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A Comparative Analysis of OSCBR Protocol in Smart Agriculture Structure for Energy-Efficient Data Communication Using IoT-Based WSN

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Abstract: Nowadays, the improving food shortage necessities ecological agriculture attained through mechanization to happen the increasing demand. Enhancing food production in a variety of an agriculture domain, like soil moisture monitoring, irrigation, and energy conservation, requires integrating the Internet of Things (IoT) and Wireless Sensor Networks (WSN). High crop analysis precision and automated farming methods are becoming more and more necessary to continue improving. However, the limited processing, energy, and memory capabilities of sensors may harm agricultural productivity. Also, the efficacy, security, and safety of these IoT-based agriculture sensor nodes are significant from attacker challengers. The main motive of the smart agriculture (SA) system is to enhance the yield of the domain. The research work designed an IoT-based WSN framework used for SA, comprising different developing phases: (i) it develops an energy-efficient (EE) protocol, (ii) optimizes the routing process, and (iii) optimizes the secure clustering routing protocol. The research work has introduced an optimized secure clustering-based protocol (OSCBR). It has also gathered data packets securely communicated from one to other agricultural SNs. The implemented protocol has transferred the data agricultural sensor node (SN) to the cluster head (Ch) and Ch to BS depending on the secure trusted key while using the DES method. This method needs the minimum memory storage and time. The agricultural SNs are hierarchical in terms of residual energy like distinct levels of energy; nodes are larger than agricultural SNs. The major section of the Ch is to get the data from SA land and advance to BS in an EE scenario. The proposed work handles and optimizes the energy and load between agriculture SNs. The simulation result analysis shows the research method using OSCBR protocol transmission performance by 98% in the form of network throughput, data drop value of 34%, network latency of 0.002 msec, energy value of 0.2 j, and overhead of 15% for smart agriculture as related to the existing protocols. After that, the comparison analysis with proposed between existing different protocols, such as EECRP, PSO-ECHS, EALEP, ILEACH, and LEACH. The researched work shows an innovative method of data routing, security, optimizing secure protocol, and improving network lifetime.

Keywords:*Smart Agriculture, Internet-of-Things (IoT), Wireless Sensor Network (WSN), optimized secure clustering-based protocol (OSCBR), energy-efficient (EE) protocol, LEACH protocol*

1. Introduction

Wireless sensor network (WSN) technologies have been used in numerous industries in the last few decades, due to their cost-effectiveness, ease of installation, and economical surroundings. Several sensor nodes distinct around the area are used in WSN to collect and process data. Economic growth and development are greatly influenced by agriculture and new skills, such as IoT-based WSNs. It can assist increase agricultural productivity while saving time and labor. Soil, weather, dampness, and temperature variables are all measured using different sensors [1]. The integration of IoT, WSN, and artificial intelligence (AI) to boost production is one of the major technological advances in the agriculture sector. Real-time information exchange between separate networks is made possible by IoT, making it simple to transmit data across international borders.

A major amount of the gross domestic production (GDP) of developing nations comes from agriculture, which is an essential component of economic development. The expansion of the worldwide IoT market is anticipated to offer novel prospects for agricultural applications, such as soil monitoring, irrigation, greenhouse environmental monitoring, etc., in the context of the food crisis and population rise. The market for sensor-based devices is predicted to expand at a multiple yearly development rate of 10.2%, from 18.12 billion in 2021 to 91.91 billion in 2022, and reach 43.37 billion by 2030. It allows farmers to make well-informed decisions in remote places with intermittent power supplies [2]. More than 70% of workers in India are employed in agriculture, which is a major contributor to the country's economy. Low crop yields and plant growth are common results of traditional farming techniques. This has made the need for automation in processes like pesticide spraying, irrigation, plowing, planting, and harvesting necessary. The IoT is essential to agricultural domains shown in Fig 1 [3].Agriculture is integrating WSN-IoT to improve crop monitoring, fertilizer optimization, autonomous machinery, plant disease and insect monitoring, and irrigation control. These developments aim to improve long-term food

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production sustainability, forecast production, protect crops, and evaluate land.Wireless sensors and mobile networks enable effective management, real-time field condition monitoring, and precise yield maps, enabling precision farming and cost-effective, high-quality crop production.

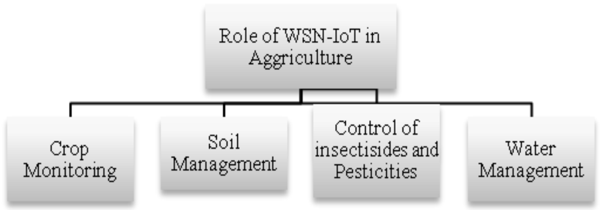

Fig. 1 Role of WSN-IoT in Agriculture [3]

IoT-WSNs are being utilized in agriculture to gather field data in real-time, guaranteeing accurate and sustainable production. In smart agriculture (SA), communication protocols such as SigFox[4] LoRaWAN [5], WiFi, and ZigBee [6]are utilized to ensure efficient connectivity, minimum data packet loss, and long-range coverage. Crucial data on soil moisture, temperature, and humidity are gathered by sensors positioned strategically throughout the agricultural field and connected to wireless communication nodes. Informed decision-making, accurate resource allocation, automated irrigation, and timely crop growth optimization are made possible by the analysis of this data. Long-term sustainable farming operations are encouraged and agricultural practices are improved by this integrated IoT-WSN strategy [2].

Numerous surveys on WSNs-based SA systems have significantly increased in the last several years. Various research on IoT-based WSNs, smart agriculture systems' communication protocols, AI integration, AI use, and important parameters in WSN-based SA systems. The analysis examines IoT-WSN architectures and network protocols, evaluating their applicability in five fields in South Africa since 2019. It draws attention to privacy issues and difficulties in incorporating IoT-WSNs into routines. The study aims to enhance South African practices' productivity and efficiency by exploring potential applications and future trends in wireless communication technologies, network protocols, IoT-WSN architectures, and WSNs. It analyses IoT-WSN architectures and related network protocols, as well as wireless communication technologies like SigFox, LoRaWAN, Wi-Fi, and Zigbee. Articles are categorized by publication year starting in 2019. Five major applications in SA are included in the survey: energy optimization, pest management, fertilizer optimization, soil moisture monitoring, and irrigation systems [7]. Since 2019, it also looks at how to integrate wireless communication protocols [8]. Also described issues with SA technology, including cost, network security, user privacy, data privacy, and scalability of IoT-WSNs [9]. To develop agricultural systems that are user-friendly, inexpensive, and sustainable, the company offers cutting-edge solutions for sophisticated architectures including AI, artificial general intelligence (AGI), 5G, agri-robotics, big data, blockchain analytics, 6G, and renewable energy [10][11].

Since the WSN nodes are placed far out in the field, they encounter numerous difficulties. Thus, these difficulties must be taken into account when building a sensor node as they may result in the node's failure. Several existing methods have been developed in this field such as the authors propose the PSO-ECHS protocol to enhance network lifetime and stability by selecting cluster heads (Ch) based on fitness functions like residual energy (RE), sensor node (SN) distance, and base station (BS) distance, initiating the cluster formation phase [12]. To reduce energy consumption for long-distance data transport, the authors suggest an EECRP for wireless sensor networks that computes centroid location and splits the network into clusters[13]. The distributed hierarchical agglomerative clustering (DHAC) protocol is related to a homogeneous background. However, the algorithm's non-optimal Ch selection and distribution lead to extra energy consumption (EC). The proposed algorithm reduces this by evenly distributing load among SNs, resulting in a longer network lifetime [14]. The goal of this research paper is to use state-of-the-art IoT-based sensor infrastructure to gather environmental data and securely send it to the BS so that it can be used to make effective decisions.

These data packets are safely transmitted to the Chs which work as memory storage to forward data toward BS. After BS receives the data safely, the BS can give the status data to consumers for a reliable decision with less time consumption (TC). Generally, the proposed Optimized Secure Clustering-Based Routing Protocol (OSCBR)to mechanize agriculture manufacturing with reduced farmer load. Agricultural land SN detection data is intelligently and securely sent to the BS, improving land monitoring and productivity. The implemented OSCBR method has also gathered the packets safely broadcast from one to another hop. The research method process is transferring the packets SN to Ch and Ch to BS depending on the secure and trusted keys while using the data encryption standard (DES) method. The secure method needs to reduce the time, storage, and RE. The research work focuses on the reduction of energy and load between agriculture sensors. The simulation outcomes defined the data transmission network performance.

The research paper is organized the sub-sections, such as Section 2 gives a detailed discussion about the existing implemented routing protocols. Section 3 discusses the proposed methods in detail, section 4 defines the experimental setup explains the network performance metrics used, and discusses the result and comparative analysis. Section 5 gives the conclusion and further improvement in this field.

2. LiteratureSurvey

In current years [15], several analyses of different routing protocols have been defined. Using some of the most well-known protocols they offer a taxonomy of routing protocols in WSNs. The primary contributions of these surveys are shown in Table 1.

Table 1. Analysis of IoT-based WSN routing protocols and Metrics

Year	Analysis	Energy-efficient and reliable routing	Machine Learning Methods	Network Throughput (Kbps)	Packet Drop	Network Latency /Delay	Energy Consumption (EC) / Residual	Packet Delivery Ratio	Execution Time
2020	[1]	✓	✗	✓	✓	✓	✓	✗	✗
2023	[16]	✗	✓	✗	✗	✗	✗	✗	✗
2023	[17]	✓	✗	✗	✗	✓	✗	✓	✗
2023	[23]	✓	✗	✗	✗	✗	✓	✗	✓
2021	[15]	✓	✗	✗	✗	✗	✓	✗	✓
2022	[22]	✓	✗	✗	✗	✗	✗	✗	✗
2024	[21]	✓	✗	✗	✗	✗	✗	✓	✗
2024	[24]	✗	✓	✗	✗	✗	✗	✗	✓
2020	[19]	✓	✗	✓	✓	✓	✓	✗	✗

Table 2 describes the analysis of various existing methods based on IoT-WSN-based routing protocol in the agriculture field and also includes proposed methods, problems, parameters, findings, etc.

Table 2 Analysis of existing methods, issues, and outcomes

Author's Name	Proposed Method	Problem	Parameters	Findings
Khalid Haseeb et al. (2020) [1]	an IoT-based WSN framework	Inadequate memory and resource transmission	Energy consumption PDR Network latency Throughput	This method improves the performance with different performance parameters.
Murali Krishna Senapaty (2023) [16]	.4. MSVM-DAG-FFO Algorithm	Weather circumstances are not properly predicted.	Accuracy Recall Precision F-Score	This method is capable of informing about his soil's health to distinguish the recommended crops
Shadi Atalla et al. (2023) [17]	IoT-based model for precision agriculture	Incomplete real-world performance	Power consumption PDR	It provides effectively pools an array of sensor dimensions as well as communication tools.
G. S. Nagaraja et al. (2023) [18]	A synchronized framework	Complications concern security and energy consumption.	Alive Nodes Residual Energy Execution time	It improves the execution times.
S. J. Suji Prasad et al. (2021) [19]	LoRa-based wireless sensor networks	Complex process due to more sensor nodes.	Temperature	Remote monitoring helps farmers and supports the development of the model.
Mehdi Gheisari et al. (2022) [20]	Fuzzy-based intelligent agricultural model CH selection.	Lack of privacy and more energy consumption.	Residual energy	Energy consumption caused improving network lifetime

3.Material and Methods

3.1 LEACH Protocol

LEACH protocol [25] defines the start of the round. It executes with numerous rounds. Each round contains a set-up and a stable state, for example, two distinct states. (i) Each node decides in the setup step whether or not to take on the part of cluster head (Ch) for the present round. The sensor nodes (SNs) choose an arbitrary number (0,1) to make this choice. For the current round, the SN becomes a Ch when the number is less than a threshold Th (m).
LEACH Protocol has defined the Th set as below:

$$Th\ (m) = \begin{cases} \frac{pro}{1-pro*(rand*mod\ \frac{1}{pro})} & m \in g \\ 0 & m \notin g \end{cases} \quad (1)$$

Here eq (1), represents pro as the preferred % of Ch, $rand$ denotes the current round, and g is the set of SN which have not been Chs in the last $\frac{1}{pro}$ rounds. After that, operations shift to the steady step, which is further divided into frames. During each frame, SNs transfer data to the Ch once they have been allotted a transmission slot. The networks are all regenerated after a while to get ready for the next round. Figure 2 displays the flowchart of the LEACH protocol. Figure 3 shows the clustering structure of the LEACH protocol [26].

3.2 Improved LEACH Protocol

The balanced LEACH protocol is an improved form of the LEACH protocol. A second Ch selection is assigned during the setup phase, and it is determined by the residual energy (RE) of every node in each round. The protocol's objectives are to dominate the number of Chs and achieve an appropriate Ch amount to maximize the network's longevity. It also provides a balanced and uniform cluster division to optimize energy consumption and network lifespan.

(i)The near-optimal number of Chs

According to [26], 3-5 clusters out of 100 nodes are the most energy-efficient configuration, with 5% being the most ideal percentage.

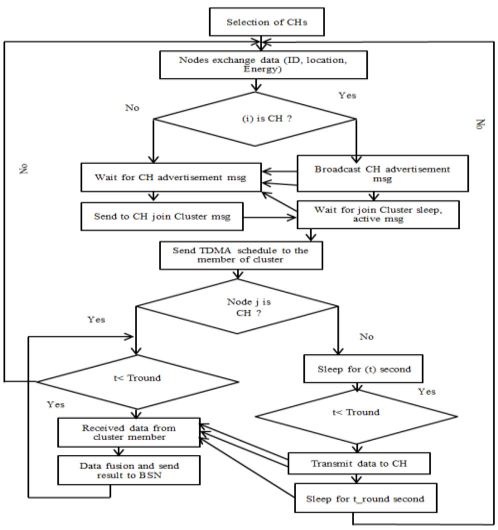

Fig. 2 LEACH Protocol Flowchart [27]

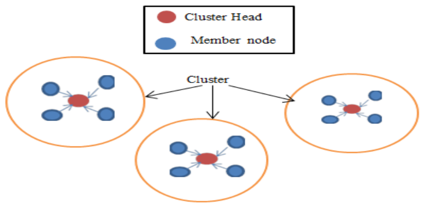

Fig. 3 Clustering Structure [27]

(ii) Another selection of the Chs

In ILEACH, the intended percentage of Ch, denoted by p, and the total no. of nodes, signified by n, are maintained while competition for Chs is introduced after they are chosen at random. Chs advertise messages that every node can use to find out the first selected number and residual energy. The uncertainty in the number of Chs generated by the LEACH algorithm prompts this method to take into account two distinct scenarios. A network's fraction of normal nodes, which use the non-persistent carrier-sense multiple access (CSMA) MAC protocol, determines the number of CHs in the network. Chs advertisement messages. The time interval's value is configured as

$$t = k/E \quad (2)$$

In eq (2), Ch is calculated by dividing the time interval created by each node's residual energy, E, by factor k.
A low-energy cluster head can be eliminated to bring the cluster number down to n p* if there are more cluster heads than n p*.
The RE is sorted by descent for cluster heads, and if the energy of a head is ranked lower than n p*, it is transformed into a normal node. The distributed method enhances the balance of energy usage by enabling nodes to make independent decisions without centralized control. Figure 4 displays the flow chart for the selection of the second CH.

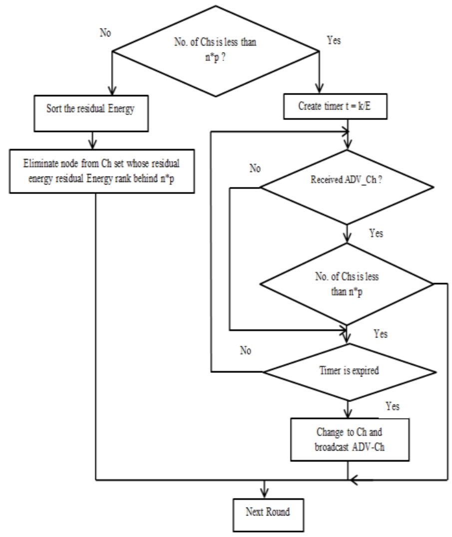

Fig. 4 Improved LEACH Protocol [25]

3.3 Energy-efficient and Secure IoT-based WSN Framework

It manages the load between agriculture SNs and it chooses reliable Chs depending on the multi-criteria decision function (MCDF). However, the discussed method creates a single-hop data transmission instead of a multi-hop pattern to minimize the network delay. After that second process is related to the security framework exploiting symmetric data encoding between agriculture SNs and defining a robust data transmission in the area utilizing Pseudo-random number generation. The discussed flowchart is defined in Figure 5.

3.4 Implemented Optimized Secure clustering-based routing method for IoT-based WSN Framework in Smart Agriculture

Enhancing agricultural land with an optimized, secure, and EE IoT-based WSN structure is the intention. Our introduced method provides EE and reliable techniques for enhancing sized agricultural land. Additionally, the presented framework used the linear congruential generated, which uses less memory and processing time, to aggregate the data security from agriculture SNs toChs and from the Chs to BS depending on secret keys using the data encryption standard (DES) method. Generally, this protocol gives an optimized, reliable, and secure routing method for the agriculture field. The introduced protocol flowchart is defined in this section. It consists of two primary features:

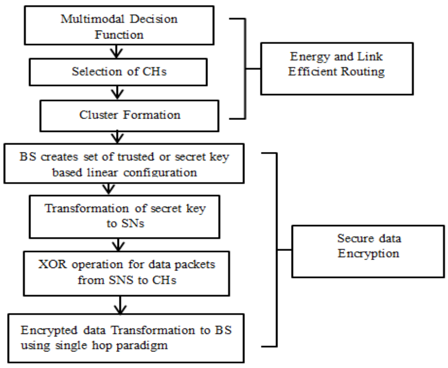

Fig. 5. EE and Secure IoT-based WSN Framework [25]

(i) agriculture SNs are distributed to collected data. The SNs are varied in the form of RE, the heterogenous SNs energy level is maximum than normal SNs.

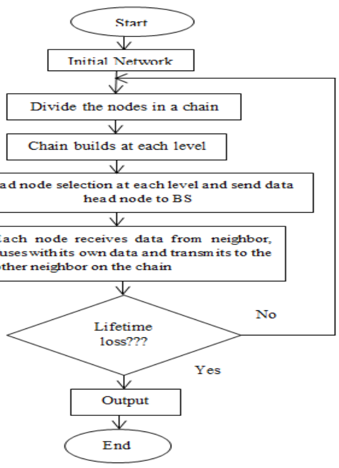

Fig. 6 Greedy Algorithm Flowchart

The agriculture SNs are distributed into several fields and each field comprises one Ch. The main role of Ch is to get the data from agricultural land and forward it to BS in the EE process. It mainly focused on optimizing and organizing energy use and data load between agriculture SNs and chose dependable Chs based on the greedy algorithm. Generally, the fundamental idea of the greedy algorithm is that each node transfers with and receives data from its nearby neighbors and that each node alternates between leading and following transmissions to the BS. The energy load is divided equally between the SNs in the network using this approach, Figure 6 shows the workflow of the greedy method[26][27].

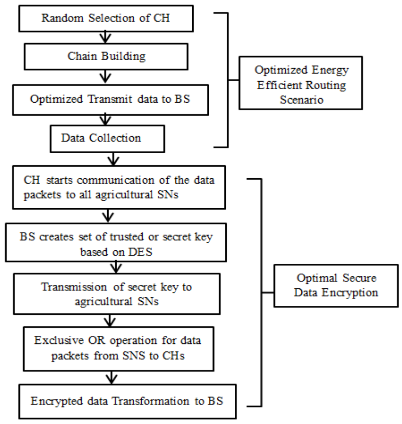

Fig. 7 Proposed Workflow

DES[28] algorithm is used for security purposes. In the symmetric DES method, the information sender procedures the original data packets, and the encoding key together with a different encryption method to make it difficult to encode ciphertext and transfer it. The recipient must decode the cipher text using the encoding key and the inverse method to convert it back to readable plaintext after getting the ciphertext if they want to understand the original text. Compared to the public key, symmetric has minimum calculation cost and reliable method. It means the EE with the DES algorithm has been used to transmit the data securely. Figure 8 shows the diagram of DES's general steps.

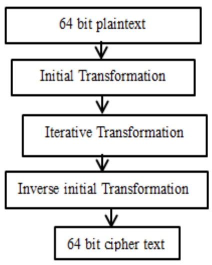

Fig. 8 DES steps

After the security algorithm, Particle Swarm Optimization (PSO) [28] was introduced to improve evaluations. It gives optimal solutions to routing issues, aiding in the selection of the reliable one to attain maximum network performance. A stochastic optimization method based on the swarm is called PSO. It mimics the social nature of various creatures, such as insects, fishes, etc. The swarm follows a cooperative strategy for finding food, and each individual in the swarm continuously modifies the search pattern in light of their own and other members' experiences. Particles in PSO can adjust their velocities and locations in response to changes in their surroundings. The swarm never stops moving instead, it never stops looking for the best answer within the range of potential solutions. This optimization method shows problem-regarded solutions by particles, evaluating performance utilizing fitness function (FFn), and choosing the local and global optimized information to update particle positions during each epoch. After, several epochs, the particles explored the optimal solution in the search space.

3.4.1 Network Assumption

An implemented optimized secure clustering-based protocol for IoT-based WSN framework in SA. Various network expectations are described as follows:

Table 3. Parameters

Parameters	**Values**
Network area	1000*1000 meters
Network deployment	Randomly
Agriculture SNs	30-100
Data Packet size	64bits
Level of energy	2 to 4 joules
Range of data transmission	20meters
No. of rounds	0-100
Simulation tool	MATLAB 2021a
Performance metrics	Energy consumption, Latency, packet drop, throughput, and overhead

- Agriculture SNs can handle their EE.
- In the network, each SN can directly communicate signals to the BS.
- These SNs have uniform EC.
- The data transmission associates are symmetric, using the DES method.
- Agriculture nodes are arranged hierarchically depending on their energy resources.
- EE-optimized solutions are explored using the PSO approach.

3.4.2 EE data transmission routing method for IoT-based WSN in SA

It designed a routing method for data transmission utilizing PSO through an improved PSO to establish the framework for the optimized secure clustering-based routing method. This proposed method is a chain-based method developed for hierarchical network routing protocols, depending on the greedy algorithm. In the proposed method, agricultural nodes exclusively transmit with their closest node neighbors. The protocol effectively allocates the reliability of transmitting a signal to BS to only those SNs that are near the BS. It starts the chain formation, the initial member of the chain is chosen from SNs, with one nearest to the BS serving as the initial member. The nearest neighbor of this start member is then selected as the second SN in the BS in the chain. The procedure keeps going until the chain reaches the member that is closest to the BS. An organization that gets ideas from the BS may plan data-collection rounds. Agricultural SNs need to connect with their closest neighbors to transmit data to the BS. It covers the network lifetime and reduces energy consumption (EC).

3.4.3 Optimal solution and Secure data transmission for agriculture nodes to BS

It optimizes the existing routing issues and helps to choose the best route to attain maximum precision. Using an optimized, secure network, the DP from the agriculture SN is sent to the Chs and then to the BS. Without monitoring latency, overhead, PDR, etc in the WSN. The implemented method assesses the network energy consumption using the optimized DES technique.

4. Experimental Result Analysis

The summary of the simulation network parameters used in the research work to ensure dependable outcomes for both the optimized, secure, clustering-based routing method and the energy-aware link efficient routing protocol[29], and Improved LEACH protocols[30]. The result analysis outcomes are using MATLAB 2021a experimental tool, for analyzing IoT-based WSN routing and transmission. The simulation metrics and their default values are shown in Table 3. A different number of rounds are used to evaluate the simulation results. Different numbers of SNs or rounds are used to evaluate the simulation results. A single simulation round lasts for 20 sec. Furthermore, there are 30-100 agriculture SNs, network size 1000*1000 meters, node deployment is random, data packet size is 64 bits, energy level is 2-4joules, and range of data transmission is fixed to 20 meters.

4.1 Performance metrics

The calculation depends on the numerous network parameters, like network throughput (NTh), packet drop (PDr), Energy consumption (EC), routing overhead (ROh), etc. The mathematical formulas are discussed below:

4.1.1. Throughput

The data rate (bits per second) that the application generates is measured by its throughput. The eq (3) illustrates how throughput TP is calculated, with packet size being the ith packet that reaches the destination, packet start representing the time a packet leaves the source, and packet arrival representing the time a packet arrives at its final destination.

$$TP = \sum \frac{packetsize}{packet\ arrival - packetstart} \quad (3)$$

4.1.2 Packet Loss

Packet loss degrades the application's appearance. Bit errors in a wireless network gone wrong or insufficient buffers because of network congestion when the channel is too busy are two common reasons for packet loss or corruption. It is represented as;

$$Packet\ loss = \left(\sum \left(\frac{lost\ packetsize}{\sum packet\ size}\right) * 100\right) \quad (4)$$

4.1.3 Routing Overhead (ROh)

Routing protocols are used to communicate control information (packets) to find routes. The path request sent, path reply sent, and path error sent packets are included in this control information. It is defined as the ratio of total control packets communicated to total data packets successfully distributed. it is described as;

$$Routing\ Overhead = \frac{Total\ no.of\ control\ packet}{Total\ no.successfully\ delivered\ data\ packet} \quad (5)$$

4.1.4 Energy Consumption(EC)

The energy consumption of all network nodes, including transmitting, receiving, and idle, is the total energy used by each node. The overall EC is equal to the total number of packets delivered, assuming each transmission uses one energy unit. P describes power units and t dedicates the time taken for energy utilization. it is calculated as;

$$Energy\ Consumption = P * \left(\frac{t}{1000}\right) \quad (6)$$

4.1.5. Latency

The average time interval between the commencement of data dissemination and the arrival of the data at a node that is interested in receiving it is known as the average message latency. Thus, temporal performance for each communication is measured by the delay.

4.2 Result and Analysis

4.2.1 Performace Analysis based on Network Throughput (NTh)

Figure 9 compares the study method in terms of NTh while adjusting the number of agriculture SNs with known routing protocols, such as OSCBR, EALEP[1], PSO-ECHS[1], EECRP[1], LEACH[29], and ILEACH[30]. In comparison to the OSCBR, EALEP, PSO-ECHS[1], EECRP[1], LEACH[29], and ILEACH[30] procedures, the study routing protocol enhances the performance parameter, Specifically NTh, by 9%, 14%, 19%, 26%, 16% respectively, in comparison to the OSCBR, EALEP, PSO-ECHS[1], EECRP[1], LEACH[29], and ILEACH[30] protocols. The clustering-based routing system, which is secure and EE, is responsible for the increase in the NTh. Due to its robustness, the developed routing protocol measures not only the signal consideration between agricultural SNs. But also the success ratio parameter when choosing Chs. This helps to improve the packet delivery rate (PDR) in smart agriculture land. Furthermore, the allocation of encryption data with trustworthy keys and optimization of secure DPs using the PSO method is responsible for the OSCBR protocol improvement in NTh as compared to current findings. The number of agriculture SNs for a given data transfer connection is used by the research method to compute the fitness value, which has a major impact on the transfer of SA data to the BS.

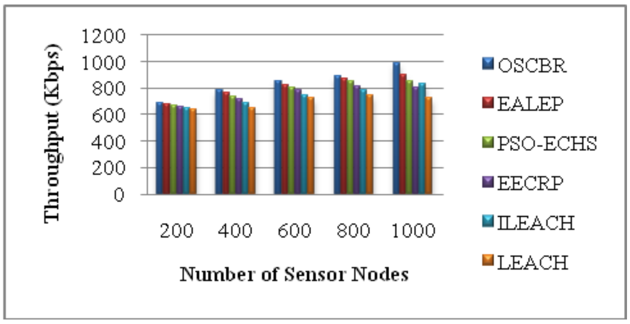

Fig. 9 Comparison analysis with distinct routing methods: Number of agriculture SNs vs NTh (Kbps)

4.2.2 Performace Analysis Based on Latency

Figure 10 displays the network latency performance parameter together with research findings and the current OSCBR
protocol.

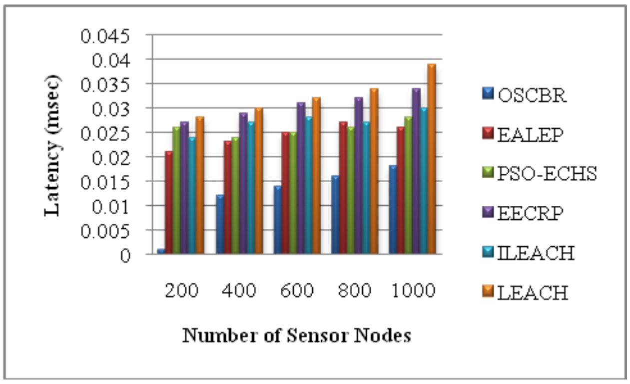

Fig. 10. Comparison analysis with distinct routing methods: Number of agriculture SNs vs Latency (msec)

Malicious nodes within the network have the potential to increase the network latency ratios and increase the probability of a network disconnect. Based on the results of the simulation, it can be concluded that the developed protocol has an 8%, 10%, 16%, 12%, and 21% longer latency than the existing protocols. When determining how to route data to BS, the implemented protocol chooses the greatest number of SNs. The implemented protocol maximizes the likelihood of selecting the weak node to relay the data by using optimizing and security concepts to confirm the movement of the attacker node. The suggested protocol reduces the latency by using the direct communication path rather than a no. of route procedures, which significantly increases the network latency rate. The adopted protocol outlines the safe and efficient data transfer that reduces latency and avoids retransmission between BS and SA sensor nodes.

4.2.3 Performace Analysis Based on Energy Consumption

The study protocol analysis is compared with alternative approaches in Figure 11**.** Comparing the implemented protocol (OSCBR) to alternative protocols, the analysis of the experimental results shows that it improves EC by 21%, 23%, 34%, 36%, and 39%.

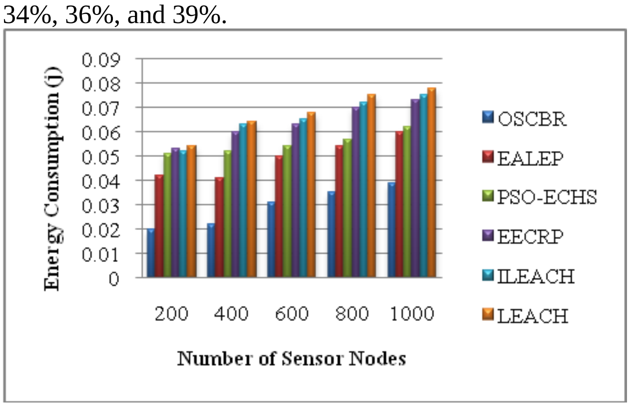

Fig. 11 Comparison analysis with distinct routing methods: Number of agriculture SNs vs EC (J)

The EC load is efficiently distributed among SNs using the research protocol. According to the study methodology, an objective function calculation is used to choose the optimal SNd for cluster sites in the agricultural land. It reduces EC in the designed domain, the BS will eventually oversee the Ch formation and Ch selection processes in a different scenario. Because of the multi-hop strategy, the study mechanism ignores the re-routing process.

4.2.4 Performace Analysis Based on Routing Overhead (ROh)

An objective function that is security-focused and optimized for the selection of CHs while minimizing the processing routing overhead on agricultural SNs is shown in Figure 12 by the RO analysis conducted as part of the research procedure. By taking into account the distance to the base station together with other metrics, the suggested protocol allows for optimum data transfer. By maintaining global data packets and updating the database as needed, the protocol lowers the RO ratio and improves data transmission performance in the agricultural area. By reducing the possibility of data rerouting, the developed protocol lowers ROs among nameless nodes. Furthermore, the optimized DES algorithm is necessary for the integration of a data encryption (DE) technique.

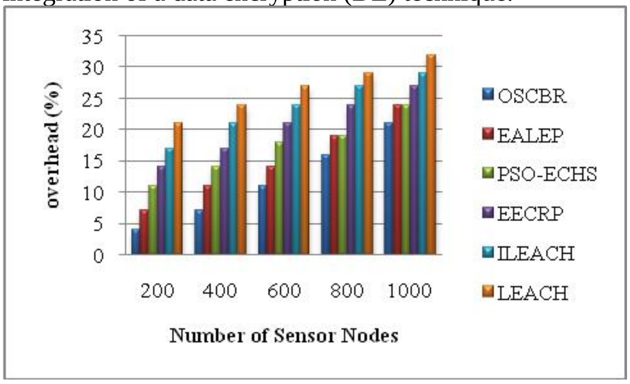

Fig. 12 Comparison analysis with distinct routing methods: Number of agriculture SNs vs ROh (%)

4.2.5 Performace Analysis Based on Packet Drop Ratio

The reproduction outcomes of the suggested outline with alternative solutions are shown in Figure 13 in terms of the packet drop ratio. The findings show that, in comparison to the current methods, the suggested framework reduced the packet drop ratio by 29% and 48%. Drop rates increase as a result of the current solution's disregard for the transmission link factor. To provide efficient routing performance, our suggested framework uses the residual energy of sensor nodes and the measurement of signal strength during data forwarding. Furthermore, by analyzing the multi-criteria decision function and removing the crowded nodes for data routing, the suggested framework raises the ratio of packet delivery.

achieving better results. We shall look at each of the individualentitiesseparatelyandfinallyclubthemtogether in an implementable way to carry our task ahead.

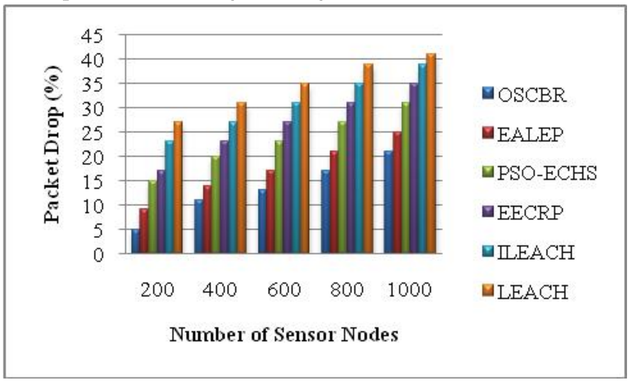

Fig. 13 Comparison analysis with distinct routing methods: Number of agriculture SNs vs packet Drop (%)

5. Conclusion

IoT is significantly impacting every industry worldwide, including transportation, smart agriculture, healthcare, etc. A technology known as WSN has greatly advanced the agriculture industry. In an IoT-based WSN overview for SA uses, this research offers an optimized secure clustering-based routing protocol (OSCBR) that makes use of an EE and optimized secure method. Through the use of trusted keys and the DES algorithm, the OSCBR protocol exhibits effective, optimal, and secure data transfer from agricultural SNs to the BS. After that, this research article shows the comparative analysis with proposed and existing methods, such as EALEP[1], PSO-ECHS[1], EECRP[1], LEACH[29], and ILEACH[30]. Compared to the mentioned protocols, the implemented protocol enhances the performance parameter, normally NTh, by 9%, 14%, 19%, 26%, and 16% respectively. Based on the results of the simulation, it is estimated that the developed protocol has an 8%, 10%, 16%, 12%, and 21% improvement in latency compared to other methods. Network performance analysis will be carried out in the context of mobile-based IoT networks and smart and intelligent systems in further studies.

AuthorContributions

Ashutosh Kumar Rao Study Conception and Design, Draft Writing,Paper framework Concept,Conduct the study and Comparative result analysis. **Bhupesh Kumar Singh**:Study Conceptualization,Supervision of Conduct Study, and Checking the Study results. **Kapil Kumar Nagwanshi**: Study Conceptualization,Supervision of Conduct Study, and Checking the Study results.

Conflictsofinterest

The authors have no conflicts of interest to declare.

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