, or a certain value reaches 100% of the limit
Red alert	Both the cumulative value and the rate reach 100% of the limit

standards and local standards, this system adopts dual-control indicators and three-level early warning. The early warning rules are shown in Table 4.2.

At the measuring point after the limit, if there is a warning again, regardless of the level, the warning should be paid enough attention. Therefore, the system defines all such early warnings as "secondary early warning", which is the highest level of early warning in the system.After the warning occurs, the message is immediately pushed to the relevant users [32]. At this time, the site monitoring engineer must deal with the warning in time to stop the push of warning messages. When the yellow and orange warnings are processed, the user only needs to enter the warning measuring point and click the button "complete the warning processing"; when the red warning and the second warning are processed, the system also provides the function of modifying the warning limit to meet the requirements. The need to re-approve the warning limit after a high-level warning occurs at the measuring point. It should be noted that the "processing completion" of the warning in the system means that the monitoring engineer understands the warning message of the measuring point and submits it for approval to complete the relevant offline processing process; after the red warning occurs at the measuring point, if the warning limit needs to be re-approved the value must be uploaded along with the scanned copy of the offline submission documents.

4.3. Data display system. The C/S terminal mainly provides the following functions: Three-dimensional display, data charts and early warning functions. The three-dimensional interface and related annotations are shown in Table 4.3.

It provides 3 display modes: The maximum value statistics of the day, survey point overview, and early warning query. When switching between modes, the measuring point data displayed in the 3D view is automatically switched. The measuring points in the 3D view are displayed in the form of icons + labels, and the relevant information includes the measuring point name, the latest cumulative value and the latest speed value. The color of the text marked on the measuring point indicates the different status of the measuring point, and the meaning is shown in Table 4.4.

4.4. Engineering application examples: Project overview. This system was applied on a pilot basis in the Qingdao Metro Line 8 Dayang Station-Qingdao North Station Interval (Subsea Tunnel) and integrated in the GIS+BIM project management and control platform. The Dayang Station-Qingdao North Station Interval

TABLE 4.3
The 3D interface and related annotations

Monitoring items	Latest measured value	Cumulative value	Rate value	Upper limit	Lower limit	Lower limit of rate value
Land subsidence	-2.22mm	-2.22mm	-0.25mm/d	30mm	-30mm	-3mm/d
Land subsidence	-3.53mm	-3.53mm	-1.22mm/d	30mm	-30mm	-3mm/d
Land subsidence	-3.59mm	-3.59mm	-0.82mm/d	30mm	-30mm	-3mm/d
Land subsidence	-3.33mm	-3.33mm	-2.11mm/d	30mm	-30mm	-3mm/d
Land subsidence	-3.3mm	-3.3mm	-0.59mm/d	30mm	-30mm	-3mm/d
Land subsidence	-2.5mm	-2.5mm	0.86mm/d	30mm	-30mm	-3mm/d
Land subsidence	-2.46mm	-2.46mm	-0.11mm/d	30mm	-30mm	-3mm/d
Land subsidence	-4.25mm	-4.25mm	0.67mm/d	30mm	-30mm	-3mm/d

TABLE 4.4
Text color meaning

Color	Meaning
White	Normal
Green	Maximum rate in the test group
Dark green	The maximum accumulated value in the test group
yellow	Yellow warning
Orange	Orange warning
Red	Red alert
Crimson	Second warning

Line starts from Dayang Station in Chengyang District, goes eastward along Aodongnan Road and crosses the Hedong Road ramp bridge, enters the sea on the east side of the bridge Hongdao toll station, and the section passes through the sea area of Jiaozhou Bay, and then connects Qingdao North Station in Qingdao (see Figure 4.1).This section is an important node project of Qingdao Metro Line 8. It is a double-hole single-line tunnel with a total length of about 8.1km, and a length of about 5.5km across the sea. It is mainly constructed by mining method and shield method. The interval includes 1 inclined shaft, 3 wind shafts, 1 shield section, 1 mining method section, and 1 open-cut section. In the initial stage, 1,000 monitoring points have been deployed, and the total number of points is expected to be about 2,000. The main monitoring the items include surface deformation, dome settlement, convergence deformation, pile top displacement and blasting vibration velocity.

4.5. Engineering Application. Relying on the "Qingdao Metro Line 8 Project Information Management and Control Platform", the construction monitoring subsystem is integrated to realize the functions of monitoring data management, display, processing, export, early warning messages, and secondary early warnings; it realizes the authority management of data. Data is divided according to different work points and different levels of personnel to control the visibility and editability of the data. The project construction system is shown in Figure 4.2.

The system can realize the functions of data curve drawing at any time of single and multiple measuring points, historical data query of measuring points, early warning processing and message push.After the construction monitoring system is integrated in the GIS+BIM platform, all data can be displayed and queried on the three-dimensional interface, including:

1) The type of measuring point, the relative spatial relationship between the measuring point and the terrain and structures, the display of the measured value, the warning state, etc.

2) After the management personnel discover the abnormal data of construction monitoring, they can immediately call the surrounding cameras to check the on-site environment, call the progress management

FIG. 4.1. *Qingdao Rail Transit Line 8*

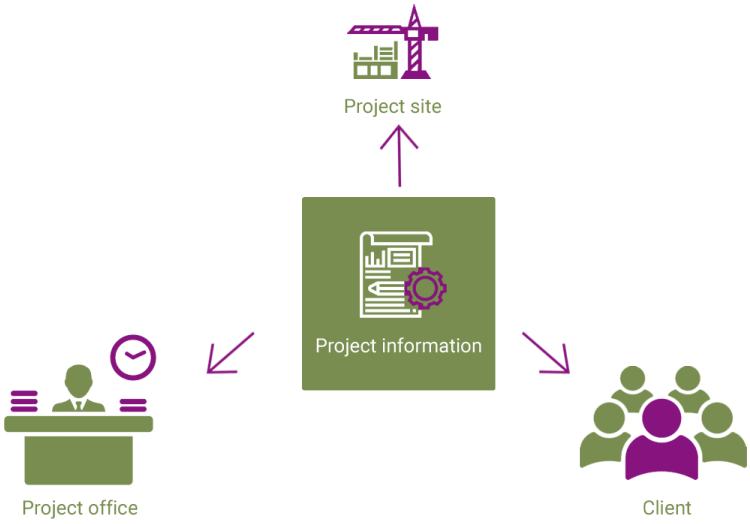

FIG. 4.2. *The project construction system*

system and the shield machine management system to check whether the recent construction status is abnormal.

3) Provide the monitoring data space query function, which can be batched View the monitoring data in a certain area, draw a graph for horizontal comparison, and improve the efficiency of abnormal data analysis. The main function applications are shown in Fig 4.3.

From the perspective of engineering construction management, the data organization plan, functional process and functional application are proposed, and the construction monitoring system is designed, and the system has been verified in actual construction management.This article introduces the core ideas and key links of the system in more detail. The main results are as follows.

1) Put forward a relatively complete monitoring data organization structure, develop a construction monitoring management system based on engineering practice, and realize the whole process management of construction monitoring data.

2) This paper puts forward the functional structure of the construction monitoring system suitable for site construction management. The system provides the core functions of monitoring data input, processing, inquiry, display, early warning and secondary early warning, early warning processing, and achieves the purpose

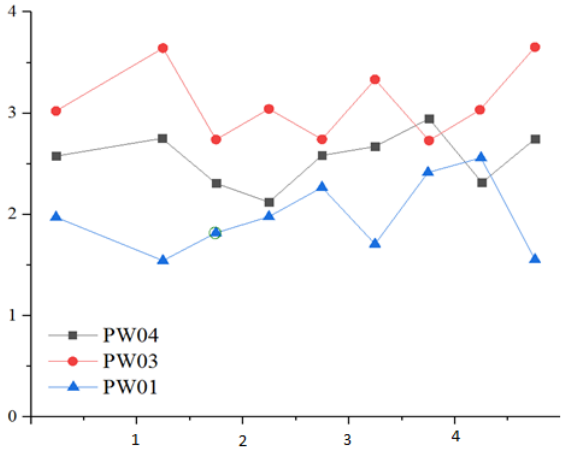

FIG. 4.3. *Multi-point curve diagram*

of flow, standardization and traceability of field monitoring data processing.

3) The construction monitoring data is associated with GIS and BIM data, and the system is integrated with the GIS+BIM management and control platform. It provides intuitive and diverse data display and query functions, and solves the problems of data flow, fast browsing, and instant warning in construction monitoring management.

5. Conclusion. With the rapid iteration of information technology and the emergence of new equipment and new technologies, the author believes that there are the following possible research directions in the development of construction monitoring systems. Introduce image recognition and machine learning technology to automatically recognize and enter the large-scale use of paper and manual data on the project site to solve the current difficulty in data entry in the construction monitoring system.The integration of construction monitoring Internet of Things equipment with construction monitoring systems and GIS and BIM technologies mainly includes the structuring of multi-source heterogeneous data, the unification of data structures and communication protocols, etc., to ensure that the data volume and throughput requirements are greatly increased. The integration of the construction monitoring system with the lightweight GIS and BIM engine makes the system suitable for mobile devices under the premise of ensuring the complete and efficient system functions. Research on the in-depth integration of construction monitoring, BIM and mechanical analysis, using construction monitoring data to back calculate the structure and stratum deformation and internal force data, and display the real-time deformation and internal force of the structure and stratum in the form of three-dimensional cloud diagrams to reflect the safety status of the project in real time. Research on construction monitoring data standards based on mainstream GIS and BIM data standards to promote the in-depth integration of construction monitoring data with GIS and BIM data, and to improve the efficiency of data entry and association.

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AN IOT AND BLOCKCHAIN APPROACH FOR FOOD TRACEABILITY SYSTEM IN AGRICULTURE

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Abstract. The food is imperative for human being anywhere in the world and this makes the agriculture sector as the prime source of employment and need. In all the developing countries, food supply chain is the major domains of research which need a growth. The production of raw food materials is growing with advancement in technologies, but the safety of food needs urgent attention. Nowadays, the world wide serious topic is a food safety and the food safety issues are tackled by the trusted food trace-ability system. It can track and monitor the food production whole lifespan in which the processes of food raw material cultivation/breeding, processing, transporting, and selling etc. are included. This work discusses the food quality problems and further proposes the food trace-ability system based on the Internet of Things (IoT) and blockchain technique for agricultural products. The presented system architecture is detailed and other existing problems are also discussed. The consortium blockchain is utilizing as the basic network and the trace-ability system can achieve more reliable and trust able devices.

Key words: Blockchain, Food quality, IoT, Traceability system, agricultural products, Food production, Food material

AMS subject classifications. 68M25

1. Introduction. To the government, the agricultural product's quality has always been a special issue. The existence of fake and inferior commodities is reduced by the trace-ability of agricultural product realization. It is simple solution for food trace-ability in which the product information is record manually and then saved in the specific database. After that a visually query interface is provided for customers. To implement this scheme, two problems are faced that are difficult to solve. First difficulty is in the guarantee authenticity of the data recorded by the humans so there is low credibility. Second difficulty is in the monitoring of the data which is stored in centralized data centre. These all problems and difficulties can be solved by combining the IoT and the blockchain technique to the some extend. The automatic measurement and transmission is realized and making the devices intelligent by the IoT technique. Utilization of the IoT improves the data credibility and saves the lobor costs instead of manual recording. The blockchain has the various features like decentralization, Persistency, Anonymity and Auditability in the network as shown in Fig 1.1. These features make the system better as compared to the other centralized database systems. The data tampering is prevented by the blockchain technique upto the certain extend and the system become more trustable by utilizing this technique.

i. Decentralization

Based on the PP network, a distributed ledger processed and validated the set of transactions in the blockchain. The central trusted party is not required in the bitcoin blockchain and all the nodes are used for adding and verifying blockchain transactions.

ii. Persistency

Once the transaction is added to the block in the blockchain then it is not possible to or rollback an identified transaction. Moreover, invalid transactions could be discovered immediately.

iii. Anonymity

By a generated virtual identity code, there is a communication between each participant with the blockchain. Also the real identity of the participant is not uncovered. Hence, this feature raises many security challenges

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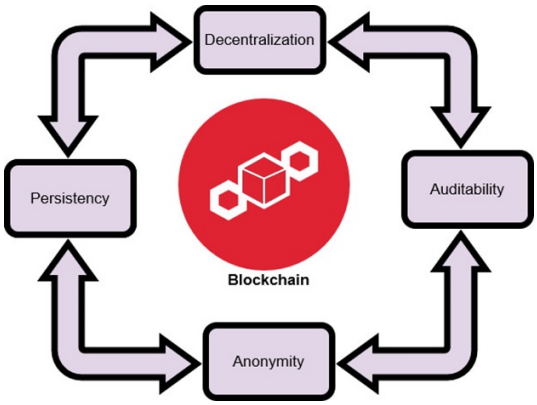

FIG. 1.1. *The various features of blockchain*

of blockchain transactions .

iv. Auditability Each block is linked to the last block and all the transactions and process made by the system design is verified and tracked easily.

1.1. Need for IoT in Agriculture. The surrounding environment is sensed and the necessary readings are notices by the IoT connected device which is then send to the server through the internet. All the information is stored for the future use or to the device, like a smart phone etc. where the data is viewed by the users. The system is continuously monitored and the user is allowed to take the decision on the actions to be performed. A connected network of devices is consisted by the smart sensing environment in which each other's data is constantly sent and received. In order to improve its condition, it also has the decision making capability on the user's behalf to perform the actions on environment. For further monitoring of the surroundings, this change is imposed on the environment calls and then moves continuously towards an evolving environment. In the smart system, the monitored data is sent by the user, action takes place and then actions effect on the environment. Further, the user is supported in decision making with the help of collected data.

In the agricultural food supply chain, a network of stakeholders like input supplier, Food processor makes sure that the right quantity and the quality product fetches up the right destination at the right time in the form of growing, processing or selling food to the end customer. This is all presented in the Fig 1.2.

Organization of the paper is as follows. The block-chain algorithms and related works are discussed in section 2. Section 3 details the research methodology. The experimental results are presented in section 4 and section 5 concludes the paper.

2. Related Work. The literature survey is provided in this paper for the development of the schemes utilizing block-chain technology to provide information security. A core requirement is identified and then the author proposed generalized security architecture based on block-chain. On the studied schemes, detailed cost analysis has been conducted [16].

The drawbacks in existing research are also uncovered by the comparative analysis. A model is proposed in this paper by the authors to uplift the traditional agriculture field to smart farming in which blockchain is considered with the IoT technology [17]. The equal opportunity to all stakeholders is provided by the system in the food supply chain. To reduce human interference, IoT devices are added for data collection and verification. The presented system is also compared with the scheme which only utilizes the IoT devices in the monitoring field without block-chain. As the food safety is becoming serious in the worldwide, so food safety issues are tackled the from the technical aspect and from the systems that can monitor the whole lifespan of food production [18]. The system includes the processes of food raw material cultivation/breeding, transporting, warehousing, and selling etc. The blockchain and IoT technology based open and ecological food traceability system is proposed. All parties of a smart agriculture ecosystem are involved in the system even if they may not trust each other. The manual recording and verification are replaced by the IoT devices in which human intervention is effectively reduced to the system.

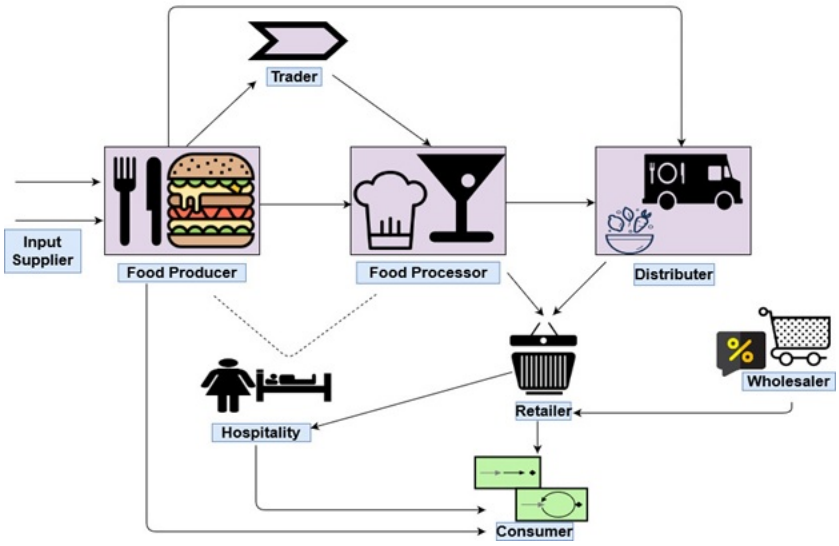

FIG. 1.2. *Agricultural food supply chain*

The comprehensive survey is done for the development of smart applications in precision agriculture on the importance of integrating both blockchain and IoT [19]. The novel blockchain models are proposed for major challenges in IoT-based precision agricultural systems[20]. The main functions and strengths of the common blockchain platforms are studied and reviewed for the management of various sub-sectors in precision agriculture. The security and privacy challenges are also discussed those obstacles developing blockchain-IoT systems. The application of blockchain technologies are overviewed and provided in this paper to enable the traceability in the agriculture food domain [21][22]. The levels of adoption, tools and advantages of traceability are defined in this paper[22], the functionality and advantages of blockchain technology is also overviewed briefly. The integration of block-chain and the traceability systems are also integrated and the complete review on this is provided by the author. The relevant existing commercial applications, the relevant challenges of the application of blockchain are also detailed [22].

For the interaction between people and things/objects, the IoT is a wireless network infrastructure to integrate various communication technologies. For the development of distinct applications, distinct applications for the so-called smart cities are opened by the remarkable technology. For monitoring and controlling water supply systems, IoT is used in the context of water management. The high quality water demand is increased by the climate change with the increase in the world's population and for that new water strategies are created [23, 24].

Block-chain is the emerging technique in which the distributed ledger is contained in the block-chain which enhances the security and data transparency [25]. In real time, blockchain is merged with the Internet of Thing. Author in this paper attempted to survey the core details of features of blockchain. The designed architecture is proposed in this paper for Smart Agriculture and ended up with some new architectural framework by merging the IOT and the BlockChain. In this paper, authors' details how the blockchain technology can help to utilized the water more effectively in the network [26, 27]. The water ledger architecture is proposed by the author in this work. In the water management system with the ultimate goal of Water, the presented architecture serves as the basis for Blockchain helps inbuilding transparency. The block-chain technology is utilized to build the smart water management system[28-30]. For smart water management applications, IoT is the natural thing even though the different technologies essential for making it work seamlessly. An IoT-based smart water management platform is developed by the SWAMP project for precision irrigation in agriculture. The SWAMP architecture, platform is presented by the author in [31], the scalability is a major concern for IoT applications. Specially designed configurations and the re-engineering of some components are required to provide adequate performance and utilizing less computational resources [31].

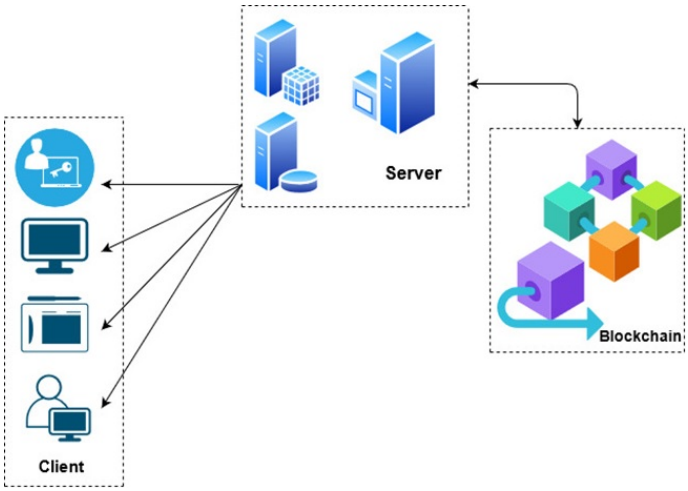

FIG. 3.1. *The proposed system architecture*

The impact of blockchain technology is examined by the author in the agriculture and food supply chain [32, 33]. Existing projects, overall implications, challenges and potential are also presented and discussed with the critical view. The blockchain is the promising technology in various food products which hinder its wider popularity among farmers and systems. The IoT and blockchain technology based traceability system is presented by the author for the agriculture products in which the problems of food quality is discussed [34-36]. The system architecture and some other problems are discussed in this paper by the authors. The consortium blockchain is utilized as the basic network and the IoT devices as the recorder and achieve a more reliable, trustable and extendable traceability system.

2.1. Contribution. In this paper, food quality problems are discussed and the food traceability system is proposed which is based on the Iot and blockchain technology for agricultural products. The presented system architecture is detailed and other existing problems are also discussed. The consortium blockchain is utilizing as the basic network and the traceability system can achieve more reliable and trustable devices. There is the complexity in the agri-products supply-chain which limits the global and efficient transparency development.

3. Research Methodology. The method and the structure of the complete system is shown and detailed in this section. The proposed system structure is shown in the Figure 3.1. There are three major parts in the presented system.

i. Client
ii. Server
iii. Blockchain

Client: This part of the system has the charge of data collection. Sensors can be arranges on the farm according to the data that need to be recorded. The network module and a data processing module are included in the sensor which has the built-in processing chip. The chip in the sensor contains elliptic curve cryptographic algorithm based key pair for the block- chain network. The device identity is represented by the key pair and by registering the device; the complete data can be tracked. The manual recording interface is also provided by the system for the manual recording of the data.

Server: The system having the server is responsible for business logic processing. In this part, there are four modules in it as shown in Figure 3.2.

The employee management and IoT device management provides unified management functions for relevant devices of the enterprise. It also facilitates the operations like authorization and registration. The system parameters and security are related to the system management module.

Blockchain: The management functions are provided by this to measure the data. The function of data storage, consensus, encryption and decryption etc. are provided by the blockchain. It can increase scalabil-

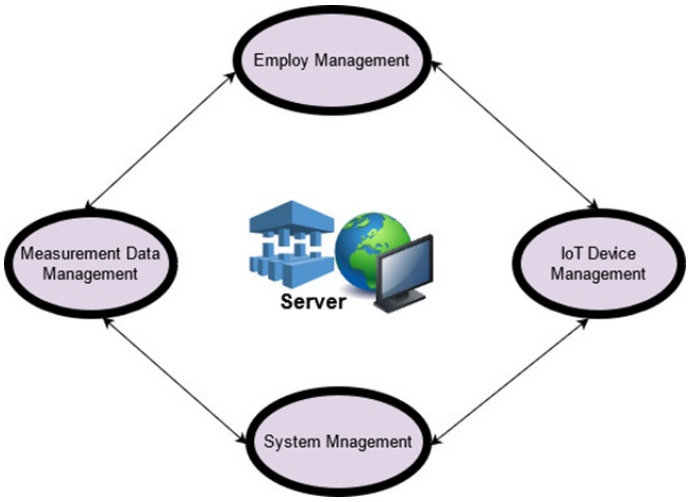

FIG. 3.2. *Modules of server*

ity, simplify processes and reduce costs by executing the corresponding logic at specific points in time. The blockchain base layer includes peer-to-peer networks, encryption algorithms, and membership services. The hyperledger Fabric is utilized for consortium chain building which requires joining authorization. There is communication between the nodes through peer-to-peer networks and is deployed in multiple enterprises. For the blockchain, the smart contract layer is the entry and it requires the authority verification. The core consists of the data insert and query. The user points operations are included in the core and according to the pre-defined requirements, it is set accordingly. The application layer is answerable for connecting the client and the blockchain network.The authority verification is executed by the program when it receives the request from the client. Processing results are then returned to the client. The support is provided by the extensive interface layer and facilitates access by the e-commerce systems and logistics systems etc.

3.1. Functions of IoT performed in the system. 1. The crop health is monitored by the IoT devices and the information is generated for providing support to the farmers. It supports the farmers to make a decision related to crop growth is collected and saved in the blockchain.

2. The machine learning is utilized to get the more insight information and it gives the crop related information like crop growth factor and recommendation for crop quality improvement [37, 38]. The machine learning algorithms helps the farmers to make improvement in the irrigation system.

3. The collection of high valued data will be stored by file System in decentralized server. It helps to avoid authority control and the reduce the data hacking risk. To facilitate specific stakeholders, the function of Smart contracts exchanges the data which is stored in the blockchain. It also provides the unified platform for the effective improvement.

4. Results and Discussion.

4.1. Experimental Analysis. The various experiments are executed and discussed here for 100 runs for each cryptographic primitive. The run time in milliseconds (maximum, minimum and average) is recorded for 100 runs and then obtained results are tabulated in the Table 4.1. Various operations are performed symbolized by the notations "Tbp, Texp, Teca, Th, Tmul and Tadd" which signifies the time required for a "bilinear pairing", a "modular exponentiation", an "elliptic curve point (scalar) multiplication", an "elliptic curve point addition", a "symmetric key encryption/decryption using the Advanced Encryption Standard". To analyse it properly, it is also shown graphically in Figure 4.1.

The proposed Scheme is evaluated and the throughput is shown graphically at different nodes for IoT implementation in agriculture sector with various nodes deployment under monitoring. Graphical representation is shown in Figure 4.2.

TABLE 4.1
The run time in milliseconds for 100 runs

Primitive	Minimum Time (ms)	Maximum Time (ms)
Tbp	7.21	3.76
Texp	0.219	0.062
Th	0.18	0.01
Tmul	0.006	0.002
Tadd	0.003	0.001
Teca	0.002	0.001

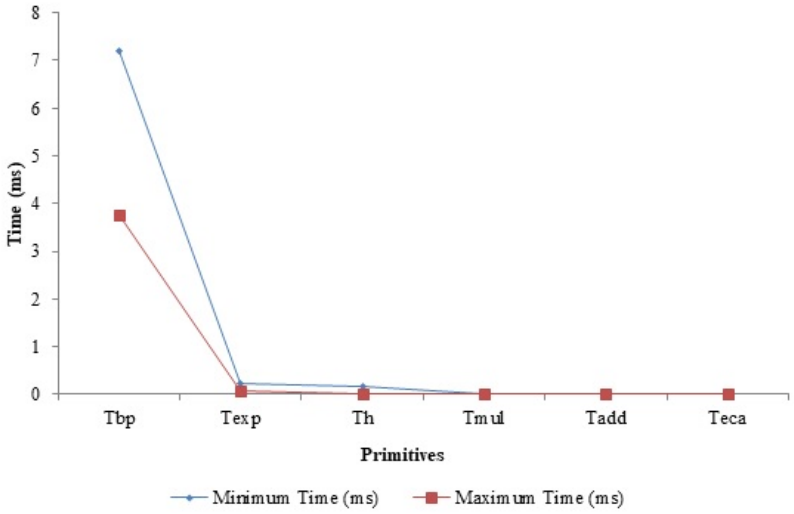

FIG. 4.1. *Run time in milliseconds for 100 runs*

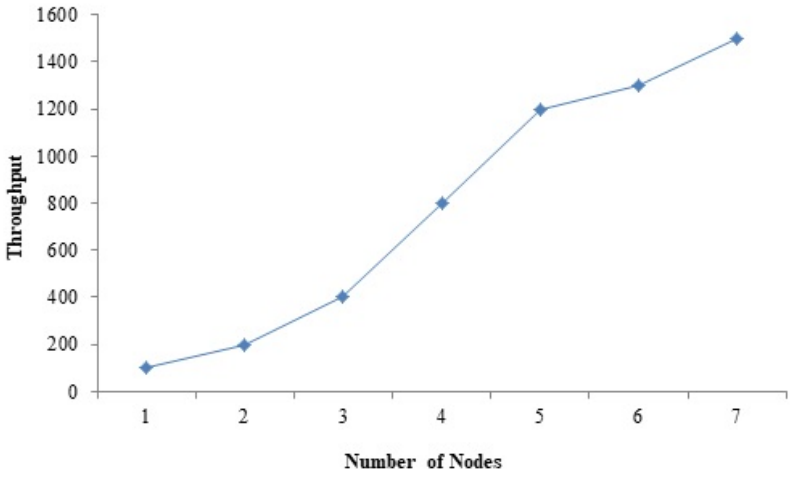

FIG. 4.2. *Throughput of the proposed scheme*

TABLE 4.2
Minimum and maximum time are checked and compared with the state-of-the art technique

Primitive	Existing Technique [39] Maximum Time (ms)	Existing Technique [39] Minimum Time (ms)	Proposed Technique Maximum Time (ms)	Proposed Technique Minimum Time (ms)
Tbp	8.440	4.424	7.210	3.763
Texp	0.241	0.043	0.219	0.062
Th	0.143	0.026	0.184	0.014
Tmul	0.007	0.001	0.006	0.001
Tadd	0.003	0.001	0.003	0.001
Teca	0.002	0.001	0.002	0.001

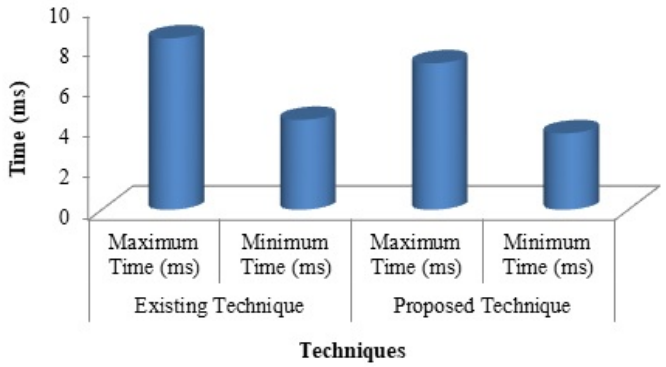

FIG. 4.3. *Time for Tbp*

With the blockchain and IOT integration, the presented scheme shows the improvement and the obtained results shows a tremendous raise from the IoT based scheme. The proposed scheme is validated in contrast to the various nodes which are tested in the agriculture. It is also seen that the throughput of the proposed scheme is higher as compared to the other existing schemes. With the emphasis on the different types of blockchains, the working of blockchain system and their applications in the various domains is discussed.

4.2. The proposed technique comparison with the existing techniques. The comparison of the results obtained by the presented technique is done with the state-of-the-art technique for the validation purpose. This comparison shows the improvement of the proposed technique. The minimum and maximum time are checked and compared with the state-of-the art technique for different primitives like Tbp, Texp, Teca, Th, Tmul, Tadd, Tecsiggen and Tecsigver which signifies the time required for a "bilinear pairing", a "modular exponentiation", an "elliptic curve point (scalar) multiplication", an "elliptic curve point addition", a "symmetric key encryption/decryption as tabulated in Table 4.2.

The minimum and maximum time obtained for the different primitives by the proposed and the existing technique is also shown graphically in Fig 4.3- Fig 4.8. The graphical representation gives the better analytic details and the better visualization.

The maximum time required by the proposed techniques for different primitives is less as compared to the existing technique and the minimum times requirement by both the techniques are comparable with less complexity of the presented technique. The percentage improvement of the proposed technique is also calculated and shown in Fig 4.9. It shows the overall performance improvement of the proposed technique over the existing technique.

The Figure 4.9 shows that the presented technique is 23.74% and 18.92% better than the existing technique

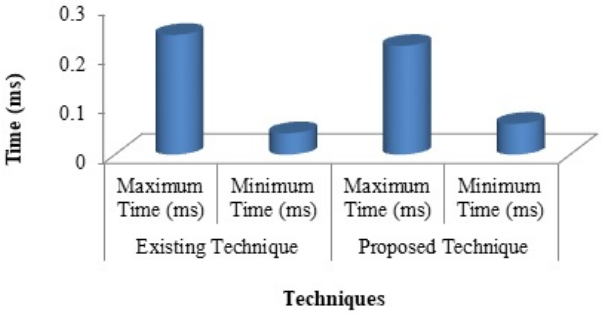

FIG. 4.4. *Time for Texp*

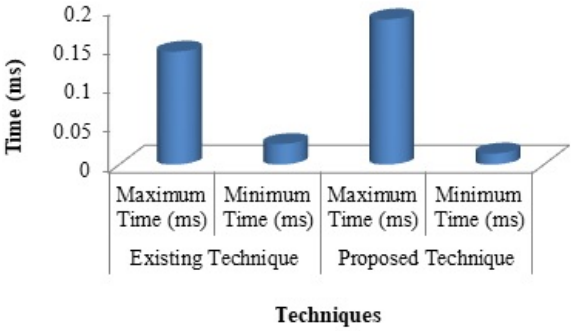

FIG. 4.5. *Time for Th*

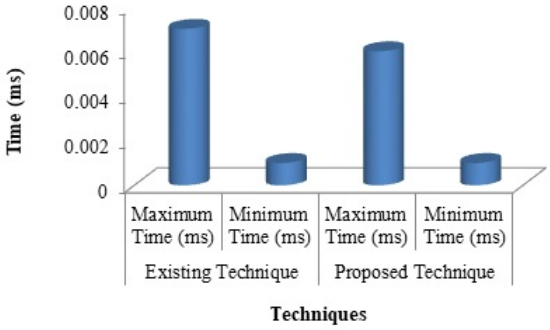

FIG. 4.6. *Time for Tmul*

in terms of maximum and minimum time (ms). It outperforms the existing techniques in terms of time interval for different primitives. The presented technique is very advantages; also there are many challenges in the blockchain technique.

1. Scalability: The issue in the blockchain is the storage space that if the blocks added in the blockchain then it cannot be deleted. The number of transactions processed per unit time is limited and in the small and

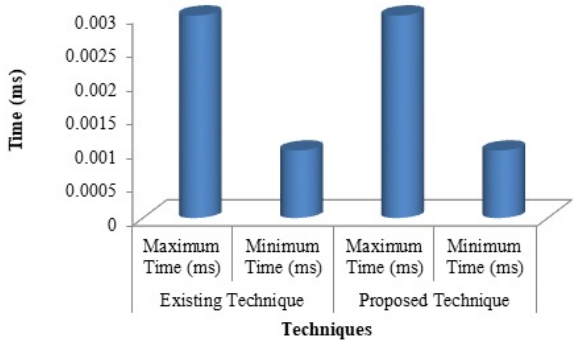

FIG. 4.7. *Time for Tadd*

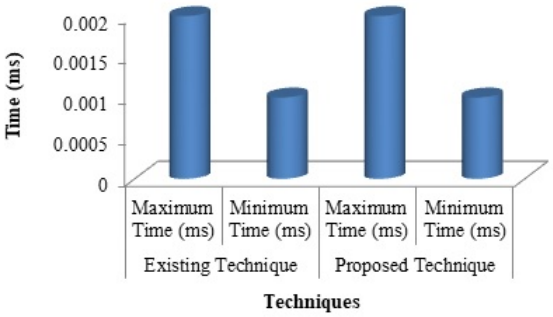

FIG. 4.8. *Time for Teca*

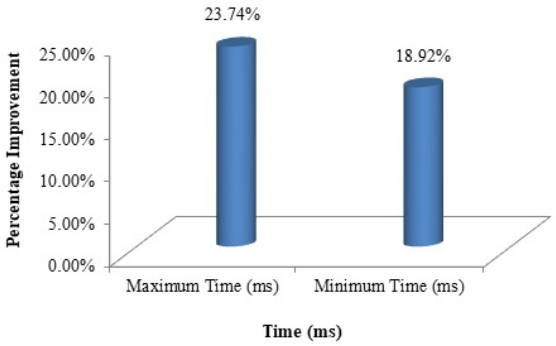

FIG. 4.9. *Percentage improvement of the proposed technique*

large blocks, there is always a tradeoff.

2. Privacy Leakage: The transaction contents are always available publically, hence the transactional privacy is not ensured by the blockchain.

3. Selfish Mining: If the some of the nodes of blockchain are not honest then the blockchains are susceptible to collusion.

5. Conclusion. The companies of food supply chain find the actual food source and the food production whole process is tracked from origin to end consumer. In this paper, food quality problems are discussed and the food traceability system is proposed which is based on the IoT and blockchain technology for agricultural

products. The presented system architecture is detailed and other existing problems are also discussed. The consortium block-chain is utilizing as the basic network and the traceability system can achieve more reliable and trustable devices. Utilization of the IoT improves the data credibility and saves the lobor costs instead of manual recording. With the integration of blockchain with the IoT, the presented scheme shows the improvement and the obtained results shows a tremendous raise from the IoT based techniques. The hybrid technique can be designed for better and efficient results in the future.

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DESIGN AND APPLICATION OF COLLEGE ONLINE EDUCATION PLATFORM BASED ON WEBRTC

GUOLIANG LI *, RIXING WANG †, AND QIKUN ZHOU ‡

Abstract. Web based real time communication enhances the current online education platform by blending it with virtual universities by the means of internet. This article explored the designing perspective of College Online Education Platform in order to provide distance education services, instant messaging, interactive online classes, video answering and video viewing functions. A media server cluster load balancing algorithm based on consistency hash algorithm and genetic algorithm is proposed in this article. This article is focused on designing and practical implementation of a fusion communication platform combined with WebRTC and related technologies to deliver online education system in colleges and universities. The online education system is tested and the test results show that the online education system designed and implemented in this paper can meet the expected needs. The media server cluster load balancing strategy proposed in this paper can ensure the cluster overall load balancing. At the same time, the node weight can be dynamically adjusted according to the real-time state of the clusters. The outcomes obtained justifies the efficiency and practicability of the proposed methodology.

Key words: WebRTC; University Online Education; Integrated Communication; Load Balancing.

AMS subject classifications. 68M14

1. Introduction.

As a unique means of human progress and development, education has deeply influenced and changed people's study and life since ancient times. Traditional conditional education can only be realized by means of paper and pen as media or personal dictation. Nowadays, with the rapid development of computer technology and the continuous improvement of Internet network level, Under the tide of continuous change in many traditional industries, the informatization and networking of education is not only the future direction, but also the urgent need of people. Therefore, a new form of education, that is, online education, or distance education, came into being [1-4]. It is a method of using information technology and Internet technology to spread content and learn quickly.

With the development of Internet technology, books are no longer the only carrier of knowledge transmission, people gradually tend to choose a more convenient way of online education. Although traditional online education can solve the problem of high threshold of students' access to knowledge, due to the lack of effective feedback mechanism, students' access to knowledge is limited. WebRTC technology users do not need to load any plug-in, with cross-platform advantages. Traditional education is a passive mode dominated by teachers, and students' learning initiative is poor [5-8]. And with the development of real-time communication technology, especially the rapid development of WebRTC technology, it will gradually break this one-way way of education, so that students can learn knowledge from anyone at anytime and anywhere [9,10]. This can make up for the regional imbalance of education to some extent, so that children in remote areas can also receive quality education [11,12].

This article contributes in the current online education platform by blending it with virtual universities by the means of web based real time communication (WebRTC). It explores the designing perspective of College Online Education Platform for providing the distance education services, instant messaging, interactive online classes, video answering and video viewing functions. The paper proposes a media server cluster load balancing algorithm based on consistency hash algorithm and a genetic algorithm for the implementation of College Online Education Platform Based on WebRTC. The novelty of this article lies in designing and practical

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implementation of a fusion communication platform combined with WebRTC and related technologies to deliver online education system in colleges and universities. The testing of this online education system is done and the results reveal that the online education system designed and implemented in this paper meet the expected requirements. Comparative to the existing RTC frameworks, the media server cluster load balancing strategy proposed in this article ensures cluster overall load balancing at the same time along with dynamic adjustment to the real-time state of the cluster. The experimental outcomes justify the effectiveness and viability of the proposed methodology.

The rest of this article is structures into different section. Literature review of the current research work going on in this field is presented in section 2. Section 3 presents the system design followed by the results and discussion presented in section 4. Conclusion of the article is depicted in section 5.

2. Literature Review. Under the current educational situation, many famous educational institutions and educational platforms have emerged at home and abroad. They have different understanding of the forms of network education, and have formed a state of blooming a variety of types. For example, some provide after-class homework and auxiliary videos for auxiliary offline education, some provide communication classes and after-class evaluation, and some directly set up study groups through chat tools and forums. The emergence of these forms is making the traditional mode of education radiate new charm. Sun, Z. et al. Develop depth learning online intelligent English teaching system, using the creation of a modern tool platform, helping students comply with their knowledge and personality to improve the efficiency of English language teaching. Decision tree algorithm and neural network have been used, and the model is generated based on decision tree technology to generate English teaching assessment. It provides valuable data for extensive information, summarizes rules and data, and help teachers improve their education and English scores. The system reflects the thinking of artificial intelligence expert system. Test applications indicate that systems can help students improve learning efficiency and more relevant learning content. Furthermore, the system provides an example model having a similar method, and has a reference definition [13]. Cheng, L. et al., considered the advanced teaching methods as the research object of cheerleading information curriculum teaching, using literature review methods, questionnaire surveys, interview methods, classroom observation methods and mathematical statistical methods. According to the characteristics of online teaching, the characteristics of cheerleading courses and students' physical/mental characteristics and teaching strategies of cheerlead network courses are designed for providing better education. Cultivation of students' learning habits, learning attitudes, learning skills and thinking innovations, create good environment and learning conditions [14].

The recent advents in the education industry are linked to the diverse benefits which are extensively being used in several universities and colleges for successful operation [15-17]. Kapp [18] concluded that the engagement of students in several games along with teaching may have a positive impact on their mental health and can inculcate the habit of not giving up in the situation of several failures. There are various studies which are evident of improvement in the student's performance when they are involved in gaming as it improves their critical analysis skills while cultivating the problem solving and decision-making qualities of an individual [19, 20]. There has been a focus on games in the present studies which further improves the learning ability [21,22], motivational skills [23], student's attitude for dealing with critical situations [24,25] and inculcate the behavior of participation [26]. There are various positive effects of games on student's personality for e-learning scenario as well. Some of the researchers employed the combination approach including the various data gathering processes for understanding the student's approach for instruction and learning [27]. The mixed strategy involves the gathering of quantitative data from various statistical tests and qualitative information is obtained by student's interview. These approaches are considered useful for developing the traditional e-learning platforms and the student's progress should be monitored from the collected information [28,29].

Based on the research and learning laboratory fusion communication platform and WebRTC technology, this paper will first analyze the requirements of the system, and then determine the overall structure of the online education system in colleges and universities. According to the demand analysis, the whole online education system of colleges and universities mainly includes login verification module, instant messaging module, online classroom module, video answering module and video viewing module [30]. The modules that need to be used WebRTC are online classroom module and video answering module. In order to improve the system concurrency performance, this paper will build multiple media servers into clusters to provide services.

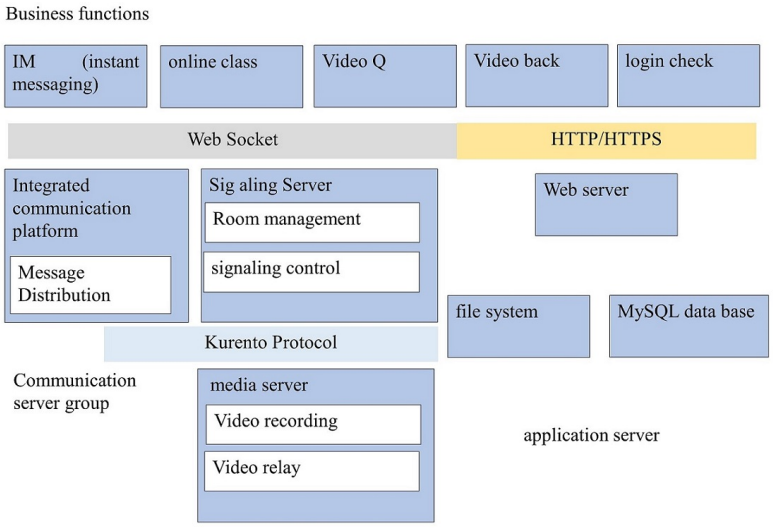

FIG. 3.1. *Overall Architecture Map of College Online Education System*

3. System Design.

3.1. System overall architecture design. The overall architecture diagram of the college online education system (the part related to instant communication and real - time communication) is designed, as shown in Figure 3.1. The top level is the business functions needed to achieve in the college online education system, including login verification module, instant communication module, online classroom module, video question answering module and video back viewing module. The bottom level is the communication server group and application server, which mainly provides communication - related services, such as text, picture expression and real - time audio and video, mainly including integrated communication platform, sign aling server and media server; the application server is mainly used to provide Web services, storage and recording video and provide database services [31]. This paper focuses on the functions related to multimedia communication, that is, the integrated communication platform and WebRTC technology based on laboratory research and development, and designing and implementing the business functions related to text, picture and real-time audio and video communication.

3.2. Design of load balancing algorithm based on consistent h ash and genetic algorithm. In order to meet the consistency demand of the real - time media flow transmission request to the same media server, in this paper, the consistency h ash algorithm is selected as the basic load balancing strategy and optimized using the genetic algorithm.

The basic flow of consistent hash algorithm is: first, the media server node is mapped to a 232-1 loop with a range of values through the hash function, after that, the real-time media streaming request is also mapped to the ring, and the nearest media server node is process the request. However, because there are fewer server nodes, the request may be offset, that is, some server nodes need to process a large number of requests, while other server nodes basically do not process requests, resulting in avalanche effect, which can be solved by using virtual nodes. To a certain extent, the avalanche effect is solved [32].

In the consistency h ash algorithm, the performance differences between the media servers within the cluster can be represented by assigning a different number of virtual nodes to the media server nodes. In the initial state, the number of virtual nodes per media server is often a fixed value of human configuration. In order to ensure the adaptability of the load balancing algorithm, it is necessary to be dynamically adjusted according to the load state of the media server nodes in the cluster, reduce the number of virtual nodes of the media servers with high load, and increase the number of virtual nodes of the media servers with low load. The load rate of

the media server node can be calculated by Equation (3.1):

$$LB_i = \alpha C_i + \beta M_i + \gamma B_i + \delta L_i \tag{3.1}$$

where the LB_i represents the load rate of the i server node, and the C_i, M_i, B_i, L_i are the load balancing index, which represents the CPU utilization, memory utilization, bandwidth utilization ratio, respectively.

$$\alpha + \beta + \gamma + \delta = 1 \tag{3.2}$$

CPU utilization ratio C_i calculated by formula (3.3), M_i and B_i the same.

$$C_i = C_t i / C_{Total} \tag{3.3}$$

The L_i number of connections, however, is calculated slightly differently. When a user invites other users in a group to communicate in real time, other users do not necessarily respond immediately, but this part of the connection number also needs to be taken into account. So, multiply a constant k to indicate the number of connections that will accept invitations, as shown in equation (3.4).

$$L_i = ((L_N i - L_t i) * k + L_t i)/L_{Total} \tag{3.4}$$

The media server node regularly sends load information to the load balancer, and then the load balancer calculates the load rate of each media server node LB_i, When the $LB_i > LB_max$ of the media server node appears, the number of virtual nodes corresponding to each physical server will be recalculated according to formula (3.5) and (3.6), where V_total, represents the total number of virtual nodes allocated by the cluster.

$$p_i = (1 - LB_i)/(\sum 1 - LB_i) \tag{3.5}$$

$$V_i = |p_i \cdot V_{Total}| \tag{3.6}$$

After calculating the number of virtual nodes of each physical server, remapping is needed to ensure that all user requests in the group can still be forwarded to the same media server for processing. The information of the media server corresponding to the group needs to be recorded (stored in the Redis database of the signaling server cluster, that is, forwarded directly to the specified media server when the group exists; when it does not exist, the media server is assigned according to the consistency hash algorithm.

However, in the above algorithm, $\alpha, \beta, \gamma, \delta$ the weights of these load balancing parameters are fixed values selected according to experience, they will have a great impact on the results. In order to solve this problem, the weights can be dynamically adjusted by genetic algorithm. Finally, the optimal weights are obtained. The key of using genetic algorithm to solve the problem is to select the appropriate fitness function and genetic operation such as selection, crossover and mutation [33, 34]. Among them, the structure of chromosomes is $\alpha, \beta, \gamma, \delta$ rough empirical value is (0.2/0.25/0.35/0.2), the initial population is 40, and the value of each position of each chromosome fluctuates not more than 0.05, which is generated by random algorithm. According to the formulas (3.7), (3.8) and (3.9), the larger the value of the f, the higher the fitness.

$$\bar{LB} = (\sum LB_i)/N \tag{3.7}$$

$$S^2 = (\sum (LB_i - \bar{LB})^2)/N \tag{3.8}$$

$$f = 1/S \tag{3.9}$$

The selection operation uses a roulette algorithm to select a chromosome with high adaptivity. At cross-operation, two chromosomes were selected by a random method, and one position on the chromosome was selected by a random method, and then two chromosomes were exchanged in this position, and the probability of crossover operation in this algorithm was 80%. Variation operation, selecting a position of chromosome by a random method, and then floating its up and down does not exceed 0.05, and the probability of mutation operation in this algorithm is 5%. In order to ensure the stability of the cluster, it does not use the genetic algorithm to change the weight in a certain period of time in the cluster.

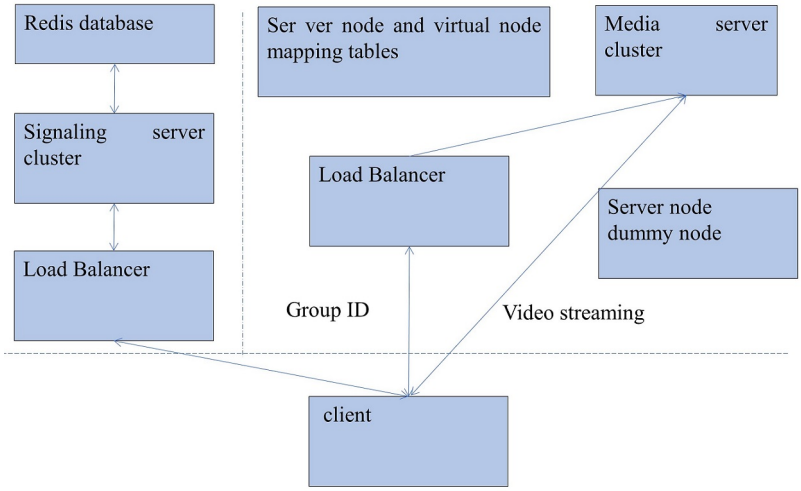

FIG. 3.2. *Overall Architecture of Real-time Communication Cluster*

3.3. Implementation of Media Server Cluster Load Balancing Strategy. In order to solve the problem of media server cluster load balancing, this paper proposes a load balancing algorithm based on consistency hash algorithm and genetic algorithm [35]. The real-time media flow of clients in the same group is sent to the same media server for processing. The architecture of media server cluster is shown in figure 3.2. The media server node collects the above information every t seconds. It should be noted that the number of bytes sent and the number of bytes received represent the total number of bytes from the beginning to the current moment, so it is necessary to record the last information. Subtracting two data is the number of bytes sent and received in the current t seconds. Media server cluster load balancing algorithm mainly includes two processes. The first process is that the media server node sends the collected CPU utilization, memory utilization, bandwidth utilization and connection ratio to the load balancer every other time. After receiving the above data, the second process is to calculate the load rate of each media server node. When the load rate of the media server node exceeds the system load adjustment threshold, the virtual node will be redistributed for the media server node in the cluster. Each function module of online education system based on WebRTC designed and implemented in this paper is systematically tested to verify whether each module can meet the actual needs. Finally, the performance of the media server cluster load balancing algorithm proposed in this paper is tested.

4. Results and Discussion. The complete system test environment architectural diagram is shown in Figure 4.1.

4.1. System business function test. The login verification module provides users with two login methods: login directly enter the user name password and scan the QR code to login. Users can choose the appropriate login method to login according to the system. The login interface is as shown in Figure 4.1. In the case of client login, users can directly scan the QR code on the left to enter the system, technically the QR code stores a random string (in this system is 8 random digits and letters in the system).

After the user has successfully logged into the system, the user will jump to the system homepage and connect to the MATT agent and the sign align server in the background. Limited to the space constraints, the process for establishing a WebSocket connection is described. To protect it for easy expansion, the WebSocket protocol can connections based on the http (s) protocol. First the client sends a hops request with a " upgrade websocket" head to the sign align server (request address: wss //192.168.139.218/edusys). Then the sign align service returned " 1 0 1 Switching Protocols" response means that the client and server have successfully established the WebSocket connection.

For data security, the system uses hops protocol to encrypt the transmitted data, control signaling and

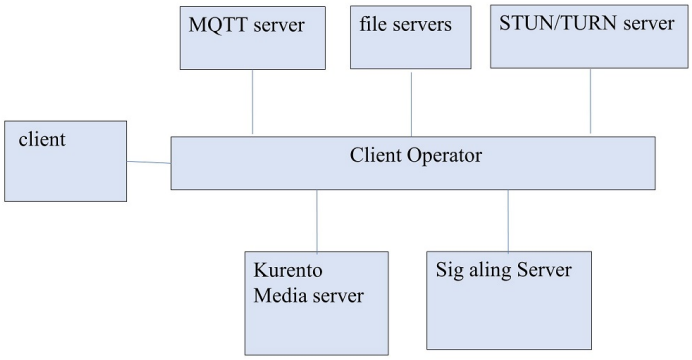

FIG. 4.1. *System Test Environment Architecture Map*

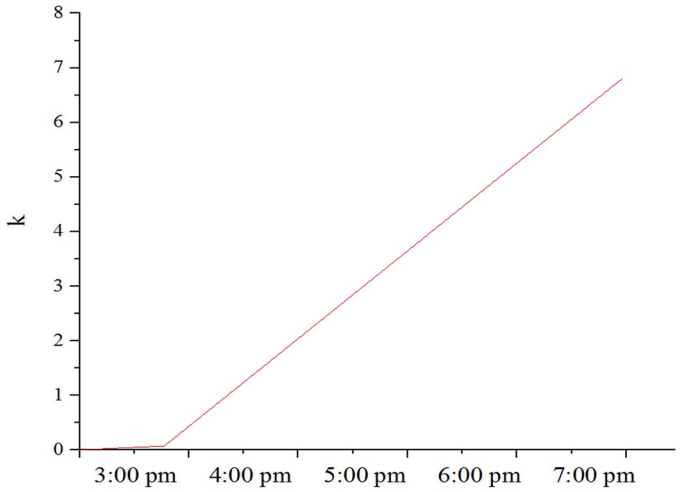

FIG. 4.2. *Screen Recording Streaming Data Distribution*

real-time media stream. Therefore, the wss connected message captured by the WireShark is encrypted and cannot read any valid data.

The instant messaging module mainly provides users with one-to-one chat and group chat functions. Users can send text, expressions or files in groups. This paper uses Mosquitto server as MATT agent and encrypts instant message by tls protocol to ensure data security. Since the server encrypts the instant message, Wireshark cannot parse the captured tls packet. In order to view the content of the MATT message sent, this paper captures the instant message by Android Studio the breakpoint debugging function. MATT message type is published, message content is ”packet capture test ”. Online classroom module is one of the core functions of the system. Different from the traditional passive learning, while watching the teacher’s teaching video, students can ask questions at any time, and the teacher can give answers in class. The whole interface is divided into three parts. The left media stream is the video captured by the teacher’s screen, and the upper right media stream is the video collected by the teacher’s camera and the audio collected by the microphone. In addition, students can ask questions to teachers through the lower right corner chat box. For ease of testing, Google browser provides the function of viewing WebRTC peer-to-peer connection establishment and sending and receiving monitoring data in the media stream as shown in figure 4.2, in which the teacher screen captures the data of the video stream.

After the user and the signaling server have established a connection, they will apply to join the room. If the room has not been created, the room will be created, and if it already exists, they will join the room

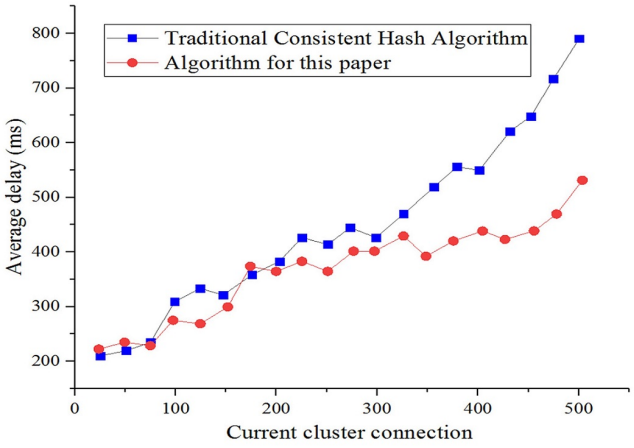

FIG. 4.3. *Comparison of the algorithms and traditional consistent hash algorithms in terms of average delay*

directly. After the client and the media server establish a connection, after the successful establishment of peer connection, send the user's media stream, if there are other users in the room, then receive the real-time media stream of other users. When a user joins the room, he receives the user's real-time media stream; similarly, when a user leaves the room, he stops receiving the user's media stream.

This module provides users with the function of watching back teaching video, that is, recording real-time audio and video released by teachers in online classroom module for students to watch. If the course has been recorded or recorded, the user can click the "look back video" button to watch the video.

4.2. Performance Test of Media Server Cluster Load Balancing Strategy. This paper uses the modified NUBOMEDIA benchmark tool to test the media server load balancing algorithm proposed in this paper, and compares the test results with the traditional consistent Hash algorithm, in which the video stream is coded by H.264, the frame rate is 30 fps, the resolution is 600 x 800; the audio stream is coded by Opus, and the sampling rate is 48 kHz. In order to facilitate the test, the client connects to the media server and continues to open the connection. The experiment is carried out in the LAN environment.

When the number of cluster connections is small, the average delay between this algorithm and the traditional consistent hash algorithm is not different, but with the increase of the number of connections, the average delay of this algorithm is shorter. As shown in figure 4.3, the average delay can reflect the efficiency of load balancing to some extent, but it is not accurate to use the average delay to evaluate the load balancing efficiency of the algorithm. To measure the load balancing efficiency of the algorithm more accurately, as shown in figure 4.4. It can be seen that the variance of load rate of this algorithm is relatively low, that is, the algorithm can balance cluster load more than the traditional consistent hash algorithm.

As the client connects to the server, the load rate of each server will continue to rise, but the overall load of each server in the cluster is balanced. Figure 4.5 is representative of the cluster load balancing results in terms of server load rate; however, the server connection comparison with the current cluster connection is done in Figure 4.6. Although the server load is balanced, the server allocation is different because of server performance difference.

Through the test of the whole function of the page, each module runs well in function and is consistent with the expected results. Through the compatibility test of the system, the actual support of the system audio and video module is consistent with the theory. Overall, the system in all aspects of good performance, to meet the expected needs.

5. Conclusion. A WebRTC-based distance education system is designed and implemented in this paper. The experimental tests done reveals that the designing and practical implementation of a fusion communication platform combined with WebRTC meet the expected requirements. This article proposes a media server cluster load balancing strategy which ensures the cluster overall load balancing while dynamically adjusting the node

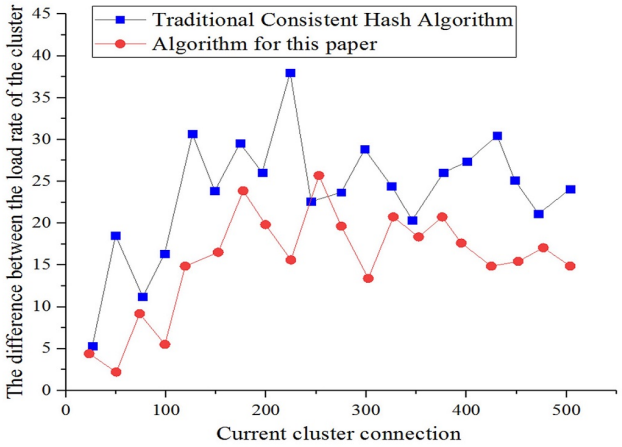

FIG. 4.4. *Comparison of the algorithms and traditional consistent hash algorithms in terms of difference between the load rate of clusters*

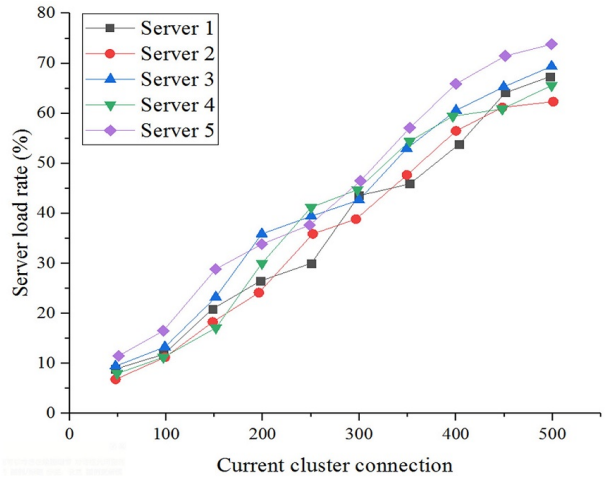

FIG. 4.5. *The results of cluster load balancing in terms of server load rate*

weights as per the real-time state of the clusters. The experimental outcomes justify the effectiveness and viability of the proposed methodology. There are some future scopes for improvement which can be studied and optimized in the future.

1. The system in this paper can achieve the desired goal, but it needs to further optimize and improve the system function according to the user feedback later.

2. The proposed load balancing strategy of media server cluster can achieve good experimental results, but the research on how to adjust the load of the system to the equilibrium state quickly is still required, therefore, further optimization can be done as a future perspective. Also, the future research directions of this work will consider Wi-Fi communication environment for experimentation analysis.

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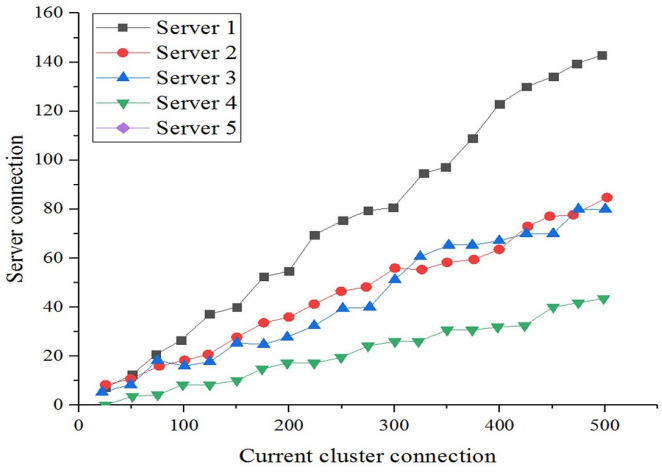

FIG. 4.6. *The results of cluster load balancing comparing the server connection and current cluster connections*

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RESEARCH ON DATA SECURITY DETECTION ALGORITHM IN IOT BASED ON K-MEANS

JIANXING ZHU *, LINA HUO †, MOHD DILSHAD ANSARI ‡ AND MOHAMMAD ASIF IKBAL§

Abstract. The development of the Internet of Things has prominently expanded the perception of human beings, but ensuing security issues have attracted people's attention. From the perspective of the relatively weak sensor network in the Internet of Things. Proposed method aiming at the characteristics of diversification and heterogeneity of collected data in sensor networks; the data set is clustered and analyzed from the aspects of network delay and data flow to extract data characteristics. Then, according to the characteristics of different types of network attacks, a hybrid detection method for network attacks is established. An efficient data intrusion detection algorithm based on K-means clustering is proposed. This paper proposes a network node control method based on traffic constraints to improve the security level of the network. Simulation experiments show that compared with traditional password-based intrusion detection methods; the proposed method has a higher detection level and is suitable for data security protection in the Internet of Things.This paper proposes an efficient intrusion detection method for applications with Internet of Things.

Key words: Internet of things; intrusion detection; clustering algorithm; network security.

AMS subject classifications. 68M25, 68M18

1. Introduction. Internet is a global tool through which people from across the globe share their personal and important information. Availability of this private and personal information at fingertip causes misuse of these data. The main cause for this is the various ways created by internet itself for stealing the security and stability of interrelated system. A data cited in figure 1.1 is representing the surge in cyber-crime from 2018-2019 and depicts the loss faced by the companies in dollars [1]. The reasons can be classified as dynamic and static. Dynamic security is provided by the static mechanism like software update and firewalls; it also provides mechanism such as intrusion detection system. In today's scenario keeping ones data safe is a major challenge for all the technocrats. That is why we need both the dynamic and static mechanism to protect valuable information of the users irrespective of other precautionary measure build in the technology. With the help of intrusion detection system any violation of the security will be monitored and identified with necessary action [2,3].

There is a standard component of a security infrastructure that allows network administrators to detect policy violations. Check all incoming and outgoing network activity and determine suspicious patterns that indicate network or system attacks from people trying to break or compromise the system. With the help of intrusion Detection System network administrators can identify any breach in the policies related to the security. It monitored the traffic over the specified network and identifies any suspicious activity from the end of user. The essentials to attribute any system as a safe system must include data confidentiality, data integrity and data availability [4].

The importance of network security becomes more vital considering the continuous development of computer technology and electronic technology that has promotes the continuous progress of science and technology, and the world information industry has set off an upsurge of the Internet of Things [5]. At present, various countries are conducting related theories and application research. As the development of the Internet of Things industry

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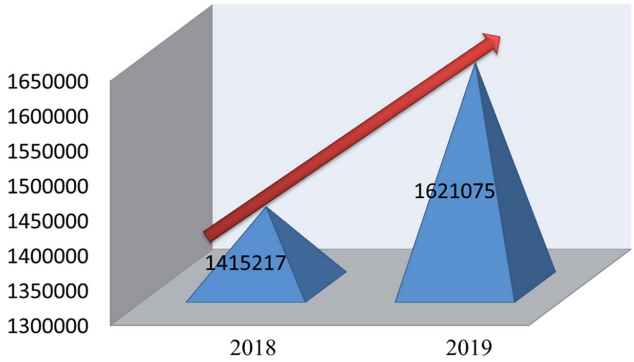

FIG. 1.1. *The average cost of insider attack, source: Accenture and Ponemon's 2019*

is included in our country's 12th Five-Year Development Plan, the development of the Internet of Things will usher in a new opportunity [6]. As a system that aims to realize the ubiquitous perception of things, the Internet of Things is composed of various sensor networks, radio frequency readers and other information acquisition equipment and communication systems [7]. The birth of the sensor network, as an important technology to realize the perception of data of things in the Internet of Things, provides the possibility to realize the ubiquitous perception of things [8]. However, the private-ness of sensing devices and their characteristics of being often deployed in unattended areas have caused the security of sensor networks to become an unavoidable problem [9].

The remaining manuscript is structured as follows: Section 2 scrutinizes fundamental ideas related to K-Means Clustering Algorithms. Section 3 presents IoT Architecture; Section 4 illustrates the Analysis of data Security issues. Section 5 represents Data security detection algorithms: proposed algorithm and Section 6 shows the Experimental results and Analysis Lastly Section 7 summarizes the conclusion of the manuscript.

2. Literature Review. At present, the commonly used security detection methods can be divided into key management, authentication and secure routing protocols, but the existing methods are still unable to defend against many network attacks. Therefore, the Internet of Things system needs to adopt an active defense mechanism to realize the intrusion detection of various attacks in the Internet of Things [10]. In the aspect of intrusion detection, many scholars have carried out many studies. The literature adopts a partition-based intrusion detection algorithm for sybil attacks in the network, but the deployment of nodes requires certain restrictions; The literature uses the method of selecting witness points in the network to achieve witness the goal, but it needs to be carried out under the premise that the position coordinates of each node in the network are known; the literature has modified the problems in the literature, and the selection of witness nodes is no longer carried out in a random mode, but specified deployment [11]; The literature uses an improved routing protocol to achieve rapid detection of attacking nodes; the literature uses location-based cryptographic mechanisms to detect network attacks, but most of the time the location of nodes in the network may not be normally obtained [12]. In [13] the authors have represented the techniques and methods used for the invasion identification. The proposed model was based on designed framework and data mining concepts. This article further articulates the techniques and methods of data mining to accelerate the process of invasion identification. In another referred article authors have presented a novel hybrid model for the identification of any intruder. The efforts made by authors were in a direction to propose an advance version of traditional intruder detection system. The obtained results have showed better performance and intelligent detection [14].

In [15] an IOT and big data based data clustering analysis algorithm was proposed with the help of K-mans. At first, in accordance with the processing technology and complex event relation, the transformation of big data processing of IOT was made into analysis of complex relational scheme and extraction. That will be helpful in simplifying the complex structure of big data. The efforts was made to enhance the traditional k-means algorithm and optimized it so that it can be helpful for big data RFID data network. Further with the help of Hadoop cloud cluster platform, the cluster analysis of k-means was performed. In addition to all these

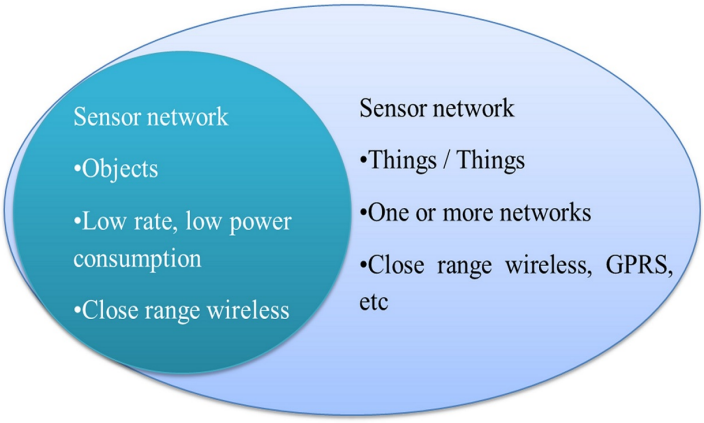

FIG. 3.1. *The relationship between the Internet of Things and sensor networks*

they have use the traditional clustering algorithm a central selection method appropriate for the RFID IOT data clustering was identified. The results have proved that the clustering efficiency has improved significantly. And on the basis on RFID and IOT clustering analysis prototype system was realized.

Although the above research has increased the security of the network to a certain extent, it usually can be completed only with the support of certain hardware. For this reason, this paper analyzes from the network data level, and studies a network intrusion detection method applicable to all IoT sensor nodes.

3. Internet of Things Architecture. According to the different communication process and objects, the Internet of Things can be expressed as a technology used for information interaction between things and people, with the goal of realizing comprehensive perception, information transmission and intelligent transmission. Its realization depends on the sensor nodes that detect the observed things and realize the networking function. A network composed of many sensor nodes is called a sensor network. Sensor network is mainly used to realize the connection between things, and at the same time, it is restricted by network self-organization structure and hardware resources. It generally exists in the form of short-distance, low-power wireless transmission. The relationship between the sensor network and the Internet of Things can be expressed as shown in Figure 3.1. As shown in Figure 3.2, each cluster in the sensor network contains a node with strong communication capability that acts as a gateway node in the network, which is called a cluster head. If data in other nodes needs to communicate with the base station, it needs to be forwarded through the cluster head [16]. Sensor network is the basis of the realization of ubiquitous perception in the Internet of Things. Its nodes are distributed in many places and are mostly in unsupervised locations. At the same time, limited by its hardware resources, its security problem is particularly important in the research of the Internet of Things [17]. How to detect and locate malicious nodes as soon as possible after an attacker appears in the network is an important issue to ensure the security of the communication process of the Internet of Things [18].

4. Analysis of Data Security Issues. In applications such as battlefield surveillance and target tracking, sensor network nodes are usually deployed in harsh environments. Attackers can not only eavesdrop on the radio, but also intercept the transmission information. Its current main forms are mainly as follows [19].

4.1. Black hole attack. A black hole attack means that one or more sensor nodes in the network do not forward the data according to the established method after receiving the data information sent by the neighboring nodes, but discard all the data to form a ”black hole” of data. Generally, a black hole Attacks can be divided into active and passive [20]. In passive black hole attacks, usually black hole nodes simply monitor and discard the data forwarded by themselves; while in active black hole attacks, ”black hole” nodes are attracted by declaring themselves as the next best path to neighboring nodes. More data sources, so passive black hole attacks are more destructive. The principle of black hole attack is shown in Figure 4.1 [21].

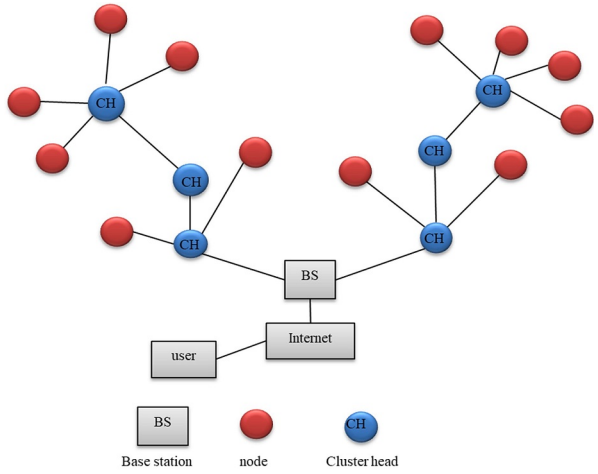

FIG. 3.2. *Network structure diagram*

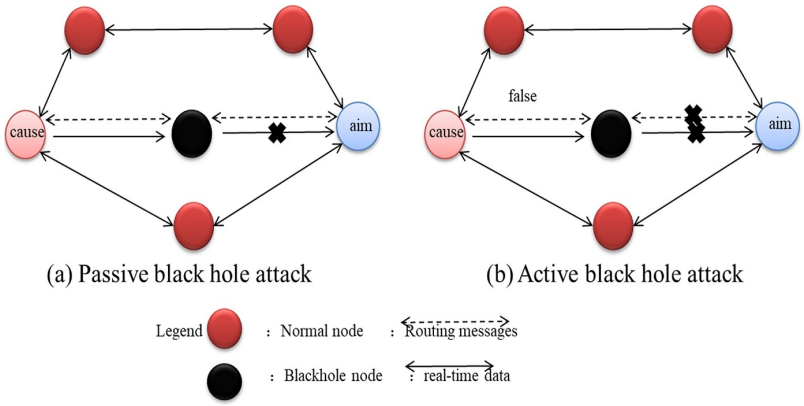

FIG. 4.1. *Black hole attack mode*

4.2. False routing information attack. This type of attack mainly uses tampering with routing information and guiding the network to transmit according to an extended or shortened established path, so as to achieve the purpose of dividing the established network, which will cause the end-to-end transmission delay of data in the network to increase. As shown in Figure 4.2(a), there is a communication path between the source node and the destination node during normal communication, and Figure 4.2(b) is the communication path between the source node and the destination node after being attacked by false routing. It can be seen intuitively from the figure that the network communication path is significantly extended, and the network delay is also greatly increased [22].

4.3. Wormhole attack. The attacker of the wormhole attack contains at least two sensor nodes. It mainly realizes the transmission of the monitored message to another network node for replay by establishing an ideal channel with low latency and high bandwidth between the two attackers. the goal of. Due to the existence of the "ideal channel", this path is preferred in the network, which may eventually lead to the failure of the network discovery process [23].

4.4. Witch attack. The attack mode of the sybil attack is to create false identity information for itself to achieve the purpose of impersonating other nodes"]. Other nodes in the sensor network will also transmit data to the attacking node and the normal node whose identity is copied, and the attacker can achieve the data for the purpose of eavesdropping. At the same time, because there are two nodes with the same identity in the

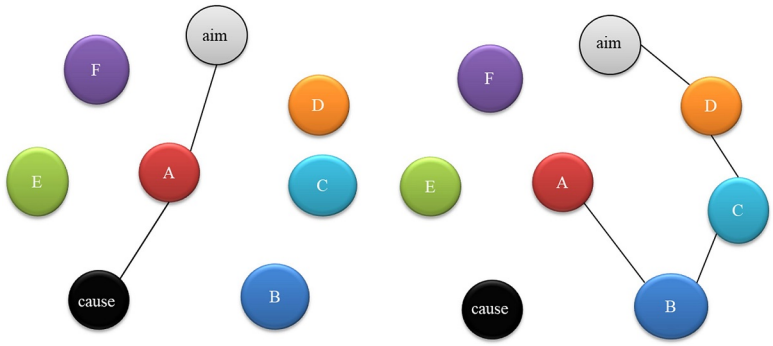

FIG. 4.2. *False routing attack network structure*

network, there may be positioning failures in some positioning services [24].

5. Data security detection algorithm. Aiming at data security issues in sensor networks, this article analyzes the types of special attacks and introduces network intrusion detection algorithms.

5.1. Data attack analysis.

5.1.1. Data feature extraction. According to the above network attack mode, the main feature of black hole attack is the loss of data. Suppose the received and sent traffic of network node i are T_rri and T_rsi respectively. If $T_rri > 0$ exists, And in theory, the sent data should be greater than 0 but the actual $T_rsi = 0$, then there may be black hole attack nodes in the network; in false routing attacks, wormhole attacks, and witch attacks, the significant feature is the change of network routing, so it is directly The result is an increase in data end-to-end delay. Literature proposes a method for obtaining communication data delay in sensor network nodes. Therefore, the data flow and data end-to-end delay at the network node can be used as one of the basis of network intrusion detection. The following is an analysis of the network intrusion detection method in this article [25].

5.1.2. Data cluster analysis. The concept of the Internet of Things is proposed to realize the ubiquitous perception of things, so the data types of the sensor network as the front end of data collection will show the characteristics of diversification and heterogeneity. The size of the transmitted data, the difference of network routing protocols, etc. will cause the difference of the end-to-end delay of the data in the network, so the pre-processing of the data before the data intrusion detection is essential. In order to extract the differences in the data of different sensor network nodes, this paper uses the K-means clustering method to cluster the data. The K-means clustering method has good clustering characteristics. It can divide the data set into k subsets according to the difference in the "distance" between the elements of the data set, and each subset has a cluster center [26,27]. Inter-coupling is zero. The steps of K-means clustering are as follows:

1) Select the value of k according to the clustering requirements, where $k > 1$;

2) In the cluster initialization stage, suppose that the data set contains total data samples, whose samples are represented by v_i, and randomly select k samples $Center_1$, $Center_2$,..., $Center_k$ as Initial cluster center;

$$dis(n) = \sqrt{(v_1)^2 - ((center)_n)^2} \tag{5.1}$$

3) Representation sample x_i The geometric distance from the cluster center $Center_n$. And according to the minimum distance principle, the sample is divided into

$$mindis(n) = 1, 2, ..., k \tag{5.2}$$

In the corresponding cluster C_k;

4) Update the cluster center to

$$Center_n = ((\sum(v_i))/p), \tag{5.3}$$

where p represents the number of samples in this class after clustering. 5) Repeat Step 3) and Step 4), taking the minimum error square as the criterion of clustering performance until the cluster $center_n$ no longer changes.

6) The algorithm ends, and the k clustering center values and clustering results are output.

5.2. Sensor network intrusion detection algorithm.

5.2.1. Symbol description. T_{rsi} : Data traffic sent by node i
T'_{rsi} : The threshold value of node i sending data traffic
T_{rri} : Data traffic received by node i
T'_{rri} : The threshold of node i receiving data traffic
T_i: Transmission delay at node i
T'_i: The transmission delay threshold at node i
d_{ij} : The distance between node i and the previous node j
d_f : The distance to the node with the farthest distance from the center after clustering
$2R$: Maximum communication distance in the network

5.2.2. Implementation of detection algorithm. Assuming that there are n sensor nodes in the Internet of Things, the detection process will be described below.

1) Intrusion detection part

Step 1: Select the network sending and receiving traffic at any node i, T_{rri}, T_{rsi}. And data transmission delay T_i. As the observation object in the network. The feature vector of node i can be expressed as:

$$V_i = (T_{rsi}, T_{rri}, d_i, T_i) \tag{5.4}$$

The feature vectors of all nodes in the network at a certain moment constitute a set V_{set}.

Step 2: Make

$$V_{mean} = (T_{rs} - mean, T_{rr} - mean, d_{mean}, T_{mean}) \tag{5.5}$$

Equal to all V_{set} The average value of the characteristic data in. Assume d_{max} is the maximum actual communication distance between all nodes in the network, and the theoretical value of the node end-to-end communication delay is the maximum T_f. If V_i in d_i, T_f and $V'_i = V_{mean}$ and update the collection V_{set}.

Step 3: Use the K-means clustering method to divide the collected data set into k groups, and use the data set separately C_k. Indicates that the data member is V_i

Step 4: Data detection process Black hole attack detection: for any $V_i \in C_k$, if $T_i > T'_i$ Then the node is identified as an attacking node. Otherwise, if the node is not judged as a black hole attack node, the node is a normal node. For any V_i, $j \in C_k$, if $d_i j < 2R$ and $T_{rri} > T'_{rri}$. The node j is determined to be the cooperative node of the network attack, and i is the attacking node of the network; otherwise, if the node is not identified as the above-mentioned attacking node, the node is a normal node[28,29].

Step 5: Generate data sets of different types of network attacks, and update the thresholds of various attributes in the network attack model.

The above steps can be expressed in pseudo code as:

Input: $V_{set} = V_{i|i} \in G, d_{max}, T_f$
Initial: $V_{mean} = (\sum V_i)/(nodecount(G))$
If $d_i \cdot T_i > d_{max} \cdot T_f$
Then $V'_i = V_{mean}$
Endif
Use K-mean, method to obtain clustering results:C_k, V_i
if $T_i > T'i$

Then i is the attack node
Else if $T_{rri}! = 0$ and $T'_{rsi}! = 0$ and $T_{rsi} = 0$
Then i is the black hole node and added to $V_{blackattack}$
Else if i is a normal node and added to V_{normal}
Endif
If $d_{ij} < 2RANDT_{rri} > T'_{rri}$
Theni is a collaborative node and added to $V_{cooperation}$
Else if i is a normal node and added to V_{normal}
Endif
Output: $V_{blackattack}, V_{cooperation}, V_{normal}$

2) Node authority management part: In order to avoid the influence of misjudgment caused by the abnormal node communication caused by accidental factors on the system, this paper uses the "distance" from the normal node as the judgment basis to control the network node. Assuming that the authority management part of the network is carried out by an independent key, the execution process is as follows:

Step 1: Suspected attack nodes in the computing network V_j;The distance from the cluster center p_j.
Step 2: Limit the node's network traffic to $M = T'_{rrj} - \mu P_j$, where the output is the flow penalty coefficient, which can be set according to needs. When certain p_j, the larger the node, the less traffic is allowed to pass.
Step 3: The master station issues traffic restriction instructions in the form of keys.
Step 4: In the next p times of detection, if the node is judged to be a normal node, the restriction on the node's traffic will be cancelled through instructions [30].

The above steps can be expressed in pseudo code as:

Input: $V_{blackattack}, V_{cooperation}$
Get the cluster center of any node j C_k $P_j = V_j C_k$
Set flow threshold $M_j = T'_{rrj} - \mu P_j$
For 1 to n
Check whether j is a normal node through the intrusion detection program
If j is a normal node
Normal Count ++
End if
End For
If Normal Count==n
Then set the flow threshold $M = T'_{rrj}$
Endif
Output: $M = \{M_j / j \in V_{blackattack}, V_{cooperation}\}$

The flow chart of the algorithm in this paper is shown in Figure 5.1.

6. Experimental results and analysis. This article uses Openet simulation software for simulation, and its simulation environment is shown in Table 6.1. The number of attacking nodes in the network is 10% of the total, or 72. We set 42 nodes as black hole attack nodes, 10 nodes as false routing attack nodes, 4 witch attack nodes, and 16 wormhole attack nodes.

In order to detect the effect of network intrusion, we choose detection rate (DR) and false detection rate (FPR) as the main evaluation indicators. Suppose the number of attacking nodes that are correctly detected in the network is TP, the number of attacking nodes that are not detected is FN; the number of normal nodes judged as attacking nodes is FP, and the number of attacking nodes judged as attacking nodes is TN. Then its expression is:

$$DR = ((TP)/(TP + FN)) \tag{6.1}$$

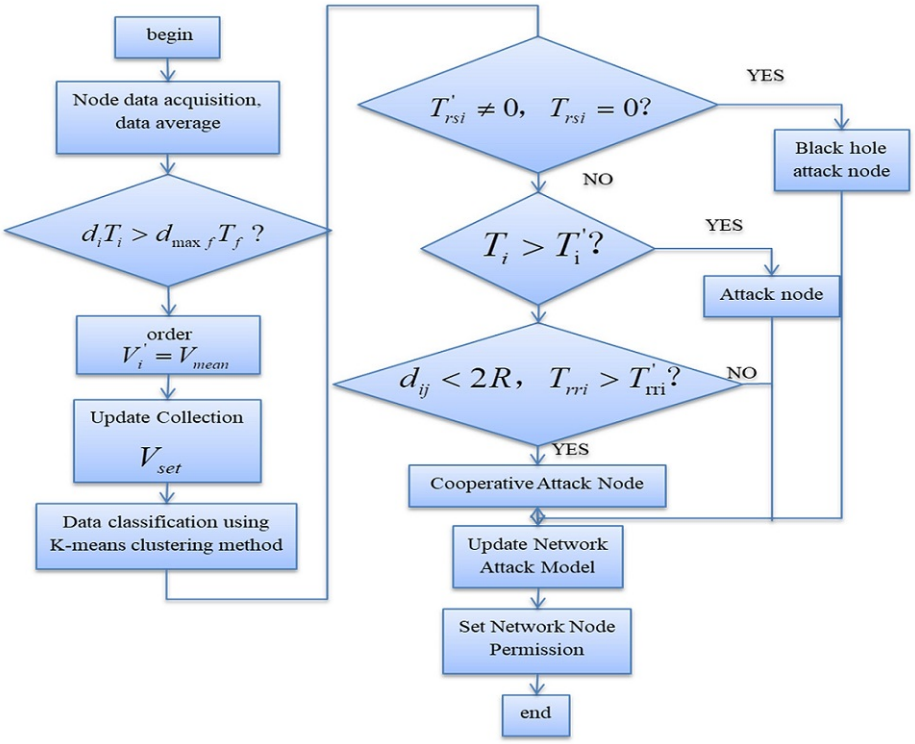

FIG. 5.1. *Algorithm flow chart*

TABLE 6.1
Simulation parameter settings

Parameters	Description
Simulation platform	Opnet 14.5
System platform	Windows XP
Network topology	Tree structure
Routing Agreement	AODV
Number of sensor nodes	720
Number of cluster head nodes	30
Number of nodes per cluster	24
Proportion of attack nodes	10%

(6.2) $$FPR = ((FP)/(TN + FP))$$

Table 6.2 shows the data delay of some nodes in the network. Among them, node 4 is a black hole attack node in the network, which has a certain network delay, but the network delay of wormhole attack node 1 in the network is greater.

As shown in Table 6.3, the data traffic received by node 7 in the network is greater than the normal threshold. By looking up the neighboring nodes of node 7 we can know that it contains node 1, so node 7 is the data forwarding terminal of attacking node 1. In order to verify the effectiveness of the method in this paper, the literature and the method in this paper are used to randomly deploy attack nodes in the above simulation environment to conduct 10 simulation experiments, and the detection rate and false detection rate are counted.

TABLE 6.2
Data end-to-end delay data (unit: second)

Node Number	T_i'	T_i
1	0. 0046	0. 0148
4	0. 0021	0. 0033
7	0. 0054	0. 0054
8	0. 0098	0. 0135
10	0. 0041	0. 0052
17	0. 0037	0. 0037
83	0. 0096	0. 0096
253	0. 003	0. 003
511	0.0107	0. 0107
.....	.....	.....
720	0.0093	0.0093

TABLE 6.3
Table 3: Network node receiving traffic data (unit: bps)

Node Number	T_{rsi}'	T_{rsi}
1	1024	1024
4	1024	1024
7	1024	2048
8	1024	1024
9	1024	2048
36	1024	1024
154	1024	1024
231	1024	1024
655	1024	1024
.....	.....	.....
720	1024	1024

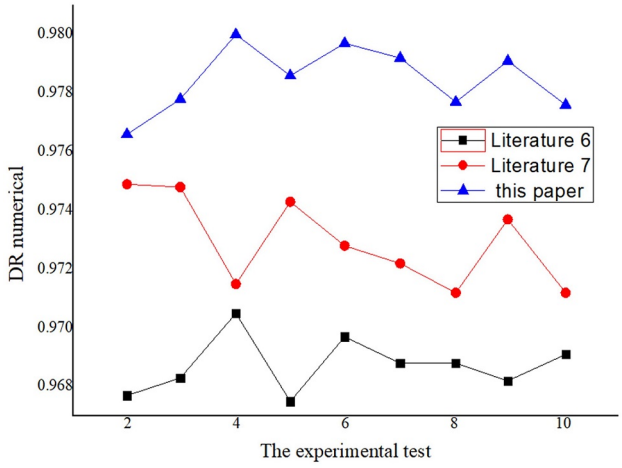

FIG. 6.1. *The detection rate of different experiments*

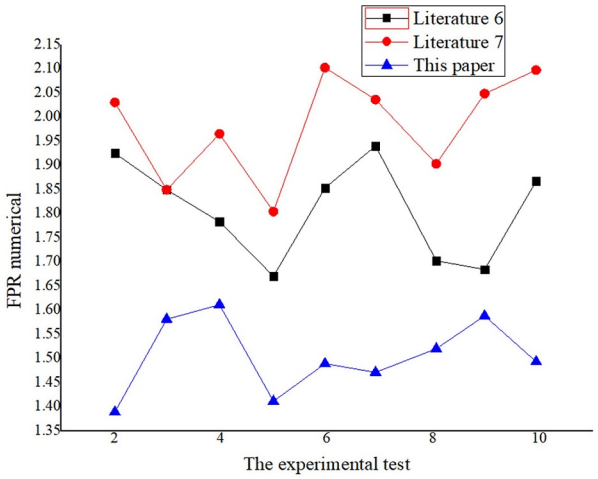

FIG. 6.2. *False detection rate of different experiments*

The detection results are shown in Figure 6.1 and Figure 6.2. It can be seen from the figures that the detection rate of the algorithm in this paper is significantly higher than the other two algorithms, and the probability of false detection is also lower than other algorithms.

7. Conclusion. Aiming at the security issues of the Internet of Things, this paper starts from the weaker wireless sensor network, analyzes the current network attack patterns, and proposes an efficient intrusion detection method for applications with Internet of Things. In order to reduce the drawbacks caused by algorithm detection errors, a node authority control strategy based on traffic restriction is proposed, which improves the security of IoT communication. By comparing with commonly used algorithms, the proposed algorithms significantly improves the detection level of network intrusion, and is applicable to guarantee the security of the Internet of Things in different scenarios. As a future work one can analyze the proposed algorithm with other data mining algorithms and can work on the identification and characterization of intruders attack.it may be further identified that how the proposed methods can be used with other real time environment data set.

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NETWORK VIRUS AND COMPUTER NETWORK SECURITY DETECTION TECHNOLOGY OPTIMIZATION

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Abstract. With the advancement in communication technology, computer network will become important for information exchange. However, the network has the potential therefore the strong security policy is needed for network security ensuring. To prevent the computer network from the virus invasion, the computer network security technology is ensured, having a clear network virus understanding. In this paper, the structural model of network security detection and monitoring system is established in a proactive way, the function of each component is described, and the design model is introduced to conduct comprehensive and effective automatic security detection on the client and each layer of the network, so as to find and avoid the system from being attacked.Result: The observed example shows that the flow rate of information in and out of the network is relatively stable, with few changes, and the rate of change is close to zero per unit time. In the case of network attack, the amount of data flowing into the target network is far more than the amount of data flowing out of the network.Computer security technology is used to improve the security of the network and prevent network virus from attacking the computer network.

Key words: Network Virus; Computer Network; Safety Technology; Automatic Security Detection; Monitoring System

AMS subject classifications. 68M25

1. Introduction. With the rapid advancement of computer field, significant changes have taken place in network security technology. As a virtual space, computer network has the unique language, behavior and social communication modes of the computer, and its space is borderless and open. The emergence of the network has changed the behavior of human beings and gradually made the society have the characteristics of information [1]. In recent years, the computer network virus attacks the network wantonly, has caused the great threat to the computer network security operation. In the face of computer malicious attack, in addition to passive defense, we should also be active defense. Computer network security detection system is an important network security defense technology, its implementation principle is on the basis of the known security vulnerabilities database, item by item to the target host of the leak detection, inspection, switch and server can be a database of target object, after the test results, the system will automatically provide detailed and reliable analysis report to administrator, this for the improvement of overall level of computer network security provides a reliable basis [2, 3].

A certain system is required to protect the security of computer network information and the users also take reasonable protective measures. Various kinds of strategies are used together in the protection process of computer information security. In this way, the probability of infringement of information security is minimized [3-5]. Figure 1.1 shows the firewall network security connection.

At present, in our country most of the computer networks are installed with the firewall software to scan the network access resources and to deal with the hidden security problems [6-8]. It supervises and controls the access between various networks efficiently. Network information is closely monitored by the firewall when the network is running. Generally, to find the data information, IP address of network users are used by the firewalls. The IP address of users can be converted by the control function [9-11]. An effective way to ensure the information security of computer network is protective wall technology. For the operation of computer network, the utilization of protective wall or security system need to be strengthened [12]. The topological structure

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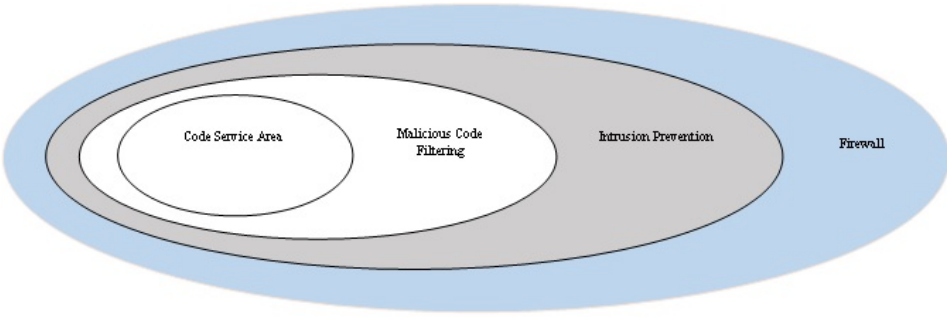

FIG. 1.1. *Firewall Network Security Connection*

can efficiently improve the security of computer network operation and for isolating viruses; Protective wall technology has an effective role. The viruses characteristics are becoming more diverse which requires relevant Internet technical managers [13].

The organization of the paper is as follows. Section 2 gives exhaustive literature survey followed by a research method adopted in section 3. A discussion of obtained results is in section 4. Finally, Section 5 concludes the complete paper.

2. Literature Review. Network security detection technology is built on the basis of modern network security technology, in a long time, people do not take network security as a special problem. With the expansion of the scope of Internet use and the increase of commercial applications, the security problem of Internet is gradually paid attention [14]. In order to adapt to the current network security needs, major companies have developed their own network security detection and evaluation tools.For example, with the release of Microsoft's wsXp, Microsoft recently released version 3.2 of its latest network security detection program. This command line tool can help the system administrator to check the security status of the computer and timely find the unpatched vulnerabilities [15]. One of the UK's leading cyber security companies has developed an online tool to detect security vulnerabilities. It works by using artificial intelligence (Al) to simulate hackers' attacks. With the help of artificial intelligence principle, automatic Web proxy authority, special protocol program, defect confirmation and four levels of internal error correction, some Suggestions on how to repair the vulnerability are proposed [16]. At home, the development of network security technology is also going on like fire. In March 2018, the world's first network security online detection system (NetworkSeeurit, OnlineAuditSystem), developed and designed by shenzhen anluo technology co., LTD., was officially released by "China network security assessment center" and made available to the public. Shanghai jiao tong university, tsinghua university, zhejiang university and other universities, as well as China green alliance technology and other units, have invested certain research strength in expanding network security detection and evaluation technology, laying a solid theoretical foundation for the development of domestic security detection technology [17, 18].

Many researchers have worked on the various techniques on the network security in past few years. To solve the problem of computer information security, there are many technologies like cryptography technology, network security technology and so on [19]. To ensure the computer network information security by setting up computer detection, a special protection system has been established. The electronic products is faster and more severe with the rapid development of science and technology. In this paper, authors detail the network security for large organizational networks which is such a challenging task [20]. The basic aim is to reduce a successful large-scale attack and complex network architecture probability. The attack graphs are utilized to accurately assess the security of networked systems and to understand how vulnerabilities can be combined to stage an attack. It is the successful measurable model to measure the security risk.

The feasibility of computer networks against virus attacks is analyzed and the computer virus weapon characteristics is pointing out [21]. From the obtained results, it is notice that the computer spread the virus in the network speed and with time, the infected machines variation with time. Authors in this paper outline an software development that utilizes QoS and Cisco Catalyst parallel technologies [22]. For Network Intrusion

Detection performance increment , high-speed networks are designed. Authors detailed the network security situational awareness after an investigation. The logical analysis is done concerning the situational awareness network security from the data value chain [23]. Factor acquisition, model representation, measurement establishment, solution analysis, and situation prediction are the five different stages in this process. Authors aim to provide some references for the scientific research and engineering personnel in network security situational awareness. Authors analyses the types of security hidden dangers and the vulnerability detection technology Fuzzing technology [24]. Obtained results show that vulnerability detection technology protects network security efficiently. WS Fuzzer, Web Fuzz and Webvul are three vulnerability detection tools used for detection time of open source system analysis.

2.1. Contribution. The innovation of this paper is to analyze the important position and function of network security detection technology in maintaining network security. On the basis of the above analysis, a structural model of network security detection and monitoring system is proposed. In this paper, the design idea and key technologies of the network security detection and monitoring system are explained and discussed in detail.

3. Research Methodology. Network viruses are divided into mail viruses and vulnerability viruses according to the transmission route:

(1) Trojan is a backdoor program, including the client and server two parts. Generally used as a hacking tool, users in the unknown, the user's data stolen. Trojans do not have the ability to copy themselves. If the user USES the trojans, the hacker has the control of the whole machine. Because be controlled by hacker, so bring huge damage to the user. The way they usually do this is to upload the trojans to a server for users to download.

(2) The worm virus can be spread through MIRC scripts and HTM files. After the user's computer is infected, the worm virus automatically looks for local and network drives, looks for directories, searches for files, and then overwrites the original user files with virus code and changes the file's extension name to VBS. Now computer network security detection technology commonly used methods.

3.1. Use of firewall and detection technology. In the era of big data, firewall and security detection technologies are commonly used to effectively resist the risk of computer network. Firewall can usually be divided into hardware firewall and software fire-wall; can set up a protective barrier between the internal network and the external network. The establishment of a firewall can block external illegal programs from accessing user information, and by strengthening network management, such as setting access rights to data, the computer can be prevented from being infected by network viruses. Firewall as a filtering technology, has a strong anti-attack ability, can protect the user's computer information also can carry out real-time monitoring of network data [25-27]. Firewall solution schematic, as shown in Figure 3.1.

3.2. Access control technology. Access control technology is to define the user's identity, combined with the user's different rights to use the corresponding ability. Use the router to set the external access rights, can also use the permission software to set.

This technology is usually widely used in enterprises. Due to the privilege and confidentiality of computer access technology, if the authentication is not passed, the relevant information cannot be accessed, reducing the risk caused by malicious access. If it is an external access, the access will be directly denied, thus playing a role of security protection at a certain level. Of course, if a virus breaks into permission software or a computer has been monitored, the technology is not safe enough, mainly to prevent human accidents.

3.3. Data encryption and big data analysis. Data encryption technology is to ensure that data in the transmission process is not blocked, data encryption technology can be divided into keys and keys, like keys and locks. In the application of data encryption technology, the first to transfer the file for encryption processing, the information for digital trans-coding, containing a key decoding tool key, after the encryption packet is designated to receive IP, you can use the key decoding, the digital information into normal text again. Even if the encryption package is intercepted by hackers, there will only be a lot of Numbers and garbled code after forced open, unable to get the correct information data. Sometimes the data is exceeded in the typical storage, processing, and computing capacity of conventional databases which is referred by the big data. Many

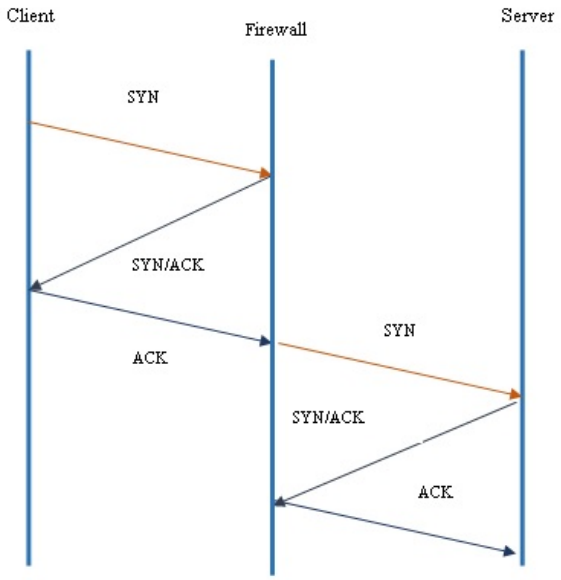

FIG. 3.1. *Firewall Solution Schematic*

tools and methods are needed for the analysis of the big data and to extract the pattern from the large scale data [28, 29]. Cause of big data is due to the increase in data storage capabilities and increased computational processing power providing more data than they have utilizing technologies to process [30, 31].

4. Results and Empirical Analysis. Because the purpose of network security detection system is to find the security holes in the system, we mainly use the existing security attack methods to carry out simulated attacks on the network system, in order to find the security holes and security Settings of the system defects. Network security detection system consists of two parts: security scanning and security analysis. The security analysis system carries out statistical analysis on the result information obtained by the security scanning system, classifies the security vulnerability according to the system, network, service and harm degree, and then queries the database through the vulnerability database control system, gives detailed information about the vulnerability, and suggests the patches to be adopted. The system structure of the entire network security detection system is shown in Figure 4.1.

4.1. Security scanning system. The security scanning system is composed of the following parts:

4.1.1. System configuration module. System configuration module is the manager of the entire system, can use gugong (graphical user interface) or HTML file and browser two ways to manage the system. The system configuration module is mainly used to configure the operation rules of each module of the system. That is, To determine the scope of the information collection. In other words, the information of a subnet or a specific host can be collected. If the information of a subnet is collected, the IP address range of the subnet can be set, such as: 202.118.179.1 – 202.118.179.254. In this way, security detection of subnet 202.118.179.0 can be conducted to collect necessary information. If you collect messages from a particular host, you can set the IP address of that host as 202,118.179.156.

Determine the object of vulnerability inspection module and network service vulnerability or operating system vulnerability. For network service vulnerability, Te1net service vulnerability, FTp, Finger, Http and other network service vulnerability can be detected. For operating system vulnerabilities, you can check file permissions, password file Settings, and system configurations. Finally, the system configuration files are generated based on various configuration information. Each other module initialization and normal operation, according to this configuration file [32-35].

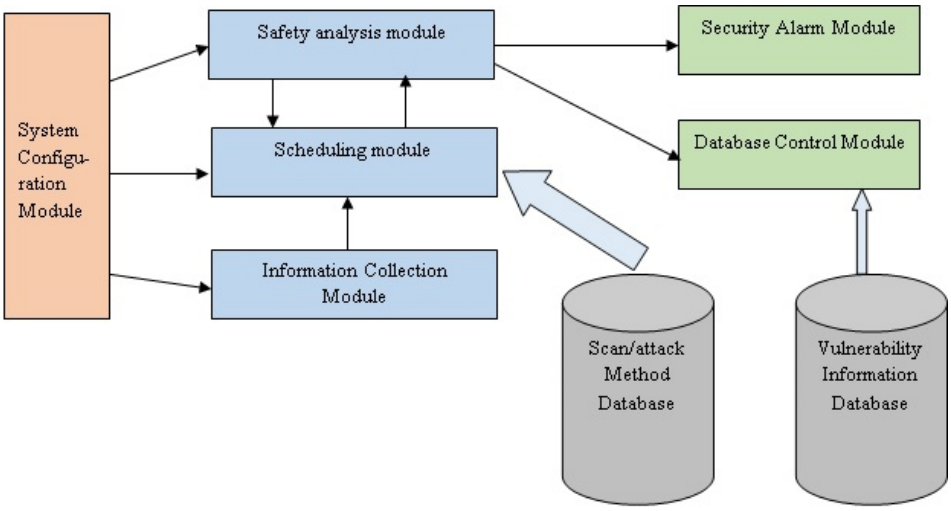

Fig. 4.1. *Structure Model of Network Security Detection System*

4.1.2. Information collection module. Construct the topology diagram of the target network The network topology diagram reflects the interconnections among the network elements in the target network. For example, the connection between router, gateway and subnet, the connection between router and router and the connection between the internal hosts of the subnet can make the network administrator master the connection between various devices in the entire network. Different network topology structure itself has different security weaknesses, that is, the network security vulnerability determined by the network topology structure is different, so the corresponding security protection measures should be taken for different network topology structure.

Computer network topology can be divided into four types: bus network, star network and tree network, ring network and mesh network.

Determine the type and version number of the target host operating system In a network, different types of computers often coexist, different types of computers may run different operating systems, and each operating system has many versions, different operating systems may produce a variety of security vulnerabilities. For example, UNxI and sail N0DwS have published about 300 insecure points of the operating system, and there are nearly 50 kinds of known hacker attacks. For versions of the IX operating system, because they are written by different manufacturers or by different people, some versions may have certain vulnerabilities and some may avoid them. The possible security vulnerabilities of Windows operating system and t xI operating system are different.

4.2. Design of network security detection system. The purpose of network security detection system is to find the security holes in the system. However, for an attack method like DDOS (distributed denial of service attack), which attacks the network through ”simple” and ”normal” channels instead of exploiting the vulnerability of the system itself, network security detection system is difficult to detect. Therefore, we need to add monitoring function to the security detection system, timely detect abnormal network activities, repair potential attack vulnerabilities, and enhance the security performance of the network. We mainly implement the detection and monitoring of the network system from the following two aspects:

4.2.1. Monitor network traffic. From the most intuitive and natural point of view: all network services, data exchange, in the final analysis, are down to the host physical port of the bit flow, the normal service is so, illegal invasion is so. Therefore, starting from the underlying physical port, real-time monitoring of the state of bit-stream flow (direction, size, rate, rate of change, etc.) can help the system administrator to timely find network anomalies.

First, in order to monitor the data traffic in the whole network, the monitoring system must be placed on the switching node (e.g., router, switch, etc.) in the network system, because all data entering and leaving the

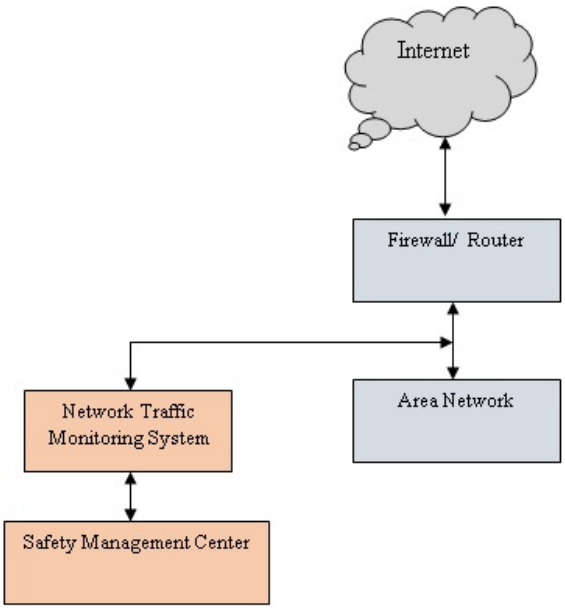

FIG. 4.2. *Location of Network Security Monitoring System*

network must flow through the switching node. In addition, the network card of the machine at the switching node is set to "promiscuous" mode so that all packets entering and leaving the network can be captured by the machine. Figure 4.2 shows the location of the traffic monitoring system in the network.

Secondly, in order to realize the real-time traffic monitoring of the network, it is necessary to obtain the changing rules of data traffic of various typical network visits and store them in the display system in the form of feature files. For example, typical network port information traffic has the following observed facts: There is a certain proportion and characteristics of the inbound and outbound flow in normal use mode as given in Eq. (4.1) to Eq. (4.4):

C_{out} represents the amount of traffic flowing out of the network;

C_r represents the traffic flowing into the network;

$$C_{out} << C_r \tag{4.1}$$

$$\frac{\theta_1 <= C_{out}}{C_r < \theta_2} \tag{4.2}$$

Changes of network port traffic under network attack:

$$C_{out} << C_{in} \tag{4.3}$$

$$\frac{C_{out}}{C_{in}} < \theta_1 \tag{4.4}$$

If the network traffic is displayed in the form of waveform, it can be seen that there is a significant difference in the waveform changes in two cases: in the case of normal network access, the waveform changes little, the waveform performance is relatively slow; However, in the case of similar DDoS attack, the waveform changes greatly and there are multiple data traffic peaks, indicating that a large amount of data flows into the monitored network. Different switching node hosts may not have the same characteristics for the above typical network access, so the characteristic files may not be the same. The monitoring system should be audited for different machines to obtain the characteristic parameters C_{out}/C_{in} and of the specified host. Also, the network port

TABLE 4.1
Same Speed Limit and Different Numbers of Packets

Packet Number (transmission interval 1 ms)	Packets Received	Packets Analysed	Packets Dropped	Packets Filtered	Packets Outstandings
100	100%	100%	0.00%	0.00%	0.00%
500	100%	49.38%	33.62%	0.00%	50.37%
1000	100%	28.83%	40.28%	0.00%	68.92%

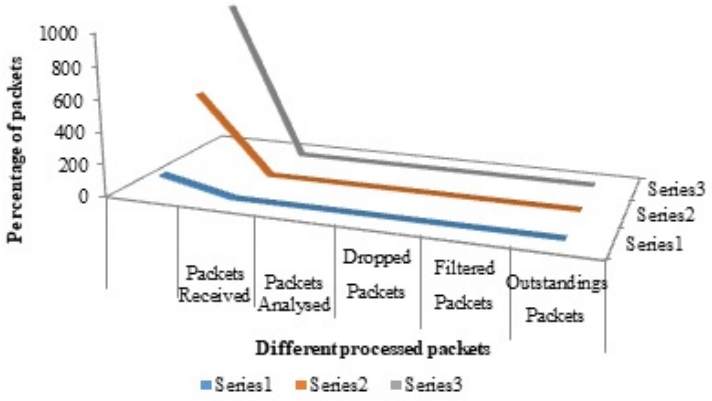

FIG. 4.3. *Same Speed Limit and Different Numbers of Packets*

information flow rate (Rout/Rout) and its rate in unit time rate of change (V_{in}/V_{out}) for identifying network normal or abnormal situation have important significance. Under the normal network access mode, there is a certain proportion and characteristics of the in-out rate as given in Eq. (4.5) and (4.6):

$$R_{out} \simeq R_{in} \tag{4.5}$$

$$V_{out} \simeq V_{in} \simeq 0 \tag{4.6}$$

Changes of data flow rate of network port under the circumstance of network attack as shown in Eq. (4.7) and Eq. (4.8).

$$R_{out} \ll R_{in} \tag{4.7}$$

$$V_{in} \gg V_{out} \simeq 0 \tag{4.8}$$

From the above observation examples, it is seen that under normal circumstances, the flow rate of incoming and outgoing network information is relatively stable with few changes, and the rate of change per unit time is close to zero. In the case of network attack, the amount of data flowing into the target network is far more than the amount of data flowing out of the network, and the rate of information flow in unit time changes obviously, indicating that there is a large amount of data pouring into the target network [36-38].

In the experiment, the packet transmission rate was remain to the similar speed (1 ms intervals) to get a fair analysis of numbers of packets (each packet carried 1 KB). We sent 100, 500 and 1000 packets batches at 1 ms intervals and the experimental results are shown in Table 4.1 and the Figure 4.3 shows its graphical representation.

TABLE 4.2
Speed and Values are same but Different Packet Size

Packet Number (speed 12,000 per 1 ms)	Packets Received	Packets Analyzed	Packets Dropped	Packets Filtered	Packets Outstanding
1 Byte	100%	100%	0.00%	0.00%	0.00%
400 Bytes	100%	42.09%	32.67%	0.00%	58.67%
800 Bytes	100%	23.67%	41.89%	0.00%	80.11%

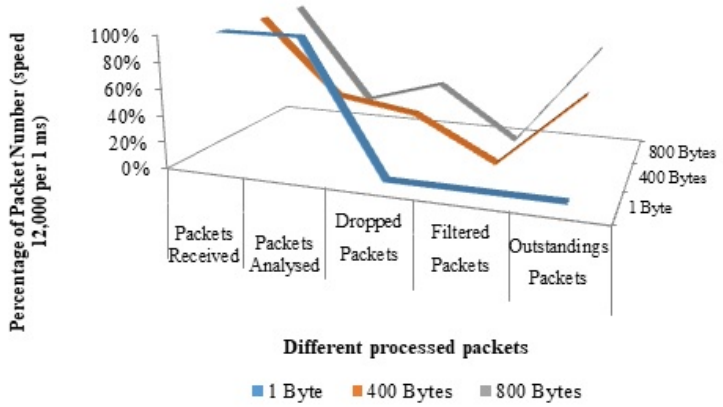

FIG. 4.4. *Same Speed and Value but Different Packet Size*

If we transfer 12,000 packets in interval of 1 ms then the packet size was increased to 400 bytes,the 35% of them are dropped.The Snort dropped more When the packet size was increased to 800 bytes. The Table 4.2 presents the experimental results.

The graphical representations of results are also shown in Figure 4.4. Experiment results shows that more packets will be dropped if there is increase in packet size.

4.3. Monitor network connections. Due to the initial design of TCP1-P protocol without too much consideration of security factors, there are many network attacks against the weak links of TCP work protocol. Here's how they work: They first choose to send SNY packet request to the service port of the target host to establish a connection with it, then the target host needs to assign the data structure needed for the connection, and the connection state becomes YSNRCVD. If the service port does not receive a response from the host after sending a SY-ACK packet to the host requesting the connection, the service port has to wait quite a long time, and if there are too many half connections, it may consume all the resources used to establish the half connection. The normal connection requests are not answered because there is no corresponding resource if the resource is exhibited. The main characteristics of these attack methods are: when launching an attack, as long as very little data traffic can produce significant results; The source of the attack cannot be located; There is no way to tell whether a TCP connection request is legitimate on the server side.

5. Conclusion. Reasonable use of the computer network security inspection system can realize the real-time monitoring of the computer network security, as well as the real-time identification of network intrusion behavior. Although it is an important component of computer network security, it focuses on finding that it cannot replace the firewall to adjust the access control of the entire network. However, firewall lacks the recognition function of unexpected intrusion behavior, so it needs security detection system to identify unexpected intrusion behavior. Therefore, the two need to supplement each other to ensure network security. With the gradual integration of the network into People's Daily life, people's requirements for network security are also getting higher and higher. The observed example shows that the flow rate of information in and out of the network is relatively stable, with few changes, and the rate of change is close to zero per unit time. Computer

security technology is used to improve the security of the network and prevent network virus from attacking the computer network. The extensive application of network security detection technology can guarantee the security of people's network life.The hybrid technique can be designed in the future for network security which can result effectively.

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A DETAILED STUDY ON GPS AND GIS ENABLED AGRICULTURAL EQUIPMENT FIELD POSITION MONITORING SYSTEM FOR SMART FARMING

JIANBO NIE* AND BIN YANG†

Abstract. To develop refined agriculture and improve Agricultural productivity, a new monitoring system has been proposed in this paper. Based on the actual situation of early agriculture and the actual national conditions of China, Geographic Information System (GIS) technology and Global Positioning System (GPS) technology have been combined. Based on the combination of GIS technology and GPS technology, the results show that the position of field vehicles can be displayed in the electronic MAP in real time within 5% error. On this basis, Agricultural production and cultivation can be realized, and the monitoring system can realize the real-time display of vehicle location in the field on electronic MAP to guide production and cultivation. The static test shows that the positioning accuracy of the four GPS receivers is the worst, and the positioning accuracy of MAP330 receiver and GPS25 receiver is better. However, the positioning accuracy of AGl32 receiver is the highest with the 0.37m error when compared with the error of 1.2m of other machines. Using GPS to measure the area, the error of farmland area and farmland side length is less than 5%, and the precision AGl32 receiver for precision Agricultural measurement is also improved with the proposed model.

Key words: Precision agriculture; GPS technology; GIS technology; Agricultural equipment; Monitoring system

AMS subject classifications. 68U35

1. Introduction.

Precision agriculture applies automatic control theory, intelligent decision-making, GIS and GPS technology. It integrates variable seeding, online real-time yield measurement, variable rate fertilization, variable irrigation, variable rate spraying and other technologies into a whole, so that the economic benefits of Agricultural operations are rapidly improved [1]. Recently, the precision agriculture made it possible to increase the productivity and ease in the agribusiness to the farmers which leads to the profitable crop yield for the farmers. The technological effrts made with the help of precision agriculture in the planning of reap the crops, in time spray of pesticides, treatment to protect the crops and study the environment to maximize the yield of crop. With the help of these important planning measures, the overall significant growth has been visualized in the study [2]. The use of precision agriculture has significantly got attention due to the use of high ended agriculture equipment's performance and sufficient increase in the profit of crop yielding in term of agribusiness [3]. The easy to use methods and timely planning added gems in it. The involvement of GPS in precision agriculture made it more cost effective, accurate and easy. The study of agriculture field using sensors such as humidity, temperature, crop growth, GPS precision are the major factors toward smart farming. Initially, it was analyzed that the use of sensors and precision agriculture can be applied to large Agricultural land but as the technology advanced with time it has made it possible to use in any kind of farms. The attraction toward precision agriculture may be due to the availability of easy to use and cheap Agricultural equipment to all farmers. The study of agricultural land using GPS, GIS and remote sensing made it possible to manage water availability, seeds, fertilizers, pesticides, and accurate crop yield time which leads to increase in farming crop yielding efficiency and reduction in the overall cost of farming [4]. Recently, numbers of Agricultural tools have been developed to manage the crop yielding using crop data processing and real-time data management for the smart farming and agribusiness [5]. The improvement in the sensors technology for fast and accurate data processing management also helped the increase in the use of precision agriculture [6]. Nowadays, all aspects of precision Agricultural can operate normally, which benefits from the correctness of information collection and processing and the fast and accurate real-time communication [7].

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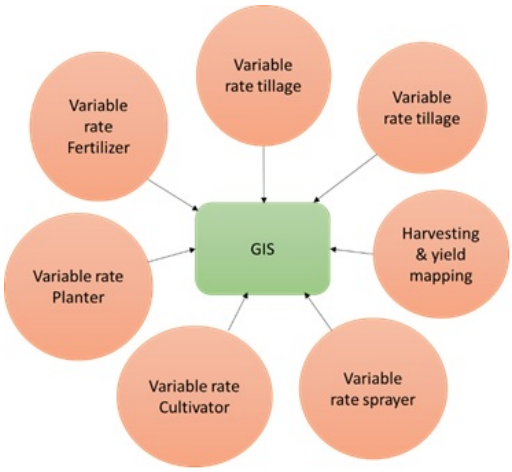

FIG. 1.1. *Precession farming overview*

The important foundation of precision Agricultural is to collect and update the spatial variable information that affects crop growth environment [8] quickly and effectively. The use of GPS enabled the smart farming with the management of area of crop yield, road/route management, and area of interest for faming from remote location. The data collection using sensors and camera to study the impact of pests in the farmland is also made possible using precision agriculture [9]. The use of drones to spray pesticides at specific farmland without interventions of human is also an important application of use of GPS and GIS technology in precision agriculture [10]. The development of several online applications for precision agriculture has boosted its use in smart farming. Several efforts are made to improve the GPS technology and remote sensing; various technological efforts have been made on GPS satellites communication [11-13].

1.1. Contribution. The basic unit of evaluating Agricultural operation benefit and unified planning of crops is farmland plot, so the key to improve Agricultural productivity is to collect and process information data effectively, quickly and comprehensively. If the above conditions are met, the adverse effects of Agricultural labor shortage can be reduced. If the problem of positioning information is solved, the problem of moving Agricultural machines and the problem of making machines complete other tasks will be solved easily.

1.2. Organization. The rest of the paper is organized as follows: A detailed literature is discussed in the Section 2. The development of various standards and systems are discussed in the Section 3. Section 4 is used to explain the system setup and result discussion. In the last Section 5, a conclusion is drawn.

2. Literature Review. Due to the great breakthrough of monitoring technology, many international Agricultural equipment manufacturers have launched their own intelligent variable controller, intelligent output monitor. ISI launched the wire LWSS lnfo project (1998 2003) to create a more advanced Agricultural and forestry management multimedia service system [14] by using High Speed Data Communication System (HSDCS) / Global System for Mobile Communications (GSM) / General Packet Radio Service (GPRS) wireless communication technology. Du Yongxing studied the development direction and feasibility of Information Technology (IT) application in Agricultural field [15]. Zhang Han et al. studied the technology of a satellite broadband wireless access system, which meets the requirements of real-time processing and high-speed transmission of cotton pest multispectral images, and improves the effectiveness and efficiency of variable operation of dispensing machinery[16]. Zhang Yali et al. developed the remote monitoring system "tetrad" for livestock transportation process, using GSM wireless technology [17]. Nowadays, France, Britain, Germany and other countries have basically realized the network management and automatic control [18] of light, humidity, spraying, fertilization, temperature and so on in Agricultural production. In recent years, with the support of national government, the development of remote Agricultural equipment and remote Agricultural monitoring system is relatively fast. Nowadays, many classic monitoring systems have been used in Agricultural operations,

such as humidity, temperature and light, as well as the network management and automatic control of sowing, fertilization, spraying and harvesting in Agricultural production [19]. The growth conditions of crops can be regulated by the monitoring and control system to reduce growth cycle, optimize product quality and increase crop yield, so as to improve economic benefits. Some monitoring and control systems also have the function of warning [20]. As long as the lower limit and upper limit of monitoring factors are set, the expert system can automatically adjust and control the system to achieve early warning effect. As early as 1980, precision Agricultural was proposed in the United States, and intelligent monitoring technology was promoted by its development of microelectronics technology. The early technology foundation of precision Agricultural was composed of cultivation management, soil testing and formula fertilization, crop growth simulation and other Agricultural expert systems [21]. From 1995 to 1996, precision Agricultural technology experiment was carried out in a farm in Alabama. Using GPS to guide fertilization can greatly reduce the use of chemical fertilizer for crops, increase the yield by about 40%, and greatly improve the economic benefits [22]. At present, the United States has applied high and new technologies such as GPS monitoring operation in Agricultural equipment such as grain combine seeder, sprayer, harvester and fertilizer. In Western European countries, the production links of corn and wheat, such as soil preparation, sowing, harvesting and transportation, have been fully mechanized, and many precision Agricultural operations of Agricultural machinery have been realized with GPS system.

In this paper, the precision Agricultural monitoring system based on GIS technology and GPS technology includes the following aspects: position positioning and navigation, control machine, data collection, data transmission and data processing. Its design idea is to establish a mobile terminal to collect data (connected by GPS receiver and computer terminal), convert the collected farmland information (including temporal information and spatial information) into data, and then package it into a file and transmit it to the control and detection center. If GSM mobile communication network is used, SMS mode can also be used to transmit the data, which will edit the collected farmland information data into SMS form for data transmission. Firstly, the collected Agricultural field information is stored as the data exchange file, which is the way to transfer the data file, and the data exchange file is transferred to the monitoring and updating service center. The application of monitoring technology and remote information collection in Agricultural system can realize precision Agricultural operation, intelligent Agricultural operation and automatic Agricultural operation.

3. System Design and GPS Test.

3.1. Overall structure design of the system. The field vehicle monitoring system based on GIS technology and GPS technology is that the data sent by satellite is received by GPS receiver, and then the radio connected by radio antenna is transmitted to the monitoring center through modem [23]. The monitoring center transmits the data to the central server, and the final data processing is completed by the GIS monitoring system of the central server. The schematic diagram of the real-time monitoring system for field operation tools is shown in figure 3.1.

3.1.1. Overall system composition . The system consists of the following parts: system software, PS satellite, GPS mobile terminals (n), computer, radio and monitoring center station. The software of field vehicle monitoring system based on GIS and GSP technology includes the following three parts [24].

- Network communication subsystem.
- MAP management subsystem.
- Serial communication subsystem.

The system composition is shown in figure 3/2. The integrated development environment and operating system used in system software development are as follows. The Development tools areAccess2000 MAPInfo7.0; VisualBasic6.0; Photoshop6.0; MAPx4.5. Further the Operating environment: Windows9X/Windows Me/ Windows200 and Windows 2000 Professional.

3.1.2. System operation process. In order to obtain GPS positioning information, GPS monitoring system should use GPS receiving equipment to transmit the processed data to the monitoring control center by wireless communication, and display it on the electronic MAP provided by GIS platform [25]. In addition, GIS platform is used to process the obtained data. However, the operation process of the system is complex, and only GPS signal transmission is described in this paper. In this way, the workflow can be expressed intuitively and easily understood. The order of work is given in figure 3.3.

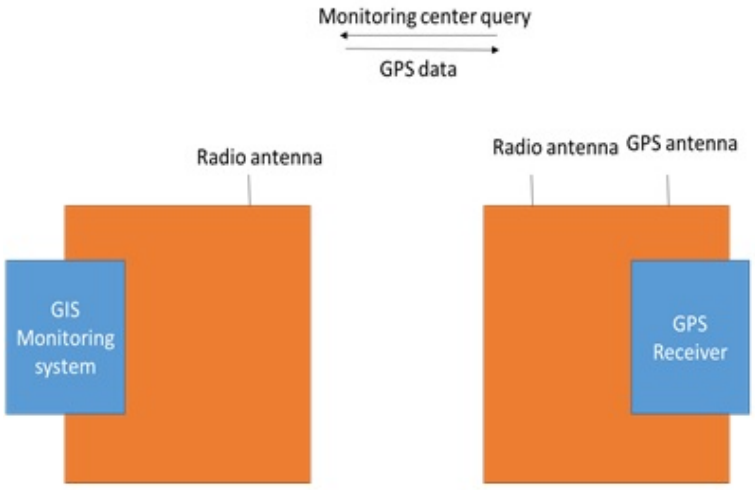

FIG. 3.1. *Schematic diagram of field tool synchronization monitoring system*

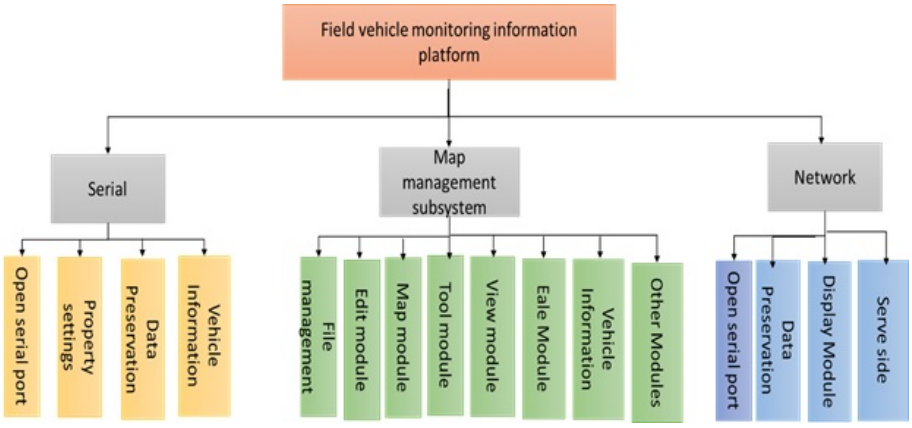

FIG. 3.2. *Composition of monitoring system*

TABLE 3.1
Requirements for positioning accuracy and operation type

Job type	Positioning requirements
Sampling survey	100-1000m
Variable rate fertilization	30-50m
Survey the yield	10-15m
Variable spray	1-1.5m
Construction of seed bed	5cm

3.2. Field GPS Positioning Test. The corresponding relationship between positioning accuracy and operation type is shown in Table 3.1. GPS has the advantages of convenient, real-time and fast positioning of farmland information, but there are many interference factors in the measurement, such as positioning error. Therefore, in order to meet the performance requirements of GPS operation [25].

3.2.1. Static positioning test of GPS receiver. In this test, four different types of GPS receivers are used for static positioning of the same position. In order to compare the positioning accuracy of these

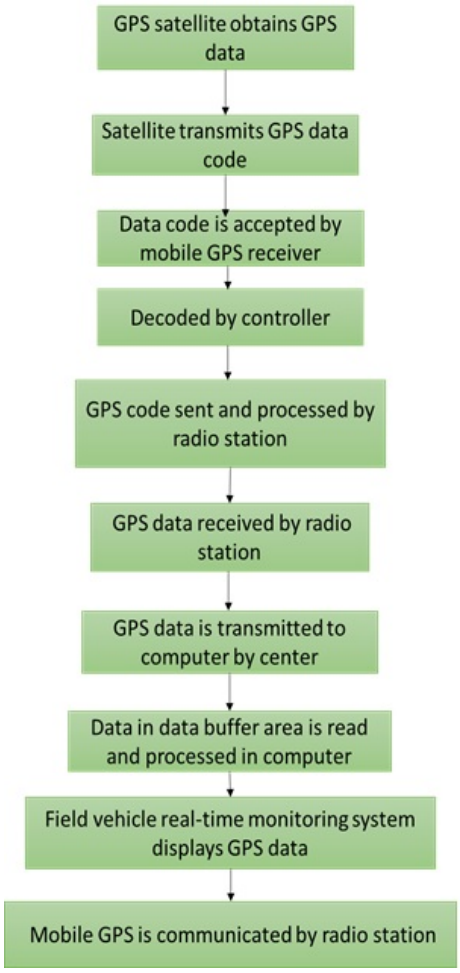

FIG. 3.3. *Order of work to monitoring system*

four GPS receivers, the time of this test is set as 3 min. The four types of GPS receivers are the OEM GPS receiver GPS25 of Garmni Company, the handheld GPS receiver MAP3 and MAP330 of M25lean Company, and the Agricultural differential GPS receiver AGl32 of American tremble company [26]. Only AGl32 uses differential method for positioning, others use non differential method. The longitude and latitude distribution of positioning data of AGGPSZ32 receiver, MAP315 receiver, MAP330 receiver and GPS25 receiver are shown in figure 3.4, 3.5, 3.6 and 3.7. It can be seen from the figures that the observed data are moving in a certain way.

3.2.2. GPS distance area test. Use a tape measure to measure a rectangular area with a length of 50.04m and a width of 28.04m. Two methods are used to measure the four vertices a, B, C and D of the rectangle. It is the first method to measure four points a, B, C and d by static measurement. The coordinates of the four points are taken as the average of the measured values, and then the area and the length of each side are calculated respectively [26]. Moving along a-b-c-d with GPS receiver in hand is the second measurement method. The coordinate values of a, B, C and D are the coordinates of intersection points of each side. Finally, the area and side length are calculated.

4. Results and Discussion.

4.1. Overall design analysis. The field vehicle monitoring system based on GIS technology and GPS technology has the following functions [27-32]:

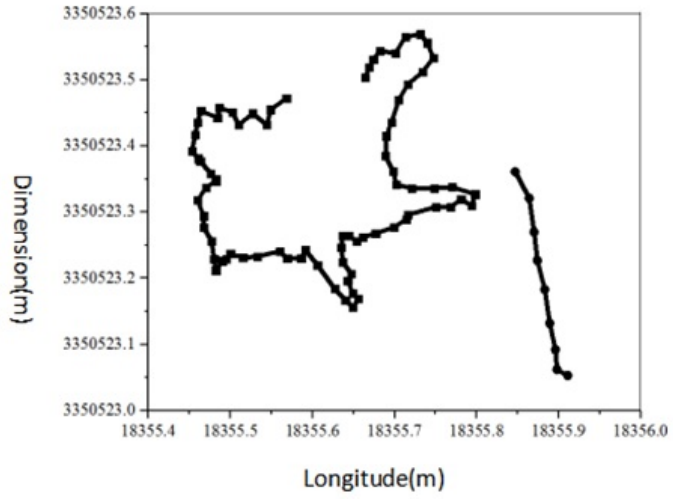

FIG. 3.4. *AGGPSz32*

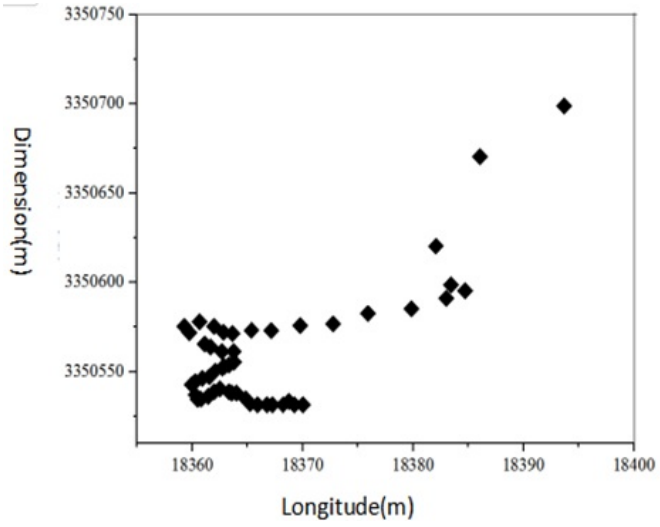

FIG. 3.5. *MAP315*

- The MAP management software has the function of MAP editing and processing, which can easily complete the MAP operation through shortcut keys, such as creating thematic MAP, various operations of layer, MAP tool operation and so on.
- Using the program written by Visual Basic 6.0 to read the data received by the central station. The information will be displayed by the mobile center.
- The mobile terminal sends the status back to the central station.
- Real time display the position of the moving end of the field vehicle in the electric MAP.
- The mobile terminal has query function in the central station.

In order to better complete the task of monitoring field vehicles, the following problems should be solved: the design of multi-target monitoring program for network transmission; the display of mobile terminal position on the electronic MAP; the receiving and decoding of GPS signal [33]. In order to solve these problems, we have carried on the software design, this design uses VB6.0 and MAP4x, realizes the network transmission multi-target monitoring; uses MAPX to embed in the VB environment to realize the mobile terminal position on the

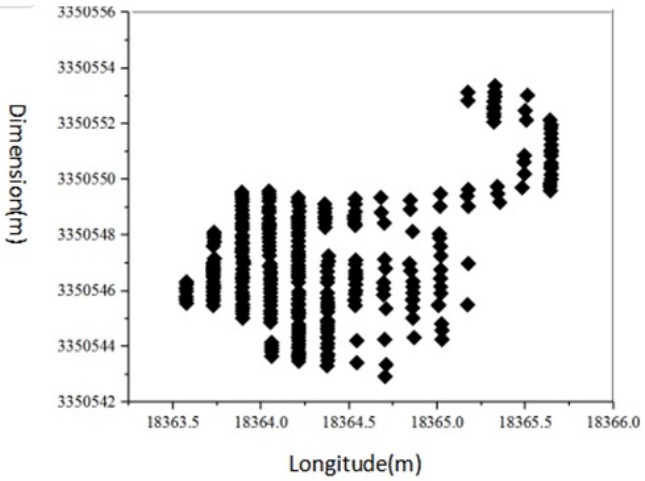

FIG. 3.6. *MAP330*

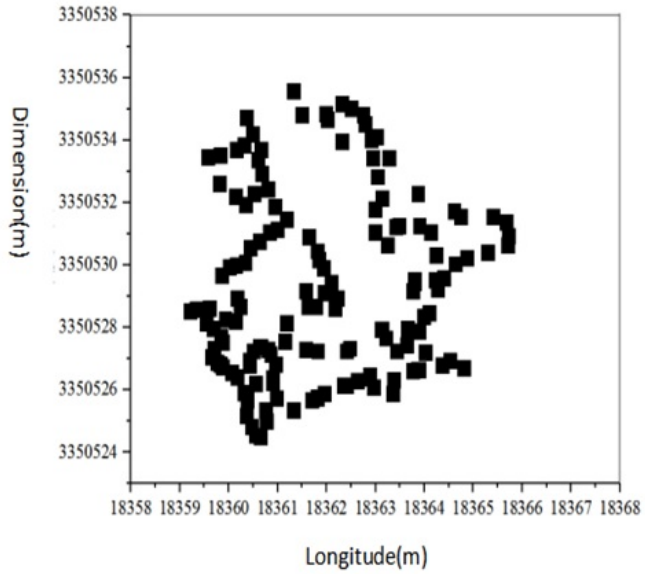

FIG. 3.7. *GPS25*

electronic MAP display; uses VB to make wislock control and MS Comm control to complete the receiving and decoding of GSP signal.

4.2. Test analysis of GPS. The OEM GPS25 receiver developed by American Garmin Company is used as the receiver of this test. It has the advantages of light weight, low power consumption, small size and easy to carry. Its main performances are as follows [35].

- Working current: 200 Ma.
- Working voltage: ± 5 VDC, ± 5%.
- Positioning accuracy: 5 m (differential mode), 15 m (without SA), 100 m (SA).
- Hot start time: 15 s, cold start time: 45 s.
- Data format: nmea-0183v2.0ascll standard.
- Channel number: able to track 12 satellites at the same time.

Table 4.1
GPS data analysis

TYPE	AG132	OEM-25	MAP315	MAP330
COUNT	1744	1787	964	1106
X	18356.0764	18362.7626	18361.9835	18364.0548
$\bar{Y}$	33350523.3321	3350529.5164	3350543.4410	3350547.8589
2σ	0.147	1.6727	2.6359	0.6075
S_x	0.118	2.4940	9.0779	2.2163
S_y	0.3696	6.0060	18.9057	4.5961
ΔX	0	6.6862	5.9071	7.9784
ΔY	0	6.1848	20.1089	24.5268

Table 4.2
GPS sampling interval

GPS	AG 132	MAP 330	GPS 25	MAP 315
Error (m)	0.3696	4.5961	6.006	18.9057
Recommended distance (m)	7.392	91.922	120.12	378.004

- Interface form: dual channel RS-232 compatible serial interface.
- Differential positioning function.

The positioning data analysis table of several GPS receivers is shown in Table 4.1. The number of data records in the table is count; the standard deviation is S_x, S_y; the mathematical mean of the observed data was $\bar{X}$, $\bar{Y}$; positioning error is 2σ. The mean value was 0 ΔX and ΔY The deviation of positioning mean was AGl32. According to figure 2, the highest positioning accuracy is AG132 receiver, and the error is only 0.3696m.The accuracy of the four GPS receivers is as follows [36]: MAP 315 receiver < GPS25 receiver < MAP330 receiver < AGl32 receiver. According to the absolute positioning error, MAP 330 receiver < MAP 315 receiver < GPS 25 receiver < AGl32 receiver. Absolute error is the common modulus in farmland positioning measurement. It has little influence on relative positioning error, or can eliminate these errors [37-39]. Therefore, the performance of GPS receiver should be measured by relative positioning error. Therefore, the author discuss that the positioning accuracy of MAP315 is the worst, that of MAP 330 is better, and that of AGl32 is the highest. As shown in Table 4.2, the minimum distance of the positioning sampling point is calculated within 5% of the allowable positioning error.

4.2.1. GPS distance area test. Three groups of mobile dynamic positioning and two groups of static positioning are included in the GPS positioning data distribution MAP. Dynamic 1, dynamic 2 and dynamic 3 move in the order of a-b-c-d-a. Taking 120 seconds as the cycle of each group, the test was carried out in the order of dynamic movement test 1 dynamic movement test 2 dynamic movement test 3.

The measurement time of each point in static test 1 is about 300s, in which a, B and D are measured according to time, and point C is measured the next day; in static test 2, there is about 30min measurement time between each point, and a, B, C and D are measured in time sequence. It can be seen from the figures of dynamic movement test 1, dynamic movement test 2 and dynamic movement test 3 gradually move to the upper right corner, indicating that random error is not the main error of GPS positioning. Its error is mainly related to the movement time. Therefore, in the dynamic motion measurement, acceleration measurement can greatly reduce the influence of drift error, and then improve the measurement accuracy.Except for static 1, the other four groups have similar measurement patterns, and the difference between dynamic measurement and static measurement is not very big.3. In static 1, the main error is caused by point C. due to the short positioning time in static test 1 and the C point tested the next day, the C point has a large deviation. Therefore, continuous measurement should be made for the measurement of farmland area and the distance of farmland side length, and the measurement time should be longer.

TABLE 4.3
Calculation of distance area

Error	Static 1	Static 2	Move 1	Mobile 2	Move 3
AB (m) error	30.73-4.09%	31.54-1.56%	30.75-4.03%	31.4-2.00%	32.11+0.22%
BC (m) error	28.23+0.53%	27.72-1.28%	28.2+0.43%	28.42+1.21%	27.26-2.92%
CD (m) error	36.10+12.7%	31.55-1.53%	31.12-2.87%	30.88-3.62%	31.26-2.43%
DA (m) error	26.44-5.84%	27.57-1.82%	28.06-0.07%	27.93-0.53%	27.98-0.36%
S (m2) error	913.40+1.52%	871.43-3.14%	870.20-3.28%	873.94-2.86%	875.14-2.73%

The side length and area of the rectangle can be calculated by GPS positioning time and data. Table 4.3 shows the calculation results. It can be seen from table 4.3. Except for static experiment 1, the area measured by other groups of experiments is smaller than the actual area. This experimental phenomenon is caused by the system error, so the correction coefficient should be added to the actual measurement area to eliminate the system error. From the error between the data measured in the table 4 and the actual data, it can be seen that the actual measurement accuracy of the static experimental measurement and the dynamic moving measurement is almost the same. However, compared with the experimental time, we need to spend more time on the static experimental measurement. Therefore, in the daily fine Agricultural operation, it is recommended to use the dynamic moving method to measure the farmland area and the farmland side length. Except for the static o, the errors of the area and side length of the other groups are within 5%, and the measurement accuracy can meet the requirements of precision Agricultural measurement. In static test 2.4.2, 4.59 m is the positioning error of MAP 330. However, in this distance test, except for static experiment 1, 1.29M is the largest experimental error, and the maximum relative error is as low as 4.03%, and the measurement accuracy has been greatly improved. Therefore, although it takes a long time to measure the distance, the distance between the two points actually has a difference effect, so the effect is still greatly improved.

5. Conclusion. The research and practice of precision Agriculture in China is still in the primary stage. In order to meet the requirements of modern agriculture, such as "protecting the environment, saving resources, reducing investment, increasing production", etc. Based on China's national conditions, the corresponding Agricultural operation information management system is established, which is of great significance for the sustainable development of Agricultural production in China. In this paper, how to establish the system is discussed, including the application background of the system, the overall scheme of the system, and the field test of GPS. According to the static test of GPS, the positioning data can change with the change of time, and its positioning data arrangement is not accidental. The static test shows that the positioning accuracy of the four GPS receivers is the worst, and the positioning accuracy of MAP330 receiver and GPS25 receiver is better. However, the positioning accuracy of AGl32 receiver is the highest, and the error is only 0.37M. Compared with the error of 1.2m of other machines, its accuracy is much higher. Using GPS to measure the area, the error of farmland area and farmland side length is less than 5%, and the precision AGl32 receiver for precision Agricultural measurement can meet the requirements. In area measurement, the accuracy of static positioning measurement is similar to that of dynamic moving measurement. However, due to too much time consumed in static measurement, it is better to use dynamic moving mode to measure the area. Because the static measurement takes a long time, it is recommended to use the dynamic moving method to measure the area. This experiment was constrained by many conditions, and it was not carried out in more and larger fields, so it is not completely accurate. The experiment can be supplemented and improved in the future.

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DESIGN OF INTELLIGENT BUILDING SCHEDULING SYSTEM FOR INTERNET OF THINGS AND CLOUD COMPUTING

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Abstract. The cloud computing (CC) and Internet of Things (IoT) are widely utilized and provided for intelligent perception and on-demand utilization like industries and public areas. The full sharing, free circulation and various manufacturing resources allocation are investigated in manufacturing. In order to ensure the real-time and effectiveness of resource storage scheduling in Internet of things information system, there are many kinds and quantities of building equipment. An improved ant colony algorithm is presented to remove the shortcomings of the existing ant colony algorithm with slow speed and fall into local optimum. The improved ant colony algorithm is transplanted into cloud computing environment. The advantages of fast computing and high speed storage of cloud computing can realize the real-time resource scheduling of building equipment. The experimental results present that the improved ant colony algorithm can obviously improve the efficiency of resource scheduling in cloud computing environment.All the experiments are performed on the MATLAB.

Key words: Intelligent Scheduling System; Resource Scheduling; Industries; Cloud Computing; Internet of Things; Ant Colony Algorithm; Path Optimization

AMS subject classifications. 68M14

1. Introduction. The IOT is a new concept put forward on the basis of the Internet, which can be understood as the extension and expansion of the Internet. It has been widely used in the integration of human society. Intelligent architecture and smart home applications are particularly significant. The public safety system of intelligent building is a technical prevention system or guarantee system constructed to maintain public safety and comprehensively use "modern science and technology" to deal with all kinds of emergencies that endanger social safety. The contents include automatic fire alarm system, safety technology prevention system and emergency linkage system. Safety is the need of intelligent building so public safety system is an important part of intelligent building. With the maturity of Internet of things technology, it brings unprecedented development opportunity to intelligent building public safety system. This paper studies how to use Internet of things technology to improve the response speed and emergency linkage ability of intelligent building public safety system and improve the record of supervision and monitoring data from the city level platform. Currently, there are many kinds of electrical equipment in buildings, and the traditional Internet of things control theory and method have been difficult to complete the overall optimization of various equipment in buildings [1-3]. Cloud computing technology converts various computing and storage resources into virtual data form storage with efficient storage and computing power, and adds and expands resources according to actual needs and service modes. Cost saving, convenience and practicality, integration of resources and energy conservation and environmental protection, these advantages promote the introduction of cloud computing technology in the operation and development of the IOT is an inevitable choice. At present, there are many kinds of electrical equipment in buildings, and the traditional IOT control theory and method have been difficult to complete the overall optimization of various equipment in buildings. Cloud computing technology converts various computing and storage resources into virtual data form storage with efficient storage and computing power, and adds and expands resources according to actual needs and service modes. Cost saving, convenience and practicality, integration of resources and energy conservation and environmental protection, these advantages promote the introduction of cloud computing technology in the operation and development of the Internet of things is an inevitable choice [4, 5].

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Cloud computing has a large number of storage and computing nodes, achieves rapid computing on data, but the rapid computing lies in the scheduling of resources [6]. The optimal problem application for solving algorithm and scheduling algorithm has become the core of improving cloud service response time. At present, common algorithms include artificial neural network algorithm, genetic algorithm, simulated annealing algorithm and ant group algorithm, etc. Because each algorithm has some limitations, such as artificial neural network algorithm is difficult to achieve high accuracy in solving the optimal value problem, genetic algorithm has blindness in the search process, resulting in low efficiency of the algorithm. The simulated annealing algorithm solves the optimal value for too long [7, 8].

The efficiency and reliability of power supplies are improved by widened opportunities of IOT and traffic management is also optimized and reduces the traffic accidents. The dangerous wastes transmission is also supervised and medical information management is coordinated. Things-related application development is faced like variable geospatial deployment, or Cloud computing [9]. The running operating systems, networks, load balancing are taken care by application developer traditionally and allowing them to interact with the system. The account of scalability is also needed by the developer and utility model is applied by the cloud computing. The cloud services are accessed by the cloud users over the internet and only services which they need are paid by the users. The large numbers of services are supported by the cloud and the micro-lifecycle management is taken care-of. The variety of services is consisted by designing the cloud computing platform for maintaining applications on the Cloud [10].

1.1. Contribution. In this paper, an improved ant colony algorithm is presented and applied to the allocation and scheduling of construction equipment in the IOT in cloud computing environment. Through simulation experiments, the ant colony algorithm can improve the resource scheduling efficiency in cloud computing environment.

The rest of the paper is organized as follows. Section 2 provides an overview of the exhaustive literature survey followed by a methodology adopted in section 3. A detailed discussion of obtained results is in section 4. Finally, Section 5 concludes the paper.

2. Literature Survey. The construction of "Ping an City" puts forward higher requirements for the public safety system of intelligent building. The public safety system of intelligent building should meet the needs of supervision and emergency linkage of constructing "Ping an City" in the new period, integrate the information of isolated public safety system, connect the public safety system of intelligent building to the city-level supervision and linkage platform, reduce the supervision cost of relevant government departments, improve the efficiency of supervision and emergency linkage, and meet the needs of "Ping an City" and "Smart City" construction. In order to solve the hardware design and the new system architecture exploration. Huang, Q et. al systematically design and achieve low-cost hybrid intelligent sensor platforms for the occupation of energy-saving buildings accurately. The presented hardware architecture is segmented into two parts: the main and door monitoring module. These sensor signals can fuse and analyze to enhance the accuracy of building occupation counts. The proposed system has been implemented on the bread plate and the PCB board. The experiment is measured to verify system functions and performance [11].

Wang, J et al. Proposed a multi-UAV wireless power supply communication (WPC) system for supporting 6G content. Specifically, each time slot is divided into an uplink and downlink sub-slot. In the downlink, multiple drones are considered as the air communication platform to transmit energy in multiple IoT users. In the uplink, the UVS and the user association is designed, and then the predetermined user is uploaded to a specific UAV by utilizing the harvested energy. Maximize the minimum average improving between all users by collaborating the UAV user association, user transmission power, and multi-UAV trajectory. In particular, the alternative iterative algorithm proposed in the text can effectively parse the non-convex optimization problem. Finally, numerical results indicate that this design can not only optimize the multi-UAV flight path, but also achieve higher objective values than the reference plan [12].

With the emergence of information age, the item Internet technology has been favored and has become another revolution in the information technology industry. In this era, in the case of building intelligent buildings, material technique can expand the intelligent systems practicality and enhance the management and service capacity of intelligent buildings, therefore improving people's quality of life. On the basis of summarizing and analyzing research work, Kong, L. et al. Proposed the design and intelligent manufacturing

architecture model of IOT technology. The result of model verification shows the construction industry's intelligent manufacturing model that can realize the human society and physical systems integration, realizing real-time management and control of people and infrastructure across networks [13].

An unprecedented opportunity is represented by the micro-grid technology for energy industry transfer to the new era of reliability, and efficiency for economical contribution. The power and transportation industry sectors both are yield by the Electric Vehicles (EVs) emergence but consume massive energy and affect the reliability [14]. The plug-in EVs problem is considered in this paper at public supply stations (EVPSS). For smart grid and cloud services, new communication architecture is detailed. The priority levels attributes and the waiting time optimization is done by the scheduling algorithms. The network architecture for smart grid based on cloud computing is presented in this paper for such issues investigation. The presented approach is evaluated by simulation and it is demonstrate the proposed approach effectiveness. The on-demand ordering and scalable storage helps the cloud computing and the processing services [15]. It is unacceptable the transferring data delay to cloud and back to the application. So much data is sent by the client to the cloud for processing and storage as network bandwidth is saturated and not be scalable. In many fields, Internet of Things (IoT) and cloud computing (CC) are utilized widely and a new is provided for intelligent perception and on-demand utilization [16]. The full sharing, free circulation and various manufacturing resources allocation are investigated in manufacturing. In this paper, CC- and IoT-based cloud manufacturing (CMfg) service system is presented and detailed and analyze the relationship among them. The system's merits, demerits and challenges are also discussed. The large datacenters powers the cloud computing by large datacenters which comprises the many virtualized server instances and supporting systems like power supply [17]. Classification of the equipment is done into hardware and software accessed by remote users. The cloud services are accessed by the users in the hardware through network equipment which connects the servers to the Internet. The cloud management system manages the user software which runs on top of servers. The reduction of energy for the given service defines the energy efficiency. The user with a novel means of communicating is presented by the IOT with Web world through ubiquitous object-enabled networks [18]. A convenient, on demand and scalable network access is enabled by the CC configurable resources computing. The integration of the IOT and CC is focused under Cloud things architecture. For integrating Cloud Computing, the various techniques are reviewed and an IoT-enabled smart home scenario is examined. The Cloud things architecture is also presented which accommodates cloud-things for accelerating IoT application.

3. Used methodology. IOT refers to the connecting objects technology through the network. The Internet of things of building equipment discussed in this paper means that all kinds of building electric equipment in the building are unified and centralized to form an Internet network connected by things and things. Through the expansion and extension of wireless network sensing to various building electrical equipment in buildings, the Internet of things system uses its own three-tier architecture [19]. Through the wireless transmission network collection system, the parameters of intelligent equipment are transferred to the cloud computing service platform of application layer. Functionally, the overall structure of the iot system of building equipment is divided into "application layer, support layer, network layer, access layer and perception layer", as shown in figure 3.1.

Figure 3.1 directly interworking with the user is the application layer, which contains a variety of Web browser or client applications, users can use the application layer to provide remote monitoring and intelligent management of various electrical equipment in the building; the support layer consists of three parts: data service, communication service and application service, which are used for data storage, communication, processing and application in the Internet of things; The network layer is located in the middle layer of the Internet of things, which can be commonly used as Internet, LAN, heterogeneous network or virtual private network [20-22]. It is mainly used to complete the interconnection of the Internet of things network and ensure that the whole system can exchange visits.

3.1. Cloud computing service model architecture. The cloud computing platform virtualizes all configurable computing resources, and then integrates and configures them to form a resource pool to provide users with various required services, the specific service model of which is shown in figure 3.2.

Cloud computing platform can process massive data and achieve high resource integration rate. At the same time, based on distributed computing, the data that needs to be processed are also distributed in different nodes.

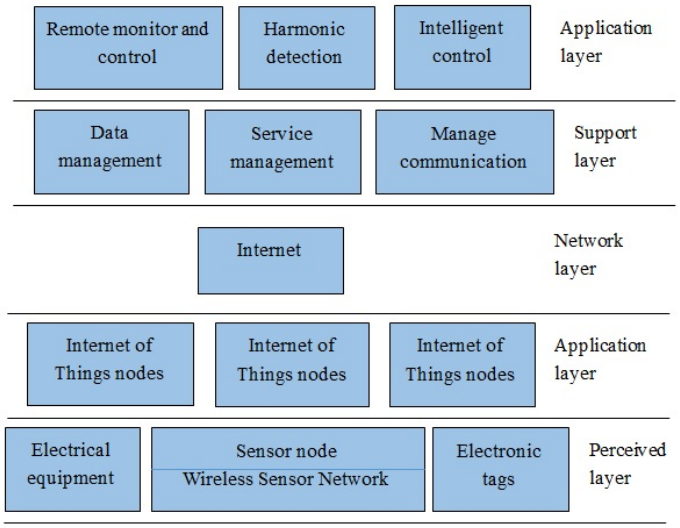

FIG. 3.1. *Overall Structure of the Internet of Things System for Building Equipment*

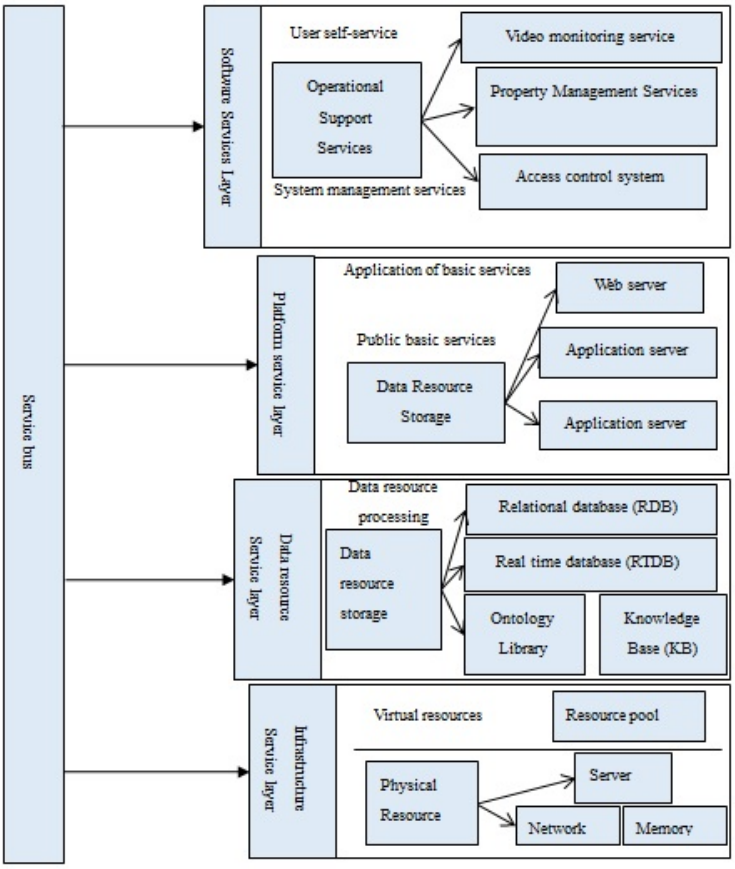

FIG. 3.2. *Schematic illustration of the service model for the cloud platform*

In order to improve the efficiency of cloud computing, it is very important to schedule and allocate computing nodes and resources reasonably [23-25]. The application of optimal problem solving algorithm and scheduling algorithm becomes the core to improve the response time of cloud service heart. Therefore, combined with an improved ant colony algorithm, the information resources in the resource pool are centralized and integrated, and finally presented to users and managers in a simple and efficient way, which can effectively support the information processing links of the Internet of things and improve the shortcomings of the traditional Internet of things system [26].

3.2. Improved Ant Colony Algorithm. Ant colony algorithm is a bionic algorithm, which is inspired by the foraging phenomenon of ant colony in nature. In the process of foraging in unknown areas, when individual ants find food, pheromones are released on the path they pass through, and their concentration indicates the length of the path. For other foraging ants, as long as the concentration of pheromone released is perceived in a certain range, it always moves in the direction of strong pheromone concentration, and always finds a shortest path to the destination in a certain time [27-29].

3.2.1. Classic Ant Colony Algorithm. The above phenomena are modeled mathematically. Let m ants be put into n random selection node. The ants k choose the direction of motion according to the concentration of pheromone and always move towards the high concentration path. At a certain time t, the transfer probability of ants moving from node i to node j is:

$$(P_{ij})^k = \begin{cases} \frac{\tau_{ij}^{\alpha}(t)\eta_{ij}^{\beta}(t)}{\sum \tau_{ij}^{\alpha}(t)\eta_{ij}^{\beta}(t)} & j \text{ belongs allowed}_k \\ 0 & \text{other} \end{cases} \tag{3.1}$$

In the equation 3.1, α represents the information heuristic factor, the larger the value represents the current path, the more important the ant is to choose the path, and the β is the expected heuristic factor. Represents the relative weight of the predictive value of computing power.

3.2.2. An Improved Ant Colony Algorithm Based on Chaos. The above equation 3.1 is the standard mathematical model of the traditional ant colony algorithm. It is obvious that when the number of ant colonies is m large or the number of nodes is n large, the calculation time of the algorithm will be slow or even stagnant. Accordingly, the mathematical model of the traditional ant colony algorithm is improved, and the Logistic mapping function is used to improve the dependence of the traditional ant colony algorithm on the randomness of the selection path. In the standard mathematical model of traditional ant colony algorithm, ants choose each path with equal probability. Using Logistic mapping function, chaotic variables with the same number of paths can be generated. The global search and optimal value are solved by the properties of chaotic motion. Logistic mapping functions can be expressed as:

$$x_{i+1} = \mu x_i(1 - x_i), i = 0, 1, 2, 3, \ldots, n, 0 < \mu \leq 4 \tag{3.2}$$

The μ is a control parameter. When μ=4, the Logistic map is a typical chaotic state, which has the characteristics of randomness, regularity and ergodicity. After the initial path is chaotic, in order to avoid the phenomenon of slow response and local optimization, the pheromone concentration is also chaotic, that is:

$$\tau_{ij}(t + n) = \rho \cdot \tau_{ij}(t) + \Delta\tau_{ij} + q \cdot x_{ij} \tag{3.3}$$

x_{ij} is the chaotic quantity produced in equation 3.3 and q is the coefficient.The initial path of the traditional ant colony algorithm is chaotic (μ=4). Assuming $n = 3$, there are six possible paths. The final each path can be obtained by arrangement and combination as shown in Table 3.1.

In Table 3.1, D represents the ordinal number of different paths; V represents the direction of motion; C represents the trajectory between three nodes. The logical transformation relationship between the three can be expressed as follows:

$$D_i = D_{i-1} - (v_i - 1)(n - i)!, i = 0, 1, 2, \ldots, n - 1;\ D_0 = D, v_i = \frac{D_{ij}}{n - i}! \tag{3.4}$$

To sum up, the process of solving the optimal value based on the proposed improved ant colony algorithm is summarized, as shown in figure 3.3.

TABLE 3.1
All possible motion paths

D	V	C
1	11	123
2	12	132
3	21	213
4	22	231
5	31	312
6	32	321

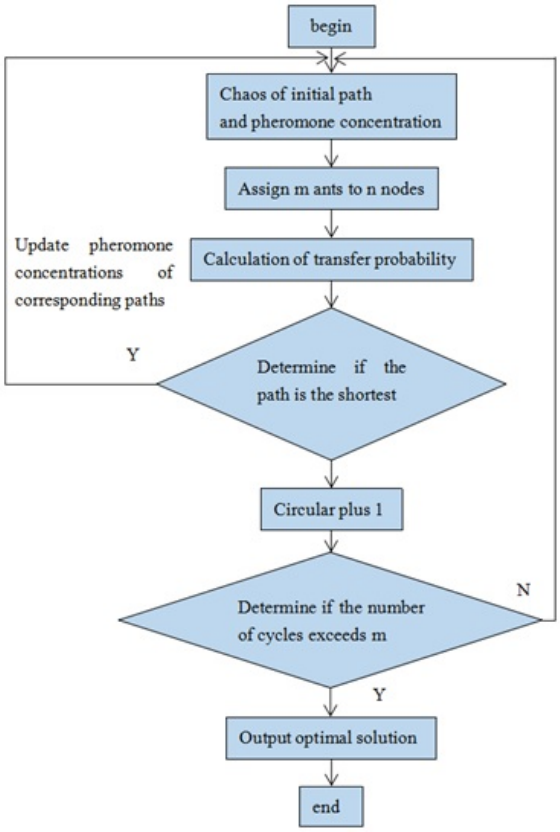

FIG. 3.3. *Flow chart of optimal solution*

3.3. Intelligent scheduling of devices based on improved ant colony algorithm. Ant colony algorithm can find the optimal path, which can be defined as the best scheduling mode in the intelligent scheduling system of Internet of things. Many devices in the Internet of things environment are modeled as nodes in cloud computing environment. The node morphology is divided into storage nodes and computing nodes. The storage nodes are mapped to data storage devices in the Internet of things, and the computing nodes are mapped to data computing and data processing devices in the Internet of things [30]. All nodes in the Internet of things system correspond to the current data processing capacity and their maximum processing capacity at a certain time point. The purpose of ant colony algorithm is to dynamically plan and distribute the traffic according to the load of the current Internet of things system and the load of each node to maximize the performance of the whole system.

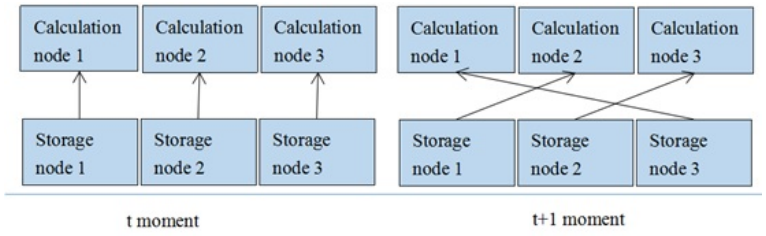

FIG. 3.4. *Scheduling of Ant Colony Algorithm in Cloud Environment*

TABLE 4.1
Record of Experimental Results of Traditional Ant Colony Algorithm

Task	Time/ s	Task	Time/ s	Task	Time/ s
15	2.0	45	8.6	75	16.6
20	2.3	50	9.6	80	20.1
25	2.7	55	10.6	85	21.8
30	3.4	60	11.9	90	26.3
35	4.5	65	13.5	95	28.4
40	6.6	70	14.4	100	29.7

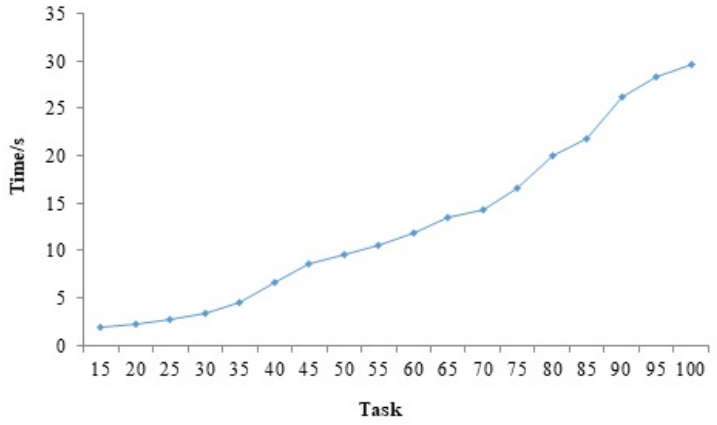

FIG. 4.1. *Record of Experimental Results of Traditional Ant Colony Algorithm*

Every t time, the computing node and the storage node in the Internet of things system synchronize the data. Data synchronization includes the current processing data and storage data of each node. The purpose of synchronization is to distribute traffic according to the optimal scheduling scheme of ant colony algorithm, as shown in figure 3.4.

4. Simulation Experiment. In cloud computing environment, the efficiency difference between traditional ant colony algorithm and improved ant colony algorithm in resource scheduling is compared. The relevant parameters in the algorithm are set as follows: heuristic factor $\alpha = 1$, expectation heuristic factor $\beta = 0.998$, control parameter $\mu = 4$ at the same time, set the number of execution tasks to 20∼100, the number of nodes is 20. The simulation experiment is carried out under the same experimental parameters. Each algorithm runs 10 times to take the average value. The statistical records of the two ant colony algorithms are shown in tables 4.1 and 4.2 and shown graphically in figure 4.1 and figure 4.2 for better visualization.

As the number of execution tasks increases from 15 100 in turn, in each state, the two algorithms execute 10 times, and the average value of the 10 calculation times as the record value, which is recorded in tables 4.1

TABLE 4.2
Record of Experimental Results of Improved Ant Colony Algorithm

Task	Time/ s	Task	Time/ s	Task	Time/ s
15	2.0	45	7.5	75	15.4
20	2.2	50	8.2	80	17.2
25	2.8	55	9.7	85	18.5
30	3.3	60	11.4	90	20.2
35	4.0	65	12.3	95	21.4
40	5.2	70	13.3	100	22.9

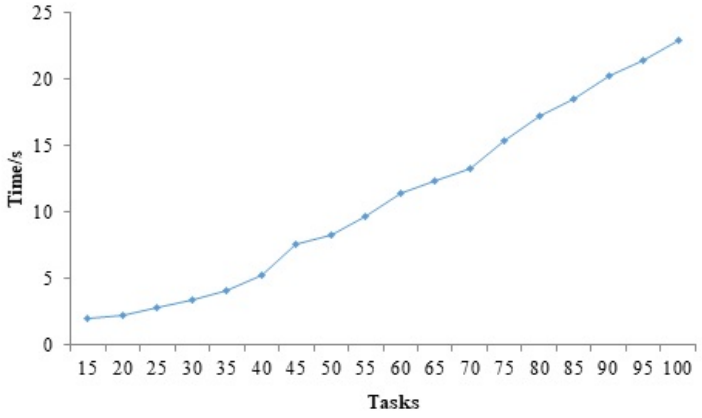

FIG. 4.2. *Record of Experimental Results of Improved Ant Colony Algorithm*

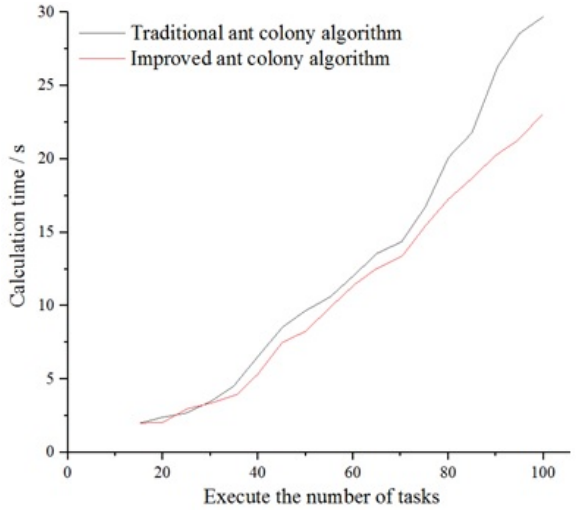

FIG. 4.3. *The optimal value of the two algorithms solves the time variation curve*

and 4.2, respectively. For recording results, the curves of execution time required by the two algorithms with the increase of the number of execution tasks are investigated, as shown in figure 4.3.

Figure 4.3 shows that when the number of tasks is less than 40, The time gap between the two algorithms in cloud computing is very small; But when the number of tasks is increased (greater than 70), The difference between them becomes more and more obvious; And when the number of tasks is 100, An improved ant colony

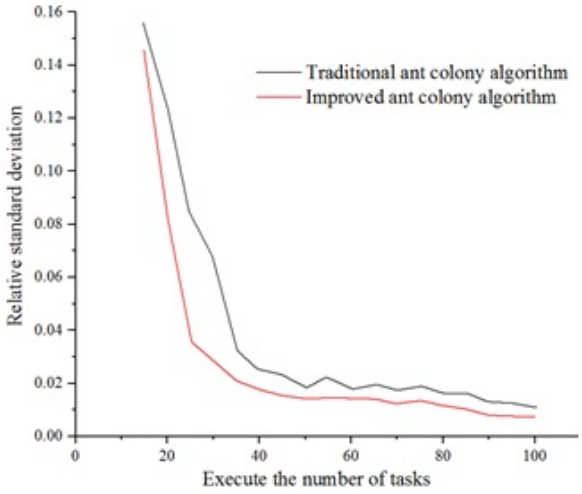

FIG. 4.4. *Optimal value of two algorithms to solve relative standard deviation variation curve*

algorithm takes less than 25 s, to solve the optimal value However, the traditional ant colony algorithm takes nearly 30 s. to solve the problem In order to further investigate the optimal value solving effect of the two algorithms, Statistical analysis of the relative standard deviation of the data recorded in tables 2 and 3 above, The results are shown in figure 4.4.

The figure 4.4 shows that when the number of tasks increases, the deviation of the improved ant colony algorithm becomes smaller and linear, which is better than the existing ant colony algorithm. In the actual cloud computing environment, it is necessary to deal with massive data, and the length of computing time directly determines the resource scheduling efficiency of the whole Internet of things information system. Through the above comparative analysis, the improved ant colony algorithm can modify the scheduling efficiency more than the traditional ant colony algorithm in cloud computing environment.

5. Conclusion. Based on Logistic mapping, an improved ant colony algorithm is presented for building equipment in CC environment. It greatly improves the dependence of traditional ant colony algorithm on the randomness of choice path, overcomes the shortcomings of slow convergence and local optimization of traditional ant colony algorithm, and integrates the improved ant colony algorithm with the advantages of CC fast resource scheduling. The simulation experiment compares and analyzes the change curve of the time required for the optimal solution when the number of tasks is increased by the ant colony algorithm. The results show that the improved ant colony algorithm is more suitable for CC environment. As the number of execution tasks increases from 15∼100 in turn, in each state, the two algorithms execute 10 times, and the average value of the 10 calculation times as the record value. For recording results, the curves of execution time required by the two algorithms with the increase of execution tasks are investigated.

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RESEARCH ON TCP PERFORMANCE MODEL AND TRANSPORT AGENT ARCHITECTURE IN BROADBAND WIRELESS NETWORK

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Abstract. The problems of Internet stability, heterogeneity, fairness of bandwidth sharing among streams, efficiency of use and congestion control have been solved in this article. This paper proposes an improved scheme of TCP proxy acknowledgement based on Automatic Repeat Request (ARQ), which improves throughput, reduces delay and saves uplink bandwidth of wireless link, and is more suitable for future asymmetric networks. The substantial improvement is observed during the experimentation as processing efficiency of protocol. The observed results revealed that overall processing time for each packet is approximately equals to one fourth of the transfer control protocol and the reduction of 59% is also observed in the utility of resources. The protocol also incorporates various simple techniques for the recovery of loss to improve the throughput in noisy wireless conditions. The results show that the adoption of the average diversity combining technology is helpful to improve the throughput and effective factor performance, and can reduce the requirement of radio link protocol (RLP) maximum retransmission times. As nearly 90% of uplink acknowledgement frames are filtered, the uplink bandwidth utilization rate is significantly improved. Decomposing large data frames into small data frames is also helpful to improve system performance.

Key words: Broadband Wireless Network; TCP performance; Transport agent; Bandwidth utilization.

AMS subject classifications. 68M14

1. Introduction.

Wireless communication is one of the most active and rapidly developing fields in the field of communication today, and it is also one of the fields of science and technology that will have a great impact on human life and social development in the 21st century. TCP, as a reliable connection-oriented transport layer protocol, provides high-reliability data communication between two hosts. Combined with the widely used IP network, it provides a reliable transport layer on the unreliable IP layer and forms a complete TCP/IP protocol family [1]. Because TCP protocol was originally designed for wired networks and fixed hosts, its performance in wired networks is ideal, and it can control and reduce congestion by its error detection and error recovery mechanism. However, its application in the growing and huge wireless network shows its drawbacks. Therefore, how to ensure the TCP performance in wireless networks and how to improve the TCP protocol to better serve the wireless networks have become a hot spot in wireless network research in recent years.

The mission of mobile computing approach is to provide unavoidable axis two different forms of information like data, video and voice [2]. Mobile computing devices and its integration with existing internetwork system that consists stationary hosts has been playing vital role in drinking best from current state of art approaches and making them one-step closer to the mission realization [3]. On the other hand there are many challenges that has been rising with the continue usage of technology in combination with wireless network Technology. These challenges are rising because of portable mobile devices requirement and the necessity of other important characteristics of wireless networks [4].

In mobile computing, the probability is considered as one of the most important element. With advancement in technology, the physical parameters such as size and weight are shrinking continuously and therefore the power capabilities and mobile computing reducing along with the constrained capacity of battery [5]. In order to maintain the efficient performance through mobile applications there is a strong requirement for minimizing

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the overall processing load from portable mobile systems [6].

The prime objective behind this study is to develop transfer protocol for computing limited environment of wireless networks. This article presents lightweight architecture as mobile transfer control protocol (MTCP), annoying the functionality of TCP among the mobile and stationary host. The process reduces the overall processing load in in mobile host with less usage of wireless medium. The communication among the mobile and the base station is carried out through a single link in order to enhance the performance [7]. Therefore, the design protocol refers as link layer protocol. For enhancing the performance, many of the functions are simplified or neglected in wireless medium off connection, which leads to the design of a lean protocol called in a machine [8]. Additional the implementation also reveals that the protocol provides offload processing through mobile devices.

The implementation of our protocol depends on model of split connection where the connection among the mobile and base station is divided into two connections [9]. One connection is considered as the connection among fixed host and base station whereas other connection is considered as the connection among base station and mobile host. The first connection is termed as wide connection and other connection is considered as wireless connection [10]. This division is not a new idea and it was already used by many previous research work. The reason behind opting this split connection strategy as this approach is efficiently providing the proxy style architecture for enabling the development of efficient protocol for wireless segment [11].

In the present work for reducing the overall communication overhead, our work incorporates different efficient simple approaches to address heavy losses in wireless communication. The wireless links are prone to various losses due to many factors like interference, user mobility, noise and channel fading. It has been observed from the literature that the transfer control protocol performs poor in wireless networks as it considers all of the losses occurs due to the congestion problems among network [12, 13]. In response to each loss, the transfer control protocol initialized various steps to provide transmission rate to the congestion issues. However, this transfer of transmission read for the leads to the poor performance of network, which exhibits as non-congestive losses. Many researches address these issues and various studies has been proposed to address the effect of non-congestive relevant losses on the performance of transfer control protocol in wireless or similar type of high loss links [14]. The base of our implementation is model of split connection, which addresses these issues by separating the recovery of losses over wireless link from wide link. The performance of the proposed mobile transfer control protocol is observed and its ability is evaluated in terms of offload processing and its throughput is measured for poor loss conditions [15].

2. Literature Review. The smooth development of mobile communication network also plays a powerful role in promoting WLAN. WLAN is a network established in a certain local area by using wireless communication technology, and it is the product of the combination of computer network and wireless communication technology. It uses wireless multiple access channel as transmission medium, provides the function of traditional wired LAN, and enables users to truly access broadband network at anytime, anywhere and at will. The frequency band used by WLAN can be 2.4 GHz and 5.8 GHz, and the data rate can be up to 54 Mbps. When the high-band LAN is running, the communication quality is good without mutual interference, which can ensure the communication safety and meet the service quality requirements [16].

TCP is designed based on wired channel. At this time, network congestion is the main reason for packet loss. After the sender finds packet loss through multiple acknowledgments or retransmission timeout timer, it immediately starts congestion control mechanism, reduces congestion control window and extends retransmission timeout timer, so as to reduce the load pressure on the network and reduce packet error caused by network congestion. When TCP runs on the wireless channel with high packet error rate, TCP will also start the congestion control mechanism when packet error is caused by channel error, which leads to the unnecessary reduction of the throughput of end-to-end TCP connection. At the same time, the ”exponential regression” algorithm of retransmission timeout timer timing length further prolongs the time of packet error recovery. The main disadvantage of link layer protocol is that TCP layer and data link layer compete for retransmission. Wong have improved the link layer protocol in the literature, which effectively reduces the problem of competitive retransmission between TCP layer and data link layer and improves TCP throughput. Another method to improve the performance of TCP over wireless channels is to use split connection protocol, which divides the TCP connection between the sender and the receiver into two segments with the wireless base station as the

boundary, one spanning the wired channel and the other spanning the wireless channel [17, 18]. However, the shortcomings of split connection protocol are also obvious: first, the retransmission timer timeout caused by high packet error rate in wireless channel will lead to the stop of TCP connection packet transmission on wired channel. Second, the TCP connection is divided into two sections at the base station, which correspondingly increases the software overhead when the packet is transmitted through the base station. Third, when the packet arrives at the base station and the receiver has not received it, the acknowledgement information of the corresponding packet has arrived at the sender, which destroys the semantics of TCP end-to-end connection [19, 20].

A third method to improve the performance of TCP on wireless channel is monitoring protocol. The specific method is to introduce monitoring module to the base station at the boundary between wired channel and wireless channel, monitor the packets in TCP connection passing through the base station bidirectional, buffer the packets that have not been confirmed by the receiving end, and retransmit the packets by using the buffered packets once the error packets are found. The focus of the above research on TCP wins is the throughput rate of TCP connection, which is the same as the performance analysis of TCP connection on TDMA wireless link. When TCP connection runs on CDMA wireless link with limited interference, it is necessary to introduce new performance evaluation index to reflect the performance of TCP connection on CDMA wireless link [21, 22]. The innovation of this paper: The ARQ-based TCP performance improvement schemes under two wireless architectures are proposed, which are base station-mobile terminal architecture and access point-fixed terminal architecture (AP-CPE architecture).

3. Research Methods.

3.1. Proposed Algorithm. ARQ technology in data link layer transforms unreliable physical links with errors into reliable data logical links, and TCP connection will not start slowly due to data frame loss on wireless links, which greatly improves TCP performance, but still has shortcomings. Because the bit error rate (BER) of mobile computing environment is very high, and the probability of continuous errors is very high, it may cause multiple retransmissions of the same data packet on the wireless link, and finally cause the source TCP to start congestion control because of waiting for acknowledgement timeout, first retransmit unacknowledged packets, and reduce the congestion window to reduce the sending rate. Then activate congestion control mechanism, including time-out clock exponential regression and reducing slow start threshold. Finally, the congestion avoidance stage is entered to ensure that the congestion is relieved. This error recovery mechanism of TCP will lead to the degradation of protocol performance, including the decrease of throughput and the increase of delay [23].

3.2. Overall Framework. The realization of TCP proxy validation algorithm in this system includes two parts: base station part and mobile terminal part. In the base station part, a TCP proxy confirmation module is added to the partition/merge/reassembly/disassembly module of RLC entity in fully reliable mode. This module analyzes the IP packets submitted by the upper layer to the partition/merge module for processing and then sent by the upper layer and the IP packets submitted by the reassembly/disassembly module to the upper layer, and decides whether to generate an IP packet containing TCP confirmation segments for the upper layer. The mobile station part adds a filtering module before the segmentation and recombination module of RLC entity in fully reliable mode. According to the filtering algorithm, which TCP segments can be filtered [24-27].

The proposed design is a slight variation in transfer control protocol which reduce the latency is depicted in Figure 3.1. In the proposed protocol instead of beginning the transfer of state during mobile has completed handing off, our work initiates the transfer of state when the process of handoff is expected. In the proposed approach the exchange among the old base station and new base station is carried out through the unicast data transfer process. The process of data transfer depends on the lower layers for providing the idea about mobile station that the hand off is pending and information about the candidate address of base station [28, 29].

Once the base station receives notification the process of state transfer is initiated. The time until mobile station starts handoff, higher amount of data have already been processed as depicted in Figure 3.1. Once the handoff is completed the rest of the data and its state of transfer control protocol is for the transferred for accurately mirroring the old state. From the experimentation it is observed that the latency can be reduced more specifically for the situations where the transfer of data is large and data requires to transfer over slow

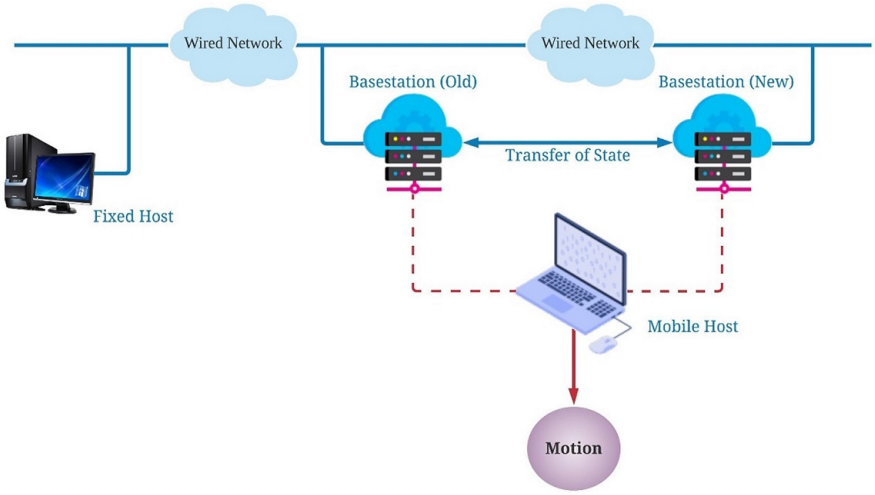

FIG. 3.1. *State transfer process between base stations where mobile is handoff*

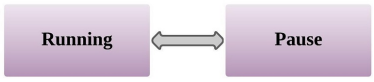

FIG. 3.2. *Proxy state transition diagram of terminal*

links.

3.2.1. Time processing process. The TCP proxy validation module of base station can be divided into several different processes according to its functions: time processing process, pre-transmission analysis process, segmentation merging or recombination de-merging process, reception analysis process and proxy validation process. The base station corresponds to the state transition diagram of the proxy acknowledgement control of a TCP connection, and the proxy corresponding to each TCP connection has two states: Running and Pause is depicted in Figure 3.2.

When a new connection entry is established, the initial state is set according to whether the notification window is 0. If the notification window is 0, the initial state is Pause, otherwise, the initial state is running. In the Pause state, once an uplink TCP segment indicating that the receiving window is not 0 or a downlink TCP segment with a data length not 0 is received, it is transferred to the Running state. If no upstream and downstream data is received for T_BASE_PAUSE, delete this connection in the trace connection table entry. In the Running state, if no upstream and downstream data is received for a continuous time of T_BASE_NODATA_TIMEOUT, delete this connection in the trace connection table entry; And if that uplink TCP message segment indicate that the receiving window is 0 is receive, shifting to the Pause state. Upon receiving other uplink TCP segments, generate uplink TCP acknowledgement segments according to the strategy of generating TCP acknowledgement segments by the base station agent. The time constants used above are defined as follows:

T_BASE_PAUSE: The longest time that a connection in the base station stays in the Pause state. In the specific implementation, it is set to 60 seconds.

T_BASE_NODATA_TIMEOUT: A connection in the base station lasts for no uplink and downlink data at most. In the specific implementation, it is set to 1800 seconds.

3.2.2. Analysis process before sending. The base station analyzes the frame submitted by the upper layer that has not been segmented. If TCP is not encapsulated in the frame. Packet, the address of the frame and the flag of whether it is TCP packet are saved in the related structure of the interface with the split and merge module, and sent to the designated buffer. If it is a TCP packet, proceed to the next step.

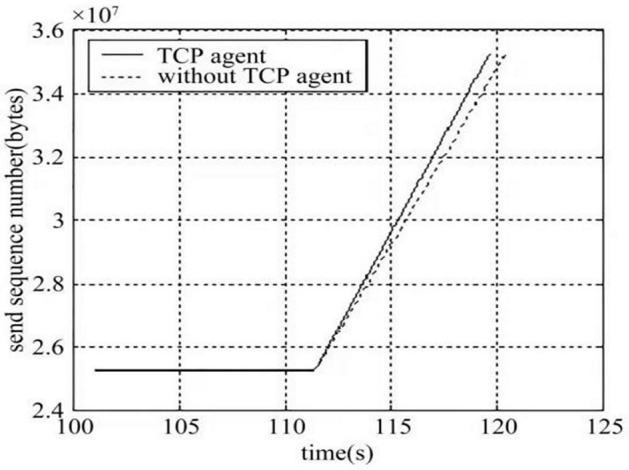

FIG. 4.1. *Comparison of transmission sequence numbers with single connection transmission rate of 150PDU/ time slot and zero frame error*

If the TCP packet encapsulated in the frame has been confirmed by the base station agent, the unnecessary retransmission TCP data segment is encapsulated in the frame, which can be filtered without sending. In the specific implementation, the sending sequence number and the data length of the TCP segment encapsulated in the frame are read, and if the sum of the sending sequence number and the data length is less than or equal to the maximum confirmed sequence number of the connection entry in the connection tracking table, the downlink data frame is filtered and not submitted to the split and merge module for sending.

3.2.3. Agent confirmation process. The ARQ module will inform the proxy confirmation module of the window information after moving a certain sending window. When the confirmation module judges that the IP packet containing the complete TCP segment arrives at the receiving end, it will move the IP packet recording node from the IP packet recording node linked list of the corresponding terminal. If it is in the Running state, it will generate the TCP proxy confirmation segment.

4. Research Results. In all simulations, the transmission rate is 50Mbps. First, simulate the case of single user and single TCP connection, and then simulate the case of multi-user and multi-TCP connection, and each case will get 18 sets of data. For each connection running 10M FTP download service, the simulation shows that there is not much difference in the total download time when using TCP proxy to confirm with zero frame error and when not using TCP proxy to confirm, that is to say, their average throughput rates are not much different. Figure 4.1 is a simulation graph of "transmission segment number-time" when the transmission rate is 150PDU/ time slot and the frame error rate is 0%. The solid line indicates that TCP proxy confirmation is started, and the dashed line indicates that TCP proxy confirmation is not started.

Because the sending sequence number in TCP protocol is in bytes, and the sending sequence number at each moment minus the starting sequence number is the total number of bytes sent in this period, so this value can be used to calculate the average throughput. The two oblique lines in Figure 4.1 are very close, which shows that the download time for downloading the same business volume is very close in both cases. However, under the condition of FTP download with the same traffic, the average throughput rate of the curve with TCP proxy acknowledgement is still higher than that without TCP proxy acknowledgement. We can use data to illustrate that the difference between the ordinate of the starting point and the end point of the curve in a period of time t is the number of bytes sent in this period of time, so B/t is the average throughput rate in this period of time. The average throughput calculated from the simulation data also illustrates this point. The average throughput without TCP proxy acknowledgement is 8.5 Mbps, and the average throughput after TCP proxy acknowledgement is 9.25 Mbps, which is 8.82% higher than the former. Under the other two transmission rates with zero frame error, the simulation data show that the download time difference is not great when TCP proxy acknowledgement is not used and when TCP proxy acknowledgement is used, but the total time spent

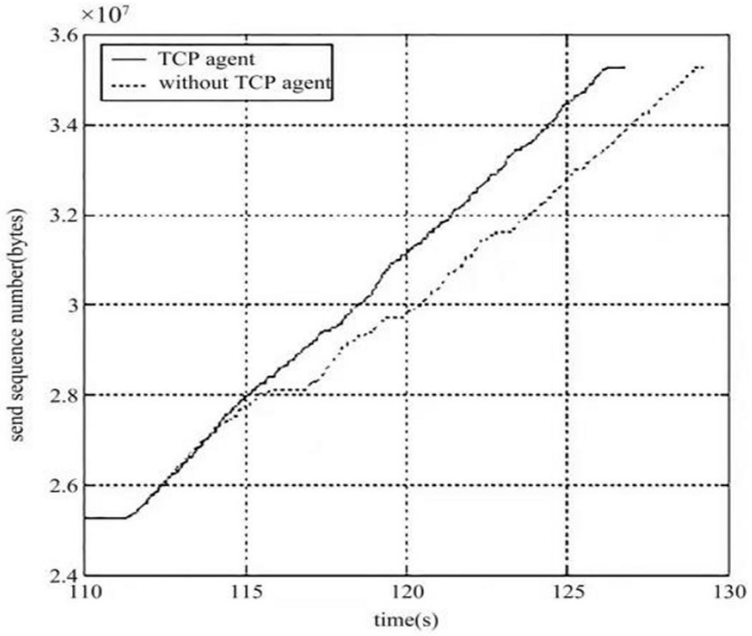

FIG. 4.2. *Comparison of transmission sequence numbers when single connection transmission rate is 150 PDU/ time slot and frame error rate is 10%*

decreases with the increase of transmission rate.

Increase frame error by 10% and load FTP service. Figure 4.2 shows the comparison of simulation curves of "sending segment number-time" when the sending rate is still 150PDU/ time slot. The solid line is the curve of increasing the sequence number of TCP sending segments with time after TCP proxy confirmation is started, and the dashed line is the curve of increasing the sequence number of TCP sending segments with time when TCP proxy confirmation is not started. According to the simulation data, the average throughput under two conditions can be obtained, in which the average throughput without TCP proxy acknowledgement is 4.4 Mbps, and the average throughput after TCP proxy acknowledgement is 5.073Mbps, which is 15.3% higher than the former. When the frame error rate increases to 20%, the average throughput rate increases even more, reaching about 45%.

As can be seen from the above figure 4.2, the total time spent after increasing frame errors increases because retransmission occurs, but the number of retransmissions decreases after TCP proxy confirmation is started. The figure 4.2 shows that when TCP proxy confirmation is not started, the increase of transmission sequence number is not completely linear, but some small "steps" appear, and each "step" means that retransmission has occurred. The retransmission occurred here is not a timeout retransmission, but a fast retransmission. The above conclusion can be easily drawn by comparing with the corresponding time in the plug window graph.

Figure 4.3 is a comparison diagram of congestion window size when the transmission rate is 150PDU/ time slot and the frame error rate is 10%. The solid line is when TCP proxy confirmation is not started, and the dashed line is when TCP proxy confirmation is started. It can be clearly seen from figure 4.3 that a slightly downward fold line appears around 1m56s of the solid line, which just corresponds to the first "step" of the solid line. This slightly downward broken line indicates that a retransmission has occurred. If you continue to enlarge Figure 4.3, you can see more retransmission places, which correspond to Figure 4.1 one by one.

TCP Protocols are mainly congestion avoidance and congestion control protocols. The above simulation only shows the superiority of TCP proxy confirmation technology in congestion avoidance stage. In order to reflect the performance of TCP in the congestion control stage, we should also simulate the processing ability of TCP when congestion occurs. In the simulation, if the size of the buffer at the receiving end is reduced, the buffer at the receiving end will be saturated soon when the frame error rate is large, and the message segment

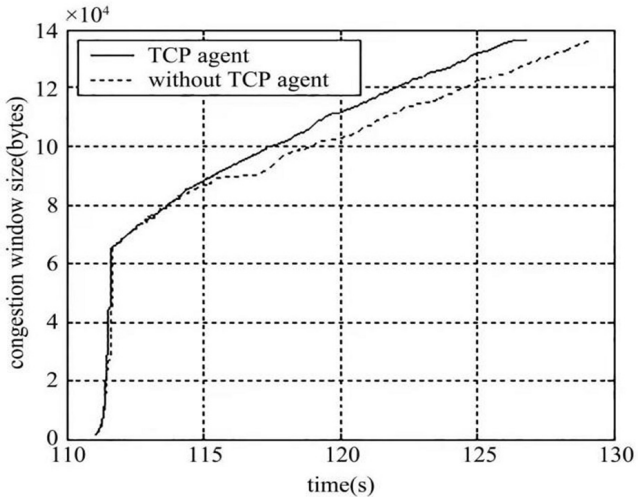

FIG. 4.3. *Comparison of congestion window size when single connection transmission rate is 150 PDU/ time slot and frame error rate is 10%*

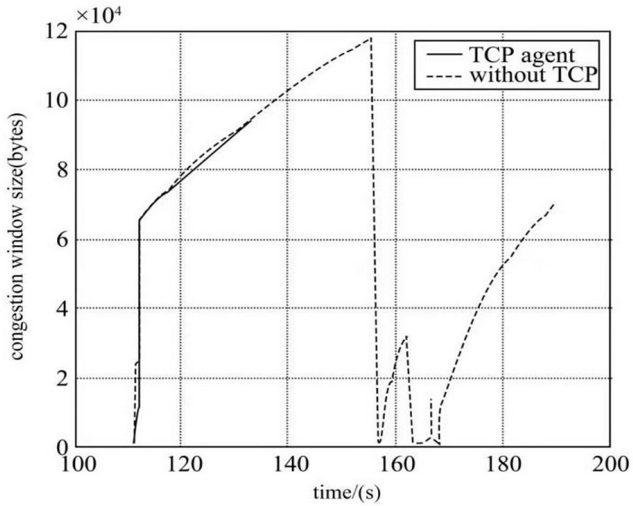

FIG. 4.4. *Comparison diagram of single connection congestion control stage*

sent later will be discarded. Once the sending end does not receive the acknowledgement after reaching the timeout, it will be considered that the link is congested, thus entering the slow start and congestion control stage.

In Figure 4.4, congestion is simulated. The simulation condition is that the transmission rate is 150PDU/ time slot and the frame error rate is 10%. In figure 4.4, the solid line is the simulation curve when TCP proxy confirmation is started, and the dashed line is when TCP proxy confirmation is not started.

The contrast in the figure 4.4 is very obvious. When TCP proxy confirmation is not started, the congestion window of about 2 m 37 s suddenly decreases to 1, which indicates that the sender detects timeout and TCP starts slowly. Moreover, it can be observed that the second slow start is entered because of timeout before the first slow start is over. Once the TCP starts slowly, it will degrade the performance of TCP a lot. After TCP proxy confirmation is started, the download time is short, and the congestion control phase is avoided. Because when TCP proxy acknowledgement is not started, if the burst frame error is high, the downlink data will be lost. Although ARQ is used for retransmission in the link layer, it is still possible to cause TCP

retransmission over time, and the uplink TCP acknowledgement segment will also be lost on the link, which increases the possibility of retransmission over time. After TCP proxy confirmation is started, it depends on ARQ confirmation information, so there is no problem that a large number of TCP confirmation frames are lost, and because ARQ confirmation efficiency is very high, it makes The validation efficiency of TCP is also greatly improved. This greatly improves the throughput of the link, so that FTP download with the same traffic can be completed quickly.

Simulation data show that when the frame error increases further, the performance of TCP deteriorates further when TCP proxy acknowledgement is not started, and the congestion window when TCP proxy acknowledgement is started always grows linearly, and the time taken is much less than that when TCP proxy acknowledgement is not started.

5. Conclusion. Under the condition of a single TCP connection, two stages of congestion avoidance and congestion control are simulated. The number of retransmissions when TCP proxy confirmation is started in congestion avoidance stage is less than that when TCP proxy confirmation is not started. Congestion control stage completely avoids the occurrence of congestion after TCP proxy confirmation is started, but when TCP proxy confirmation is not started, it will enter slow start for many times. The average throughput rate and average round-trip delay are improved in different degrees in the two stages. Under the condition of multiple TCP connections, the average round-trip time is greatly improved, and the average throughput of links is also improved. At the same time, the phenomenon of bandwidth preemption is found, which makes unfair among TCP connections. Due to filtering nearly 90% of uplink acknowledgement frames, the uplink bandwidth utilization rate is greatly improved. The performance of TCP has been improved, and it is observed that the worse the condition will be, the better its performance.

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RESEARCH ON MULTI-AGENT SYSTEMS IN A SMART SMALL GRID FOR RESOURCE APPORTIONMENT AND PLANNING

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Abstract. With the advancement in the technology, deployment of sensors in the industrial or public building is increasing rapidly. The basic aim is to obtain the data from the environment and decision making to the energy saving. The activities caused by the human results the undergoing negative change in the environment. There are many techniques available for decision making and consider the environmental factors solely which cause the energy consumption. However, user's preferences are not adapted by the systems, but at energy consumption optimization, these systems are very successful. The end-users use the system which considers the factors and their wellbeing are get affected. The distributed generation is incorporated by the Smart Small Grid (SSG), communication network and the sensors for the more reliable, flexible and efficient grid. The energy saving system is presented in this paper which also adapts to the inhabitants preferences apart from environmental conditions consideration. The architecture of Multi-Agent System (MAS) and the agents are utilized for negotiation process performance between the users comfort preferences and optimization degree that according to these preferences, achievement of system is done. The energy consumption of 40% is obtained and in the inhabitants' behavior pattern, the algorithm was specialized. The 16.89% of reduction is obtained by the existing system and it was focused to obtain the agreement between the system and users for user preference satisfaction and the energy optimization is also performed at the same time.

Key words: Multi-Agent System; Energy Saving; Consumption Optimization; Environmental Factors; Industrial or Public Building

AMS subject classifications. 93A16

1. Introduction.

The smooth and clean electric power is delivered by the smart small grid (SSG), the generators, archival and certain control units are comprised in it. The SSG is low voltage network, usually situated at the side of consumer [1, 2]. There is rapid increment of the electric power in the recent years for fulfillment of the daily basis needs. The sources of renewable energy are very efficient and the distributed generation sources control is also very effective with power storage devices. The renewable sources practice is increasing and taken attention in modern smart electric power grids as there is great demand of the electrical power [3]. The utilization of the renewable energy sources are utilized normally as they are eco-friendly. For the renewable energies, the fast technological growth is utilized for making the system more economical and for under-developing countries; the import of fossil fuels is reduced. The electrical energy is generated by the renewable energy resources at lower price. Without any environmental hazards, the living standards are improved [4, 5]. In supporting the distributed electrical network, it plays important role in the remote areas. In 2010, the wind energy generation's investment rate is very high, then reduction occurred in the next years but maintained till 2015. In the solar energy investment rate, the problem occurred after a year by wind power in contrast [6]. So, there is reduction again in the renewable energy generation investment rate during 2010 and 2014 but then again maintained in 2015. The several projects are funded by the different countries in spite of economic problems for the renewable energy sources connection to the power grids. The different energy sources are combined in the SSG like small wind turbines, and integration of the micro turbines with storage devices, like batteries connected at low voltage systems [7, 8]. For electric power distribution, there is installation of the different protection systems at every feeder. The basic hybrid MG architecture is depicted in Fig 1.1.

The distributed generation is incorporated by the SSG, communication network and the sensors for the more reliable, flexible and efficient grid. The reconsider of traditional power system operations is required by

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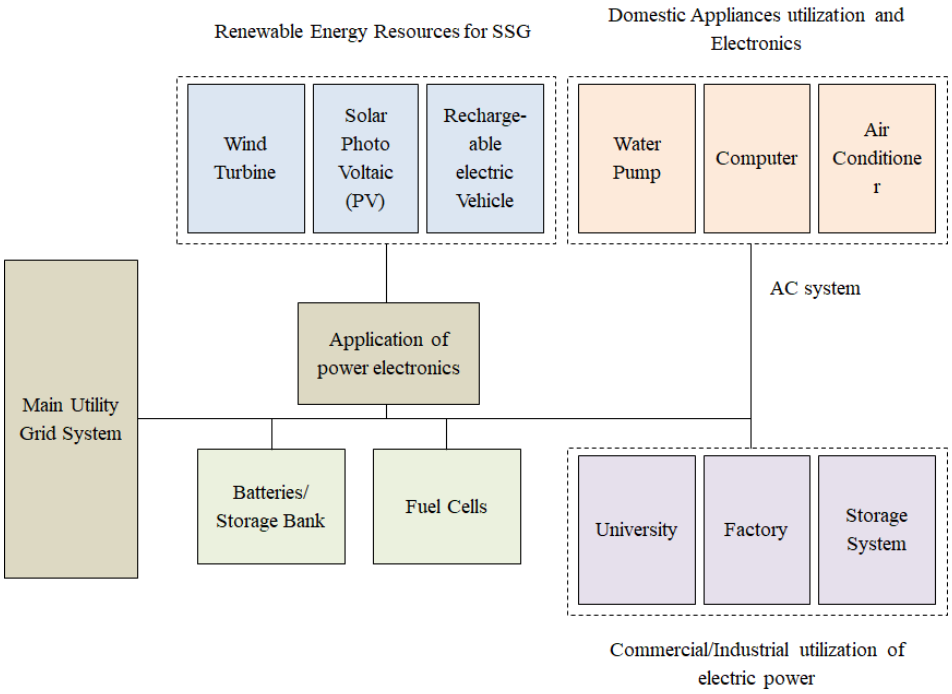

FIG. 1.1. *The basic hybrid MG architecture*

the power system paradigm for distribution systems and next-generation transmission. The competition is created in the energy market for power generation companies along with renewable energy sources integration [9]. The allocation of the generation sources is required properly for maximizing the profit by considering the customer demand. The many technological challenges are created by the increased Renewable Energy Sources (RES) penetration for the power companies to maintain the power quality to consumers. The power generation is maintained by the mixture of conventional and RES at the required level [10, 11]. The generators and allocating the required generation level commitment process has challenge to meet the increased demand. The centralized control is made by these factors and less effective for the data diversity and controls process [12]. The Multi-Agent Systems (MAS) concept solves this problem by utilizing the automated agent methods. At a component level, the centralized control system is converted by MAS into a distributed control model. According to rules and regulations, the numbers of objects are met by designing the MAS. A set of agents are integrated by an MAS system for communicate, coordinate and interaction for the objects establishment. The way referred by the self-coordination in which objective of consuming less resource are achieved by the system co-operations and also it consumes fewer resources. The communication plays very significant role in the MAS [13, 14]. The communication and self-organization's basic principles are maintained. An environment, objects and agents are consisted in the MAS and the entities performs a set of operations. The control schemes MAS ability prediction like artificial intelligence techniques and there is an additional advantage of expert system analysis hybrid controllers in SSGs. The MAS system incorporation becomes very easier, faster and feasible. The productions of distributed generators (DG) are enhanced and the electric power exchange is considered for optimization of the interconnected SSG operation [15]. The load demand of network is fulfilled by utilizing the MAS in the management system. This paper contributes the energy saving system which also adapts to the inhabitants preferences apart from environmental conditions consideration. The architecture of MAS and the agents are utilized for negotiation process performance between the users comfort preferences and optimization degree that according to these preferences, achievement of system is done. The MAS concept solves this problem by utilizing the automated agent methods. At a component level, the centralized control system is converted by MAS into a distributed control model.

The organization of rest of the paper is as follows. Section II provides an overview of the exhaustive literature survey is provided in section II followed by a research methodology adopted in section III. The obtained results are discussed in section IV. Finally, Section V concludes the paper.

The distributed generation is incorporated by the SSG, communication network and the sensors for the more reliable, flexible and efficient grid. The reconsider of traditional power system operations is required by the power system paradigm for distribution systems and next-generation transmission. The competition is created in the energy market for power generation companies along with renewable energy sources integration [9]. The allocation of the generation sources is required properly for maximizing the profit by considering the customer demand. The many technological challenges are created by the increased Renewable Energy Sources (RES) penetration for the power companies to maintain the power quality to consumers. The power generation is maintained by the mixture of conventional and RES at the required level [10, 11]. The generators and allocating the required generation level commitment process has challenge to meet the increased demand. The centralized control is made by these factors and less effective for the data diversity and controls process [12]. The Multi-Agent Systems (MAS) concept solves this problem by utilizing the automated agent methods. At a component level, the centralized control system is converted by MAS into a distributed control model. According to rules and regulations, the numbers of objects are met by designing the MAS. A set of agents are integrated by an MAS system for communicate, coordinate and interaction for the objects establishment. The way referred by the self-coordination in which objective of consuming less resource are achieved by the system co-operations and also it consumes fewer resources. The communication plays very significant role in the MAS [13, 14]. The communication and self-organization's basic principles are maintained. An environment, objects and agents are consisted in the MAS and the entities performs a set of operations. The control schemes MAS ability prediction like artificial intelligence techniques and there is an additional advantage of expert system analysis hybrid controllers in SSGs. The MAS system incorporation becomes very easier, faster and feasible. The productions of distributed generators (DG) are enhanced and the electric power exchange is considered for optimization of the interconnected SSG operation [15]. The load demand of network is fulfilled by utilizing the MAS in the management system. This paper contributes the energy saving system which also adapts to the inhabitants preferences apart from environmental conditions consideration. The architecture of MAS and the agents are utilized for negotiation process performance between the users comfort preferences and optimization degree that according to these preferences, achievement of system is done. The MAS concept solves this problem by utilizing the automated agent methods. At a component level, the centralized control system is converted by MAS into a distributed control model.

The organization of rest of the paper is as follows. Section 2 provides an overview of the exhaustive literature survey is provided in section II followed by a research methodology adopted in section 3. The obtained results are discussed in section 4. Finally, Section 5 concludes the paper.

2. Literature Review. In this paper, a distributed micro-grid control system (DCS) framework is proposed for micro-grid assets control which includes the loads and the point of interconnection [16]. For controlling micro-grid assets, the technique is proposed including distributed energy resources. A multi-agent system is employed by the design where each asset is assigned an agent. The DCS capability of meeting micro-grid dispatch is demonstrated by this work. The optimization of controllable distributed energy resources is done at maximum power point tracking. The different load types, sizes, and costs are considered to carry out the distributed load curtailment. The sourcing of critical commands is centralized by the features of the control system during emergency events. Reinforcement Learning, the electricity prices are fluctuating increasingly by the growing share of renewable power generation. To the volatile prices on the markets, energy demand of production processes is adapted to reduce the electricity expenses [17]. The new paradigm of energy flexibility is depicted by this approach for electricity costs reduction. The possibilities for decreasing energy costs are offered by utilizing the electricity self-generation. The battery storage and self-generation are included in the manufacturing system and the supply side. Due to unforeseen events, a complex optimization problem is represented by the coordination which is stochastic. An approach to controlling a complex system is presented in this system by utilizing the multi-agent reinforcement learning (MARL). The developed system is demonstrated in the study that outperforms the rule-based reactive control strategy (RCS). The state-of-the-art developments in MASs are reviewed in this article and this methodology contributed in various paradigms utilized in energy

optimization [18]. This paper describes the different types of agent-based architectures and analyzed the role played by the environment. For various purposes, the utilization of MASs is considered in this paper. The multi-agent systems are utilized in the energy optimization field to model energy efficiency solutions. To reduce the CO2 emission, the green energy technologies is adopted in the Micro-grid (MG). The solar photo voltaic (PV) [19]. The power system evolves the distributed energy resources, such as solar photo voltaic (PV), diesel engines, small wind turbines and fuel cell technologies. There is a great effect of this power maintenance on power systems. The main focus of this article is on MAS technologies for MG control and its optimization. The centralized and decentralized approach comparison is also detailed in this paper. Scalable Multi-Agent System (MAS) for operation of a Microgrid in islanded mode, scalable MAS is presented. An intelligent agent in MAS represents the autonomous element in the micro-grid [20]. The power production of local distributed generators is maximized by the MAS and the operational cost of microgrid subject is minimized. The objective of microgrid operation is done after the interaction of agents in MAS and the Power World simulator is utilized and no technical violation is confirmed. The studies present and demonstrate the proposed MAS effectiveness for microgrid optimal operation and also show autonomous built-in simulation of microgrids possibility. MASs for Resource Allocation and Scheduling in a Smart Grid For scheduling and allocation of resources in a smart grid, integration of Distributed Energy Resources (DER) is increasing in power grid [21]. The major resource allocation problems are Economic Dispatch (ED) and Unit Commitment (UC) in grid system. The resource allocation problems become more challenging by the renewable energy sources. The development of a decentralized approach is necessitating by the complex smart grid system and inter-node communication is allowed by it. The traditional centralized resource allocation aspects are decentralized by the MAS. Multi agent system: concepts, platforms and applications in power systems. The vital changes are experienced by the power system and it is advancing from centralized structure to a decentralized [22]. The new requirements are fulfilled by the systems and the restricted data transfer capacity for communications. Through the connection of these agents, accomplishment of degree of distributed or collective intelligence is done. A comprehensive survey on the power system applications is provided in this paper.

3. Proposed Methodology. In this section, the MAS-based architecture is presented which allows the measures simulation to obtain an optimization of energy. The lower energy consumption user provides the previous technologies synergies without sacrificing comfort in non-invasive way. There are three aspects in which the system should be focused.

1. Knowledge and learning.
2. The environment Communication, analysis and adaptation.
3. Decision making

There are two aspects that are the user knowledge and the environment knowledge on which the knowledge capacity is granted by the agents [23, 24]. The use knowledge means knowing all the user aspects which affect the energy consumption like preferences, habits, and timetables in the building. On the other hand, knowledge of the environment means the building's exterior temperature is required to be known like solar incidence, weather forecast. The previous data analysis will provide the MAS information which is utilized for the environment adaptation. The MAS capacity of self-adaptation allows the system to behave in deterministic way regardless of the context and the users are allowed for the detection of external consumption factors which influence consumption of energy, without having to make complex configurations [25]. The standard communication protocols are developed by the agents that allow the communication with the HVAC and lighting. Through the user's knowledge, the devices are completely and independently interacted by the system. It is necessary to deploy wireless sensor networks (WSN) in multi-story office building and the problems are presented that the ability to observe dynamic scenes by controlling the changes in status and the configuration [26, 27]. Different types of the problem are managed by the system by deploying the agents that utilized the techniques of Information Fusion (IF). The more precise data and estimates obtained from the individual or multiple sources. The management of the WSN user is facilitated by the system in which the complex configurations have not been performed. The goal of optimizing energy is achieved by the MAS with greater intelligence with the highest possible result. For the conception of technical development, the GAIA method has been utilized and this method focus on the software system design based on the agent's intelligent. This technique facilitating the problems solution that arises in the development and the main jobs utilized in MAS. The decomposition

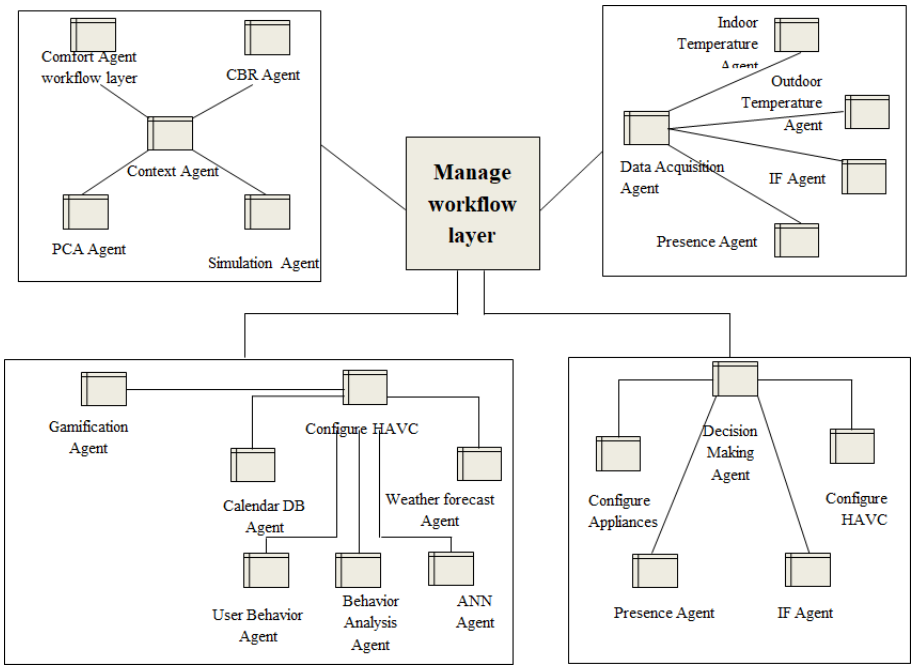

FIG. 3.1. *Architecture divided in layers according to the functionality of agents that integrate them*

of problem into sub-problems is very important. The layers are formed by different agents which encloses the system functionality. This structure of organizational is made according to the activities affinity that each of them performs, as shown in Figure 3.1.

Simulation Layer: The system's behavior is simulated by the layers which allow the term establishment and according to this the energy optimization is performed. The characteristics of environment are collected by the context agent and deployment of the system is done. A series of parameters are set by the Principal Component Analysis (PCA) agent in which optimization decisions are done and the parameters are obtained. The agent of this layer implements AI techniques and a case-based reasoning system (CBR) [28]. The previous optimization cases are collected by the system that allows us to obtain the consumption optimization. The simulation execution is allowed by the simulation agent by coordinating the system agents. The consumption data possibility is offered by it and WSN's each sensor collected in real time.

Manage Workflow Layer: The agents make up the system are coordinated by this agent and between the different parties, it established the communication [29]. The correct order for the each agent activity is allowed by this communication establishment. The need to automate actions is responded by the agent's inclusion which responds to frequent events.

WSN Data Acquisition Layer: The responsibility of data collection from the environment is on this layer. The external temperature and interior data are obtained by the agents of WSN data acquisition layer [30]. The data collection frequency is set by the data acquisition agent. Through a middleware, communication with the sensors is also established by this layer.

Knowledge Information Layer: The optimization activities are modeled by the information layer and the data from the WSN Data Acquisition Layer is also obtained. The behavior patterns of the IB users are analyzed by utilizing the behavior analysis agent [31]. The behavior patterns of the IB users is known and allowed the user behavior agent together with the gamification Agent.

Action Layer: The information from the other layers is utilized for making decision by this layer. The HVAC system, appliances configuring agent and configuration of consumption mode are configured by the agents [32].

TABLE 4.1
Energy consumption results in the different experimental periods

Simulations	Baseline Period (Wh)	Simulation Period (Wh)	Difference (Wh)	Savings (%)
Simulation 1	25.89	21.28	3.56	14.66
Simulation 2	25.89	21.12	3.84	15.93
Simulation 3	25.89	21.07	3.98	16.08

4. Results and Discussion. The system implementation results are described in this paper in the working environment (smart buildings) since one of the system objective is to be self-adaptive to the building characteristics. The validation of the different technologies coupling is the presented work purpose which is utilized in the different area of energy utilization. The different methodologies are integrated by multi agent system in the data management from WSN. The energy consumption data is obtained by the MAS if it was to be deployed in a household simulation. The two phases are consisting in the experiment. First is the baseline period in the first phase and the electrical consumption is monitored by the MAS. Each person's timetables are learnt and all the indoor and outdoor temperatures ($\circ$C) recorded. The simulation period is the second phase in which conditions of the baseline period is recreated for the proposal MAS efficiency evaluation. The optimization decisions made in the second phase made by the Decision Making Agent and the first phase conditions have been recreated. The decisions are made by the agent of decision making according to the comfort knowledge of the users. The climatic conditions are known in the first phase under which HVAC system temperature is modified by the users. The CBR system is implemented by the agents that predict the people presence and absence in home and adjust the HVAC system temperature. Lowering the temperature is consisted in the temperature settings when no one in the house and when inhabitants returns home, temperature increasing progressively. The database are connected to the agents from where it is obtained that the days are non-working. These agents have cooperation and it is possible to know which days the inhabitants may or may not spend on the floor. The system doesn't require the PCA agent as problem dimensions are very few which have been addressed.

The environment data is obtained by the mechanism in the architecture through a WSN. The simulation of the decision making is done although the communication with HVAC system is provided by designing the architecture. The system's increase, decrease, and turning on or off are allowed by the system. The device connection with the MAS system simulation is done by utilizing the IoT devices. The CBR system is implemented by the agent incorporation in addition to several technologies conjunction. The learning behavior pattern is allowed by it along with other variables. Through the floor schedules knowledge, translation is done into energy savings and schedules are learnt for intelligent thermostats programming. The MAS agents learning capacity incorporates and allowed a data analysis and automatically performed it. The system checked the data collection before new analysis which is same as of previous analyses. The system effectiveness is verified by the case study simulation and the consumption of 25.89 Wh is obtained in the baseline period. The maximum rate of 21.28% is achieved by the MAS system by carried out the simulations and user behavior recreation. The HVAC system is better adjusted by the CBR in each simulation stores. The results of each simulation are shown in Table 4.1 and presented graphically in Figure 4.1.

The consumption of energy is notably lower in the case study as presented in Table 4.2. It ensures that the decision for temperature reduction and devices are turned off when there is no one at home and energy consumption reduction is provided. The graphical representation is shown in Figure 4.2 for better visualization.

4.1. Comparison of the presented work with the existing technique. The effectiveness of the presented technique is shown by comparing the technique with the existing work. The energy consumption in terms of mean value is compared with the existing work which is obtained from the presented technique. The mean obtained from the presented technique is little less as compared to the existing techniques both in baseline period and evaluation period. The obtained mean values for baseline and evaluation period are tabulated in Table 4.3. For better analysis and visualization, it is also presented graphically in Figure 4.3.

The comparison is also done in terms of standard deviation of the existing and presented technique in terms of baseline period and evaluation period. The obtained standard deviation values for baseline and evaluation

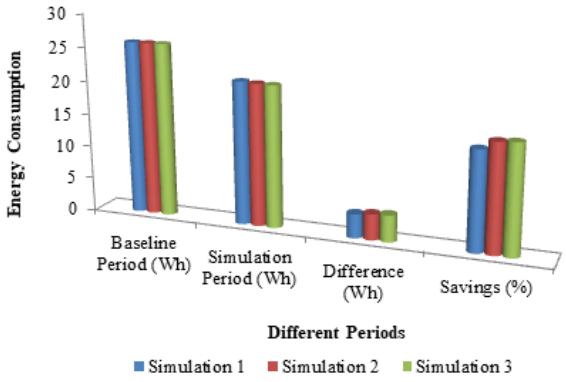

FIG. 4.1. *Energy consumption results in the different experimental periods*

TABLE 4.2
Difference of means and variances between the baseline period and the evaluation period of the simulations

Simulations	Baseline Period (Wh) (Mean value (kWh))	Baseline Period (Wh) (Standard Deviation (kWh))	Evaluation Period (Mean (kWh))	Evaluation Period (Standard Deviation (kWh))
Simulation 1	25.89	1.48	21.28	1.76
Simulation 2	25.89	1.48	21.12	1.54
Simulation 3	25.89	1.48	21.07	1.43

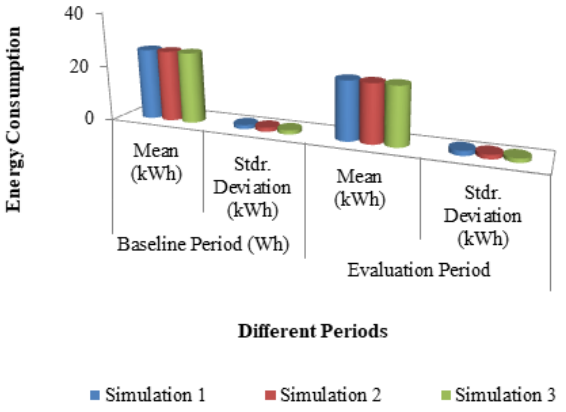

FIG. 4.2. *Means and variances between the baseline and evaluation period*

period are tabulated in Table 4.4. It is obtained from the table that the values calculated from the existing technique are more as compared to the presented technique. There are not that much variation in the obtained values from the existing and the presented technique. Graphical representations of the obtained values are shown in Figure 4.4 for better visualization and analysis purpose.

The percentage difference of the presented technique and the existing technique is also calculated to see the exact difference between the two techniques. The percentage difference is calculated for baseline and evaluation period for existing and presented techniques in terms of mean and standard deviation which are the main parameters. The obtained values are presented in Table 4.5 and also presented graphically in Figure 4.5 for

TABLE 4.3
Comparison of presented and existing techniques in terms of Mean value

Simulations	Existing Technique (Baseline Period (Wh))	Existing Technique (Evaluation Period)	Proposed Technique (Baseline Period (Wh))	Proposed Technique (Evaluation Period)
Simulation 1	26.19	22.33	25.89	21.28
Simulation 2	26.19	22.09	25.89	21.12
Simulation 3	26.19	22.01	25.89	21.07

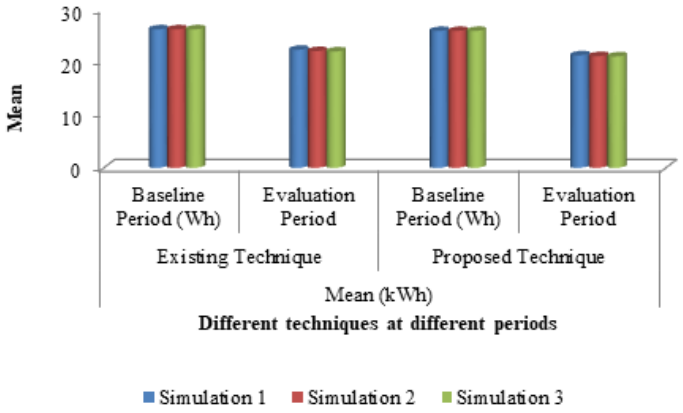

FIG. 4.3. *Comparison of presented and existing techniques in terms of mean value*

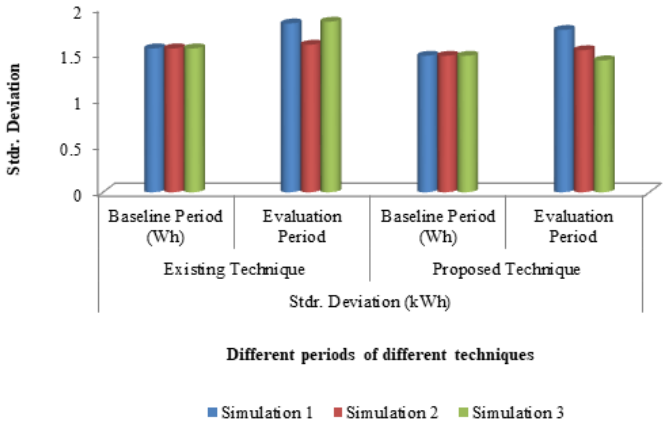

FIG. 4.4. *Comparison of presented and existing techniques in terms of standard deviation value*

better analysis and visualization.

The results obtained by the presented techniques and the existing techniques are compared and it is found that the values are comparable in both the techniques in form of mean and standard deviation. The energy consumption of 40% is obtained and in the inhabitant's behavior pattern, the algorithm was specialized. The 16.89% of reduction is obtained by the existing system and it was focused to obtain the agreement between the system and users for user preference satisfaction and the energy optimization is also performed at the same time.

TABLE 4.4
Comparison of presented and existing techniques in terms of standard deviation value

Simulations	Existing Technique (Baseline Period (Wh))	Existing Technique (Evaluation Period)	Proposed Technique (Baseline Period (Wh))	Proposed Technique (Evaluation Period)
Simulation 1	1.56	1.83	1.48	1.76
Simulation 2	1.56	1.60	1.48	1.54
Simulation 3	1.56	1.85	1.48	1.43

TABLE 4.5
Percentage Difference between the presented and existing technique in terms of mean and standard deviation

Percentage Difference	Mean (Baseline Period (Wh))	Mean (Evaluation Period)	Stdr. Deviation (kWh) (Baseline Period (Wh))	Stdr. Deviation (kWh) (Evaluation Period)
Simulation 1	1.16%	4.93%	5.41%	3.98%
Simulation 2	1.16%	4.59%	5.41%	3.90%
Simulation 3	1.16%	4.46%	5.41%	29.3%

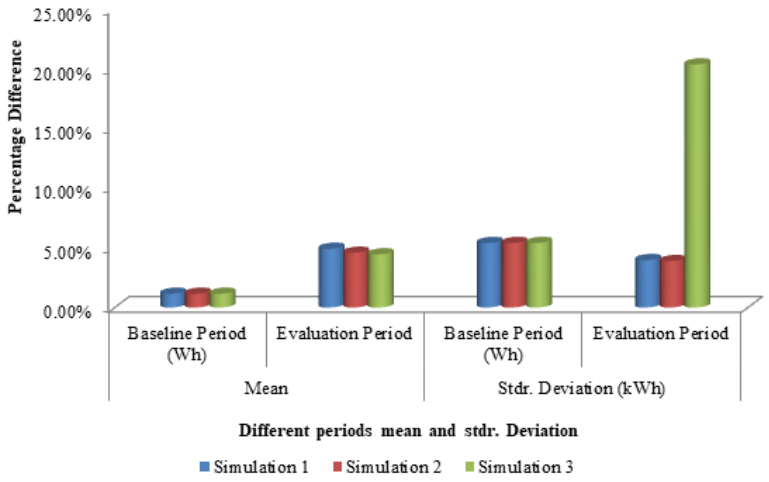

FIG. 4.5. *Percentage difference between the presented and existing technique in terms of mean and standard deviation*

5. Conclusion. The presented MAS concept solves this problem by utilizing the automated agent methods. At a component level, the centralized control system is converted by MAS into a distributed control model. According to rules and regulations, the numbers of objects are met by designing the MAS. A set of agents are integrated by an MAS system for communicate, coordinate and interaction for the objects establishment. The way referred by the self-coordination in which objective of consuming less resource are achieved by the system co-operations and also it consumes fewer resources. A WSN has been implemented in the agents within the multi-agent system developed. The environmental data is collected by the WSN to make it possible to meet needs of users' comfort. The negotiation process is performed between the user preferences and the system's decisions. The MAS is capable of monitoring and negotiating through the agent's deployment. The energy consumption of 40% is obtained and in the behavior pattern of the inhabitants, the algorithm was specialized. The 16.89% of reduction is obtained by the existing system and it was focused to obtain the agreement between the system and users for user preference satisfaction and the energy optimization is also performed at the same

time. The architecture of MAS and the agents are utilized for negotiation process performance between the users comfort preferences and optimization degree that according to these preferences, achievement of system is done.

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STUDY AND RESEARCH ON IOT AND BIG DATA ANALYSIS FOR SMART CITY DEVELOPMENT

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Abstract. With the development of smart meters, like Internet of Things (IoT), various kinds of electronic devices are equipped with each smart city. The several aspects of smart cities are accessible and these technologies enable us to be smarter. The utilization of the smart systems is very quick and valuable source to fulfill the requirement of city development. There are interconnection between various IoT devices and huge amount of data is generated when they communicate each other over the internet. It is very challenging task to effectively integrate the IoT services and processing big data. Therefore, a system for smart city development is proposed in this paper which is based on the IoT utilizing the analytics of big data. A complete system is proposed which includes various types of IoT-based smart systems like smart home, vehicular networking, and smart parking etc., for data generation. The Hadoop ecosystem is utilized for the implementation of the proposed system. The evaluation of the system is done in terms of throughput and processing time. The proposed technique is 20% to 65% better than the existing techniques in terms of time required for processing. In terms of obtained throughput, the proposed technique outperforms the existing technique by 20% to 60%.

Key words: Internet of Things; Smart city development; Processing time, Throughput; Smart systems

AMS subject classifications. 68M14

1. Introduction. Nowadays, with the advancement in technologies, there are many requirements and needs that are required to be full-filled. The Information technology is required always when we look at peculations in each and every form. In many community services like local departments, law enforcement, public libraries and learning institutions, there is always ease of access [1, 2]. Alternatively, the mitigated accesses of all the devices are encapsulated by Internet of Things (IoT). In the same way, to improve the outputs at greater levels and in order to pace up the accessibility, devices are meant to be automated. The automatization of the devices can be done by utilizing a single device like wrist watch etc [3]. The sensors can be used to automate the daily life operations for saving the human efforts and also time collaboration is reduced. The new advantages are added by the large data sets to the table in which high speed and efficiency is required. In previous time, the information is gathered, analyzed and updated by the companies for easy retrieval for decision making in future but nowadays, for faster decisions, the companies can easily find ideas [4, 5]. The faster processing is the greatest advantage in the companies nowadays that is never existed before. It is very important to deal with the big data and the quick and accurate decision should be the main goal. The clustering and a better understanding of the information led by the industrial awareness which can be controlled and the deviation analysis are performed from the patterns that can influence the business process outcomes. For the economic growth, the speculation of the whole smart cities is done in the development of urban areas which are feasible to rectify the technological dependent issues [6-8]. For digitized information exchange, the big data and Internet of Things (IoT) are utilized by the smart cities for the city services improvement w.r.t performance and wellbeing of citizens. The management of the urban flow is improved while developing the smart city applications. With time, the population in cities is expected to get doubled by 2060. The enormous pressure is increased by it. The integration of IoT and big data has the significant impression and implanted in the smart devices and directly or indirectly make available to billion people [9, 10]. The various inferences are deducted by applying the big data analytics. The quality of people's lives standards are raised by the IoT

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and big data.

The enormous volume of structured/unstructured data is described by the Big Data which is managed by utilizing the traditional databases. The exponential growth and availability is described by the big data and utilize the structured and unstructured information [11]. From smart cities applications, big data system will stock in an efficient way and the enhanced information is provided regarding the smart city services. The decision-makers are helped by this enhanced information in various smart city services. The volume, variety, velocity, variability and value are the different features of big data. The amount of data is referred by the volume feature. The structured and unstructured data is included in the variety feature of big data which is diverse in nature and from multiple sources. The velocity refers the speed which shows the flow of big data from diverse sources. In the structure and meaning of data, there is a constant change which is showed by the variability. The value feature of the big data shows the big data advantages which is provided to the business [12]. Hence, huge potential is depicted by the different features for advancements bounded by the available technologies to achieve the goals in smart cities. The correct tools and methods are required by the big data that give efficient results.

1.1. Challenges of big data and IOT in smart cities. As the smart cities are developing, there are many challenges that are faced while utilizing the big data and IoT during smart city implementation. The multiple sources and their formats are the biggest challenge and utilization of the traditional software for data processing is very difficult. The data integration is the challenge from different environments and intelligent devices. When information is passed, the scenario becomes more challenging and the privacy of the people's lives is prevented by the smart city solution [13]. The various organizations collect the data and data maintenance is very challenging. Without tampering the data quality, data is required to store in specific format with the incorporation of big data. In the big data environment the security of the data is also challenging as the data size is very high. A secured smart city is designed and the data breaching required be avoiding and properly encrypting [14]. With time and advancement in the technology, the smart city is becoming smarter than the past. Different types of electronic equipment are consisted in the smart cities applied by the applications, such as monitoring system's cameras and transportation system's sensors and so on. The individual mobile equipment is spreading with time. The different aspects of smart cities are smart buildings, smart technology, and smart infrastructure. The features of a smart city are shown in Figure 1.1.

According to geographical position, device aggregation is done in an IoT environment and it is assessed by applying analyzing systems. The utilization of the specific data by sensor services with the projects regarding the monitoring of each cyclist [15]. An IoT substructure is utilized by the lot of service domain applications for simplification of the air operations and noise pollution control as well as surveillance systems.

The aim of this paper is to propose a smart city development which is based on the IoT utilizing the analytics of big data. A complete system is proposed which includes various types of IoT-based smart systems like smart home, vehicular networking, and smart parking etc., for data generation. The rest of the paper is organized as follows. Section 2 provides an overview of the exhaustive literature survey followed by a methodology adopted in section 3. A detailed discussion of obtained results is in section 4. Finally, concluding remarks and future directions are provided in Section 5.

2. Literature Review. Nowadays, there are rapid evolvement of the Internet of Things (IoT) technologies and big data [16]. Hence major role is played for development of smart cities. A perfect blend is formed by the IoT and big data in fetching an interesting and novel challenge for smart cities. The business and technology related issues are focused by these new challenges that help smart cities for principles and vision requirement formulation. Authors in this paper analyze the big data role and the IoT technologies w.r.t smart cities. The benefits of big data and IoT in smart cities are also discussed by the author. In the new era, enhancement of the technological aspects is done with the rusty flaws mitigation and it encapsulates in a wide range of methodologies [17]. The human efforts are focused in daily based tasks done in the city and an enthusiastic solution is provided for the maximum level of ease incorporation. The automation of such tasks is involved in it to save time and ensure the productivity. The idea of automation is incorporated in city and the mechanism is controlled through the automation system like sensors etc. The bulk of data is there in form of database, device operational attributes and user responses and it is called IoT environment. The services provision and infrastructure is demanded by the population rapid growth in urban areas [18]. The IoT devices are utilized by

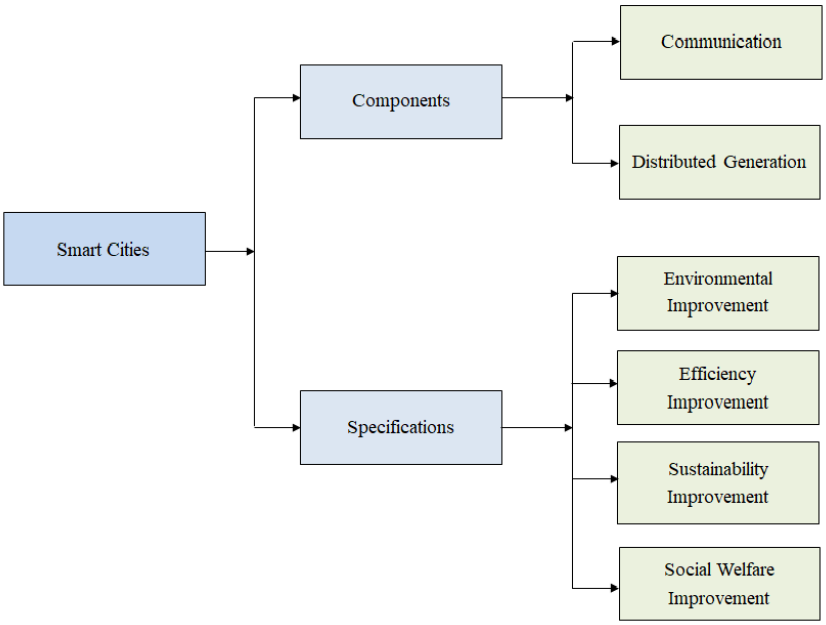

FIG. 1.1. *Key aspects of smart city*

it like sensors, actuators and smart systems. There is interconnection between thousands of IoT devices and they communicate with each other for smart systems establishment and the huge amount of data is known as big data. The integration of IoT services and Big Data process in an effective way is the challenging task. An IoT-based system is presented in this paper for planning super city by utilizing the analytics of big data. A complete system is proposed by the authors and includes smart systems like smart home, weather and water system. The efficiency of the presented technique is shown by the throughput and processing time. The smart city concept is adopted by many governments in their cities and big data applications are implemented that supports the components of smart city for the improvement of living standards [19]. The performance of health, transportation, energy, education, and water services are improved by the smart cities by utilizing the multiple techniques. The cost reduction and resource consumption is involved in it for more efficiently engaging with citizens. For the enhancement of smart city, big data analytics is the recent technology which is having high potential. Nowadays, almost everything is digital and collection of large data in the huge amounts of data accumulation can be utilized in various beneficial application domains. In many business and service domains, big data utilization and analysis is the key factor for success. The more facilities and resources are demanded by the large population density in urban areas. The Internet of Things (IoT) devices and the smart systems are utilized as the quick and valuable source to meet the requirements for the development of city [20]. Huge amount of data is generated by interconnecting the IoT devices and the Big Data. The IoT system using big data analytics is presented by the author for the development of smart cities. Various researchers utilize the existing datasets by including smart homes, pollution and vehicle for analysis and testing. The real-time system efficiency is tested by utilizing all the datasets and finally the system is evaluated in terms of throughput and processing time. The various kinds of electronic devices are equipped with the smart city with the smart meters expansion like Internet of Things (IoT) [21]. Therefore, technologies enable us to make smart cities more accessible and applicable. An inclusive review on the concept of the smart city is provided in this paper with their benefits. All across the world, implementation's key barriers are expressed thoroughly. The solutions of the smart cities are implemented monolithically from the sensors data through to the provided services [22]. The different developers faced the same challenges in a new city. The methodologies are presented in this paper for the minimization of the efforts for the new smart city implementation and the component sharing

are maximizing. The atomic service examples are detailed in this paper with some data predictor components. Furthermore, real-world atomic services are described by the usage in the scenarios of Santander. A side market is also generated by the atomic services that allow the expertise to be re-used by different stakeholders. The ability to management and remotely monitor is provided by the IoT from huge streams of real-time data [23]. A scalable IoT video data is offered by the model for smart cities for scalability exploitation to execute analysis on large datasets. The data analytics programming are provided by the model in which scalable analytics services are designed by the authors. The video analysis process is automated by the system and the manual intervention is reduced. The development of the design model is extended for IoT devices, message routing and data analytics. The Internet of things (IoT) in the smart city is examined, managed and controlled by the proper utilization of resources in smart cities [24]. The applications of IoT are used in the smart cities without human involvement [24]. There are interconnection between the IoT devices which communicate for different tasks. The huge volume of data is produced by billions of devices connected on IoT that is bound to cloud for processing and storage. The diverse research directions are produced by the IoT evolution for the smart city. A SOA (Service Oriented Architecture)-based platform is presented by the authors in this paper that enables the big datasets stemming social networking (SN) sites and IoT [25]. The application of data analytics are studied in this paper like sentiment analysis saved into an SQL database and algorithms are further investigated for minimization of dataset processing delays. A new era in urban research, planning and policy are defined by the big data analysis. The pattern detection and real-time data mining can now be carried out at a large scale [26]. The limitations of big data for urban policy and planning are discussed in this paper. A theoretical perspective is developed on urban analytics as a practice which is a part of a smart urbanism.

3. Research Methodology. The IoT-based Super City planning system is established for data generation and analysis. For safety, the numerous sensors deployment and other fixed devices are presented. For Super City planning, existing smart systems data in the city is utilized. The abundant amount of big data is generated by the systems and the sensors at very high speed. The data is processed in an efficient way by utilizing the Hadoop ecosystem. The proposed architecture is demonstrated in this section containing the sensors deployment details and how the data is generated by the system. The integration of the IoT-based smart systems is done with the city data generation for the super city planning and generation as shown in Fig 3.1. For future Super City planning, analysis of smart systems' large data is done which is stored in the large storage. The electricity consumption of the previous years is analyzed by the government authorities which gives the electricity demand prediction by the generated data by the homes. To produce more energy, the future needs are accomplished by taking the action by the municipalities. For power bill management, the analysis of the power usuage patterns with different time periods is done at all houses [27-30]. For various time-periods, various energy plans can also be set and design the future plan from data analysis of smart parking and vehicular traffic.

Furthermore, air-pollution causes are identified and environmental data is analyzed which is utilized for find the places with toxic gases. The pollution is reduced by the plans made by authorities e.g., transferring factories, diverting traffic, etc. similarly, by weather and water resources datasets analysis. The better strategies are made for electricity saving during the hot seasons on the basis of electricity expenditure and temperature datasets [31]. The unsafe places, number of crimes events, number of victims, etc. are investigated by utilizing the historical surveillance data. A model is also designed by the researchers for the implementation of the system that guide the authorities for the urban planning performance by the proposed system implementation. The Fig 3.2 presented this model; the large data is generated by every smart system in the beginning by environmental sensing. By utilizing the Zig-Bee communication, there is a connection of the relay node with every smart system. The data is then transmitted by the relay node to the analytical system which is passing through the internet [32, 33]. In the raw data, the majority information is the metadata from the sensors. Therefore, discarded all the irrelevant data and the sensor data has the message information and the identifier which is utilized for data classification. There is transformation of the classified data to the Hadoop readable file format like sequence file. The large amount of data is handled by it and an effective system is needed by the authors which process the huge amount of data speedily [34]. Hadoop ecosystem is deployed by the authors to fulfill the basic requirements and it is also equipped with master node and other nodes working under master node.

The large datasets are stored in the Hadoop ecosystem by utilizing the Hadoop Distributed File System

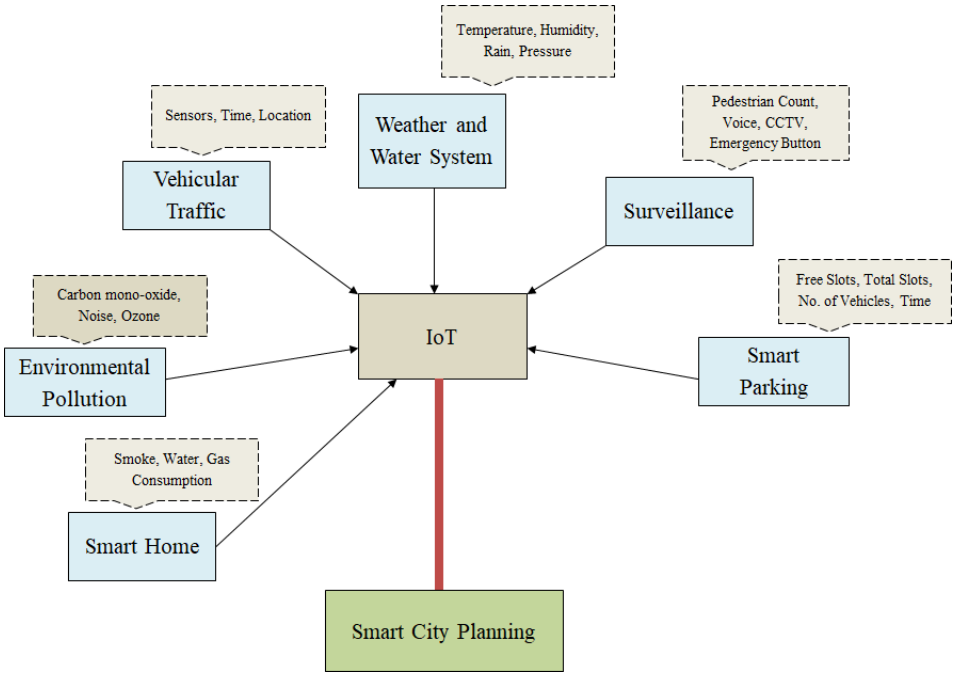

FIG. 3.1. *Integration of the IoT-based smart systems with the city data generation*

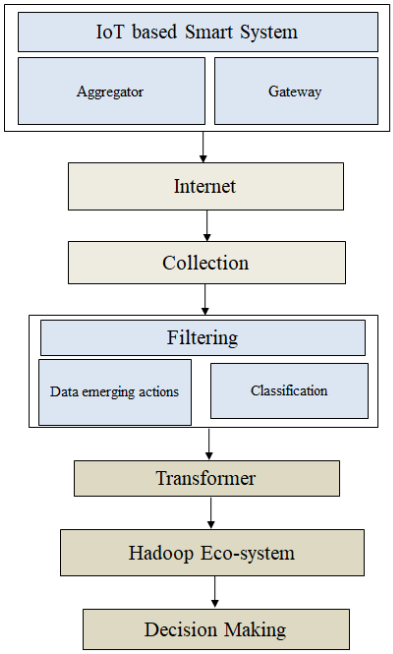

FIG. 3.2. *IoT based smart city system*

(HDFS) which divide them into equal sized chunks. These chunks are also stored by it in different nodes by duplicating every chunk on more than one data nodes for more safety and reliability achievement. The processing of these chunks is in parallel for performance analysis. All the generated chunks are then aggregated by utilizing the Hadoop eco-system reduce function. The decision making is then finally performed based on

TABLE 4.1
Processing time of various increasing size datasets

Dataset Size	Processing Time
70	20000
150	25000
300	30000
450	40000
1220	55000
1840	130000
3270	190000
5340	240000

the Hadoop ecosystem's results. The pattern recognition, soft computing models are utilized for the decision making approach.

4. Results and Discussion. For data generation, implementation of smart systems is very difficult at this time. So, from various reliable resources, already generated datasets are taken through the smart systems. There are different datasets which includes the flood dataset details the flood occurrence, the temperature and water usage of house collected by the smart home sensors, vehicle's information such as speed etc. The incessant measurements of heat, moisture, humidity, rain, etc. are included in the weather datasets.

By the parallel processing, huge amount of data is accomplished through Hadoop and analysis of such large data is really a challenging task. The government authorities are not only beneficial by the proper super city planning but with high security and healthy environment, it also benefits the public. For urban development various kinds of data is analyzed by authors and guidelines are given to the consultants that how the IoT technologies and the Big Data are utilized produced from IoT. By utilizing the presented system and the data analysis, the super city is achieved by the authorities for the citizens of the next generation. Mainly, vehicular traffic, smart home, flood, and pollution are focused for analysis. In Super City planning, analysis of smart home data played very important role including energy and water management, house building structure planning etc. The authors are presenting the water management analysis and individual house usage based planning. The water meter readings of 60324 houses and the reading period of house are consisted in the database. By analyzing the normal utilization of water at house, future need of water can be predicted. More than 7000-8000 cubic meters are consumed by more than 5000 houses as obtained by the analysis. The area wise usage of water is also analyzed from where flow of water is controlled by the authorities depending on the area requirement.

4.1. System Evaluation . The processing of big datasets is the main focus for the development of the system. The system effectiveness is focused by the authors while performing the implementation and evaluation of the system. The various datasets are taken for the system efficiency evaluation. The various heterogeneous datasets are merged into the single dataset to make the complex dataset. The system throughput and the processing time are the two main parameters to evaluate the system and measuring the system efficiency. The processing time of various datasets is tabulated in Table 4.1 which is also presented graphically in Figure 4.1. The Table 4.2 depicts the throughput results and graphical representation is shown in Figure 4.2. The time of processing is based on the datasets. Throughput of the system is inversely related to the processed data volume. The parallel processing Hadoop ecosystem environment results the inversely proportional throughput.

On the nation development, there is key influence of the city planning and decision control is increased. The IoT is utilized for planning the super city and the proposed implementation model is analyzed by utilizing the Hadoop. The functionality of data aggregation, processing and management is devised by the four tired architecture. The different smart systems generate the various datasets that are utilized for the analysis of the urban data. Data investigation and evaluation is also done. On the life of the citizens of coming generations, there is great impact of the presented system. Then the complex system is presented for planning of the super city by utilizing the IoT. The big data generated by the smart system is processed and the presented implementation model analyzed it by utilizing the Hadoop. The functionality of data aggregation,

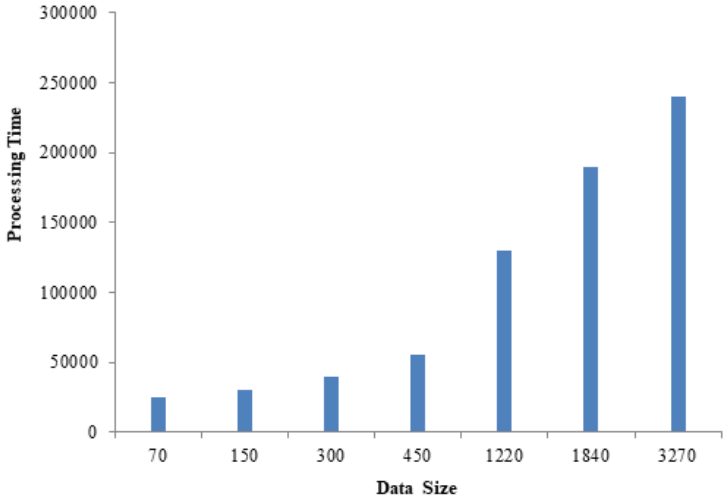

FIG. 4.1. *System processing time (sec) on increasing data size*

TABLE 4.2
System throughput for increasing size datasets

Dataset	Throughput (MBps)
100	5
200	7
300	8
600	9
1200	10
1800	15
3200	19
5300	22

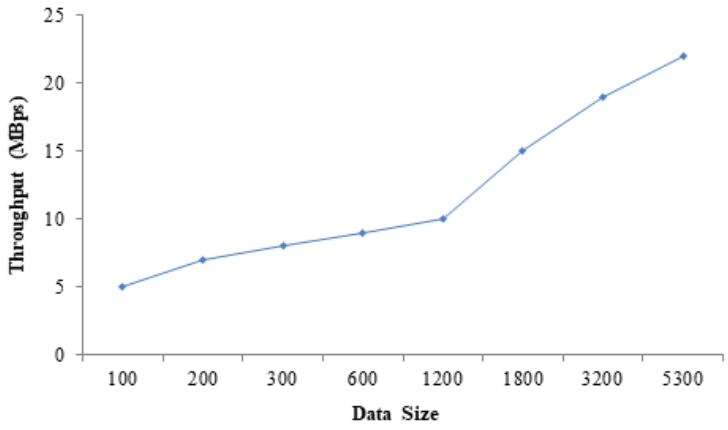

FIG. 4.2. *System throughput on increasing data size*

data processing and management is devised by the four tire architecture. On the coming generation's life, there is a major impact of the presented system and many facilities and needs are provided by the system. Based

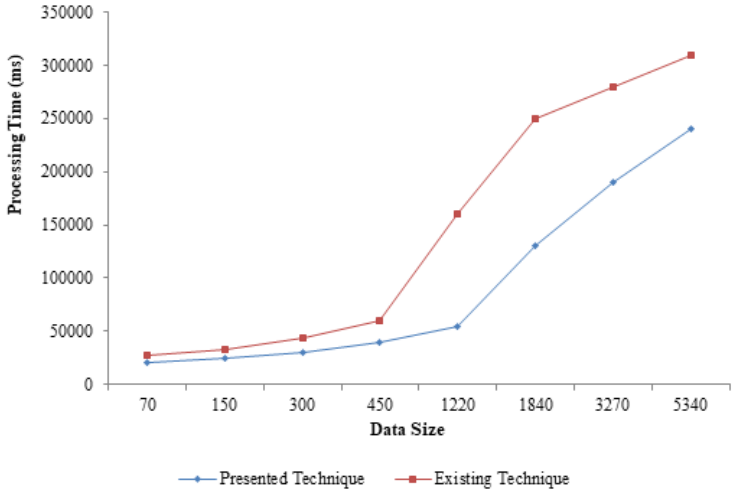

FIG. 4.3. *Proposed and existing system's processing time on increasing data size*

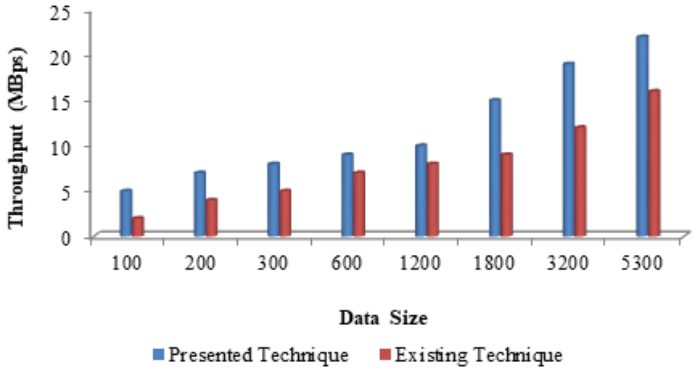

FIG. 4.4. *Proposed and existing system's throughput on increasing data size*

on the performance efficiency, the evaluation of the system is done and the system throughput and processing time are also focused. The performance of the system is extraordinary when large datasets are processed. The throughput of the system is increases with the increase of the data size.

4.2. Comparison of the presented Technique with the existing Technique. The performance of the proposed technique is also compared with the existing technique [18] for evaluation purpose. The comparison is done in terms of processing time taken by the system and the overall throughput obtained for different size of the data. The values of the processing time by the existing technique and the presented technique are presented in Figure 4.3 for better analysis and visualization.

It is clear from the Figure 4.3 that the processing time consumed by the proposed technique is less as compared to the existing technique. The presented technique is performed well while consuming less processing time as compared to the existing technique. The comparison is also made in terms of overall throughput obtained with the existing technique. The obtained throughput values obtained by the presented technique and the existing technique are presented graphically in Figure 4.4.

It is obtained from the Figure 4.4 that the proposed technique gives high throughput in comparison with the existing technique. The proposed technique performs well in terms of throughput while consuming the less

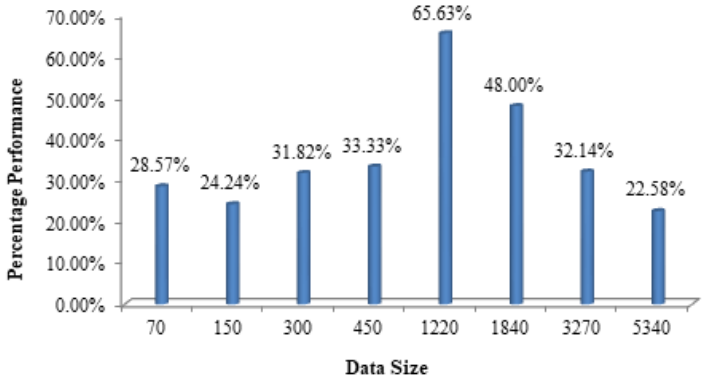

FIG. 4.5. *The percentage improvement of the proposed technique in terms of system's processing time*

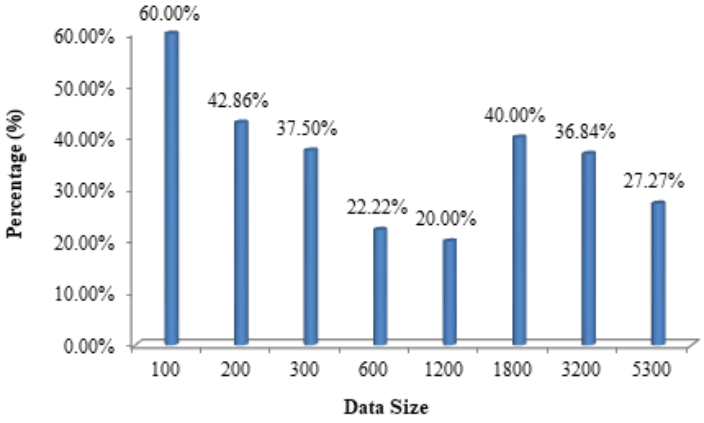

FIG. 4.6. *The percentage improvement of the proposed technique in terms of system's throughput*

processing time. The performance of the proposed technique is also evaluated by calculating the percentage of the proposed technique over the existing technique in terms of processing time and the obtained throughput. The graphical representation of percentage improvement of the proposed technique over the existing technique in terms of processing time is shown in Figure 4.5. The proposed technique is 20% to 65% better than the existing techniques in terms of time required for processing.

The percentage improvement of the proposed technique is also seen in terms of throughput over the existing technique. The graphical representation of the percentage improvement is shown in Figure 4.6.

It is clear from the Figure 4.6 that the high percentage performance is obtained by the proposed technique over the existing technique. The proposed technique is 20% to 60% better than the existing technique in terms of obtained throughput.

5. Conclusion and Future Work. The Information technology is required always when we look at peculations in each and every form. In many community services like local departments, law enforcement, public libraries and learning institutions, there is always ease of access. To facilitate the government as well citizens, an IoT-based system is presented in this paper. The government authorities are not only beneficial by the proper super city planning but with high security and healthy environment, it also benefits the public. Large amount of data is processed which is coming with high speed by the Hadoop ecosystem at the top of the layer. The system's efficiency is evaluated by utilizing the datasets of the existing smart systems. The

performance of the proposed technique is also compared with the existing technique for evaluation purpose. The comparison is done in terms of processing time taken by the system and the overall throughput obtained for different size of the data. The presented technique is performed well while consuming less processing time as compared to the existing technique. The proposed technique is 20% to 65% better than the existing techniques in terms of time required for processing. In terms of obtained throughput, the proposed technique outperforms the existing technique by 20% to 60%. The deployment of the system by utilizing practical smart systems will be in future directions. To achieve Super City, the smart systems can be integrated with the municipality's system in the future. The system security is also important as the high criticality of the system.

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CLOUD BASED RESOURCE SCHEDULING METHODOLOGY FOR DATA-INTENSIVE SMART CITIES AND INDUSTRIAL APPLICATIONS

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Abstract. For the data-intensive applications, resource planning and scheduling has become an important part for smart cities. The cloud computing techniques are being used for planning and scheduling of resources in data-intensive applications. The regular methodologies being used are adequately successful for giving the asset allotment yet they do not provide time effectiveness during task execution. This article presents an effective and time prioritization based smart resource management platform employing the Cuckoo Search based Optimized Resource Allocation (CSO-RA) methodology. The opensource JStorm platform is utilized for dynamic asset planning while using big data analytics and the outcomes of the experimentation are observed using various assessment parameters. The proposed (CSO-RA) system is compared with the current methodologies like particle swarm optimization (PSO), ant colony optimization (ACO) and genetic algorithm (GA) based optimization methodologies and the viability of the proposed framework is established. The percentage of optimality observed for CSO-RA algorithm is 97% and overall resource deployment rate of 28% is achieved using CSO-RA method which is comparatively much better than PSO, GA and ACO conventional algorithms. Feasible outcomes are obtained by using the CSO-RA methodology for cloud computing based large scale optimization-based data intensive industrial applications.

Key words: Resource planning and scheduling; smart cities; data-intensive industrial applications; Cuckoo Search based Optimized Resource Allocation; particle swarm optimization; ant colony optimization; genetic algorithm; large scale optimization.

AMS subject classifications. 68M14, 68W50

1. Introduction.

The concept of cloud computing has developed as a significant part of organizations involving computational models, industrial sectors and smart cities including different business assets in the existing situation. The innovative appearance of technology has reformed the cloud computing reforms as the third innovation over the most recent couple of many years [1]. With the development of information concentrated industrial applications, cloud computing has become the most generally utilized virtualization platform for industries and smart cities [2]. The different kinds of utilizations including distributed computing are web applications, appropriated applications like online business, and many more [3,4]. This innovation has arisen as another worldview for offering a reliable support in the current data intensive environment. The essential idea of cloud computing depends on its capacity that is intended to store the client information on web as an alternative of putting away it locally. With the fast improvement in energy utilization of the web-based information, time viability has become a main consideration for improving thee cloud computing exhibition [5]. The time viability of a distributed computing-based application is influenced by correspondence limit of web information for performing multiple tasks execution at a specified time [6]. Therefore, the general capacity as well as performance of cloud computing tasks can be improved by utilizing proper task planning and execution systems.

Recently, the issue of task scheduling has gathered the researchers' attention for improving the various factors of cloud computing environment like execution cost, resource utilization, consumption of power as well as its fault tolerance capabilities [7]. The finding of compromise between accurate time scheduling as well as least energy consumption has become a major research challenge. Cloud computing require the vast number of servers connected to the internet, therefore, there is a need for task scheduler to effectively arrange the

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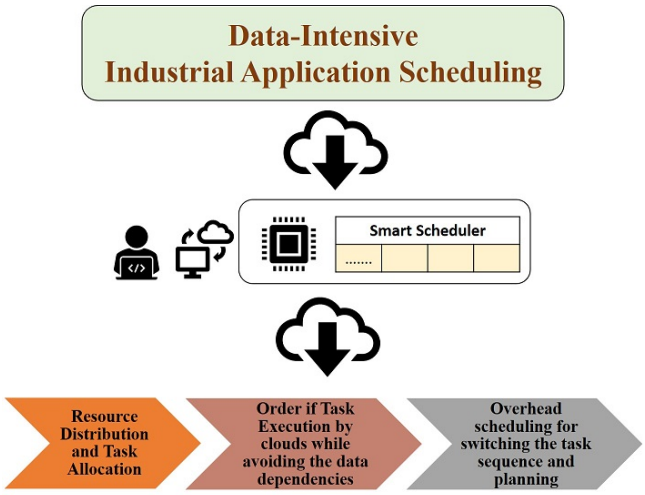

FIG. 1.1. *Concerning aspects of data-intensive industrial application scheduling*

execution of various tasks involved. The major factors affecting the performance of task scheduling algorithms is the time span as well as the energy consumed as the effective task scheduler should use fewer resources as well as consume less time [8,9]. These factors are specific in designing and implementation of the task scheduling strategies and plays a vital role in improving the fault tolerance capabilities of energy efficient tasks [10]. The various concerning aspects for data intensive application scheduling are depicted in Figure 1.1.

In the current situation, the task planning and asset allotment systems ought to be advanced for exact and precise asset provisioning and adaptable execution of cloud computing for data intensive applications [11,12]. There are different components of task allotment and scheduling revealed in the previous literatures which adds to the cloud computing-based computer programming structures providing various new methodologies [13-15]. However, some of these methods are not cost effective, error prone and are computationally complex providing a scope for improvement for current research paradigms.

This article presents a powerful asset for resource planning and execution for data-intensive smart city and industrial applications. An intelligent resource management platform is proposed in this research employing the Cuckoo Search based Optimized Resource Allocation (CSO-RA) methodology. Time prioritization is considered as the fundamental important aspect for this study and optimization is achieved using the cuckoo search mechanism. This approach poses the novelty of dynamic and optimized resource allocation that can accomplish effective scheduling and planning. Open source JStorm dataset platform is utilized in this article for dynamic asset planning while using big data analytics. The proposed (CSO-RA) system is likewise compared to the current methodologies being utilized in this field like particle swarm optimization (PSO), ant colony optimization (ACO) and genetic algorithm (GA) based optimization methodologies and the consistency of the proposed framework is established. The effectual time-sensitive resource scheduling is accomplished utilizing the proposed approach and its adequacy to perform better in the real time environment is justified by the comparative exploration.

The remainder of this article is organized as: Literature survey is given in section 2 which presents the contemporary related work in this field. The material and strategies used for this exploration work are given in section 3 followed by the outcomes of experimentation in section 4. Section 5 of this article gives the conclusion of this examination work alongside with the future exploration scope.

2. Literature Survey. The information concentrated data intensive frameworks have become a functioning exploration domain because of the usage of large information in the current innovative technological world. Different researchers inspected the utilization of huge information innovation using the big data analytics in the field of medical care, biomedical and informatics [16, 17]. In the last few decades, researchers in the do-

main of healthcare are utilizing the enormous information-based approaches for imagining new procedures and revelations for resource allocation. Different empirical and exploratory methodologies have been reviewed by the analysts to give better alternatives for task scheduling.

An empirical methodology has been adopted by Lee, et al. [18] for providing proficient resource scheduling and achieve effectual cost effective and least energy utilization outcomes. Nosrati, et al. [19] achieved the resource allotment task by recognizing the latencies in correspondence and geological distance of the framework. The optimization procedures are adopted in this approach for limiting the losses in energy utilization. Verma, et al. [20] introduced the resource allotment method that dynamically predicts the resource scheduling and allotment strategy avoiding high computational time and cost. Xiao, et al. [21] proposed a theory of resource distribution and allocation which can easily limit the energy utilization processes by optimized planning. A PSO based provisioning technique was introduced by Netjinda, et al. [22] for cost minimization and cloud provisioning and arrangement. Ding, et al. [23] assessed various techniques involving the resource allocation methodology for QOS aware applications while taking the nature of resources and various other related factors into consideration. A dynamic resource allocation platform was established by Koch et al. [24] utilizing the maximum likelihood estimation approach for resource optimization.

An application-oriented effort for resource allocation was presented by Peng, et al. [25] for workload management and resource allocation. Fereshteh, et al. [26] established a multiple objective based PSO platform for the allocation of resources as well as to maximize the customer utility. Thein et al. [27] carried away the work of an effective cloud-based resource allocation infrastructure while sidewise managing the cost and revenue resources of the data center. Yang, et al. [28] proposed an energy management platform for dealing with the energy utilization scenario based on the task scheduling and optimization mechanism. Tafsiri, et al. [29] proposed a linear optimization-based approach for strengthening the human relations as well utilize maximum of the pricing resources using auction-based methodology. A multi-specialist framework was described by Prieta, et al. which empowers the successful assignment of resources utilizing the cloud computing approach with worldwide coordination through web [30-32]. The researchers examined various downsides of conventional unified frameworks for allocation and planning of resources and its optimization [33-36]. In the recent literature, the authors have claimed that the cloud computing frameworks have become an important aspect of future internet-based mechanisms as they can adapt to the user demand and may realize dynamic resource management. However, resource allocation and planning are sometimes difficult for expanding information intricacy due to the effect of energy utilization. There is the requirement to keep a compromise between resource allocation, distribution and execution which is the research challenge for the researchers working in this domain.

3. Proposed Methodology. The significant goal of proposed CSO-RA methodology is to perform cloud-based resource allocation and distribution in order to improve the internet reliability of data by employing the time efficient approach. The significant target of this particular work is time prioritization therefore, an optimized cuckoo search algorithm is used for resource prediction and allocation. The proposed CSO-RA algorithm is depicted in Figure 3.1.

This algorithm is a natural-inspired optimization method that is completely based on the process of reproduction of a cuckoo bird. There are several constraints which restricts the CSO-RA algorithm like:

i. The nest is selected in a random manner by each of the cuckoo bird and it lays single egg in it.

ii. The host species may find the alien eggs in their nest and the probability of finding it is p [0,1].

iii. Only the eggs with good quality are carried over to the next generation, otherwise they are either thrown away or abandoned by the invaders.

These constraints should be accomplished in the minimum execution time slot available and they should comply with the characterized time constraints. Time prioritization is experimentally investigated using the different grouping scenarios and dynamic allocation is done to validate the proposed CSO-RA framework.

The proposed algorithm works well for resource scheduling while undertaking the real-time task execution. This methodology works well for the applications with information optimality having differing timing restraints. The execution strategy for the CSO-RA methodology includes various steps like checking the practicality of the assigned tasks then optimizing the capacity of resource storage for performing a particular task. The proposed algorithm should meet the base execution time and should comply with the characterized time restrictions.

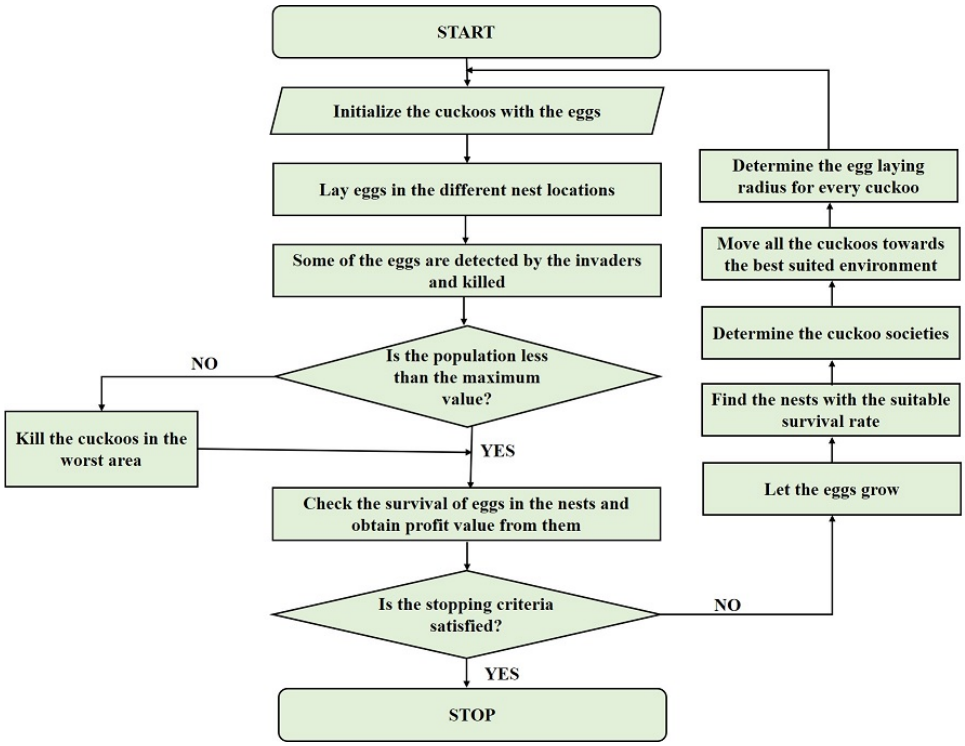

FIG. 3.1. *CSO-RA algorithm for efficient resource allocation*

TABLE 3.1
Experimental Simulation Environment

Resource Type	Simulation Environment Configuration
Hardware Resource	Intel ® Core 0.5-4 i5 processor
Software Resource	RAM 2-8GB, external storage: 1TB, Maven 3.2.2 Compiler and a single ethernet port

3.1. Experimental Simulation Environment. The experimental analysis of the CSO-RA algorithm is done using the different computer configurations. The computer configuration is varied in between 6 physical nodes which comprises of single master node, 4 computer nodes and 1 client node. The configuration of the system is varied in accordance to the user request and the opensource J-Storm platform is used in this experimentation for real time resource allocation and schedule planning. The entire experimental environment is tabulated in Table 3.1.

3.1.1. Performance Assessment Parameters. There are certain assessment parameters on the basis of which the performance of the proposed CSO-RA methodology has been assessed. The different assessment parameters exploited for this study are time-efficacy, average response time and resource deployment time.

i. Time-efficacy: The parameter Time-efficacy is evaluated as the ratio of successful resource allocation to the total number of resources requested in a specific amount of time. It is expressed by Eq. (3.1).

$$T_{Eff} = \frac{RA_{successful}(T_p)}{REQ_{total}(T_p)} \tag{3.1}$$

where $RA_{successful}(T_p)$ indicates resources, which are successfully allocated and the total number of resources requested are denoted by $REQ_{total}(T_p)$ in the time period (T_p).

TABLE 4.1
Test load specifications for different grouping mechanisms

Grouping Mechanism	CPU core utilized	Memory usage (in GB)
Group 1	0.5	2
Group 2	1	2
Group 3	2	4
Group 4	3	4
Group 5	4	8

ii. Average Response Time: Average response time is defined as the average time taken for the successful completion of the resource allocation task. It is articulated as the difference between the total amount of allocation time to the time in which actual processing is completed. The calculation can be done by using Eq. (3.2).

$$T_{Av} = \sum_{i-0}^{n} (T_p) \frac{D_j}{n(T_p)} \tag{3.2}$$

where T_p is the p^th time slot, $n(T_p)$ indicates the total resources to be allocated in time period T_p, the initial data point is denoted by j and D_j is the time delay during the actual processing.

iii. Resource Deployment Time: The resource deployment time is computed as the average of ratio between the exact usage of the resources to the entire resource allocation in a given time slot. It is expressed by Eq. (3.3).

$$R_{Deployment}(T) = 1/n \sum_{s=1}^{n} \frac{RA_{use}(T_s)}{RA_{allocation}(T_s)} \tag{3.3}$$

where $RA_{allocation}(T_s)$ are the resources allocated during the time slot T_s and $RA_{use}(T_s)$ are the resources which are actually utilized out of the total number of n resources.

4. Results and Discussion. The experimental analysis initially includes the assessment of CSO-RA methodology for the performance assessment parameters on the basis of information gathering mechanism. The time-viability for differing resource allocation scenarios is assessed and investigated followed by the assessment and comparison of state-of-the-art techniques. The experimental computations are done in terms of time-efficacy, average response time and resource deployment time for analyzing the impact of resource allocation configuration for different grouping mechanisms. The test load specification for each of the grouping mechanism is depicted in Table 4.1.

The tabular depiction of test load specifications reveals that the CPU core utilization for group 1 is 0.5 with 2GB memory usage which increases to 1 CPU core utilization with 2GB memory usage for group 2, and 2 CPU core utilization with 4GB memory usage for group 3. These values further increase for group 4 and 5 to 3 core and 4 core with respective memory utilization of 4GB and 8GB respectively.

4.1. Result evaluation considering the varying resource configuration. These configurations are used to compute the time efficacy as well as response time for the JStorm platform which are depicted respectively in Figure 4.1 and Figure 4.2.

It is seen from figure 4.1 that the initial resource configuration corresponding to minimum core requirement with less memory storage leads to the resource intensive CPU demand. In this case, the system is not able to obtain the sufficient amount of resources for data processing at the time of peak loads. This situation may lead to excessive data accumulation. However, if we see for group 2 and 3, there are sufficient amount of resources to ensure the data processing, while improving the time- efficacy of the system.

Considering the response time depicted in Figure 4.2, it is seen that the average response time is improving for all the grouping mechanisms. The gradual increase in response time enables the accurate processing of the

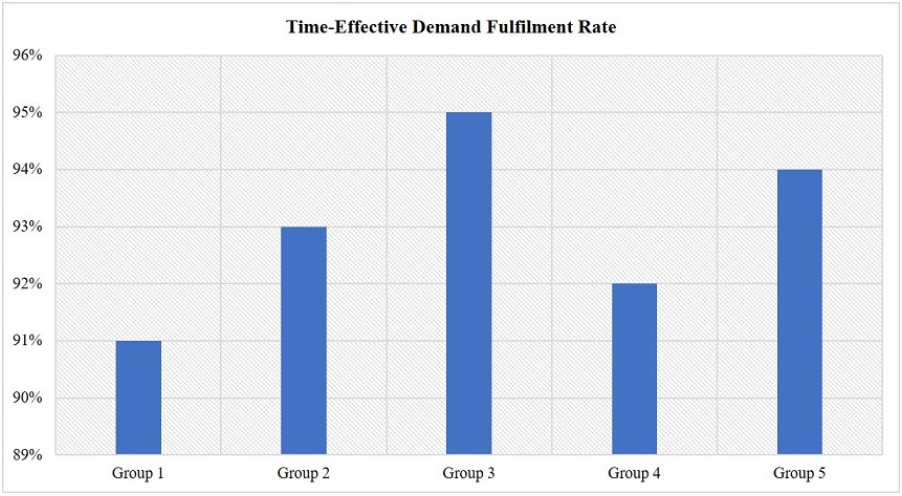

FIG. 4.1. *Time efficacy for test load specifications under different grouping mechanisms*

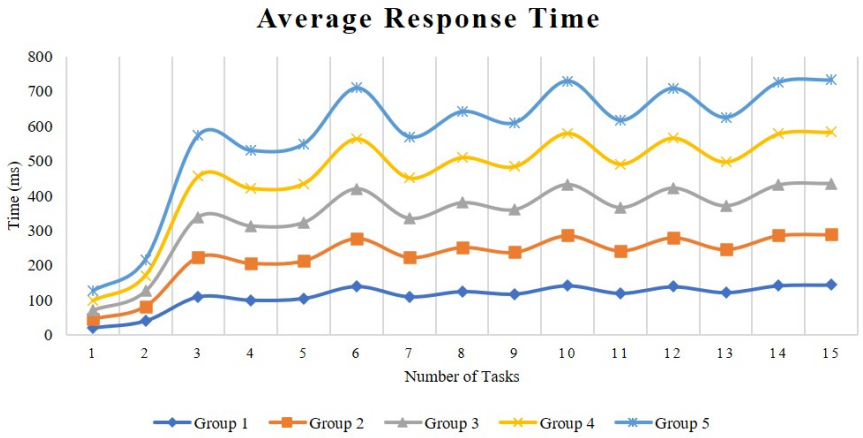

FIG. 4.2. *Response time for test load specifications under different grouping mechanisms*

data while significantly reducing the overall execution time. A comparative analysis is also drawn in this article in terms of resource deployment time for varying load specifications under different grouping mechanisms. This comparison is drawn in Figure 4.3.

The dynamic allocation accomplished in this article using the CSO-RA methodology has reduced the large queue of data for different component being deployed in the scheduling and planning mechanism. The resource deployment time increases during the peak load time and it in-turn minimizes the dwell time. All these assessment parameters also provide the information about the optimized reduction in complete processing time that also minimizes the overall time elapsed for the flow of data during the cloud computing process.

4.2. Comparative analysis with the state-of-the-art techniques. To assess the viability of the proposed CSO-RA methodology for task scheduling and planning, a comparative analysis is done with the three state of the art technique in terms of overall resource deployment rate and optimality rate. The compared techniques were particle swarm optimization (PSO), genetic algorithm (GA) and Ant colony optimization (ACO) approach. The comparison of overall resource deployment rate is done in Figure 4.4.

The comparison is drawn for different conventional approaches in terms of resource deployment rate for varying number of tasks. The proposed CSO-RA methodology provides stable performance comparative to the

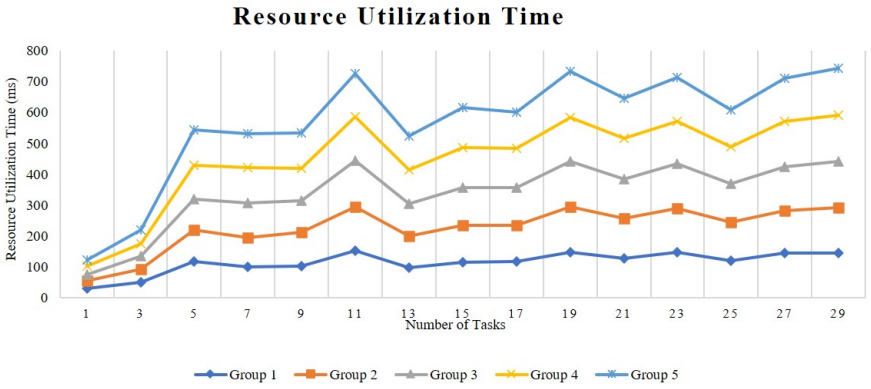

FIG. 4.3. *Resource deployment time for test load specifications under different grouping mechanisms*

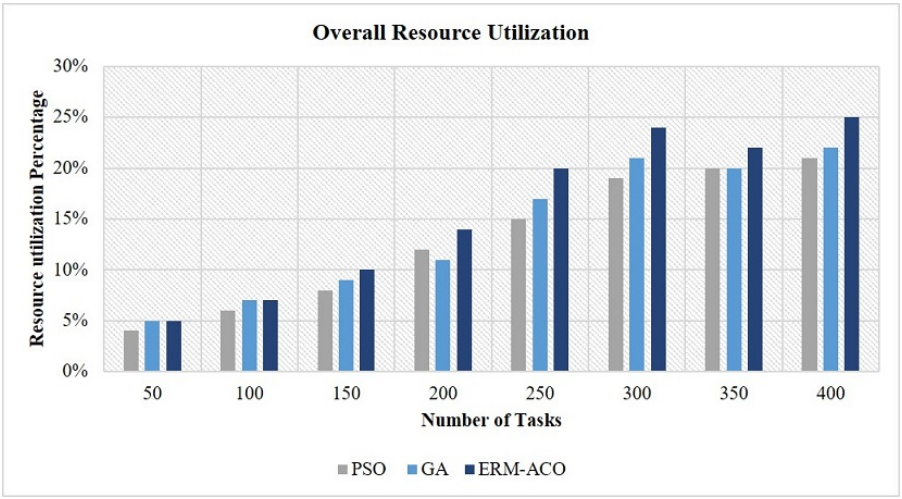

FIG. 4.4. *Comparison of overall resource deployment rate with state-of-the-art technique*

other PSO, GA and ACO algorithms. The performance of PSO, GA and ACO methods initially provides an upward trend however, a sharp fall is noticed toward the end when the number of tasks increases. However, a better gradual increase is noticed in the performance of CSO-RA algorithm when the increased number of tasks are involved.

A comparison for all these methods has also been done in terms of optimality rate for different quality of service and it is indicated in Figure 4.5.

The maximum optimality rate of 97% is achieved for the proposed CSO-RA technique which is far better than other algorithms providing 95%, 89% and 85% of optimality rate for ACO, PSO and GA algorithms respectively. It is observed that dynamic optimality value gradually improves with the increasing number of quality services and the best results are obtained for the proposed CSO-RA methodology.

As the number of task increases, the proposed CSO-RA algorithm performs much better comparative to the conventional approaches. All the resource deployment and allocation constraints are fully satisfied by CSO-RA methodology that provides the feasible outcomes for cloud computing based large scale optimization problems related to data intensive applications.

5. Conclusion. This article proposes an effective and time prioritization based CSO-RA methodology has been proposed in this article that provides a competent solution for data intensive applications. The opensource JStorm platform is utilized for the real time experimental analysis of the study and the outcomes of

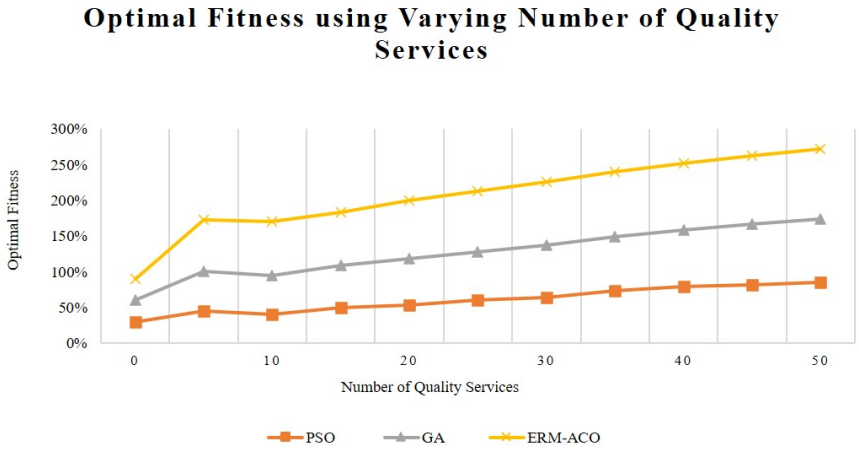

FIG. 4.5. *Optimality rate for different state-of-the-art techniques*

the experimentation are observed in terms of different parameters like time-efficacy rate, average response time, resource deployment rate and optimality value. The proposed CSO-RA methodology when compared to the presents overall resource deployment rate of 28% which is comparatively much better than the 21%, 22% and 25% respective rates obtained by PSO, GA and ACO conventional algorithms. The percentage of optimality observed for CSO-RA algorithm is 97% which is much better than 95% 89% and 85% optimality fitness values obtained for ACO, GA and PSO respectively. The CSO-RA methodology provides feasible outcomes for cloud computing based large scale optimization problems related to data intensive applications. The future perspective of this work is to extend its competence for other grouping mechanisms as well as varying cloud platforms.

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RESEARCH ON MOBILE USER INTERFACE FOR ROBOT ARM REMOTE CONTROL IN INDUSTRIAL APPLICATION

JIANGNAN NI* AND VIPIN BALYAN †

Abstract. The mobile interfaced robot arms are majorly being used nowadays in order to provide the remote-control applicability for various industrial and manufacturing applications. This article proposes a robotic arm platform for controlling the industrial application. The proposed system includes various modules like a robot arm, a controller module and a remote mobile operating application for visualizing the robot arm angles having real time applicability. Augmented reality (AR) is utilized for robot control WIFI communication and the robot angle information is obtained for varying real time environment. This novel approach incorporated the AR technology into mobile application which allow the real time virtual coordination with physical platform. The feasible trajectories are generated using the proposed methodology and a comparison is made between the desired and real trajectory paths. The simulation results are obtained for various assessment indicators and effectual outcomes are achieved with 98.03% accuracy value and 0. 185, 0.180 of error and loss values for training phase. The accuracy value of 97.65% is achieved for testing phase with corresponding 0.209 and 0.190 minimum error and loss values. The proposed platform provides the feasible and reliable outcomes in the real time environment for real time manufacturing industry applications.

Key words: Mobile interface; Augmented reality; real time environment; trajectory path; virtual coordination; manufacturing industry application.

AMS subject classifications. 65D19

1. Introduction. The advent of widespread utilization of wireless technology for mobile communication is now being used very often in the industrial automation and many other evolving sectors. The mobile systems are being used nowadays for the automation and mechanical movement [1]. There are several applications of industrial automation in various sectors like surveillance in army [2-4], different automation industry and petroleum, oil and other industrial sectors [5-7]. The various application of robotics in different industrial sectors indicates that the automobile industry plays a significantly leading role in the employment of robots [8]. The clear representation of various sectors utilizing the robotics are depicted in Figure 1.1.

The other sectors utilizing the robotics in day-to-day application are automatic surveillance systems initiated for the safety of mankind, gas monitoring and oil pipeline systems for controlling extremely high pressure [9]. For this purpose, small robots are employed which can easily fit inside the pipelines and move around in order to monitor the pipeline issues [10]. For the automobile industry, robots are used in the inventories for manufacturing purpose and also at the assembly line in order to obtain high accuracy and speedy manufacturing. Utilization of the modern wireless technology for the operation and control of manufacturing process make use of mobile devices for sending the commands to machine using a computer or a mobile system [11].

The robot systems used in the past few decades involve the robot arms or hand manipulators for the controlling purpose. The current act of robot arm controller involves the human specialists. These specialists train and coordinates the controller's developments for leading diverse pre-characterized tasks. The significant learning includes the changing of robot arm joint position, when any impediment is experienced by the controller during the pre-planned task [12-14]. This learning method is reasonable for a particular assignment and specific climate, yet as the work space changes, this kind of manual learning system fails. At that point, the robot learning should be done again for an alternate workplace or the dynamic environment. The other limitation of present methodologies in the robot arm controller is its optimality and undertaking adequacy. The manual

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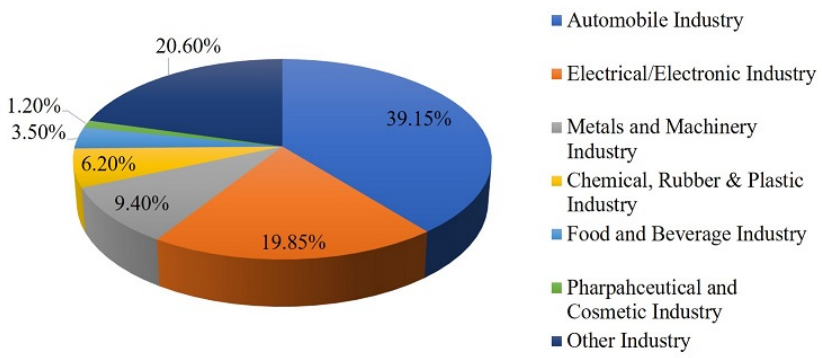

FIG. 1.1. *Industrial Applications of Robotics*

learning is task explicit, accordingly, tracking down an ideal way for robot controller in the dynamic environment is troublesome [15,16]. With the new progression in profound learning, neural networks and reinforced learning mechanisms are being utilized by the researchers for the learning interaction in different scenarios [17,18].

This article proposes a robotic arm platform for controlling the industrial application using the manipulation concept. The presented system comprises different modules like the robot arm, a controller module and a mobile operating application for visualizing the robot arm angles in real time scenario. This work focuses on the utilization of augmented reality (AR) application for robot control utilizing the WIFI communication channel. It contributes in obtaining the robot angle information using AR application in the real time scenario. This work specifically contributes in manufacturing industry, information technology and various other application platforms. The novelty of this work likes in the utilization of augmented reality into the mobile application, thus allowing the remote access of real time virtual coordination with the physical platform. The reference profile is created for programming the robot using a desktop application and the controller module is utilized for providing trajectory path to the joint movement of the robot arm. For the manufacturing industry application, the proposed platform provides the feasible and reliable outcomes in the real time environment.

The rest of this article is structured as: literature survey is presented in section 2 which is trailed by the methods and materials described in section 3. Section 4 presents the experimental results and analysis which is further trailed by the concluding remarks of the research work in section 5.

2. Literature Review. The utilization of robotics for the various applications in networking and various other industrial sectors originated from the concept of tele-robotics. Tele-robotics have been evolved with the development of internet and networking expertise. There are several networking robots developed by the researchers and various innovation have been done in this field [19]. There are several robotic applications which are being utilized for the public usage and exploration [20]. The network robot expansion has evolved the scope for integration in various domains.

There are various applications of robots in medical science field. The literature overview presented in [21] addressed the problem of invasive surgery using augmented reality system. Authors in [22] summarized the robotic systems using the virtual reality technology for the surgical assistance using the robotic platforms. Systems utilized in [23,24] consists of robot-based systems for providing assistance for efficient operation of surgeries for improving the safety of patients, medical manipulations, etc. they utilized the augmented reality-based platforms for the automated detection and diagnosis of the pathological regions. The recent work presented in Quero, et al. [25] dealt with the robotic platforms for achieving high precision for liver surgeries using 3D image visualization. The improvement in the surgeon perception is noticed by the utilization of 3D visualization method and robotics. Authors in [26] utilized the visual form of x-rays for getting the real time perception of invasive laparoscopic surgery. The robotics platform has been used for the integration of surgery and robotics

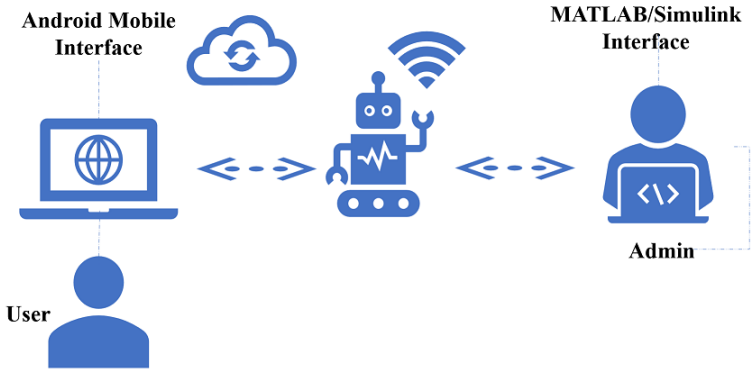

FIG. 3.1. *Workflow of the proposed system including various working modules*

in the medical scenarios [27]. There are various developments being noticed in recent literary work being done from the last 5 years.

Recently, there are various state of the art work in the field of simulation and design in industrial manufacturing domain. The article presented by Mourtzis [28] implemented a design and simulation platform for the manufacturing process and along with another author Mourtzis and Zogopoulos [29] an augmented reality-based interface is provided for supporting the assembly processing in the manufacturing industry. This industrial advent continued with the integration of robotics along with the warehouse designing in the papermaking industry [30]. For such application robotics plays a very important role in the industrial as well as programming platforms. Such applications of robotics in the industrial sector improves the significance of motion planning as well as robots while reducing the extensive human labor [31]. Ong et al. [32] interfaced the robotics in welding industry scenario for ease of workload reduction. Avalle et al. [33] also presented a scenario in which welding robots are developed for ease of programming and to complete the complex tasks with requirement of human expertise. Gong et al. [34] used the robot for providing technical assistance to the human operators for the reduction of cognitive workload. This can be accomplished by involving the robot-based object manipulation for real-time environment.

3. Material and Methods. This section provides the outline of the proposed system including three major modules like the robot arm, a controller module and a mobile operating application. The robot arm is responsible for the movement and the controller module receives the signal from the application platform and then send it to the robot arm encoder. The mobile operating application proves the real time visualization and remote access of robot angles using the augmented reality (AR) interfacing. The entire workflow of the proposed system is depicted in Figure 3.1 which is further detailed in this section.

- The admin sends a command to the robot arm using a desktop interface and a USB serial protocol.
- The robot arm controller encodes the command and revert back as the angular movements for each of the articulation which are plotted as graphs at the MATLAB/Simlink interface.
- The connection request is sent by the user from the mobile interface using the WIFI communication channel. The control unit of the robot arm accept this request and allow the mobile interface to establish the remote access interaction connection.
- Using this connection, the mobile interface is able to identify the robot arm locations specified by the controller module. The degree of each articulation is identified and displayed on the remote mobile interface.

3.1. Robotic arm and the controller module. The flowchart of robotic arm and the controller module is presented in Figure 3.2. The flowchart indicated in Figure 3.2 establishes a configuration routine using the USB connection for external communication. The connection request is made by the configuration manager and it detects whether any request is made either by the mobile or the desktop interface. The configuration connection requirements are verified and the base angle for the robot is generated. The robot arm angle is

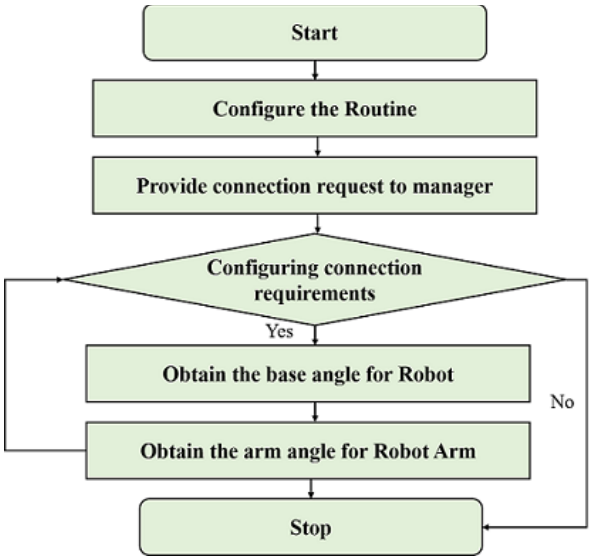

FIG. 3.2. *Flowchart of robotic arm and the controller module*

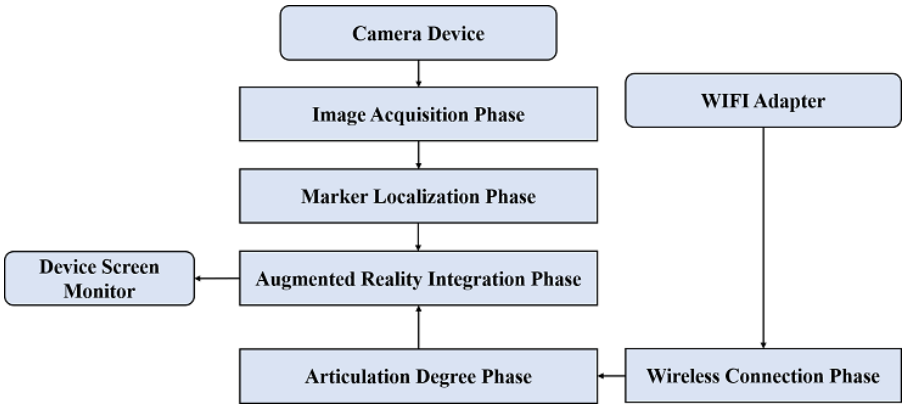

FIG. 3.3. *Main phases of mobile interface module*

obtained and articulated into digital form and these angle specifications are sent to the mobile interface using the WIFI connectivity.

3.1.1. Mobile Interface Module. The third module of the proposed system consists of the mobile interface whose main phases are depicted in Figure 3.3. The major phases in the mobile interfacing module are as follows:

i. Image Acquisition Phase: This phase acts as a connection in between the physical optical sensor and the application module. The image acquisition phase exploits a camera-based technique for the assessment of robot arm location.

ii. Marker Localization Phase: This phase is responsible for obtaining the robot arm marker locations from the input image or video captured using the image acquisition phase. The obtained image is used in the training phase for obtaining the specific marker locations and these locations are stored in the system so that it can be utilized in the testing phase.

iii. Degree Articulation Phase: It performs the operation of robot arm degree articulation depending upon the marker location defined by the marker localization phase. For each location marked, this phase specifies an angular degree which is to be passed to AR integration phase.

TABLE 3.1
Assessment Indicators

Indicator	Computation Formula	Eq. no.
Sensitivity (SN.)	$SN. = \frac{TP}{TP+FN}$	(1)
Specificity (SP.)	$SP. = \frac{TN}{TN+FP}$	(2)
Precision (PR.)	$PR. = \frac{TP}{TP+FP}$	(3)
F-Measure	$F - Measure. = \frac{2*PR.*SN.}{PR.+SN.}$	(4)
Accuracy (ACC.)	$ACC. = \frac{TP+TN}{TP+FN+TN+FP}$	(5)

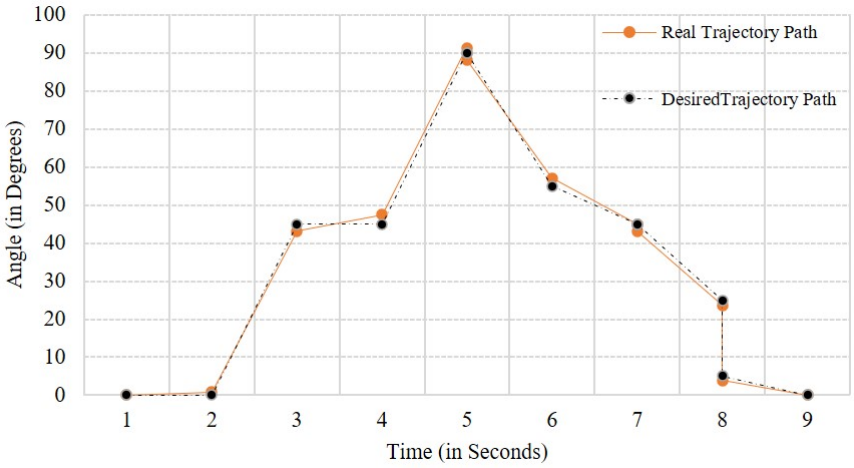

FIG. 4.1. *Analysis of real and desired trajectory paths*

iv. Wireless Connection Phase: This phase is able to detect the robot compatibility with the WIFI module and it is responsible for linking the robot device with the entire platform. The wireless linkage is able to link the data from the application to the platform and also responsible for activating the rest of the functionalities of the application module.

v. Augmented Reality Integration Phase: This phase obtains the input from the localization marker and degree articulation phase and then generates the projection image which can be seen on the monitor screen of the device.

3.1.2. Assessment Indicators. The confusion matric is created for the desired and the actual class and based on that matric, the behavior of the proposed framework is assessed using the true and false indications of the robot arm path trajectory. The different indicators utilized for this purpose are given in Table 3.1. TP, TN, FP and FN indicate the true positive, true negative, false positive and false negatives respectively.

4. Results and Discussion. The experimental set-up comprises of optical encoders with 12V DC motor, a WIFI module for communicating to the robot arm using AR application, a robot arm and a mobile interfacing device with a device screen camera at the back of the device. Several experimental tests are performed and comparative analysis is done for validating the trajectory localization and effectiveness of the robot arm platform for various applications.

4.1. Comparative analysis of the robot arm trajectory. A comparison is done using the MATLAB/Simulink environment which plots the graph between the desired and the real path of the robot arm. The movement commands are generated using the desktop interface for every movement of the robot arm and the articulation is processed by the controlling module of the robot arm. The analysis of real and desired trajectory path is done in Figure 4.1.

TABLE 4.1
Assessment indicator values obtained after experimentation

Performance Indicator	Training	Testing
Sensitivity (SN.)	98.28%	97.72%
Specificity (SP.)	97.54%	97.54%
Precision (PR.)	98.77%	98.36%
F-Measure	96.59%	96.59%
Accuracy (ACC.)	98.03%	97.65%

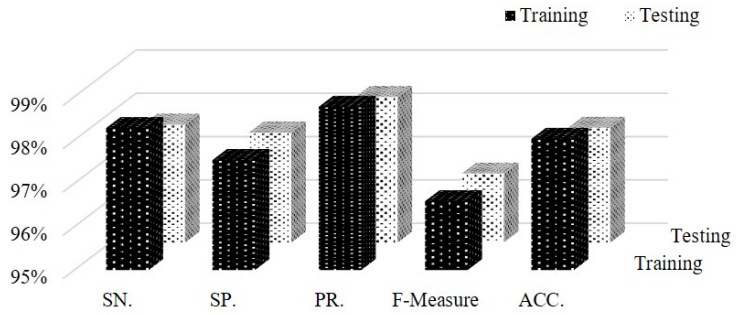

FIG. 4.2. *Graphical representation of assessment indicators*

The robot arm learning is done using the analysis of real and desired trajectory paths. Further, the planning and control action is determined by the learned path information. This learning is application for trajectory planning in case of unfavorable environment in the testing phase.

The data from training and testing phase are compared in terms of true negative, true positive, false negatives and false positives. On the basis of this information, the confusion matrix is created and the performance is evaluated in terms of various assessment indicators.

4.2. Performance evaluation in terms of assessment indicators. The performance of the proposed robot arm-based platform is assessed in terms of different indicators for both training and testing scenarios. Trained outcomes are stored as learning which are further utilized in the testing phase for dealing with unfavorable environment. The outcomes obtained are shown in Table 4.1 and its graphical depiction is provided in Figure 4.2.

These outcomes reveal the practicability of the proposed robot arm-based system as the SN., SP., PR., F-measure and ACC. values of 98.28%, 97.54%, 98.77%, 96.59% and 98.03% is achieved for the training phase and 97.72%, 97.54%, 98.36%, 96.59% and 97.65% are achieved for the testing phase respectively. The feasible and effective solution is achieved using the robot arm-based solution which is applicable for unfavorable industrial environment. The cost effectiveness is evaluated in terms of error and losses during the system integration and working which are depicted in Figure 4.3 and Figure 4.4 respectively.

The errors indicated in Figure 4.3 provides the depiction of reduction in error with the increasing number of iterations for both the training and testing phases. The minimum error value of 0.209 is achieved for 50th iteration in the testing phase which is a bit more comparative to the error value of 0.185 obtained for the training phase.

Figure 4.4 reveals that losses also reduces significantly with the increase in the iteration count. The minimum loss value of 0.180 is achieved for the training phase which is comparable to the minimum testing loss of 0.190 without leading to overfitting.

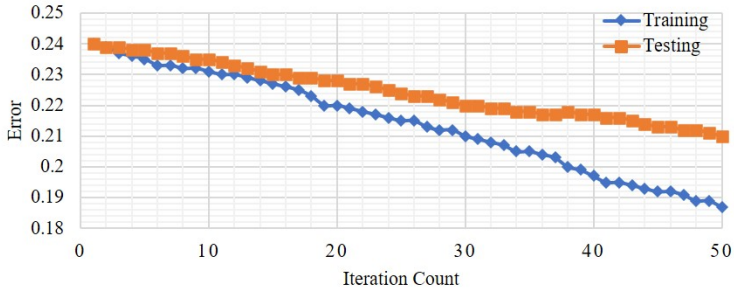

FIG. 4.3. *Error Rate outcomes*

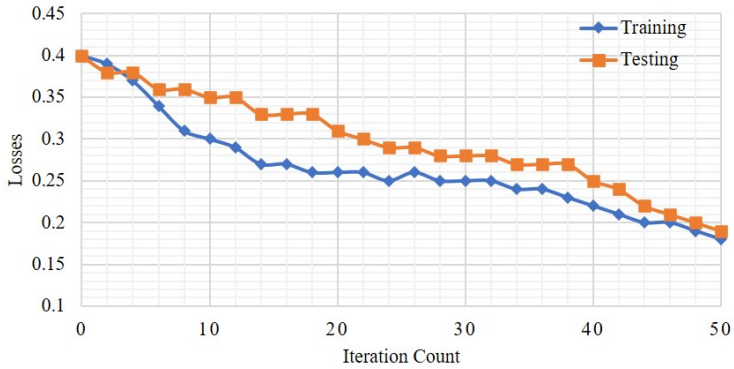

FIG. 4.4. *Loss Value outcomes*

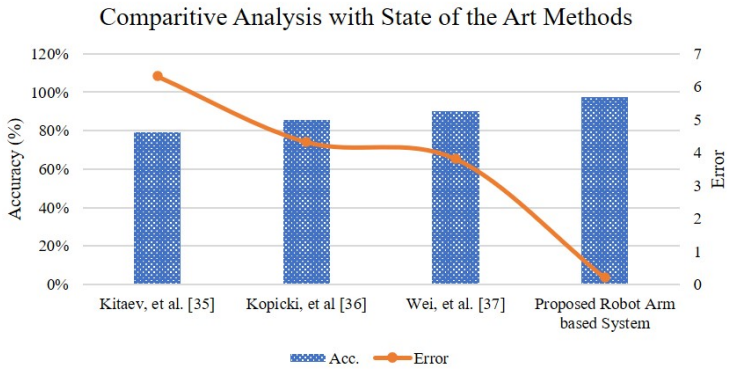

FIG. 4.5. *Comparative analysis with current techniques in this domain*

4.3. Comparative assessment with the current techniques in this domain. The comparison of the proposed robot-based solution is done with other state of the art research work going on in this field. The comparative study of accuracy and the error is depicted in Figure 4.5.

It is evident from the comparison of the proposed method with state-of-the-art methods that the proposed robot arm-based platform out performs the conventional methods by providing a maximum accuracy percentage improvement of 23.61% while obtaining an error minimization of 0.209. This comparative analysis reveals that proposed methodology is competent and reliable for monitoring the control and planning actions for unfavorable industrial applications.

5. Conclusion. In this work, a robotic arm platform for controlling the industrial application using the manipulation concept is proposed that utilizes the augmented reality (AR) application for robot control. The major components of the proposed system are robot arm, a controller module and a mobile operating application for robot visualization in real time environment. The feasible task-specific trajectories are generated using the proposed methodology and a comparison is made between the desired and real trajectory paths. The simulation results are observed using various assessment indicators which provides effectual outcomes for all the different environmental scenarios. The training phase provides the values of 98.28%, 97.54%, 98.77%, 96.59% and 98.03% for sensitivity, specificity, precision, f-measure and accuracy, respectively, while maintaining a reliable error rate of 0.185 with 0.180 loss value. Similar outcome trend is achieved for the testing phase by observing the sensitivity, specificity, precision, f-measure and accuracy value of 97.72%, 97.54%, 98.36%, 96.59% and 97.65% respectively with corresponding minimum error and loss values of 0.209 and 0.190. The optimal and effective outcomes are achieved by the proposed methodology in terms of all the assessment indicators. This work specifically contributed in providing reliable outcomes for unfavorable real time industrial environment. The perspective of this work is that in future the direct object recognition capabilities will be explored in this research in order to provide larger degree of freedom for different types of robot arms. Moreover, the practicability of the research will be established by using reinforced learning for much complex environments.

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A CLUSTER BASED INTELLIGENT METHOD TO MANAGE LOAD OF CONTROLLERS IN SDN-IOT NETWORKS FOR SMART CITIES

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Abstract. Software Defined Network (SDN) is a programmable network which separates the control logic-plane and hardware data-plane. The SDN centrally manages different Internet of Things (IoT) enabled smart devices like, actuators and sensors connected in the networks. Smart city infrastructure is an application of IoT network which purpose is to manage the city network without human interventions. To collect the real time data, such smart devices generate large amount of data and increasing the traffic in network. To maintain the quality of services (QoS) of smart city IoT networks, the SDN needs to deploy the multi-controllers. But the communication performance reduces due to unbalance load distribution on controllers. To balance the traffic load of controller an intelligent cluster based Grey Wolf Optimization Affinity Propagation (GWOAP) Algorithm is proposed when deploying the multiple controllers in SDN-IoT enabled smart city networks. The proposed algorithm is simulated and the experimental results able to calculates the minimum overall communication cost in comparison with Genetic Algorithm (GA), Particle Swarm Optimization (PSO) and Affinity Propagation (AP). The proposed GWOAP better balance the IoT enabled smart switches among clusters and node equalization is balanced for each controller in deployed topology. By using the proposed methodology, the traffic load of IoT enabled devices in smart city networks intelligently better balance among controllers.

Key words: Controller, CPP, IoT, SDN, optimization, smart city.

AMS subject classifications. 68M14

1. Introduction.

The new paradigms of programmable networking infrastructure is becoming popular because of its separation feature of data plane and control plane [1]. Such networks facilitate the flexible management in a complex large, distributed network. Software defined infrastructure centrally monitors the devices like, sensor and actuator which are connected in IoT networks to process real time data. The smart networking is significantly promoted by Software defined infrastructure due to limitation of existing IoT networking like, security issues, device management, configurations management and flexibility [2]. As number of smart devices increasing in smart city IoT network, the flow of heavy traffic are also increasing.

The smart cities are employed with the varieties of SDN-IoT networks by using with artificial intelligence in mobile networking, automatic traffic monitoring, streaming of videos, smart surveillances, secure communication and e-healthcare [3] [4] [5]. Such applications required high volume of real time data transmission with low latency. The traditional network environment is unable to meet the processing of such real time data with minimum delay. So, the SDN infrastructure is the promising solution of real time data processing in smart city networks.

For the number of real time devices in smart cities infrastructure a single controller is not sufficient. So, more controllers are needed to place to manage such SDN-IoT network [6]. But multiple controller placements are NP-hard problem with the issue of required number of controller and controller placement at optimal place to balance the traffic load at minimum latency. Still there are few challenges like, optimization of the multiple controllers and minimize the propagation delays in such networking so that costs may be reduced and performance may be improved [7]. The Controller Placements Problem(CPP) is described by Heller et.al. [8] and calculated the average delays between controller and switches. Jalili et al. [9] described the controllers

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placements problems and proposed a multi objective Genetic Algorithm (GA) that yield low memory space and better computations time. There are many optimization methods applied to solve such complex issues like, CPP. Gao et. al. [10] and K.S.Sahoo et. al. [11] studied the some optimization methods to maximizes the network survivability and minimize the latency and also suggested the Particle Swarm Optimization (PSO) based mechanism to solve the problem of CPP and managed the dynamic load over capacitated controllers.

Few researchers studied the multiple controller deployments approaches. To improve the controller's reliability and survivability in SDN, the multi controller's deployments strategies suggested based on capacitated controllers' and multi-path diversity method [15] [16] [17].

The current research works of CPP in programmable network concludes the multi controller deployments models which are commonly based on communication delays between switch to controller and controller to controller latencies. Such calculations of the communication delays are based on different optimization models.

Grey Wolf Optimization (GWO) [18] hunt the preys by using the supportive technique. This search method based on the hunting behaviour of grey wolves in nature. The wolf alpha (α) is the leader and beta (β) and delta (δ) follow the wolf alpha (α). The remaining wolves in pack are represented as omega (ω). Each wolf guides their subsequent wolf in the hierarchy to hunt the prey. The clustering algorithm Affinity Propagation (AP) [19] is based on similarities and data points between pairs. The similarities serve as the cluster centre and is selected by the greater value of similarities. The advantage of this algorithm is need not to initialized the cluster centre and cluster numbers.

The main contributions of the paper are:

- An intelligent cluster-based load balancing Grey Wolf Optimization Affinity Propagation Algorithm (GWOAP) is proposed to deploy the controller in SDN-IoT enabled smart city networks.
- An effective fitness function is proposed to minimize the overall communication cost in SDN-IoT networks.

The rest of paper is summarized as follows. In section 2, the related works are summarized, In section 3, the problem is mathematically formulated. Section 4, Discussed the related algorithm, Section 5, illustrates the network model and proposed GWOAP algorithm. The section 6 illustrates the result and discussion. Finally, section 7 concludes the paper.

2. Related Works. The benefits of Software Defined Networks always attracted to researchers in recent few years. The programmable network SDN centrally manages different IoT devices connected in the networks. SDN-IoTs network has significant attentions in both academia and industry.

Heller et. al. [8] introduced the Controller Placements Problem to decide how many and where controllers to be placed in SDN to achieve scalability. Author also discussed the challenges of CPP for each switch node and threshold of communication latency and fault tolerance.

Gao et. al. [10] suggested the PSO based methodology to solve the Controller Placement Problem and manage the dynamic load of controllers. Sahoo et. al. [11] proposed the CPP_PSO and CPP_FFA optimization methodology that minimizing the latency and maximizing the network survivability. Author also proposed a fitness functions to focused the network survivability which designed for reliable control plane.

Jimenez et. al. [12] used the K-critical methodology to deploy the minimum controller in the networks and found robust controller deployments. Ishigaki et. al. [13] suggested a controller deployment methodology based on node calculations index. Zhao et al. used affinity propagation to modify their methodology and suggested new clustering algorithm. Zhao [14] evaluated their algorithm and found better networks performance when compared with other clustering algorithms. Sallahi et. al. [20] evaluated the controller deployment cost and suggested a multi controller deployment model. Wang et. al. [21] used the capacitated controllers' approach to balance the load of controllers and followed the multi controller deployment strategies .

A small area network is efficiently manageable by a single controller due to its less overhead in network congestion. But for large area network the overhead of single controller increased and is insufficient to manage their network [22].

For a distributed Software Defined-IoT network to manage the flow of data multiple controllers are needed but the issue of multiple controller placements is challenging [23].

Onix [24], Hyperflow [25] , and Devoflow [26] were used as the distributed control architecture to solve the problem of reliability and scalability of SDN.

ONOS [27] and Open Daylight [27] are open-source controllers and used in large data centres and in WAN. These controllers are capable to control and manage the large data flow of IoT devices in smart city networks. A POCO model is suggested to consider multiple controller deployments optimizations. The Pareto methodology included the controller overhead and latency delay to consider the multiple controller placements optimization problems [28].

Liu et. al. [29] considered the propagation latencies, controller's load and suggested the networks clusters using PSO methodology . Beheshti et. al. [30] studied the SDN reliability as well as resiliency and evaluate the controller-switch performance. To deploy the controller heuristic approach is suggested to consider the reliability as well as resiliency in SDN network . Killi et al. [31] proposed the game theory and k-means partitioning method to place the multiple controller in large distributed network.

Keshari et al. [32] proposed an intelligent method to place the controller in SDN-IOT network. Here, author addressed the dynamic controller placement issue but when nodes increase the load balancing issue arises. Smart city network is employed with large IoT network infrastructure and to improve the better networking experience the virtual network placements are needed to optimize [33] [34] [35].

The above literature focuses on controller deployment only. Few researchers used partitioning clustering but dynamically load management is not suitable. Therefore, a cluster-based approach by using affinity propagation method is proposed where the cluster centre need not to initialize. In this paper, GWOAP algorithm is proposed to deploy the controller and dynamically mange the load of controllers.

3. Problem formulation. The network topology can be depicted like undirected graph $G(N, L)$, here N represent the set of forwarding node and L represent a link set. The node set consists of the switches and controllers.

Let $d(n, c)$ denotes the shortest distance paths between node $n \in N$ and controller $c \in C$. C denotes a set of all possible controllers, $C = \{c_1, c_2, ...c_x\}$.

Let $d(c_i, c_j)$ be the shortest path between controller c_i to controller c_j where $c_i, c_j \in C$.

If any i^{th} switch node is connected to a j^{th} controller node then the distance between i^{th} switch node and j^{th} controller node is $d_{ij}(i, j)$. The binary value $z_{ij} = 1$, which means i^{th} switch is successfully connected to j^{th} controller.

Then shortest distance between i^{th} switch node and j^{th} controller node is:

$$z_{ij} = \begin{cases} 1 : \textit{when switch } i \textit{ is connected to controller } j \\ 0 : \textit{otherwise} \end{cases} \tag{3.1}$$

Every controller in the network topology processes the request flow for all connected switches. The total traffic load processed by j^{th} Controller at time t is equal to sum of traffic flow by all connected switches in domain. Then,

$$\Theta_j^t = \sum_{i=1}^{N} l_{ij}^t \tag{3.2}$$

where, l is the load of i^{th} switch at time t. The processing capacity i.e. flow rate (kb/s) of controller is consider as A_j. Then, by the Queuing theory [36] and Littile's Law [37].

The mean waiting time to process the flow by the j^{th} controller is:

$$W_j^t = \frac{1}{A_{j-}\Theta_j^t} \tag{3.3}$$

If the total node $|V| = |N| + |C|$ then the total average response time for j^{th} controller is:

$$\Delta t_j = |V|^2 * W_j^t \tag{3.4}$$

Δt_j is considered as average processing times for j^{th} controller. So, at time t, the average controller's response times for the controller and switch is:

$$T^t = \frac{\sum_{j=1}^{c} \theta_j^t * \Delta t_j}{\sum_{j=1}^{c} \theta_j^t} \tag{3.5}$$

To calculate the total load cost, we have to find out the individual cluster domain cost i.e. intra domain cost and inter domain cluster cost. Considering here intradomain constant flow rate is v.

Then intra domain cost is:

$$T_{intrad} = 2 * v \sum_{j \in c} \sum_{i \in N} \left(\left| \frac{l_i^t}{v} \right| d_{ij} * z_{ij}^t \right) \tag{3.6}$$

And inter domain cost is:

$$T_{interd} = v \sum_{j \in c} \sum_{k \in c} d_{jk} \tag{3.7}$$

So, Overall Cost:

$$Total_{min} = \gamma * T_{intrad} + (1 - \gamma) * T_{interd} \tag{3.8}$$

Where, the weight factor , controls the inter domain and intra domain communications cost.

4. Related algorithms. Grey Wolf Optimization (GWO) [18] follow supportive techniques to hunt the preys. The search method in GWO algorithm is based on the grey wolves hunting behaviours as observed in the nature. There is wolf alpha (α) who is the leader of their pack, then there are another supportive leaders beta (β) and then delta (δ) who follow the wolf alpha (α). The rest wolves are considered as omega (ω). Every wolf has their own responsibility which is represented as hierarchical structure that leader alpha (α) is on top position that provides the first solution. Other wolves respectively, beta (β), delta (δ) and omega (ω) provides the subsequently second, third and final solution. Lastly, omega (ω) wolves are guided by their previous three leaders.

When all wolves find the prey, then there are three variables of coefficients that are enclosed with prey and use the encircling mechanisms.

The encircling mechanisms defined by following equations:

$$D_\alpha^{'} = |C_1^{'}.X_a^{'} - X_i^{'}|$$

$$D_\beta^{'} = |C_2^{'}.X_\beta^{'} - X_i^{'}|$$

$$D_\delta^{'} = |C_3^{'}.X_\delta^{'} - X_i^{'}|$$

$X^{'}$ is the symbolizes the position vectors for the grey wolves and denotes the iterations. Then, $X_i^{'}$ denotes different wolves α,β and δ.

$$X_1^{'} = X_\alpha^{'} - A_1.D_\alpha^{'}$$

$$X_2^{'} = X_\beta^{'} - A_2.D_\beta^{'}$$

$$X_3^{'} = X_\delta^{'} - A_3.D_\delta^{'}$$

and

$$X_{i+1}^{'} = (X_1^{'} + X_2^{'} + X_3^{'})/3$$

$$C = 2r_2$$

$$A = 2 * a.r_1 + a$$

C and A are coefficients vector, whereas a is the controlling variable parameter to change the coefficient A.

1. Initializes the populations $X_m^{'}, (m = 1, 2, ..., n), X_\alpha^{'}, X_\beta^{'},$ and $X_\delta^{'}$
2. Set the C and A vectors.
3. While $(i < Maxi)$
4. For every search agents
5. update present locations search agents.
6. End For
7. Update A, C and a
8. Evaluating the fitness function
9. Update $X_\alpha^{'}, X_\beta^{'}, and X_\delta^{'}$
10. $i = i + 1$
11. End while
12. return $X_\alpha^{'}$

Affinity Propagation (AP) [19] is the clustering algorithm based on data point as input and similarities between pairs. By using the negative Euclidean distance, first denotes the similarities between available data point.

Suppose, $x_i = x_1, x_2, ..., x_m$ is data set for m objects. The Similarity is

$$S(i, j) = -\|x_i^2 - x_j^2\|$$

where $i, j \in [1, m]$.

The similarities represent the degrees for a node to serve as the cluster center. The cluster center is selected by the greater value of similarities. In AP algorithm, there is no need to initialized the cluster center and cluster numbers. Here the preference needs to specify in advance and that is set to constant.

The availability and responsibility are calculated by AP algorithm for each node. If i node denotes the cluster center and j node denotes the responsibility. Then, the availability degree is represented by the node i selecting cluster center to node j:

$$r(i, j) = \begin{cases} S^{'}(i, j) - max_{j \neq k} a(i, k) + S^{'}(i, k) & (i \neq j) \\ S^{'}(i, j) - max_{j \neq k} S^{'}(i, k) & (i = j) \end{cases}$$

$$a(i, j) = \begin{cases} min\{0, r(i, j) + \sum_{k \neq i,j} max[0, r(k, j)]\} & (i \neq j) \\ \sum_{k \neq j} max[0, r(k, j)] & (i = j) \end{cases}$$

The search follows the iterative processes in AP algorithm to assemble the exemplar clusters.

To avoid oscillation, λ introduced as a damping factor for availability and responsibility values. For the fast iteration and strong global searches, the smaller value is capable in AP. After continuous iterations, the AP select the cluster centre to the largest node. The iteration processes,

$$r_t(i, j) = (1 - \lambda) r_t(i, j) + \lambda r_{t-1}(i, j)$$

$$a_t(i, j) = (1 - \lambda) a_t(i, j) + \lambda a_{t-1}(i, j)$$

and cluster centre

$$c_i = arg\ max\{r(i, j) + a(i, j)\}$$

5. Network model and proposed methodology. The proposed network model is illustrated in fig. 5.1. Here the controllers are deployed in a distributed environment and forms the clusters to balance the load of controllers. The figure shows that there are four controllers $C = \{C1, C2, C3, C4\}$ and fifteen switch nodes $N = \{S1, S2, ., S15\}$ are deployed. Different number of switch nodes are assigned to different controllers. This situation leads to generate the unbalanced scenario among controllers. Thus, the controller deployment cost

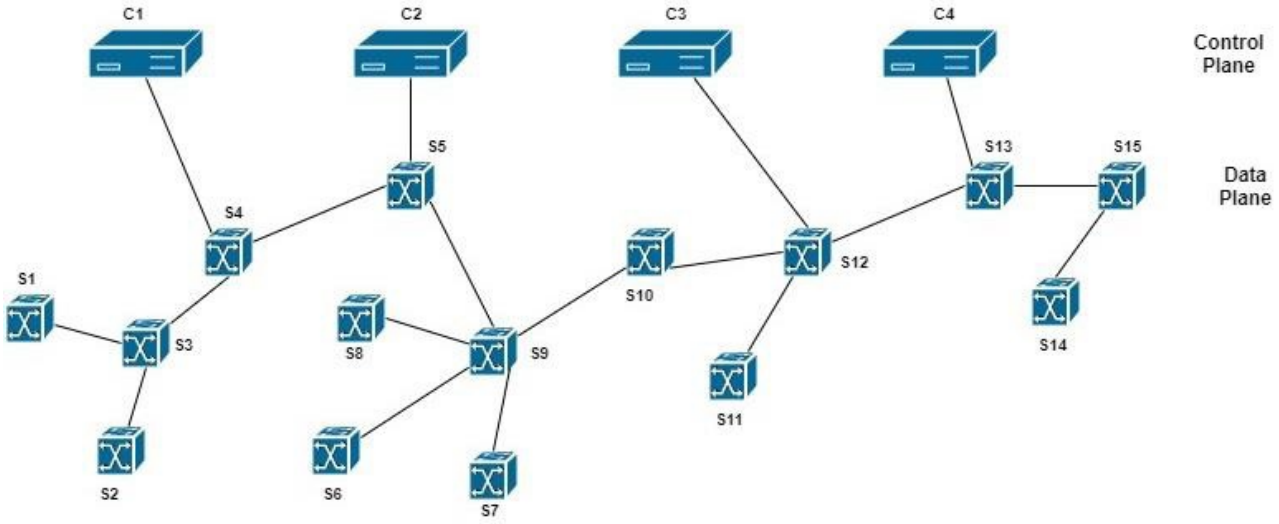

FIG. 5.1. *Multi-controller deployment and cluster assignment*

will be increased and affect overall communication cost to flow the traffic. Therefore, the proposed methodology solved such SDN problems and it maps the switch nodes to respective controller in the network. In the proposed methodology, the GWOAP algorithm forms the clusters of nodes by calculating the distance among switches and then assigned each cluster to respective controller by calculating the distance between cluster head to respective nearest controller. As given in fig. 5.1, the four switch nodes S1,S2,S3,S4 forms the cluster-1 and assigned the load of cluster to controller C1. Similarly, the five switch nodes S5,S6,S7,S8,S9 forms the cluster-2 and assigned the load of cluster to controller C2. The three switch nodes S10,S11,S12 forms the cluster-3 and assigned the load of cluster to controller C3. Finally, the three switch nodes S13,S14,S15 forms the cluster-4 and assigned the load of cluster to controller C4. The switch nodes S4,S5,S12 and S13 are assigned the cluster head in their respective cluster. The methodology, forms four clusters and assigned to respective four deployed controllers.

Proposed Grey Wolf Optimization Affinity Propagation (GWOAP) Algorithm.

1. Extract and input the nodes from the Topology G (N, L).
2. Traverse the all nodes and calculate the request rate of switch.
3. Initialize the similarity matrix.
4. Update the AP parameters until condition reached.
5. Calculate the Cluster matrix.
6. Initialize grey wolf population $X_m(m = 1, 2, ...n), X_{\alpha}^{'}, X_{\beta}^{'} and X_{\delta}^{'}$
7. Set the C and A vectors.
8. For every search agents calculate the fitness by equation 3.8:
   $X_{\alpha}^{'}$- is the best search engine
   $X_{\beta}^{'}$- is the second best search engine
   $X_{\delta}^{'}$- is the third best search engine
9. While $(i < maxiteration)$
10. Update present positions for search agents
11. Update A, C and a
12. For every search, evaluating the fitness function
13. Update $X_{\alpha}^{'}$, $X_{\beta}^{'}$, and $X_{\delta}^{'}$
14. End For
15. i = i+1
16. End while

17. return $X_{\alpha}^{'}$

The proposed methodology for GWOAP algorithm is illustrated in figure 5.2. The traffic load of data needed to manage in SDN-IoT enabled networks due to real time data collections. Here, the goal is to manage the total traffic load processed by IoT enabled nodes. Therefore, the proposed methodology solved such SDN problems and it maps the switch nodes to respective controller in the network. The methodology forms the clusters and assigns the balance traffic load to respective controllers. The proposed GWOAP algorithm is the hybridization of GWO and AP. Grey Wolf Optimization solves the controller placement problems whereas, affinity propagation forms the clusters according to traffic load. The benefit of using AP algorithm is that, there is need not initializing the number of clusters in advance. It calculates dynamically, and identify the cluster centre. The OS3E topology is taken to evaluate the methodology. The approach follows the total 34 nodes, where 29 nodes are taken as switch nodes and 5 controllers are taken as controller nodes to make clusters. The experimental results, calculated minimum overall cost communication cost by our defined objective function. The proposed GWOAP better balance the switches among clusters and node equalization is balanced for each controller as compare to GA, PSO and AP approaches.

6. Result and Discussion. The proposed methodology is simulated and evaluated on MATLAB 2019b. The OS3E topology is taken to evaluate the experiments. The approach follows the total 34 nodes, where 29 nodes are taken as switch nodes and 5 controllers are taken as controller nodes to make clusters. The switch nodes and controller nodes create 42 links in the network and each node is independent from other node in the proposed network model. The simulations are evaluated on the 64-bit machine of Intel Core i5-4-processor having Windows 10 operating system with 8 GB RAM.

For the objective function the weighting factor is set equal to 0.8 and flow rate v is set to 1 Kb/sec. The objective is to minimize the overall communication cost using GWOAP approach. The AP algorithm better balance the number of nodes among different clusters and switch nodes managed by controller nodes. The GWO algorithm better place the controllers to manage switches. In AP algorithm, without initializing the no. of controllers the CPP problem is solved. But the GA and PSO approaches, needs to initialized the no. of controllers using other clustering approaches.

In the OS3E network topology, we applied the GA, PSO, GAAP, PSOAP and GWOAP algorithms and found that GWOAP better balance the switches among clusters. Thus, we calculated minimum overall cost communication cost by our defined objective function.

In fig. 6.1, the objective function shows the overall communication cost by applying the GA, PSO, GAAP, PSOAP and GWOAP algorithms by simulating the OS3E network topology. This figure also clearly shows that by applying the GA and PSO algorithm up to 6 controller the communication cost decreases as number of controllers increases. But after 6 controller the cost varies up till controller 10 due to unbalanced load of switches. When using the optimization algorithms GA, PSO and GWO with AP, algorithm the clustering approach better balance the switches on controllers. As shown in fig. 6.1, that on OS3E topology on 5 controllers the proposed GWOAP method performs better and obtain the lowest total cost which is the optimal value.

Fig. 6.2 shows the number of switch nodes controlled by individual controller for all five algorithms, when deployment of OS3E topology network. The same number of controllers deployment are considered controlled by each controller. There are 29 nodes are taken as switch nodes and 5 controllers are taken as controller nodes to make clusters. The largest differences found using GA algorithm in which controller C1 load is almost double of C2 and C4 controller due to crossover mutation. The PSO algorithm improves little better as compare to GA where C1 and C5 controllers balance more switches as compared to C2 and C4. Here also C1 load is almost double of C2 and C4 controller.

The AP algorithm is hybridized with GA, PSO and GWO optimization algorithms. AP forms the clusters by calculating the distance between switch and controller. So, the initialization of number of controllers are not required here. The node equalization is increasing better by using GAAP, PSOAP and GWOAP algorithms. Fig. 6.2, clearly shows that the GWOAP better balance the switches among clusters and node equalization is similar for each controller in deployed topology.

Fig. 6.3 is the iterations convergence diagram which compares the performance of taken all five algorithms. The execution times using GWOAP is better and optimal among all other taken algorithms. The objective

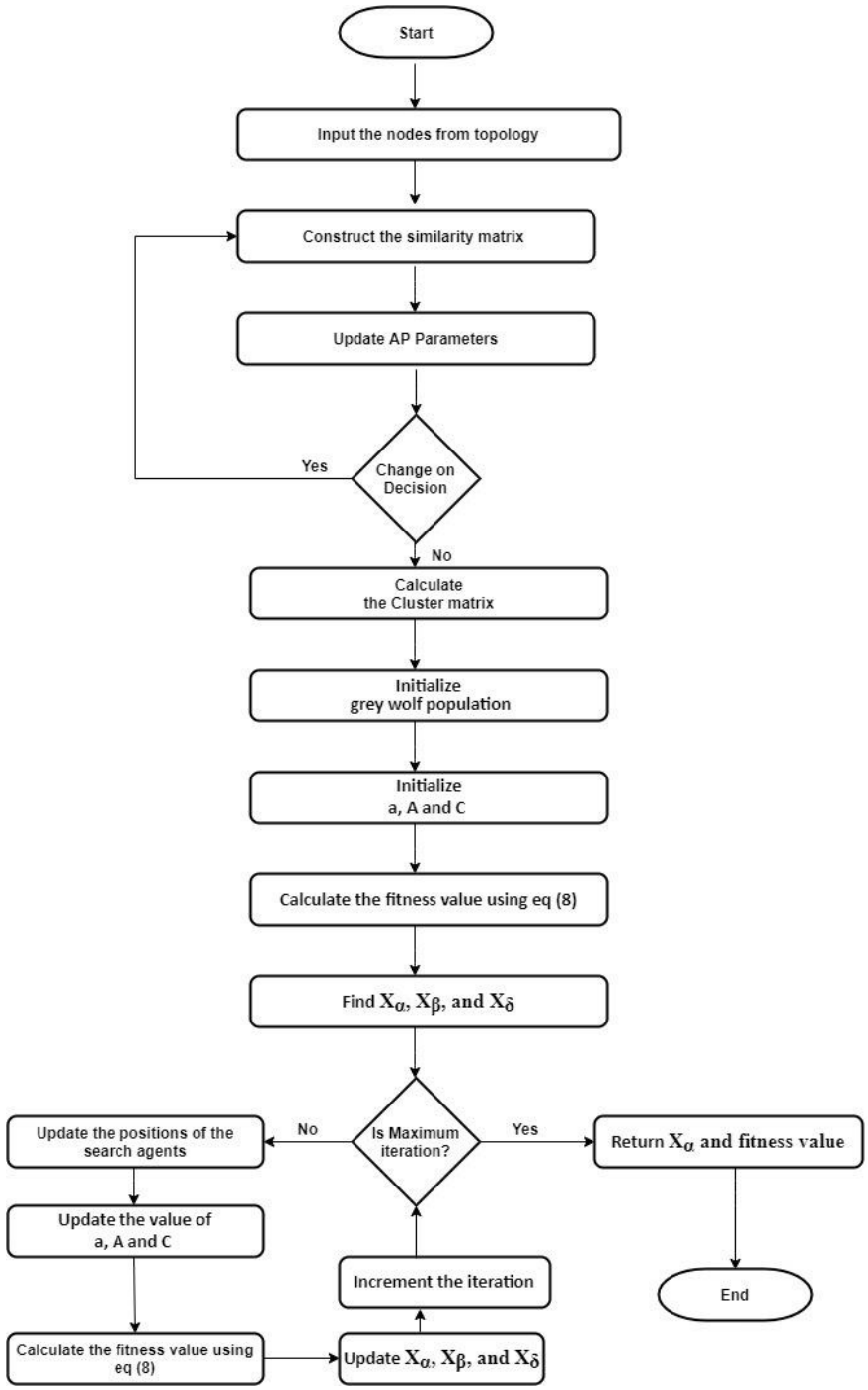

FIG. 5.2. *Flow diagram of proposed GWOAP algorithm*

function is iterated up to 300 executions to find optimal communication cost for taken algorithms.

The controller's deployments in the OS3E network topology divides the network into sub domains by the execution of AP algorithms and optimization algorithms optimize the processing delays as well as manage the controller's traffic load.

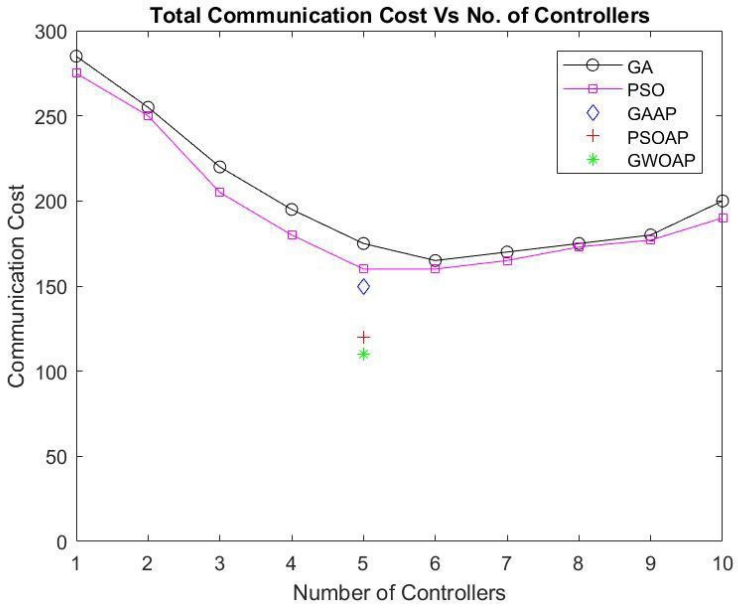

FIG. 6.1. *Total Communication Cost Vs No. of Controllers*

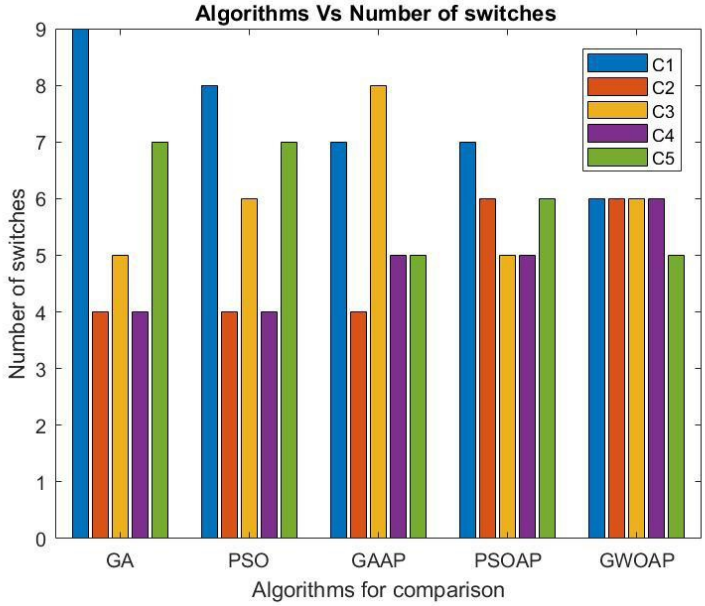

FIG. 6.2. *Algorithm Vs Number of Switches*

7. Conclusion. Software Defined Networking is a programmable network paradigm and having the advantages of it's separation of data plane and control plane. The programmable network SDN centrally manages different smart IoT devices connected in the networks. One of the emerging applications of IoT network is Smart City which purpose is to manage the city without human interventions.

This paper proposed a GWOAP algorithm for the placement of multi controllers in smart city networks. The controllers manage the traffic of connected smart devices in the network. The proposed algorithm is

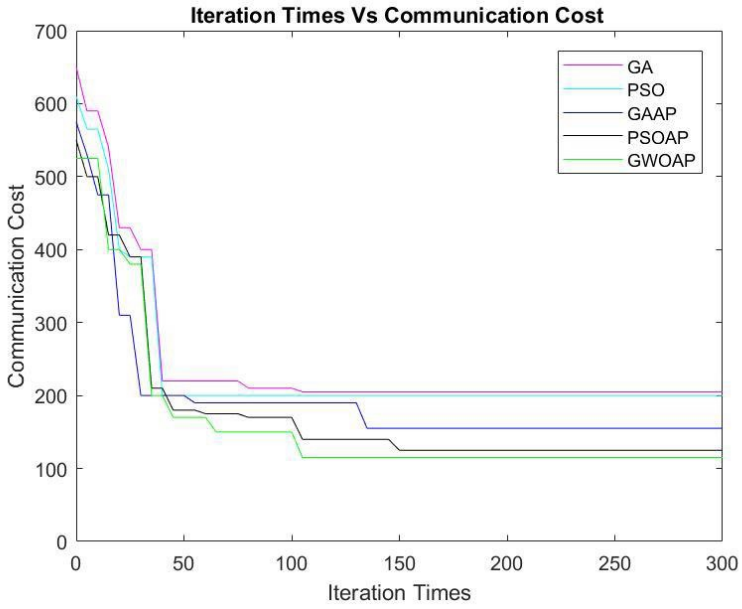

FIG. 6.3. *Iteration Times Vs Communication Cost*

simulated using OS3E network topology. The controller's deployments in the OS3E network topology divides the network into sub domains by the execution of AP algorithms and GWO optimization algorithms optimize the processing delays as well as manage the controller's traffic load.

The experimental results, calculated minimum overall cost communication cost by our defined objective function. GWOAP better balance the IoT enabled smart switches among clusters and node equalization is balanced for each controller in deployed topology. By using the proposed methodology, the traffic load of IoT enabled devices in smart city networks intelligently better balance among controllers.

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EMERGENCY RAPID RESPONSE TO EPILEPTIC SEIZURES - A NOVEL IOT FRAMEWORK FOR SMART CITIES

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Abstract. Epilepsy is a common neurological disorder that results in seizures in patients of all ages. The frequency of seizure episodes can be controlled by prescribing anti-seizure drugs. Drug-resistant epilepsy is a condition where the seizures are uncontrolled by strong medications. Such patients are at a high risk of getting seizures frequently and prone to injuries due to sudden falls. Many countries prohibit epileptic patients from driving as sudden seizure attacks can cause loss of lives and property. In the past decades immense work has been carried out in the to monitor the seizure activity in patients and alert caregivers to extend help in emergencies. The study proposes a smart health care Internet of things framework to provide immediate help to the epileptic patient during an episode while travelling in a self-driving car. In the proposed framework, the seizure alert from a wearable device of the patient is transmitted to the control application via cloud. The control application also receives data from the vision, ultrasonic, and radar sensors. The critical information of seizure alert and the sensor data commands the car to force stop. The seizure google map location of the car is sent to the patient's caregiver as well as the registered hospital. Many applications are being developed to provide luxury and comfort to fully automated car drivers. Far from providing luxury to the driver Emergency Rapid Response to Epileptic Seizure aims to propose a solution that could save the life of an epileptic patient who is drug-resistant or prone to frequent attacks despite severe medications. The experimental results on synchonization of clouds show that the minimum time is 30 sec 30 ms and maximum time is 31 sec 63 ms. The experimental results prove that its recommended to alert the patient's caregiver directly from control application rather than alerting via cloud.

Key words: Internet of Things, Automobile Sensors, Self-driving cars, Wearable devices, Epilepsy, Seizures

AMS subject classifications. 68M14

1. Introduction.

Epilepsy is a set of chronic neurological disorders caused by abnormal discharge in brain neurons, which is characterized by unprovoked and re-current seizures [1]. Around 50 million people in the world suffer from epilepsy [1]. With timely diagnosis and effective treatment, epileptic patients can be seizure-free after a couple of years of medication. In most low-income countries, the lack of effective diagnosis and non-availability of anti-epileptic drugs has led to patients suffering from seizures all their life. Despite of prolonged medications patients suffer from sudden and unpredictable seizure attacks. The unpredictable nature of seizure attacks develops anxiety and stress for the patient and their family. The epileptic patients are forced to be accompanied by caregivers. Epileptic seizures can be classified as Tonic-clonic (TCS), Myoclonic, Clonic, Tonic, and Atonic. Tonic-clonic is a condition where the patients lose consciousness followed by violent jerking and body stiffness. Myoclonic involves jerking which resembles jerking due to electric shocks. Clonic is repetitive, rhythmic jerking movements. Tonic is a seizure that causes muscle stiffness and rigidity. Atonic is a seizure that causes a general loss of muscle tone [2].

Most epileptic seizure patients are on medications that reduce the number of episodes during their lifetime. Some epileptic seizures cannot be controlled by drugs and are referred to as Drug-Resistant Epilepsy (DRE). Such patients may have to undergo surgeries as part of treatment [3]. The patients whether on medication or drug-resistant are at higher risk of getting seizures when they are under stress. Driving is a daily activity that makes a person independent to do their tasks. The task of driving can be dangerous for epileptic patients when a seizure attack occurs while driving. The accidents caused due to seizures can lead to vehicle crashes and deaths. The risk increases while driving vehicles whether it is automated cars or partially automated cars.

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This results in damage to public or private property and a threat to public safety [2]. Epileptic patients are prohibited from driving in certain countries but developing countries do not have such restrictions.

The recent technological developments in automotive engineering, have led to the development of innovative and safe cars. Artificial intelligence algorithms which are efficient in predicting and forecasting issues have found application in automotive engineering. In the past two decades, the automotive industry has witnessed remarkable development in the field of automation of vehicles. There is a substantial increase in investment in the design of semi -automated and automated cars. Smart vehicles are the future of smart cities. The manufacturers now integrate the concepts of Artificial intelligence, including Machine learning and deep learning with automotive technology to design smart cars. The manufactures now incorporate the features of driver assists, connected vehicles, smart parking, lane switching based on sensors in the cars. The automobile sensors acquire data from the surroundings and are processed by the inbuilt control application in the car. This system has full control over the car to act without human intervention. In this study, we propose an Internet of Things (IoT) framework for smart health care in smart cities.

The advancement in cloud computing technologies integrated with IOT has witnessed the development of several health care applications in smart cities. Smart health care is found to provide a timely and effective response to patients in an emergency condition. Apart from data collection, analysis, and monitoring new health care applications emerge every day to provide emergency care. The epileptic patient having a seizure is found unconscious and compulsorily need immediate help. The patient needs some first aid like turning them to one side to allow them to breathe freely and loosen their clothes to make them feel comfortable. In case of any injuries, the patient needs immediate medical attention. In most cases due to organ contractions that occur in seizures the patients are at risk of vomiting. Hence immediate attention is required in such cases. An unattended patient recovers consciousness, but the patient suffers from severe fatigue and confusion. Due to this health condition, they are unable to call for any help. These risk factors are of prime concern for the families of epileptic patients who are unable to drive by themselves. The patients become dependent on others for their daily tasks of travelling. There is a pressing need for a health care solution that would make the dream of several epileptic patients come true. The health care solution empowers the patients to drive by themselves and provides emergency help in case of need. The health care monitoring and response framework proposed in this study is a milestone in health care research that ensures patient safety while driving.

This research paper is the first of its kind that focuses on a proposed model which provides emergency help for patients during the onset of seizures while driving cars. This proposed model of IoT, Emergency Rapid Response to Epileptic Seizures (ERRE) will prove to be an effective system to help seizure patients from meeting with accidents in the event of getting a seizure attack in a self-driving vehicle. It also alerts the patient's family and nearby hospital about the patient's status and location. The IOT model includes wearable devices to detect seizures which alerts the car's inbuilt control application. The control application based on the data from automobile sensors stops the car seconds within alerting the vehicles nearby. The car sensors detect the vehicles and objects moving near the patient's car and alerts the cars to break in the case of an emergency. The implementation and performance evaluation of the framework is the future direction of work. Section 2 is the related literature study of the applications and frameworks for epileptic patient monitoring system. Section 3 throws light on the background of the paper. Section 4 explains the architecture of the proposed model for Emergency Rapid Response to Epileptic Seizure. The section 5 is the result and discussions sections. Section 6 is the conclusion and future direction of the study. The Figure 1.1 shows the block diagram of the proposed system ERRE.

2. Related Study. Epilepsy patients require immediate attention on getting seizures as they are prone to injuries due to losing consciousness suddenly [3]. There are several applications developed for seizure management all over the world. One such application is Epi & me which provides efficient management of seizures in children and adults by communicating and storing data of seizures and treatment. It records the events of seizures, their occurrence, detects factors that trigger seizures, creates awareness of the side effects of medications, assists in treatment, and tracks the movement while the patient is asleep. It also provides a graphical

[1]https://www.who.int/health-topics/epilepsy
[2]https://my.clevelandclinic.org/health/diseases/9917-epilepsy-types-and-their-symptoms
[3]https://epilepsysociety.org.uk/about-epilepsy/drug-resistant-epilepsy

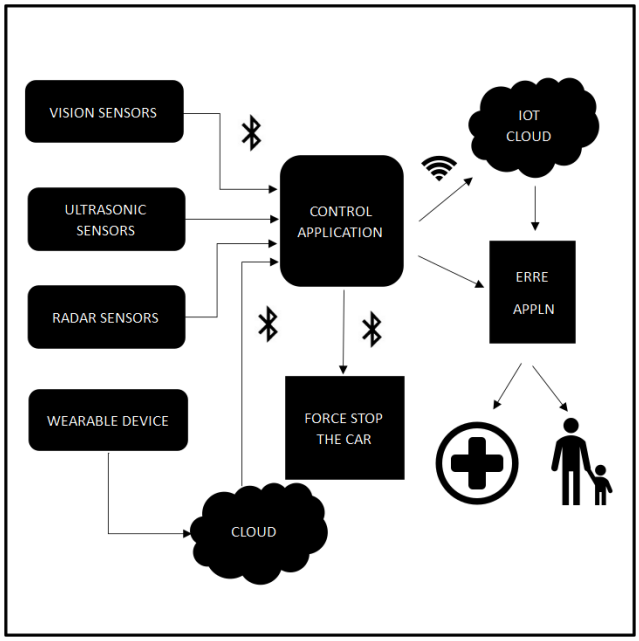

FIG. 1.1. *Block Diagram for Proposed ERRE*

representation of the frequency of occurrence of seizure attacks and video recordings of such episodes. A smart app called Epilepsy Self Monitor EpSMon, has emerged as a collaborative effort of clinicians, the National Health Service (NHS), and epilepsy charity's Sudden Unexpected Death in Epilepsy (SUDEP) Action. This app monitors the health condition of the patients based on a set of questionnaires and suggests the patients have more regular medical reviews. This in turn results in seizure control and accidents due to seizures [4]. Eppdetect, is an application that identifies a potential seizure by sensing movements that last for more than a period of 10 seconds [5]. The seizure tracker is an app that allows the parents of children suffering from seizures to record the details of each episode of the seizure. Epilepsy Foundation of Minnesota has developed an application called Seizure First Aide which provides first aid instructions to the person who attends to an epileptic patient. This lists out the steps to follow in case of a seizure attack in the patient [6]. ICE Medical Standard has created a facility that allows the patient to share information such as contact numbers, medication details to the first responder on the patient's phone's lock screen. This ensures rapid response in case of emergency. Epilepsy Health Storylines is an app designed to be more than just a seizure tracker. The app provides a variety of tools that manages a patient's condition. Its comprehensive feature set includes recording symptoms, seizures, moods, and setting reminders for taking medication. Epilepsy Health Storylines is designed to provide a variety of tools to manage patients. Its features include recording symptoms, the occurrence of seizures, setting reminders for medication according to prescriptions, and detect mood patterns [7]. SeizAlarm is an app that monitors repetitive motion and detects increased heart rate to alert the contact person to alarm the occurrence of seizure. This feature can be disabled while playing or engaging in any physical activity which results in increased heart rate to avoid false alarm [8].

In some apps, location is sent to the contact person to locate the patient. The system proposed by authors [4] is a cloud-based IoT framework that includes EEG sensors to record and transmit EEG signals of the patients. The framework decides to send the alert to the deep learning module based on the patient's real-time

[4]https://sudep.org/epilepsy-self-monitor
[5]https://www.mdedge.com/neurology/epilepsyresourcecenter/article/103200/epilepsy-seizures/smartphone-apps-help-manage
[6]https://www.medicalnewstoday.com/articles/319430#ICE-Medical-Standard
[7]https://healthstorylines.com
[8]http://seizalarm.com/about/

data. The features for epilepsy detection include the patient's body movements, gestures, actions, and facial expressions to classify the seizure condition. The data from EEG sensors as well as the features perform seizure detection in the cloud. On detecting seizure conditions the alert is given to medical practitioners. The model achieves accuracy and sensitivity of 99.2 and 93.5 percent, respectively.

The architecture proposed in research work by [5] is a solution for epilepsy monitoring. The system includes a wearable device and a smartphone which are portable and is near the patient all the time. The two wearable devices are linked by Bluetooth 4.0 to a Smartphone. This is addressed as a patient kit. The types of epilepsy on which this system focuses are tonic-clonic seizures and absence seizures. This type of epileptic seizure can be detected by triaxial accelerometer and heart rate sensors. The battery life can be extended by a suitable balancing algorithm. A study is carried out by researchers to maintain a balance by decreasing the communication activity and decreasing the computation amount. In addition to ontology-driven tasks, the system also performs dynamic data gathering personalization. An Adhoc decentralized solution Mobile Ad Hoc Networks is implemented. MANNET demands heavy and computationally expensive cloud services. The smartphone and the app together with the ontology perform the sensor sampling. The data transfer takes place with Wi-Fi. Connectivity facilitates notifications and alarms. In addition, specific hardware performs the function of a federated Cloud computing server. MANET Mobicloud, has the potential to support distributed and collaborative CC services. The main tasks include receiving and storing data from wearable devices. The second task performs partition the data and in turn sending requests to CC or MCC.

This research has achieved its goal of detecting seizures, receiving and maintain data from sensors, and alerting the medical staff. This drawback of this research work is that it focuses only on a specific type of seizure called tonic-clonic seizures. In the IoT framework proposed by [6] the EEG recording is measured and communicated via Bluetooth to FGPA which has an embedded deep learning algorithm. The EEG data along with prediction results is sent to Rasberry pi. The classification results in fire an alarm to the patient's caregiver. A Deep Convolution neural network extracts the features of the brain during the preictal state. The IoT network also stores the EEG data in the cloud to be referred by doctors. The Raspberry Pi 3+ device with WiFi sends the data to a cloud-based platform. The performance analysis of the classification techniques such as SVM, CNN, and DCNN are recorded. The DCNN shows improved results compared to other classification models. It gives an accuracy of 96.1 percent, sensitivity of 97.41 percent, and specificity of 94.8 percent. The security and privacy issues of the wearable devices, WiFi connectivity vulnerability are the drawbacks of this system. In the IoT-based epilepsy monitoring system proposed by [7] the data from sensors for measuring temperature, accelerometer, sound are retrieved. The fall in temperature, convulsions of limbs, and sound due to fall are measured. The microcontroller and the RF modem which is a handset to manage RF correspondence and transmit baud rates from CMOS/TTL source. The data is stored in the database for future reference.

This research work does address the security issues and does not alarm the patient relatives regarding the occurrence of seizures. The IoT framework proposed by [8] acquired EEG data and it is pre-processed and communicated through gateways to the Cloud. The preprocessing of data is followed by feature extraction before performing classification. The proposed system classifies the data and allows health care professionals to access the data to provide emergency care. The patient data is stored in the cloud and can be accessed by IoT devices. This study is a proposed model and focuses on the classification of the data. An EEG-based epileptic seizure detection is developed for the cognitive health care framework. EEG signals from the scalp of the patients, psychological signals, movements, facial expressions, and gestures of the patient are collected and communicated to the cognitive system. Facial expressions from health care are transmitted to the cognitive system and the system makes decisions regarding the detection of seizures. An alert is given to the patient's caregiver. In the cloud, seizure detection is performed. The results of seizure detection are sent to the health care professionals and other stakeholders.

This paper proposes a novel integration of deep CNN and stacked autoencoders. Deep CNN is adopted due to the artifacts in EEG signals and hurdles in feature extractions [9]. There are many frameworks developed for monitoring epileptic patients and providing smart health care by leveraging the facilities of IoT. The research work proposed in this paper is the first of its kind to provide emergency care to a patient with a sudden epileptic seizure attack who is driving in a self-driving car. The framework commands the control application to force stop the car based on the data received from wearable devices and car sensors. The EEG data is preprocessed

by DWT and the feature extraction is performed. The statistical features are extracted from the raw data. Naïve Bayes classifier classifies the presence of seizures. The system is validated with Simulink, ThingSpeak, and available microcontrollers. Experimental results record a classification accuracy of 98.65 percent [10].

3. Background. This section throws light on the ERRE framework concepts. This section discusses the different types of wearable devices that can detect the onset of epileptic seizure attacks. IOT automobile is a technology that makes the driving experience easier and safer for drivers. This section summarizes the distinct features of automated self-driving cars. The significance, working, and architecture of IoT are also discussed in this section.

3.1. Wearable Devices. Wearable devices and their application in health care. Wearable devices are pragmatic in continuous patient monitoring, detection, diagnosis, and therapy. Smartwatches and wrist bands are popular wearable devices among health care wearable devices. These devices are designed to monitor the health parameters which in turn reduces the risk due to lifestyle-related diseases. The compatibility of wearable devices with other devices like smartphones and applications has led to reliable health care monitoring systems. Availability of wearable devices for measuring health parameters and bio-signals claims to detect several disease conditions including epilepsy. The range of bio-signals and routine scalp electroencephalogram (EEG) was monitored by wearable devices. Real-time data acquisition of the patients by Empatica's E4 wrist band and Everion upper armband proves effective in monitoring the patient's condition. Sensors include surface electromyography (sEMG) wires and Epilog scalp patch electrodes. Devices that are wearable and removable proves to be fruitful in monitoring the health condition of patients [11]. Seizure detection wearable devices can be classified into four types of models based on the biomarker used for epilepsy detection.

3.1.1. Conventional Wearable EEG Devices. The wearable EEG devices are available as the head-band and headset-type devices. These devices are efficient in measuring the EEG signals from the forehead over the prefrontal cortex. It measures factors such as attention, emotion, and cognition [12,13]. The headset-type EEG devices can measure EEG signals from brain areas, including the parietal, temporal, and occipital cortices. The EEG acquiring wearable devices employ their electrode configurations. The disadvantage in this device is that the electrodes should be in tight contact with the scalp surface in the hair-bearing area [14]. EPOC+ by Emotiv (phase 1 study) has an accurate recall of 39 percent with a precision of 71 percent and an F1-score of 0.51 [15].

3.1.2. Wearable device based on accelerometry-based sensors. The devices which are designed on accelerometry sensors are Smartwatches. Smart Monitor (recall of 31percent) is provided with an alarm facility that alerts the caregivers. Wii Remote has a recall of 100 percent and an F1-score of 0.86. The i -pad Touch has a recall of 87 percent and an F1-score of 0.40. The epi alert has a recall of 91percent and F1-score of 0.80 and Epicare has a recall of around 90 percent. [16].

3.1.3. Wearable device based on Electromyography. Electromyography detects muscle contractions during an epileptic seizure. EDDI (phase 3 study) has an inbuilt sEMG sensor which is worn on the upper arm with a recall of 94 percent in the detection of Tonic-clonic seizure (TCS) [17]. SPEAC, the Brain Sentinel Monitor and Alerting System, showed a recall of 95 percent with an F1-score of 0.95 and a low FAR of 0.017 in the detection of TCS [18].

3.1.4. Hybrid Models. The Nightwatch measures ACM and PPG with an accuracy of 86 percent and an F1-score of 0.62. It ensured rapid response to caregivers [19]. The Empatica wristband has sensors for Accelerometry (ACM), Electrodermal Activity (EDA), temperature, and photoplethysmography (PPG). The recall rate is between 92 and 100 percent [20]. Embrace is a wristband that has EDA and ACM sensors for the detection of TCS. The recall rate is 94 percent and low precision of 10 percent with an F1-score of 0.18 [21]. The hybrid models are preferable compared to the other models in efficient detection of seizure in TCS. Figure 3.1 represents the working of the Embrace Smart monitor for epileptic seizures.

3.2. Automated Self-driving Cars. In a smart city, the recent technological developments have led to the new trend of automated cars. The environmental data collected from the surrounding area of the cars using sensors are processed by the inbuilt-CPU of the car effectively to provide partial or full automation. The data

collected from sensors like radar, pressure, temperature, image detection, oxygen sensors, ultrasonic sensors, promotive, rain, humidity, speed, parking sensors aid the CPU on board to make the accurate decision and enhance the driving comfort. The rapid advances in the field of microelectronic devices are a milestone in the development of automated cars. Automated cars integrate the high-tech features of robotic systems. In case of emergency, automated cars have lesser responses time to act compared to human-driven vehicles [22].

3.2.1. Tesla Autopilot. Tesla one of the leading automobile manufacturers presents autopilot cars with full driving capability. Tesla delivers that "Autopilot is intended for use with a fully attentive driver, who has their hands on the wheel and is prepared to take over at any moment" [9]. Tesla cars are provided with onboard computers with cameras and sensors which enable a smooth self-driving experience for the drivers. Full driving capability includes features like an auto lane change, auto park, and smart summon. Safety features available in these cars are automatic emergency braking, front collision warning, side collision warning, obstacle aware acceleration, blind-spot monitoring, lane departure avoidance. The cruise control is a feature that allows the speed of Tesla cars to be adjusted based on the position of the car ahead. This is enabled by radar and forward-facing cameras. If any vehicle is detected in the lane in front of the car the speed of the car is automatically adjusted. The autosteer function ensures that the Tesla cars stay centered in a lane as well as assist in change lanes, and self-park. To ensure that Tesla cars are centered, the road markings are detected by the cameras and the sensors monitor the vehicles available on the road to maintain a safe distance. The sensors ensure that the cars do not collide with other cars. The cameras and sensors assist in the self-park of the cars without colliding with sides [10]. Level 2 automated system has full control of the vehicle but in case of emergency, the driver must be ready to intervene. Tesla Autopilot is an Advanced Driver-Assistance System feature that provides autonomous driving. This technology provides the capacity to automatically shift lanes and summon cars to and from the parking lot. Autopilot includes track-aware cruise control and autosteer facilities. Autopilot is loaded with hardware that adopts deep learning techniques to adapt to real-time situations [11]. The built-in controller identifies the location of the car in its reference map and updates the control instructions according to events in the surroundings of the car. The control application relies on the sensor to change the position of the car. The Tesla cars are the future which has advanced features of automation which include track-aware cruise control, lane centering, self-parking, automatic lane changes, summon a car from the parking lot, and navigation.

3.3. Internet of Things. Internet of things includes sensors, actuators, processors, software systems, humans, and communication channels to enable effective communication between entities. This powerful concept has found its application in all fields including industries, health care, transport, smart homes, and smart cities. The technological growth in IoT has paved the way for new innovative technological solutions to Heath care issues. The novel technological framework developed in IoT has aided in monitoring the patient status more effectively. Each IoT develops an independent network of intelligent objects that can communicate with each other. Each IoT implements a unique service and new communication methods between things. Internet of things is not an independent technology it is an aggregation or cluster of distinct technologies that collaborate and serve to make life easier for users. IoT applications are the future that will provide solutions to various diversified problems. IoT addresses issues of heterogeneous device management, communication, integration, and security. Figure 3.1 showcases a graphical representation of IoT. Data synchronization is the process of synchronizing the data between two or more clouds such that any updates or changes in data are automatically reflected. This ensures consistency within the systems. Data synchronization is growing in importance as there is an escalated accessibility to cloud-based data in IoT. In health care, the consistency of data is an important factor as there is frequent updating of data. The issues of consistency and security are also to be addressed. Healthcare compliance is a very critical issue and can be catastrophic in case of failure. Time is the prime factor in healthcare, and to provide efficient patient care there is a demand for collaboration tools to keep pace with time. There is no compromise on security and scalability with data moving to the cloud [23].

[9] https://www.tesla.com/support/autopilot. Accessed August 12, 2020.

[10] https://www.jameco.com/Jameco/workshop/Howitworks/how-it-works-tesla-autopilot-self-driving-automobile-technology.html

[11] https://www.tesla.com/support/autopilot

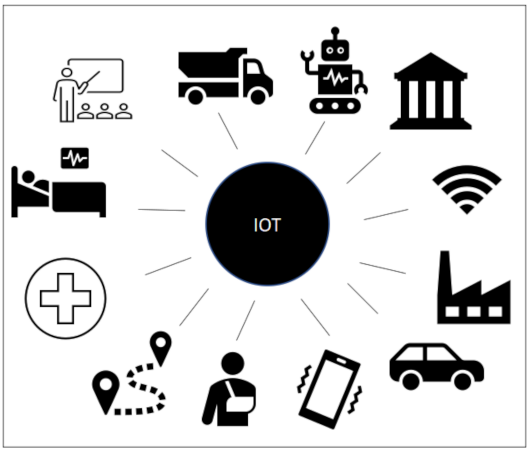

FIG. 3.1. *Internet of Things*

3.4. Architecture for IOT. The two main IoT architecture for designing solutions in IoT include Reference Architecture and Internet of things architecture. Reference Architecture is applicable for Industries IoT and Internet of things architecture is intended for any IoT solution. These architectures are popularly used for any reliable structure. The architectures of IoT are broadly classified as three-layer and five-layer architecture.

The three-layer architecture includes Application, Network, and Perception layers. The five-layer architecture includes the Business, Application, Processing, Transport, and Perception layer. The business layer manages the IoT system including the applications and business models. The application layer delivers the specific service to users which could be a service related to smart cities, smart homes, smart factories, or smart health. The processing layer includes the databases and data processing capabilities that process the data from lower layers to higher layers. The transport layer is dedicated to transfer sensor data from the lower layer of the architecture to the processing layer through the communication protocols. The Physical layer integrates all the information from smart objects necessary for the smart application [24]. The figure 3.2 represents the five layers of IOT architecture.

4. Architecture of Proposed Framework - EERE. The Emergency Rapid Response to Epileptic Seizure is an IOT that provides rapid action to epileptic patients in automated self-driving cars. The five-layer the architecture of the proposed model includes the Perception, Transport, Processing, Application, and Business layers. The perception layer is the lowest layer of the architecture that collects data from sensors. The sensors used in this proposed model includes the wearable device to alert epilepsy, visual sensors, radar sensors, ultrasonic sensors of the automated self-driving cars.

4.1. Perception Layer of ERRE. The perception layer is the physical layer which is a collection of sensors, network devices, and cloud servers. The perception layer of EERE includes the wearable devices that alert seizure episodes, sensors of the automated cars, the cloud servers.

4.1.1. Epilepsy Seizure Detection Sensors. The wearable devices for the detection of epilepsy proved to be a boon to patients who are drug-resistant and are suffering from tonic-clonic seizures. They are life-saving devices that alert the family or friends regarding the seizure attack thereby avoiding sudden death due to seizures. The physiological condition of the patient is the biomarker to detect an epileptic seizure. One such biomarker is electrodermal activity. Electrodermal activity measures the skin conductance which is affected by the sweating of the skin. Sweating arises due to emotional and psychological stress in epileptic patients during a seizure attack. The skin conductance value increases with the sweat gland activity. EDA is measured in units called micro siemens. The EDA has two electrodes, and a small alternating current is passed to the skin through the electrodes. The measurement data vary between the left and right wrist. The hydration level in a

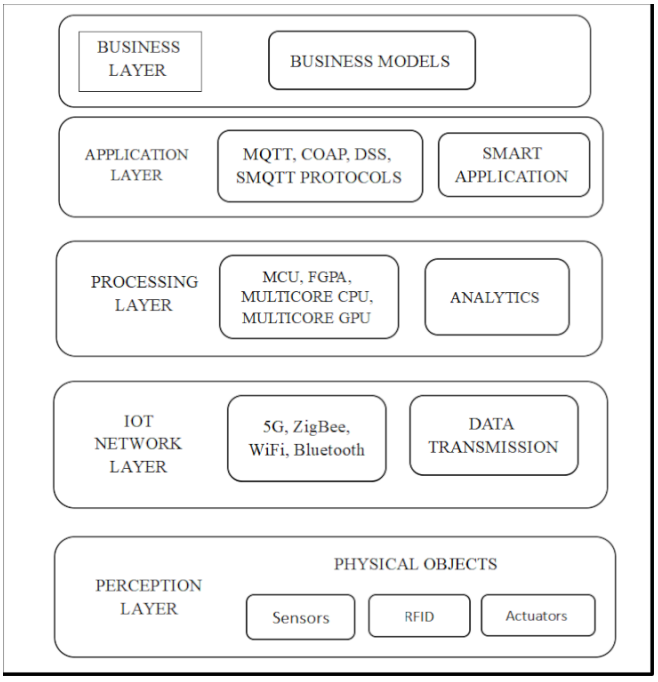

FIG. 3.2. *Five Layers Architecture of Internet of Things*

person's body also affects the EDA measurements. The temperature of the patient is measured by an optical infrared thermometer located in the EDA. This technology provides faster measurement without contact with skin. The optical sensor measures the temperature accurately. Epileptic seizures cause body temperature to fall considerably compared to the regular body temperature. This reduction in temperature is a biomarker for generalized tonic-clonic seizures (GTCS) detection. The tri-axial accelerometer (3DACC) is a sensor that measures the rhythmic movement of the GTCS occurring in patients. The 3DACC generates the data related to raw acceleration, body acceleration, and gravity. Its default value is -2g to +2g.

The accelerometer measures linear motion, whereas the gyroscope sensor is used to measure the orientation and angular velocity of the patient. It measures the motion of the patient [25]. The double T-structure made up of crystal material is an internal vibrating element. This T-structure holds a stationary part in the center to which a sensing arm is attached. The drive arm found on both sides is symmetrical in structure. A continuous lateral vibration is generated due to the alternating vibration of the electrical field. The leaking vibrations are handled by the left and right movement of drive arms. The signal resolution is in 8 bits. When a GTCS is detected, the wearable device alerts the patient's family through the Alert app. Embrace2 is a wrist-worn biosensor device that detects the seizure by sensors. Embrace 2 has an inbuilt CPU, memory chip, Bluetooth antenna, and LEDs along with sensors. Embrace2 measures the electrodermal activity, motion activity, and skin temperature of epileptic patients. These physiological parameters are communicated to the Alert and Mate app. These data are then transferred to Empatica's cloud. The Embrace biosensor device has sensors of Electrodermal activity, temperature, Accelerometer, and Gyroscope . A machine learning algorithm with the data from the sensors predicts the onset of seizures in patients. The Mate app records the physical activity, details of seizure episodes, and sends alerts to the Patient's caregiver. The Figure 4.1 shows the working of Empatica, Seizure detection device [12].

4.1.2. Automobile Sensors. Automobile sensors are intelligent sensors that control and process levels of coolant and oil. Some car sensors include mass airflow sensor, engine speed sensor, oxygen sensor, voltage sensor, and vehicle speed sensor. In addition to these, there are sensors for object tracking and detection in

[12] www.empatica.com/en-eu/embrace2/

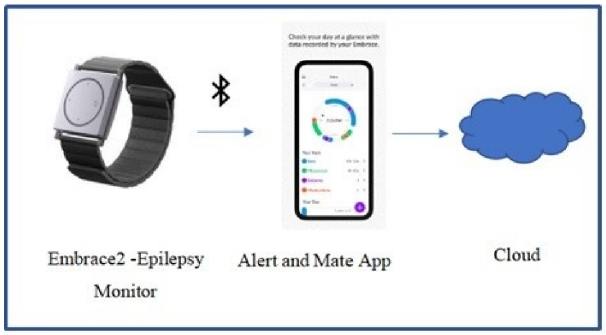

FIG. 4.1. *Empatica Wearable Device for Epilepsy Detection*

automated cars. These sensors collect data from the surroundings of the vehicle and transfer the data to the control application for further processing.

Self-driving cars can drive and maintain the car at a safe distance from other cars. It can automatically break when there is a car or pedestrian in the moving direction of the car. This technology is implemented by motion detection and object tracking. This detection and tracking devices retrieve data from the camera sensors which detects and alerts the driver if the car is on autopilot mode. These sensors could be used for the ERRE framework as the power consumption is less in these sensors. In addition to power saving, they also provide efficient and flexible data transfer to the processors. This makes these types of sensors more suitable for image processing in embedded IoT. The photons that fall on the photodiodes are converted and stored in capacitors. The voltage of the capacitor is converted into digital signals by analog signal chain and analog to digital converter. The vision sensor, CMOS image sensors converts the charge accumulated to a voltage at the pixel level. The image processor performs the processing of the image and transfers it to the main processor which is FPGA. Ultrasonic sensors emit ultrasonic waves of sound and convert the sound that has been converted to an electrical signal to detect the distance between the car and the objects. One of the sensors to detect an object is the ultrasonic sensor which assists in automatic parking. These sensors measure the proximity of the object by calculating the propagation time. The sensor has a piezoelectric transducer, printed circuit board, and microcontroller for signal transfer. The piezoelectric transducer converts electric charges to vibrations and vice versa. Applying a voltage to the electrodes generates the acoustic waves. Acoustic waves can generate voltages in the device. The frequency band is between 40 to 50 kHz. The electronic control unit in the sensor causes the circuit to excite the Piezoelectric transducer, which causes the membrane attached to vibrate and emit pings. Ultrasonic sensors cannot detect objects which are in very close proximity as they cannot receive signals before the ring downtime which is approximately 700 µs [27]. The ultrasonic sensors detect objects around the car and that information helps in automatically switching lanes.

Radar sensors detect objects around them by analyzing the signals that are electromagnetic waves transmitted to extract the information of objects. Radar uses the doppler property of electromagnetic waves to detect the speed and position of the objects. The Doppler effect is the wave frequency shift that is between the source and destination. The time delay and phase shift assist in the measurement of the range and Doppler velocity of the objects. Radars are available at different frequencies varying from 24 GHz to 79 GHz. The recent technology uses 79 GHz for automotive radars. The advantage of using a radar sensor is that it works well in all climatic conditions, but it falsely detects road signs, rails, and stationary objects. Unlike the camera sensors, the radar works well even in bad weather conditions such as fog, dust, smoke, and rain [28]. For automated cars, short-range sensors allow blind-spot monitoring and parking assistance whereas long-range radar sensors assist in automatic distance control. The radar sensors of the car can view up to 160m ahead through sand, snow, and fog along with the cameras. The automated cars use short-range radar for cruise control, collision proximity warning, and blind-spot detection.

4.2. IOT Gateway Layer of ERRE. The gateway layer of ERRE performs a translation of protocols between the perception layer with sensors and the internet layer. The gateways act as a bridge between the

Internet layer and the sensor network. Edge computing facilitates a geo-distributed network of smart gateways between sensors and the cloud layer. This provides advantages of load balancing, mobility, and scalability. The wearable devices do not facilitate storing patient data. One approach is to transfer the data to the cloud and store them in the cloud. An effective solution is fog computing. The context data from sensors or smart wearable devices are transferred to the fog layer and then to the cloud. The fog or edge layer is the intermediate layer that provides the extended cloud computing service for IoT. The data from the wearable device to detect GTCS is now transferred to the fog layer by Bluetooth technology. Protocol conversion is performed on data from different subnetworks. The backend is the cloud that performs the storing and computation.

4.3. Processing Layer of ERRE. The selection of sensors and processors for IoT device is an important factor that affects the efficiency of IoT design. The available processors are General Purpose Processors (GPP), Digital Signal Processors (DSP), Microcontroller Units (MCU), Graphics Processing Units (GPU), Field Programmable Gate Arrays (FPGA), and System-On-a-Chip (SOC) devices. The processor for the IoT must be chosen carefully. The GPP is designed for computers and the compatibility with IoT devices is limited. It requires additional peripherals to carry out IOT functions which prove to be expensive. Microcontrollers are standalone devices suitable for image processing in IoT. Microcontrollers do not possess a Very Long Instruction Word (VLIW) architecture; hence the parallel execution of multiple instructions is challenging. DSPs adopt the VLIW architecture. Multiple instructions are executed simultaneously implementing the feature of parallelism, which is an advantage in image processing. DSP is more suitable for computing simple programs, but memory is a constraint. Logic programming is supported by FPGA. The FPGA architecture has multiple logic gates compared to the DSP. FPGA allows parallelism which makes it a suitable IoT processor. FPGA is a better power-draining component compared to other processors. Inexpensive FPGA chips with low power are developed for IoT applications [29]. In this proposed design of IoT FPGA will be the suitable processor.

4.4. Application Layer of ERRE. Protocols are essential to eliminate the problem of interoperability between the application and the internet. The application of ERRE and the protocol are part of the application layer of the IoT which delivers application-oriented services. Some of the protocols for the Application layer of IoT include Message Queue Telemetry Transport (MQTT), Constrained Application Protocol (CoAP), Data Distribution Service (DDS), Secure Message Queue Telemetry Transport (SMQTT), and Representational State Transfer (RESTFUL SERVICES). In this ERRE we propose SMQTT which is apt for sensor networks. SMQTT is a lightweight protocol based on the publish-subscribe architecture model. EERE falls under the publish-subscribe architecture. The patient's epileptic condition is published to the server. The subscribed clients and in this case receive information through the broker. The data from the sensors are published by the broker, an IoT device. This data is published with a key. The client in this case may be a tablet or mobile. These clients receive sensor data by establishing a connection with the broker. The data from the sensor is sent to the requesting client through the broker. In exceptional situations of a connection failure due to low bandwidth, the protocol manages the crucial situation. The publisher sends encrypted data which is decrypted by the subscriber. The sensor which detects GTCS publishes the data and the caregiver's smart device will decrypt the data. This protocol is adopted to provide secure data transfer [30]. Hence the critical issue of security in data transfer in IoT is also addressed in this framework of EERE.

5. High Level Architecture of ERRE. The epileptic seizure alert from the wearable device is transmitted to the cloud. On receiving an alert, the control application requests and receives the automobile sensor data. The data from the vision sensor, ultrasonic sensors, and radar sensors detect the proximity to the patient's car. On detecting that the other cars are at safe distance from the patient's car, the patient's car is commanded to force stop. The control application now sends the current location of the car to the cloud. The IoT cloud sends the location to the smart device to the patient's caregiver. The framework ERRE gives an alert to the registered hospital. Retrieve the data from a wearable device for seizure alert. If an Epilepsy seizure is detected, then retrieve the data from car sensors. The radar, camera, and ultrasonic sensors detect objects by sensor fusion technology. The control application gives the command to stop the car. The data is transmitted to the IoT cloud. The control application also transmits the message to the patient's family informing the onset of the seizure The ERRE App sends the current location of the car to the caregiver and registered hospital. The patient data is stored in the database in the cloud for future use by the medical team.

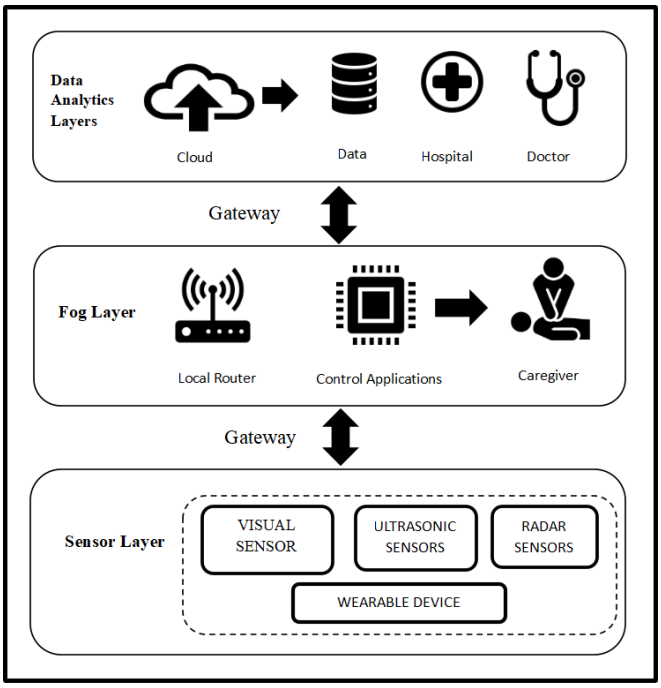

FIG. 5.1. *High Level Architecture of ERRE*

Step 1: Retrieve the data from wearable device for seizure alert.
Step 2: If Epilepsy seizure detected, then retrieve the data from car sensors.
Step 3: The radar, camera and ultrasonic sensors detect objects by sensor fusion technology.
Step 4: The control application gives command to stop the car.
Step 5: The data is transmitted to the IOT cloud.
Step 6: The control application also transmits the message to patient's family informing the onset of seizure
Step 7: The ERRE App sends the current location of the car to the family member and registered hospital.
Step 8: The patient data is stored in the database in the cloud for future use by medical team.

The high-level architecture has three layers namely the Sensor layer, Fog layer, and Cloud layer [31]. The sensor layer performs sensor fusion and low-level data fusion. Sensor calibration and sensor fusion are important concepts in automated vehicles. Sensor calibration explores the actual position of the object in the surrounding. The exact calibration of the sensor is the prerequisite for sensor fusion. Sensor fusion allows data from multiple sensors to be fused to reduce the contradictions. Camera-Radar fusion (CR fusion) is a unique technology that integrates data from camera and radar for object detection. The low-level fusion approach allows each sensor like the radar, ultrasonic, and camera to carry out the object detection and tracking independently. The data collected from the seizure detection sensors and the car sensors are relatively small and the fusion is performed on board. This fusion of streaming sensor data and seizure alert sensor data facilitates emergency alert. The middle layer is the fog layer which has the data onlooker nodes and n-fog nodes [32]. The data on-looker nodes perform data filtering and filter redundant data and generate the seizure alarm. The fog nodes are responsible for classifying the user's current health status based on the fused sensor data. The fused sensor data is combined with the static information of the patient and is transferred to the higher layer. This is the middle-level data fusion. The high-level layer is the IOT cloud layer that maintains the data of the patient for future reference by medical practitioners. The high-level data fusion enables the fusion of the patient data with the existing database in the cloud [33]. On detecting a seizure alert from the wearable device, the control application based on the data from the sensors force stops the car. The car location is sent to the patient's relatives to trace the car. The High level Architecture of ERRE is showcased in Figure 5.1.

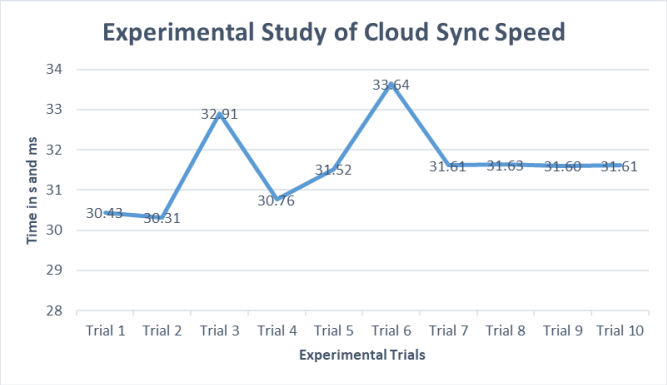

FIG. 6.1. *Experimental Results of the Cloud Synchronization*

6. Result and Discussion. The experiment study includes evaluating the transfer speed and the cloud syncing speed. The cloud chosen for this experiment is google drive. We have synced and transferred data across clouds and measured the transfer rate. The syncing of data is an essential component for an IoT framework. The syncing is performed by a professional data synchronization system. To evaluate the performance of the part of the IoT framework a syncing of the drives was performed. The trial runs of the data synchronization are performed, and the results are showcased as a graph in Figure 6.1. The experimental results show that the synchronization of clouds shows minimum time is 30s 30ms, maximum time is 31 sec 63ms. Processing the data in the cloud layer increases the latency of emergency events. It is not appropriate to handle large-scale systems and it is unsuitable for mobile users. Hence the emergency alert will be directly sent to the person concerned from the control application of the car. The control application of the automated cars possesses a built-in feature to send the location of the car to external entities. On receiving an emergency alert the patient can receive help within seconds which can be lifesaving for an unattended epileptic patient. The map coordinates of the car with GPS location of the car are sent to the patient's caregiver. This enables the patient's relative to use google maps and trace the location of the car. The message delivered includes a text message "HELP!" along with coordinates. Code is executed in Python language.

7. Conclusion. The revolutionary changes in technology in the fields of automobiles and networking have led to the emergence of several IoT-based smart health care solutions. Health care is one such field that demands continuous synchronization of the data in the cloud with scalability at a low cost. Several cloud providers support data storage and sharing among the users. This facilitates the patient to stay connected to the family and health care practitioners. Several applications are available for patient status monitoring and alerting the caregivers in case of emergency. This alerts the medical team to recah the patient in emergency condition. Smart health care solution allows the continuous monitoring of the patient's health condition through IoT. The ERRE is one a novel IOT framework which alerts the patient's family on a seizure episode while driving a self-driving car. The proposed IOT framework is an integration of sensors that include vision sensor, radar sensor, ultrasonic sensor to detect the object near the car.The wearable device has sensors that can alert the onset of the seizure. The control application on receiving the alert from the wearable device sends the command to stops the car and alerts the patient's caregiver and the registered hospital. The patient's family can trace the car's location and immediate medical help will be provided within a short time. This prevents the epileptic patient in the car to remain unattended due to seizures. Among the IoT framework for epileptic seizure monitoring, this proposed framework will be beneficial for epileptic patients who are drug-resistant or suffer from frequent seizure episodes. ERRE is the first of its kind to provide emergency response for the epileptic patient in the self-driving car. To the best of knowledge this is a unique work which proves to be lifesaving for an unattended epileptic patient. There are many IOT framework available which automate the tasks of users to provide luxury a nd comfort to them. This framework provides emergency help to the patient in critical condition. The future research work includes the implementation of the complete IoT framework. The IoT framework performance evaluation is also part of future research work. Such health applications create confidence in the patients to live independently as they are constantly monitored by caregivers and the medical team.

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ENHANCED SECURE ATM AUTHENTICATION USING NFC TECHNOLOGY AND IRIS VERIFICATION

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Abstract. In today's world technology has advanced to such an extent that it is interchangeable with connection and convenience. ATM was one of the major breakthroughs, and over the time it has provided better convenience in fulfilling one's banking needs. Although, there are certain predicaments that such ATM transactions are susceptible too. The conventional PIN based authentication that is presently accustomed in all ATM apparatus is liable to shoulder surfing, hassle in remembering the multiple PIN and the rest. The physical card brings along setbacks in particular, wearing out of the magnetic strip attributable to frequent usage, losing or getting it stolen. Aside from these there are other unlawful activities that are carried upon. The objective of this paper is to present a solution to the above stated problems. In contrast to standard architecture, the proposed solution incorporates NFC enabled smartphones as a substitute for physical card and iris based authentication for PIN.

Key words: Internet of Things, Wearable devices, Security

AMS subject classifications. 68M25

1. Introduction.

When it comes to making banking activities approachable, the role of the ATM cannot be overlooked. Hence, it is crucial to make such activities secure yet convenient [12]. Authentication using PIN (Personal Identification Number) is ubiquitous, but comes with many downsides [15]. First, ATM skimming, skimming devices and small cameras may be fit to steal authentication details. Second, physical cards have magnetic strips which get damaged due to frequent usage and become non-functional. Third, physical cards take users longer to authenticate [8]. Near Field Communication (NFC) is a wireless technology that requires very tiny proximity between two NFC-enabled devices in order to establish a connection [12].

NFC has an array of advantages over Bluetooth, RFID(Radio Frequency Identification) and other such technologies in the aspect of secure transaction [13]. There are several factors that make NFC dominant over other wireless technologies. Unlike Bluetooth and RFID, NFC tag is passive, it is read or written by the powered terminal. Whereas in the case of Bluetooth and RFID, both of these require some power source. As mentioned, small distance between respective devices is a requirement for this technology to work, there is a poor possibility of data to get stolen during communication [15]. NFC, unlike RFID, establishes bidirectional communication, hence can be used for complex interactions such as Peer-to-Peer sharing. NFC has different modes of communication such as peer-to-peer mode, reader/writer mode and card emulation mode, and each of these modes indicates how NFC will behave in respective context. NFC has varied financial applications. One such application is contact less payment, such payments are made through wallets in smartphones, smart watches or tap-to-pay credit and debit cards [12].

One of the examples of smart cards is Visa payWave that uses an embedded computer chip to send payment information to a secure reader at the point of sale. To make payments users may wave their card or device within 2.5-5 cm (1-2 inch) of the reader. This NFC through ATM transaction will transform the way conventional transactions are done, in a more secure manner. Since PIN is the classic approach, multifarious ways have been discovered by the imposters to compromise the system [1, 10]. As opposed to this, biometric technology has a wide range of benefits, from a user's stance bio-metric is greatly convenient and faster [18]. Moreover, as biometric authentication cannot be delegated, no transaction can be made without the consent of the user [5]. The level of security provided by bio-metric is again undeniable.

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Refonaa et al. [19] proposed a model to enhance security in ATM account with the help of biometric system. This framework used two security parameters: portable help and biometric. For authentication purpose author used fingerprints. The model consists of various modules such as Registration of use, Enrollment of finureprints, Sending an email, Account Login and Finger print verification.

Anothor work in similar domain is presented in [21] by Sangeetha,with an objective to introduce a framework for current ATM system to confirm withdrawal message and to introduce second level authentication framework where there is withdrawal limit.

1.1. Research Contribution. To fulfill banking needs, ATM is one of the chief innovations and is providing well suitability. Despite the success of ATMs, ATM transactions are still vulnerable to safety breaches. The conservative PIN based verification that is presently familiarized in all ATM gadgets is accountable to shoulder surfing. We propose a solution to this problem by incorporating biometric details during the authentication process. The proposed work includes NFC-enabled smartphones as a substitute for a physical card. We also take into account Iris-based authentication for PIN number. Apart from Iris, finger-print, voice, and face are a few other biometrics. In our work, we also have given a comparative analysis of all these biometrics and selected Iris because it has a high level of security as there is no way to forge Iris also it is compatible with contact lenses and spectacles. Iris-based verification confirms that the user will not have to worry about transactions being made without his/her approval. The small proximity need of NFC makes sure a secure transfer of sensitive details. This proposed unification of NFC and Iris authentication can surely boost the security of existing ATM systems.

1.2. Paper Organization. The rest of the paper is structured as follows: Section 2 presents reviews of various biometric technologies. Section 3 presents related work in the domain. Our proposed model is presented in section 4. We have assessed the robustness of the proposed work in section 5. Future direction and opportunities are discussed in section 6. We finally end with a conclusion in section 7. Oranization of ppaer is pictorialy presented in figure 1.1.

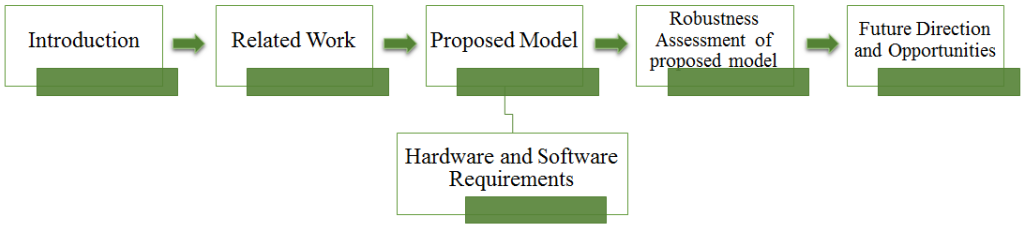

FIG. 1.1. *Paper Organization*

2. Biometric Technology Review:. Biometric technology has a wide range of benefits, from a user's stance bio-metric is greatly convenient and faster [18].. The Comparative study on various biometric technology presents in this section.

- **Fingerprint** based recognition is one of the oldest approaches used to authenticate and identify a person uniquely. Fingerprints are believed to be never changed throughout the person's life span. Also, the fingerprints on both the fingers of the same individual are different [20]. Fingers have ridges and furrows, those are used to identify a person in fingerprint recognition systems. The two fundamental principles immutability (ridge patterns never change during the lifetime) and uniqueness (distinct ridge patterns on different fingers of the same individual) are used in identification of individual's fingerprint [20].
- **Voice recognition:** Voice recognition biometric is also famously known as Speaker Recognition Biometrics. The voice of a person is a combination of physical and behavioural aspects. The vocal tract, lips, nasal cavity and shape and size of mouth are the physical characteristics and the pronunciation, emphasis, speed of speech, accents are the behavioural characteristics [20]. As a person's voice can be

forged easily, voice recognition is not considered a reliable system. Voice recognition system employs three styles of spoken input as Text dependent, Text prompted and Text independent. [2].

- **Face recognition** system identifies a person based on its facial features like size, diameter and location of nose, eyes, lips and other such. Face recognition can be carried out in the following ways [20][2]:
  1. Facial metric: The location and shape of facial attributes are measured. For example, distance between nose to lip or pupil to chin
  2. Eigen faces: The overall face image is analyzed i.e., collection of weights describing the canonical faces.
  3. Skin texture analysis: This is an emerging technique of face recognition along with other visual details of skin. Finding the location of the unique spots, lines and patterns in a person's skin.
- **Iris** recognition systems are used for high levels of security and authentication. Iris of two humans can never be the same, even for twins it is different. Iris recognition offers a very high capability to distinguish between individuals, even between user's left and right eyes[5][20]. Iris is a unique self-generated pattern which remains stable throughout adult life [22]. The characteristics of the iris cannot be changed by the eye surgery or the wearing of glasses and contact lenses.[20]. Hence we can say that iris can be considered as most reliable when it comes to authentication [23] and security [17].

Each biometric has its merits and demerits. Table 2.1 comparatively discusses level of accuracy and security of each biometric along with its working mechanism.

3. Related Work. Lots of work has been done in the domain of secure ATM transactions. This section presents different design facets that have been used by various researchers in the domain.

Ranasinghe et al. [18] has presented a scheme wherein the proposed device design works as RFID or NFC along with fingerprint authentication. Choices are given for selection of input and output of data. After selection, data is exchanged between device and NFC/RFID reader via RF signals but prior to that fingerprint authentication is carried out. Only after validation data exchanging process is proceeded. The RFID/NFC reader device consists of a power button, navigation buttons, fingerprint scanner and display screen.

Hassan et al. [8] has presented a card-less model in which the card is replaced with fingerprint and a shuffling keypad method is used where the proximity sensor mounted upon the terminal senses the finger of the user and changes the layout of the keypad. Different layout for each time a finger of the user is sensed.

A card-less NFC enabled approach was proposed by Mahansaria et al.[12] In this work, the mobile device exchanges required details with a terminal via NFC mounted upon the ATM apparatus. The process starts with the user entering username and PIN. A default PIN is generated at the time of registration. Entered credentials are verified and upon successful authentication, an OTP is generated. OTP and the username is read by the NFC reader, validated by the authentication server, and finally a transaction is granted upon successful validation. The presented idea works in Card Emulation Mode.

Madalapu et al. [13] proposed an NFC enabled solution where an ATM card has to be swiped as an initial step. Subsequently, the user has to tap the NFC enabled phone on the reader fixed upon the terminal. The reader contains an URL which when read will open up the browser within the smartphone and the user will be prompted to enter a pre registered Mobile number. Having this step followed, a consecutive process involves the user entering a Pattern password that was registered during the registration process. The authentication process is completed by the user entering the generated OTP on the ATM screen within a preset time.

Mohanty et al. [15] brought forward an architecture where there are card taps upon the terminal, and upon tapping the NFC enabled cards data from the card is read by machines. PIN generated in the android application is entered and then verified against the data in the database. If authenticated then the user gets logged in and transaction is permitted. The card specific details are prewritten into the NFC memory chip by admin at the time of issuing.

Muley et al. [16] has also proposed a card-less model where the fingerprint is replacing the physical card. The ATM servers will have many samples of users' fingerprints and the system will verify the scanned fingerprint against every sample unless a matching sample is found. This system only works with customers having one account.

TABLE 3.1
Comparative study among different bio-metrics

Bio-metrics	**Working**	**Accuracy**	**Level of Security**
Finger-print	When the finger is placed on sensor surface, the ridges of the finger touches the surface, hollow distance between the ridges can also be observed, these distances is calculated by the sensor and later used while authenticating user	Medium level accuracy can be achieved as a person might get a cut on the finger which can result into nonrecognition of that person, moreover wet fingers may also lead to the same	Medium level security as many ways have been discovered to forge person's fingerprint
Voice	Firstly, the biometric software registers the voice sample of a person. Then a statistical methodafter recording and analysing the voice of many distinctive characteristics creates a voice print or biometric model, this model is then encrypted and stored in a secure database. So, when the person interacts with the system, the system compares the respective person's voice sample with one stored in the database.	There is a low level of accuracy here as the voice of a person is physical and behaviour dependent. In addition to this, it is non-viable for a person to speak at the same pace and frequency consistently.	Low level since it is immensely susceptible to forgery
Face	A picture of a person is captured first by software, then key factors of face geometry are identified like distance between an eye, or distance from fore-head to chin and several other parameters. For authentication such parameters are recognized and compared with parameters stored in the database.	Medium level accuracy as it works on principle of analysing several facial geometric parameters, and at times there can be changes in a person's facial appearance due to makeover, age, surgery or any injury which can lead to the system showing in- appropriate results.	Medium level as facial traits change / vary over time.
Iris	The camera, in iris recognition, locates the centre of a person's pupil, edge of iris, eyelids, and eyelashes. The iris scanner software analyzes and translates to the iris template. This data is then compared to authenticate the user.	High level accuracy as it is compatible with contact lenses and even eyeglasses and can be used by blind people too, as long as they have an iris.	High level security because there is no way a person's iris can be forged or duplicated.

TABLE 3.2
Different communication and authentication technologies availed by the researchers in their work

Ref No	Communication Technologies				Authentication Technologies				
	NFC	**RFID**	**Card less**	**Card based**	**Face**	**Finger-print**	**Voice**	**Iris**	**OTP/ PIN**
[18]	Yes	Yes	Yes	No	No	Yes	No	No	No
[8]	No	No	Yes	No	No	Yes	No	No	Yes
[12]	Yes	No	Yes	No	No	No	No	No	Yes
[13]	Yes	No	No	Yes	No	No	No	No	Yes
[15]	Yes	No	No	Yes	No	No	No	No	Yes
[16]	No	No	Yes	No	No	Yes	No	No	No
[24]	No	No	Yes	No	No	Yes	No	No	Yes
[25]	No	No	Yes	No	No	Yes	No	Yes	No
[19]	No	No	Yes	No	No	Yes	No	No	Yes
[21]	No	No	Yes	No	No	Yes	No	No	Yes
[14]	No	No	Yes	No	Yes	Yes	No	No	Yes
[9]	No	No	Yes	No	No	Yes	No	No	Yes
[6]	No	Yes	No	Yes	No	Yes	No	No	No
[7]	No	No	Yes	No	No	Yes	No	Yes	Yes
[4]	No	Yes	No	Yes	No	Yes	No	No	Yes
[11]	No	No	Yes	No	Yes	No	No	No	Yes
[3]	No	No	No	Yes	Yes	Yes	No	No	No

In this work as proposed by Taralekar et al. [24] substitutes physical cards with fingerprints and incorporates GSM modules for OTP generation. The databases are stored on cloud and using web services access to all bank accounts linked to the user are given. First step of authentication requires a fingerprint to get validated. Upon successful validation UID is given and using this UID all the details from the bank database are fetched. Furthermore, the user selects the bank account to make transactions displayed on the screen from all the accounts that the user holds. After selection of bank account and before transaction OTP generated using GSM module sent to user's registered mobile has to be entered and then transaction is granted.

Tyagi et al. [25] here a bimodal biometric system has been brought forward. First the user enters the amount to be withdrawn. If the amount is less than 10,000 then the user has to go through a single authentication process which requires only a fingerprint to be scanned. However, if the amount is more than 10,000 then two authentication processes are involved, which is iris recognition and digital signature. In iris recognition, the iris pattern is scanned and verified against the sample available in the database, if valid then the user is allowed to proceed with the second level of authentication where a digital signature is asked to provide to complete the verification process. If the provided digital signature is valid then the transaction is granted.

Manish et al. [14] introduced a bimodal biometric system. The system involves enrolling the customer data into the database. Secondly, there is the Login Phase where registered users can login by providing their fingerprint, scanning their face and then completing the process by receiving an OTP pin. After successful verification of all these three inputs , a transaction is granted.

Researchers of this domain have incorporated many different technologies in their proposed design. Table 3.2 presents various communication and authentication technologies that have been put to use in the domain by different researchers.

4. Proposed Model. Since the use of smartphones is pervasive, and every individual has a unique iris pattern. designing a card-less unimodal biometric system that replaces the traditional ATM card with the user's NFC enabled smartphone and Iris recognition based authentication instead of PIN. Model proposed incorporates Host Card Emulation mode. All the sensitive details will get stored into the server of respective banks. As and when the authentication process is initiated by the user via the application, required details are

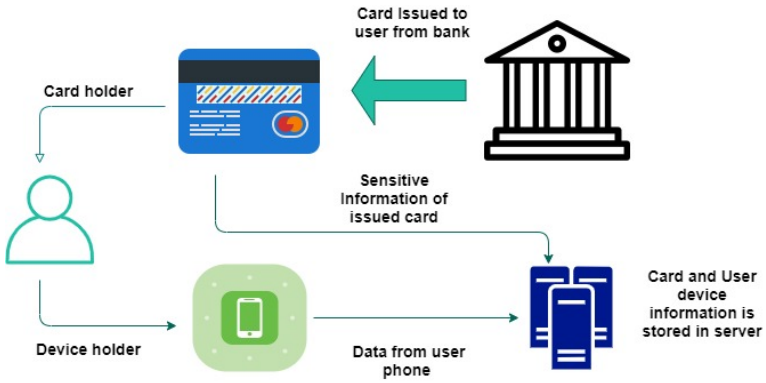

FIG. 4.1. *Registration Stage*

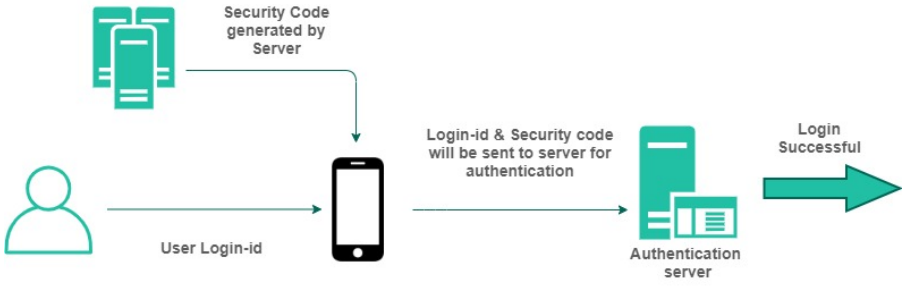

FIG. 4.2. *Login Stage*

sent from the server to the user's smartphone. Each bank will have its own custom application.

As mentioned in Fig 4.1, when a card is issued to the user, the card will get registered into the bank's server. All the sensitive details associated with the card will get stored into the server by the issuer at the time of issuing. When a card is issued to the user, the card will get registered into the bank's server. All the sensitive details associated with the card will get stored into the server by the issuer at the time of issuing.

As mentioned in Fig 4.2, after registration, the user will have to log in into the custom application with a user id and security code. User id will be unique and provided from the bank, and the security code will be dynamic. For each login, there will be different security code, generated by the server and sent to the registered mobile. For users having different accounts, will be provided with different user id associated with each account.

As mentioned in Fig 4.3, for initiating the authentication process, first the security mechanism of the smartphone will have to be bypassed. It could be either in pass-code or pattern or biometric. Following that, the server will send a token number instead of the original account number which will be sent and stored within the smartphone. The sent token number will be dynamic in nature and will have no relevance to the original card data and only be valid for 10 minutes. Once the time period gets exhausted that token will no longer be in use. Once the token is received the user will be asked to swipe the smartphone before the NFC enabled ATM terminal. The token will be read by the reader and the user will be prompted to get his/her Iris scanned by the scanner mounted upon the terminal.

As mentioned in Fig 4.4, the scanned Iris data and the token number will be sent to the host processor, the host processor will map the token number with the original account number and match the iris data with the existing iris sample.

Having verification done successfully, an OTP will be sent in the user's registered number which is to be entered in the ATM terminal. After validating the entered OTP, the transaction will be granted for 20 minutes. Once the given time limit is passed. The user will have to re-authenticate.

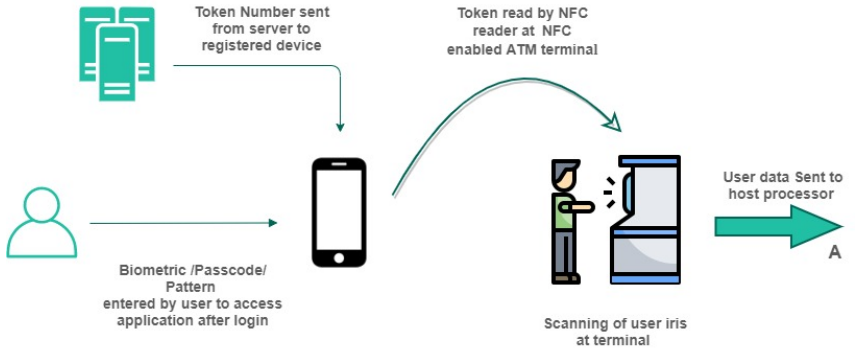

FIG. 4.3. *Authentication Stage*

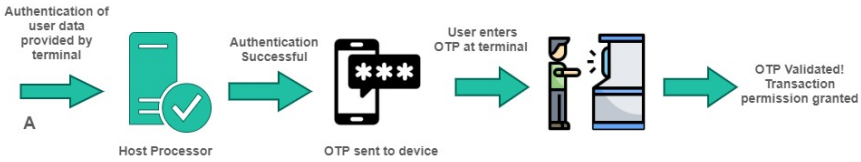

FIG. 4.4. *Acknowledgment of verified details with an OTP*

TABLE 4.1
Hardware and Software Requirements

Software Requirements	
Modules	**Description**
Login Page	This module is used to get user-id and password.
Entry lock	This module will authenticate user biometric/pin/password to let user use the application.
Inquiry module	this module will allow the user to view his account user.
History module	This module will help users to know their transaction history.
NEFT/Fund Transfer module	This module is required in order to let users transfer money online.
Change password	this module is used to change login-password
Report Transaction/Concern	this module is used to help user report any concerns or transactions not committed by them
Hardware Requirements	
Component	**Description**
NFC enabled device	A NFC incorporated mobile device is required for communication with the terminal.
ATM terminal	A NFC reader incorporated an ATM terminal.
Iris Scanner	Iris scanner for user identification which will be mounted on the ATM terminal itself.
Authentication server	Used to send Token to user device and verify token number as well as verify user iris sample sent by terminal to server
Database server	Used to store information of card issued to user along with their device and iris data which is later used to authenticate user for transaction.

4.1. Hardware and Software Requirements. In order to implement the proposed model, basic hardware and software modules are listed out in Table 4.1.

TABLE 4.2
Robustness analysis of the model

Ref.	Issues	Issues addressed by proposed model
[8]	In this paper, the proposed card less approach involves fingerprint as security mechanism which as discussed in sec 1, is not often secure and is subjected to fingerprint forgery. In addition to that, it is PIN based which is again susceptible shoulder surfing	· This model is free from PIN based authentication that is less secure and susceptible to shoulder surfing attack. ·The biometric chosen for authentication is iris which has poor possibility to get forged. ·The level of accuracy is high as iris detection can be done through glasses or contact lens too ·User only needs to carry his/her smartphone from which the authentication is to be done. · There is no need of carrying different cards for different accounts as the smartphone is the one step platform for authentication of all accounts. ·This model ensures that the sensitive details of the user are still safe in case the smartphone gets compromised as locally on the smartphone no data linking to the user's account gets stored. ·In the authentication process, the involvement of iris verification makes certain that even if the smartphone is not under user's possession, the authentication process stays unfulfilled and hence, transaction and any other activity is not granted.
[13]	The researchers of this paper proposed an NFC enabled solution which incorporates two devices, a physical NFC card as well as the user's smartphone. For security, there is pattern-based authentication which needs to be remembered and can also get stolen.	
[15]	This model proposed in this paper is card based and is susceptible to many predicaments associated with physical cards discussed in the paper The data specific to one account is pre-written at the time of issuing which makes user to carry multiple cards for multiple bank accounts	
[16]	The researchers of this paper have proposed a design that works for users having one bank accounts	
[24]	The system that has been proposed in this paper involves a GSM module which is susceptible to electromagnetic interference and leads to substantial amount of latency	
[18]	In this paper the device that the researchers have proposed is based on fingerprint verification which has low accuracy. Moreover, here it is required for the users to carry an additional device for inputting required details.	
[12]	The researchers have proposed a model that is completely card less. However, it is PIN based and comes with many downsides of PIN based systems.	

5. Robustness Assessment of proposed model. Different researchers have presented different models for enhancing the authentication process, making it more secure and robust . However, there are some issues in their proposed designs. In Table 5.1 the issues in the different design facets that have been discussed in sec 2 are taken into consideration and addressed by the model proposed in this paper.

6. Future Direction and Opportunities. Near Field Communication is the latest emerging technology which can be used to solve issues of many current technologies used like RFID. NFC in the upcoming future will be used in many sectors, one of the sectors related to banking is covered in this paper. In future, sclera vasculature biometric technique can be used for high level security authentication. Additional things for further research in NFC [26]:

1. Development of required NFC standards from policy, regulations and legal points of view.
2. The economic performance of NFC developments
3. Potential NFC-enabled applications that are operating in peer-to-peer mode, adoption issues
4. Possible implications of cultural differences on adoption of NFC technologies
5. Impacts of NFC technologies on companies, organizations and business models

7. Conclusion. In this day and age, security of ATM systems has become paramount as multifarious ways have been discovered to compromise the system. There are many pitfalls in the existing system such as they are prone to security breach due to simple PIN based authentication. Moreover, remembering PIN for different accounts is also a impediment. The usage of physical card also carries along obstacles particularly, getting it stolen. This paper proposes a model alternative to the existing system, that uses NFC technology and biometric for authenticating users. We have compared various biometrics and choose to work with Iris due its inherent advantages. Iris based authentication makes certain that the user will no longer have to be concerned about transactions being made without the user's consent, PIN theft, remembering multiple pins, etc. Tiny proximity requirements of NFC ensure secure transfer of sensitive details. Hence, the amalgamation of NFC and Iris verification enhances security of existing ATM systems.

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