An Optimized Energy Aware Routing Algorithm based on Multi-Objective in Wireless Sensor Networks

Aarti
Pallavi Garg (Assistant Professor)
"SIRDA Institute of Engineering & Technology Sundernagar, Distt-Mandi, Himachal Pradesh-175021"

Abstract: The affordable, dependable, and energy efficient sensor technology revolution has spawned a slew of WSN-based applications. With prospective technologies such as Wireless Sensor Networks (WSNs), a variety of monitoring applications have been imagined. Finding an appropriate feature of WSNs routing protocol that corresponds to a certain network circumstance scenario is difficult. Many studies have been conducted in the previous 10 years to evaluate the performance of the WSN routing protocol based on energy efficiency, yet there are still numerous issues. The proactive and reactive routing protocols are the two types of WSN routing mechanisms. Alternatively routing protocol is available that is known as the Hybrid routing protocol, which is a blend of proactive and reactive routing protocols. Hybrid routing protocols are preferable than proactive and reactive routing protocols in that they can alleviate WNS energy consumption by developing a clustering-based routing protocol. With the aid of the Swarm-based Grasshopper Optimization (SGO) Algorithm, we suggested an Optimized Energy Aware (OEA) routing algorithm based on multi-objective in WSNs. In this research, we used the concept of K-means for network clustering and the Artificial Neural Network (ANN) to provide network security by analyzing the nodes during communication. The OEA-oriented routing mechanism perform better as compare to others routing protocols that clearly mentioned in the results analysis section based on the Quality of Service (QoS) parameters such as Throughput, Packet Delivery Ratio (PDR), Delay, Energy Consumption and Active/Dead Node Count.

Index Terms: *WNS, Routing Protocol, Optimized Energy Aware (OEA), Swarm-based Grasshopper Optimization (SGO) Algorithm, ANN, QoS*

I. INTRODUCTION

Recently, Wireless Sensor Networks (WSNs) are becoming increasingly common, and it's essential to comprehend the architecture of these networks before using them in any application. In order to have a strong background on the wireless sensor network, this paper investigates the WSN architecture using the OSI model and various protocols [1]. WSN is a single compact device that combines sensing, processing, and communication. A sensor network is made up of a number of different sensor networks that are all connected via a wireless communication system. The data from the sensors is exchanged among the sensor nodes via intermediate nodes and we need to consider an appropriate number of intermediate nodes in the communication. So, the mechanism of clustering-based routing mechanism helps to provide better wireless communication in networks [2]. In the present day, Hierarchical WSNs (HWSNs) have important application domains, particularly in the monitoring and tracking of occurrences without the need for human interaction. Sensor nodes in WSNs are known for having a limited life duration due to continual sensing, and as a result, the battery drains quickly. Sensors in close proximity to the sink die quickly in high-traffic areas, resulting in an energy-hole problem. As a result, in WSN-assisted applications, making the best use of available energy is a major difficulty. To save energy, precise clustering and effective path selection from sensor nodes to sink have become critical. In general, transmission of data consumes more energy in a general WSN node than processing and sensing [3]. When a node begins transferring data to a Base Station (BS) or Sink located at a greater distance, its energy consumption skyrockets [4]. The BS or Sink node is a powerful machine with ample storage and computing capabilities, as well as no power constraints [4]. Multi-hoping transmission has been used in several ways to shorten the distance travelled [5, 6]. Several routing protocols are developed to facilitate multi-hoping, and they use diverse tactics such as data-centric, geographic location-based, clustering, and hierarchy-based [7].Data transfer between nodes and BS is initiated by data-centric protocols via relay nodes [8]. These protocols eliminate data redundancy and reduce the number of data packets that must be transmitted. At the same time, these protocols limit the network's scalability. Geographic protocols provide data packets to BS based on the location of sensor nodes [9]. The key challenge here is figuring out where the nodes are located geographically. For data transfer, hierarchical protocols use a multi-tier design [10]. The entire network is considered as a tree, with regular sensor nodes, a CH, and a BS for better and in efficient way to data packets transmission and the mechanism of HWSNs is show in the Fig. 1.

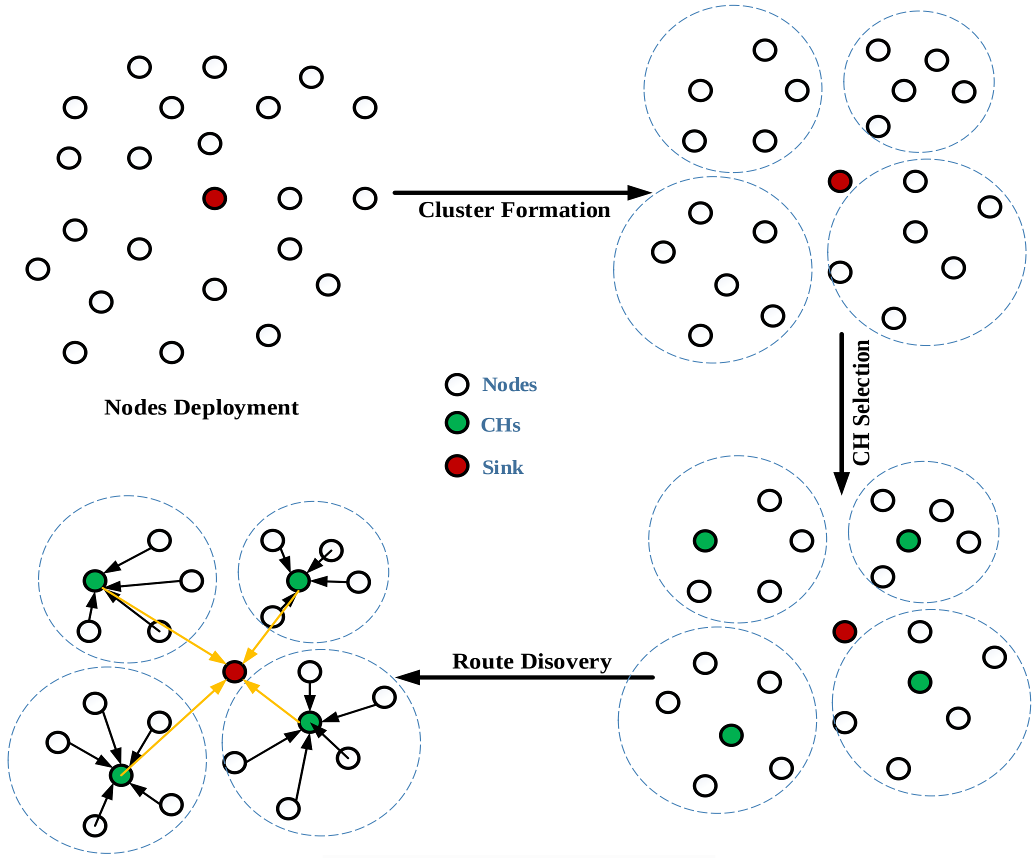

Fig. 1: Architecture of HWSN [11]

Basically, the working of HWSN is based on the clustering mechanism that is also known as region or zone-based approach. The dilemma of energy efficient routing is almost addressed using this technique, although there are still issues such as node failure during data transfer. So, the primary motivation for improving the HWSN routing mechanism for network is to provide a more energy-efficient as well as failure detection capability by utilizing an optimized ANN as a classifier in the network, where the Swarm-based Grasshopper Optimization (SGO) algorithm is used to optimize the ANN, and the major contributions are as follows:

- ❖ We presents a brief analysis of the existing HWSN routing mechanism to find out the issues faced by the researchers.
- ❖ We introduce a clustering-based Optimized Energy Aware (OEA) routing algorithm based on multi-objective SGO technique.
- ❖ The concept of an optimized ANN as an AI technique is used to detect the failure of sensor nodes during the transmission of data packets within the network.
- ❖ To validate the proposed OEA routing mechanism in HWSN, a comparison with the existing state of the art using different approaches are performed in terms of Energy Consumption, Throughput, Packet Delivery Ratio (PDR), and Network Lifetime.

The rest of the article is arranged as follows: in Section 2, existing work related to the routing protocol for HWSN is analyzed; in Section 3, material and methods are discussed with an experimental set up of HWSN scenario; and in Section 4, we provide a brief introduction about the proposed OEA routing mechanism In Section 4, the simulation findings are examined, and in Section 5, the conclusion with future prospects is discussed.

II. RELATED WORK

There are lots of approaches already used to solve energy consumption problems in WSNs by focusing on the routing failures issues but in this section of article, we focus to identify the problem regarding the proposed OEA routing algorithm based on multi-objective in WSNs". In 2020, ***D Mehta and S Saxena*** had conducted a research on the Multi-objective cluster head based energy-aware optimized routing (MCH-EOR) algorithm in WSNs. First routing mechanism is named as Multi-objective Cluster Head based Energy-aware Optimized Routing (MCH-EOR) algorithm. In MCH-EOR algorithm, multi objective Sailfish Optimizer (SFO) is used to select CH during route discovery to sustain energy efficiency in WSNs based on effective fitness function which is formulated from multiple objectives. Design routing algorithm helps to minimize energy consumption of network and reduces sensor nodes dying rate. After CH selection using SFO, an optimal path is created to transmit the data packets from T_X-node to R_X-node via CHs and base station or sink node. To validate the proposed MCH-EOR algorithm, simulation results are compared with the similar existing approaches namely, Grey wolf optimization (GWO), Genetic algorithm (GA), Ant Lion optimization (ALO), and Particle Swarm Optimization (PSO) in terms of Quality of Service (QoS) parameters like energy consumption, throughput, packet delivery ratio, and network lifetime. The simulation results show that proposed method has performed 21.9% and 24.4% better in terms of energy consumption and number of alive sensor nodes respectively when compared to GWO. Further, it shows significantly better results than other optimization-based approaches but need to introduce the concept of classifier to identify the dead node at initial stage of transmission. So, in next routing mechanism, we use Fuzzy Logic (FL) as a classifier with bio-inspired optimization algorithm [11]. In 2019, a cluster-based WSN model was developed with the help of trust aware nature inspired optimized routing protocol by ***EPK Gilbert et al.*** In this WSN based research, an optimized trust aware data aggregation and routing mechanism has been proposed that based on the clustering approach. To reduce the network overhead, compressed sensing method is used as a data aggregation technique from sensor nodes and nature inspired swarm-based optimization has been implemented to transmitted data packets using the most trusted route and trust-based reconstruction is done at the base station in the presence of various malicious or fail nodes. Developed model was evaluated in the presence of 10%-30% malicious of fail nodes and provides better efficiency [12]. In 2019,***Al-Humidi et al.*** have resolved the problem of random selection of cluster heads through a new developed cluster-based approach known by EACCC (Energy-Aware Routing using Centralized Control Clustering). It works on the basis of centralized control cluster mechanism and initially each sensor nodes sent information related to remand energy along with the nodes position to the base station. On the basis of received information by base station, it decide that in which portion of the wireless network the sensor nodes will be considered as a cluster head. EACCC run in multiple round and in every round the selection of cluster head has been performed, after the selection data transmission takes place [13]. A model of clustered WSN was presented by ***X Fu et al. in 2019*** using the concept of cascading approach. Authors proposed a congestion-aware routing recovery mechanism for constructed cascading model for clustered WSN and the load function is defined on each sensor node according to size of data packets, and based on the congestion state of each node, overloading is decided. The overloaded sensor node within the network can recover after a certain time delay and not need to delete permanently from the region of network. The experimental results of proposed model prove the network invulnerability with the overload tolerance phenomenon. The concept of cluster size balancing and putting the sink node near the center of the deployment area can help the network reduce the risks of cascading failures. By introducing cluster-based routing recovery mechanism, the network is able to recover the fail nodes after sometime and recover time should be reduced in the future [14]. An evolutionary trust aware routing with energy efficient network (TAREEN) with an aim to provide an optimal security between robustness and network life time has been proposed by ***M. Udhayavani & M. Chandrasekaran*** in 2018. They design a model for simulation of WSN using the concept of TAREEN with enactment of TARF and try to solve the security problems. So in order to protect WSN from different types of attacks and to perform improvement in routing mechanism they have implemented a low overhead TAREEN with routing protocol. Developed hybrid routing protocol is to solve the energy as well security concern with energy efficient network routing protocol by minimizing the effects of attackers, the network QOS improved with the selection of trustworthy and energy efficient route for data transmission which leads to increase the life time network [15].

III. MATERIAL &METHOD

The strategy and procedures used to create an OEA oriented WSN with the help of ANN and SGO to discover a safe and energy efficient path or route are explained in this fragment of article, and the model is displayed in Fig. 2. OEA routing protocols are used in WSN to build a secure and efficient path for data packet transmission from source node to destination node. There are three types of routing protocols available in WSN, as indicated in the previous section: proactive, reactive, and hybrid routing protocols. Where, hybrid is the combination of the proactive and reactive and the goal of this study is to create a routing algorithm that uses a hybrid approach based on the optimized energy aware mechanism. To begin, we just use proactive routing mechanism to establish and sustain the route, and then we leverage the reactive routing mechanism to reduce the routing overhead that happens with proactive routing protocols. As a result, it is referred to as a hybrid routing protocol, and it has a higher capacity than a single mechanism. The intended OEA-oriented routing mechanism is an example of hybrid routing. The used routing technique is employed in this study to find a route from the T_X-Node (Source) to the R_X-Node (Destination). The suggested OEA-oriented routing mechanism for WSN approach, which is based on a clustering-based mechanism using the combination of ANN as an AI technique and SGO as an optimization technique which helps to find out the fail nodes, implementation procedure is as follows:

A. OEA-oriented WSN Simulator

First, we must create a simulator for the simulation of proposed WSN using the notion of GUI (Graphical User Interface) in MATLAB 2016a software using the OEA-oriented routing mechanism. A certain area should be defined using the network height and breadth according to the above equation to create simulation:

$$A_{WSN} = H_{WSN}(m) X\, W_{WSN}(m) \quad (1)$$

Where, H_{WSN}→ Height of the WSN simulator and
W_{WSN}→ Width is the WSN simulator

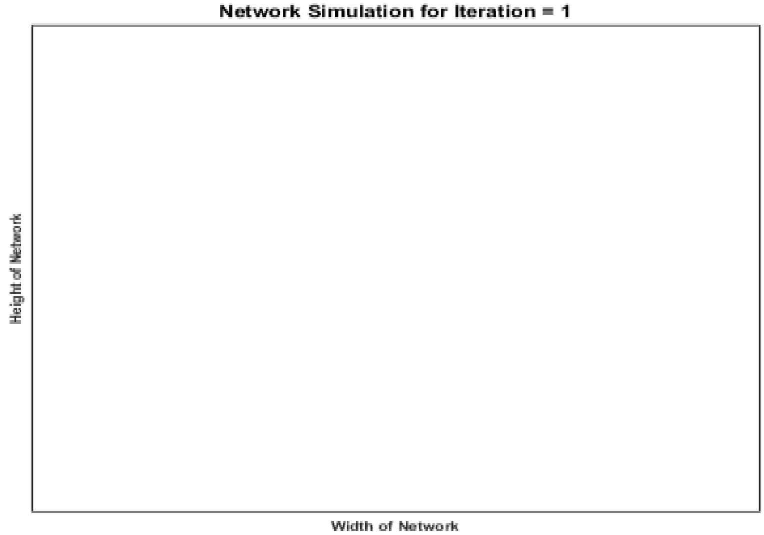

Fig.2: Proposed OEA-oriented WSN Simulator

B. Sensor Nodes Positioning

After creating the WSN simulation area, we go on to the next stage, which is sensor node deployment within the area. We install a total of 100 number of sensor nodes within the simulation region, as shown in Fig. 3. To find out count of active and dead sensor nodes in the deployed nodes, we use given procedure:

```
For m = 1→Nodes
If Node Residual Energy >Threshold
 Active Senser Node
 Else
        Dead Sensor Node
  End – If
End – For
```

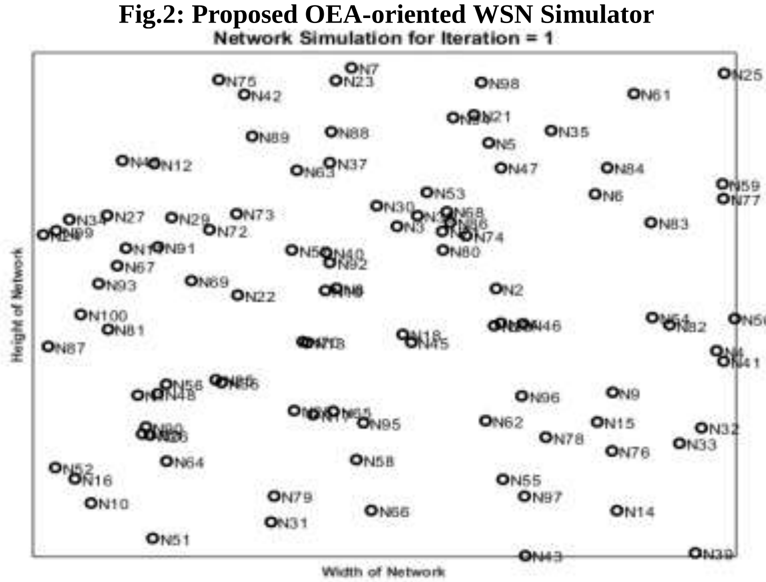

Fig. 3: Sensor Nodes Positioning in WSN Simulator

C. Network Clustering

After the sensor nodes positioning in the network, we perform clustring using the concept of K-means based on the distance distribution cocnept. Here, total number of Cluster Heads (CH) are suggested by the using the cocnept of 10% of total remaining alive nodes and repesenst with different color pattern as shown in the Fig. 4.The distributed clustering method provides a number of benefits, including increased lifetime, scalability, and load balancing. It decreases intra-cluster communication in the vicinity of the BS and protects nodes near the sink node from becoming overloaded.

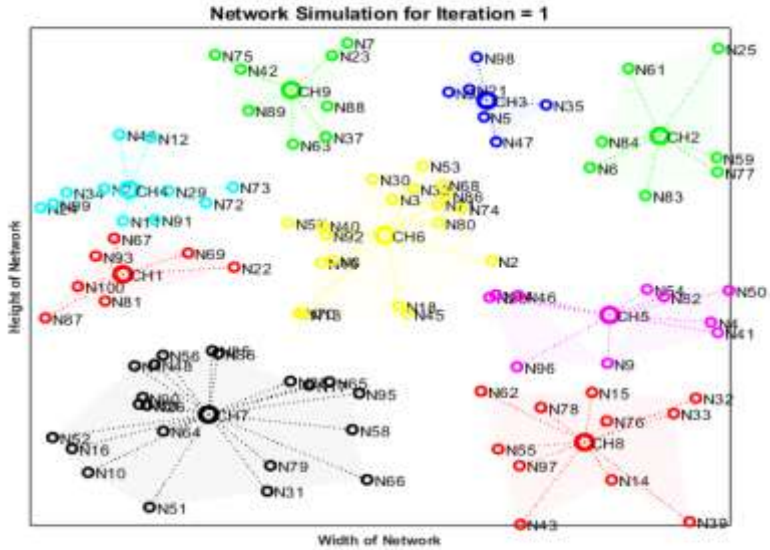

Fig.4: Clustering of Network

D. Base Station Deployment

In this step, we deploy a base station at the center of network that coordinates are,

$$X_{BS}= H_{WSN}/2$$

$$Y_{BS}= W_{WSN}/2$$

Using the above mentioned coordinates, we deploy a base station in WSN simulator that is depicted in the Fig. 5 with red color hexagon marker. After that a connectivity is made with all CHs and then all CHs are connected with the all member nodes. In figure, dotted line denotes the connectivity with nodes and CHs and CHs with base station.

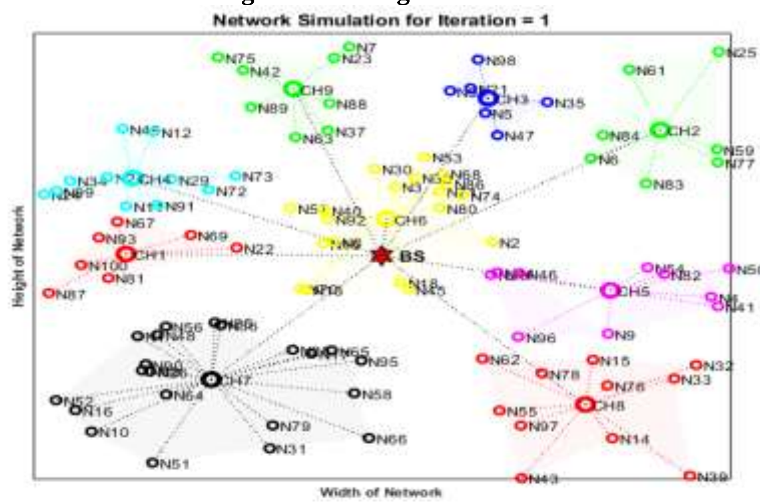

Fig. 5: Base Station Deployment in WSN Simulator

E. T_X& R_X in WSN Simulator

For the experiment, we choose a sensor node to act as a source or T_X-Node and another sensor node to act as a destination or R_X-Node that is shown in the Fig. 6. The source and destination sensor nodes are depicted in redcolor with a hexagon marker shape in Fig. 6. We can see that the source that is also known as T_X-Node, is located in CH7, whereas the destination that is known as R_X-Node, is also located in same cluster. We can't define the source and destination explicitly because the nodes are chosen at random as source or destination. Following the selection of T_X-Node and R_X-Node, we use the OEA-oriented routing technique to build a route for data transfer.

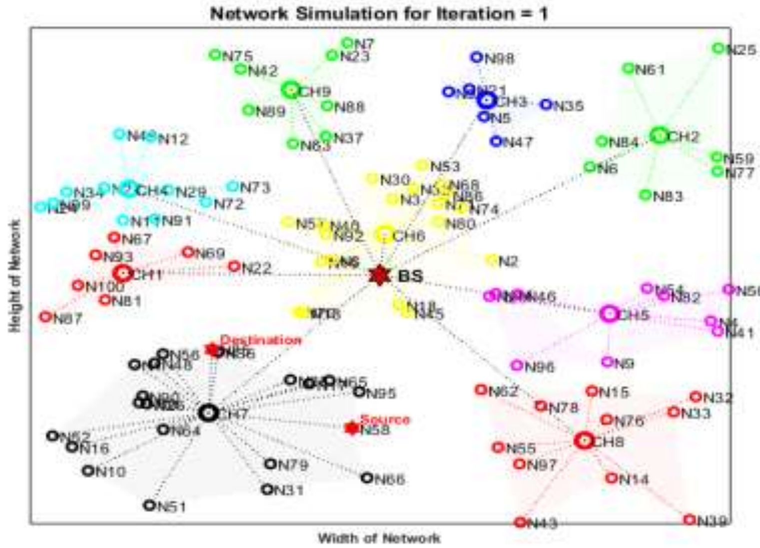

Fig. 6: T_X-Node and R_X-Node in WSN Simulator

F. OEA-orientedrouting in WSN

After the basic set up of WSN simulator, route discovery is performed using OEA-oriented routing mechanism to transmit the data packets from $T_X$to R_X node via CHs and base station. The route discovery mechanism using OEA-orientedmechanism is shown in the Fig. 7.Based on the figure scenario, T_X transmit the data packets to its CH and then that CH select a node for further transmission via base station. According to the figure, a route is created from source to destination node via its CH and base station that is represented with black color solid line. The base station contains addresses of all sensor nodes in the network.

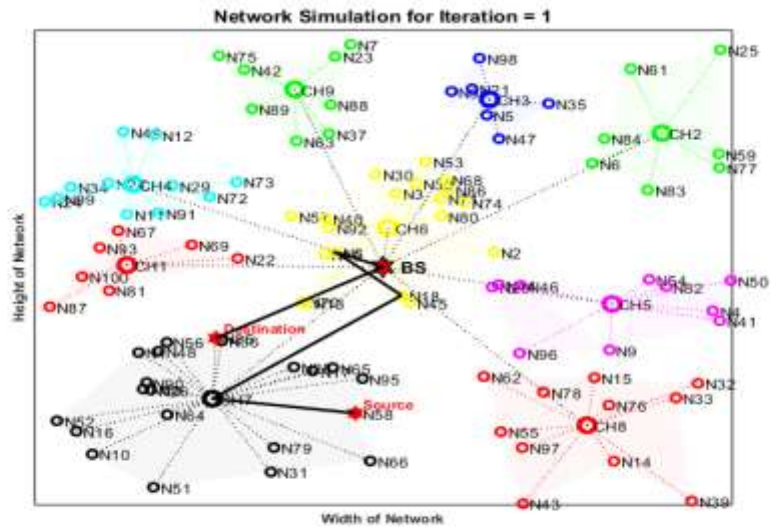

Fig. 7: OEA-oriented routingin WSN

G. Identification of Fail Nodes

After the OEA-oriented route discovery, in this research article, we evaluate the performance parameters of the proposed WSN simulator in terms of QoS such as Energy Consumption, Throughput, Packet Delivery Ratio (PDR), and Network Lifetime. If the achieved QoS is not satisfactory, that means data packets are losses in the network during communication, then we utilize the concept of SGA-based ANN as classifier to detect the fail or malicious sensor node within the route to prevent the network. So, to identify the dead or fail sensor nodes within the route, the written SGO and ANN based OEA routing mechanism is used:

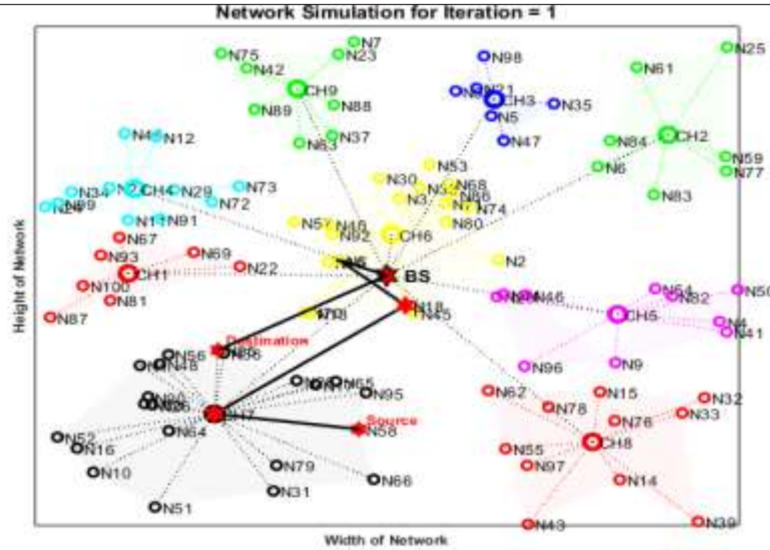

Fig.8: Fail Node Identification in WSN

OEA-oriented routing mechanism with SGO-based ANN Algorithm

OR = OEA (N_{SN}, T_X, R_X, N_{DATA}, Cat, N)

Where, N_{SN} = Number of Sensor Nodes
T_X = Source node as transmitter
R_X = Destination node as receiver
N_{DATA} = Nodes Feature Data
Cat = Target of ANN as an Active and Dead Nodes
N = Carrier Neurons Number
OR and Dead Node = Optimized and Validated Route from T_X to R_X with dead nodes

1. **Start OEA-oriented routing**
2. Divide the entire set of WSN simulators into clusters using K-means.
3. CLR = CLR_1, CLR_2, CLR_3,……CLR_N
4. **If R_X is not in T_X Coverage**
5. Discover route
6. Route, R = [] // Assign an array
7. Nodes (T_X) start searching its CH
8. Route, R = [T_X, CH of T_X]
9. While R_X not founded
10. Update Route and search again until R_X not founded
11. **If R_X founded**
12. Final route, FR = [T_X, CH of T_X, N, R_X]
13. **Else**
14. Check next route condition
15. **End – If**
16. To optimized the FR, SGO-based ANN is used
17. Index = Find index of N_{DATA} in FR using SGO
18. **If index of route is normal then**
19. OR(i) = FR (index)
20. **Else**
21. Mark as faulty route
22. **End – If**
23. Call and set the ANN using OR properties as training data (T), number of TX as group (G) and Neurons (N)
24. Set, WSN-Net= NEWFF (T, Group, N)
25. WSN-Net= TRAIN (WSN-Net, T, G
26. Current Sensor Nodes, NC = Properties of current sensor node in network
27. O = SIM (WSN-Net, NC)
28. **If O is valid then**
29. OR = Validated
30. **Else**
31. OR = Fail or Dead Nodes
32. **End – If**
33. **Returns:** OR as an Optimized and Validated Route from T_X to R_X with dead nodes
34. **End – Function**

We establish an energy efficient path from T_X node to R_X node through CH and Base Station using the previously described OEA-oriented routing mechanism with SGO-based ANN algorithm, and then we compute the QoS parameters again to validate the proposed simulation by comparing it to existing work using the experimental setup in Table I.ANN is the technique of machine learning that is designed to work like a human brain. The working of ANN is similar to a human brain is works and memorizes from the experience. ANN is a non-linear statistical model, which processed input to discover a new pattern. The ANN consists of three layers as discussed below Fig. 9.

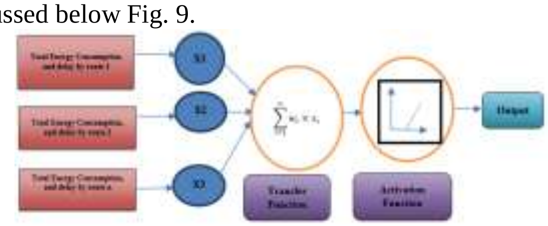

Fig.9: ANN Structure

Input Layer: The input regarding the number of the optimized route is obtained based on the node's properties like as packet delay and energy consumed by nodes that is provided as input information to the ANN.

Hidden Layer: This is positioned between the input and output of ANN. It can be single or multiple layers. Here, we used single hidden layer. The main function of this layer is to process the input data to know the relationship between the attributes fed to the input layer.

Output Layer: The resultant value after computation is obtained at this layer. The ANN computes the input values and provided the best route with minimum energy consumption and delay. The complete structure of ANN is shown in Fig.9.

Table I: Setup of WSN Simulator

Sensor Nodes Numbers	**100-1000**
WSN Area	**1000m^2**
Simulation Tool	**Communication, Optimization and AI Toolbox in MATLAB 2016a Software**
Routing Protocol	**OEA-Oriented**
Simulation Time	**10 to 100 s**
Clustering Approach	**K-means**
Classifier	**SGO based ANN**
Validation Parameter	**Delay and Energy Consumption**
Evaluation Parameter	**Throughput, Packet Delivery Ratio (PDR), Delay, Energy Consumption and Count of Dead Node**

The results have been computed in MATLAB 2016a software that offers a simple platform for network simulation. The nodes are deployed in range of {N=100, 200, 300, 400, and 500}. The results have been computed based on parameters such as throughput, PDR, Delay, Energy Consumption and Dead Node Number. The simulation results of proposed OEA-oriented routing mechanism based WSN scenario using the concept of SGO with ANN is described in the next section of this research article.

IV. RESULTS AND DISCUSSION

In this portion of the study article, we discuss and evaluate the experimental simulation findings of the proposed OEA-oriented routing mechanism forWSNusing the concept of SGO and ANN. The simulation results of the proposed WSN simulator with current work by ***D Mehta and S Saxena*** [11] are shown below, based on the Table II scenario stated in the previous section:

Table II: Throughput of OEA based WSN

No. of Nodes	Existing Work [11]	Proposed OEA
100	0.98	1
200	0.93	0.99
300	0.89	0.97
400	0.85	0.92
500	0.8	0.88
Average	**0.89**	**0.95**

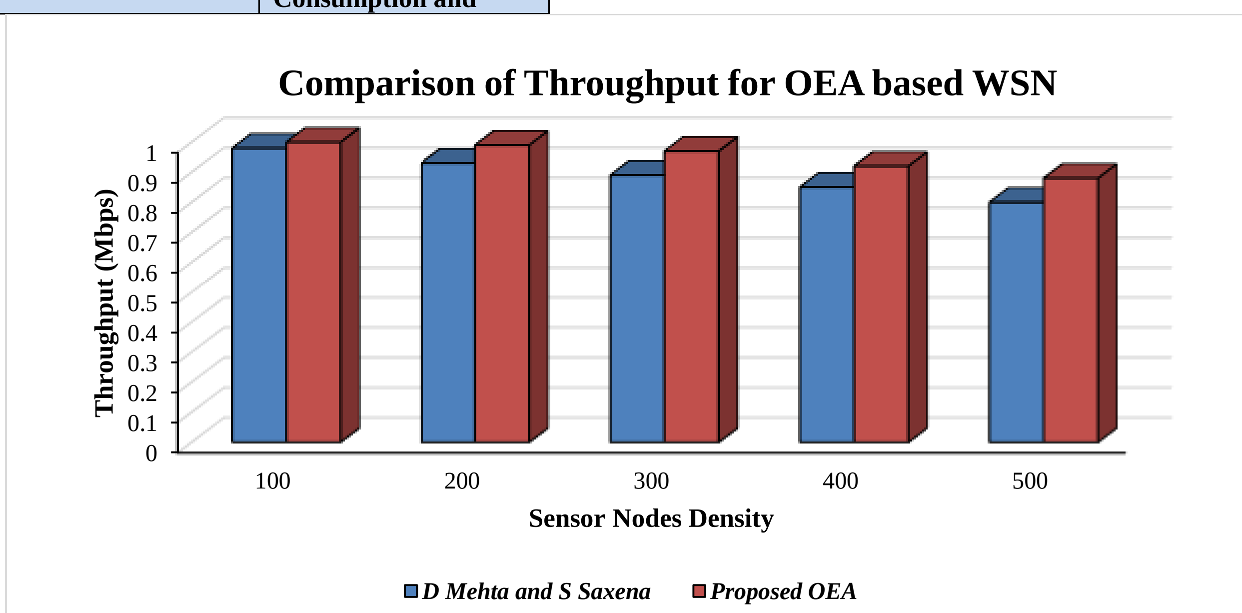

Fig.10: Comparison of Throughput for OEA based WSN

From the above Fig. 10, we observed that the throughput of proposed OEA-oriented routing mechanism for WSN using the SGO with ANN as an AI concept to detect the dead node and make an improved scenario. The parameter throughput is described in WSN through the successful delivery of the message or delivery of packets throughout a communication network. Typically, throughput is estimated in bit/s or bps. Mathematically, given by equation.

$$\boldsymbol{Throughput(Th)} = \frac{\boldsymbol{Numberofpacketrecieve}}{\boldsymbol{Totaltimeinterval}} \quad ..(1)$$

The throughput of network is depends on the data transmission rate of network and in Table III, we provided the Packet Delivery Ratio (PDR), according to the number of simulation sensor nodes.

Table III: PDR of OEA based WSN

No. of Nodes	Existing Work [11]	Proposed OEA
100	98.7	100
200	98.05	98.8
300	97.7	98.1
400	96.4	97.4
500	95.5	96.05
Average	**97.27**	**98.07**

PDR seems to be the proportion of total ratio between the total accumulation of number of packets received at R_X node and the total accumulation of data packets created at T_X node in a network. The PDR formula is as follows:

$$\boldsymbol{PDR}\ (\%) = \frac{\sum_{i=1}^{N} \boldsymbol{Data\ Packets\ at\ T_X(i)}}{\sum_{i=1}^{N} \boldsymbol{Data\ Packets\ at\ R_X(i)}} \times \mathbf{100} \quad .... (2)$$

Where, N is the total number of the sensor nodes in the WSN. Fig. 11 shows that the comparison of PDR between proposed and existing work in terms of percentage. It shows that the PDR of OEA-oriented mechanism is higher as compared to the existing routing protocols.

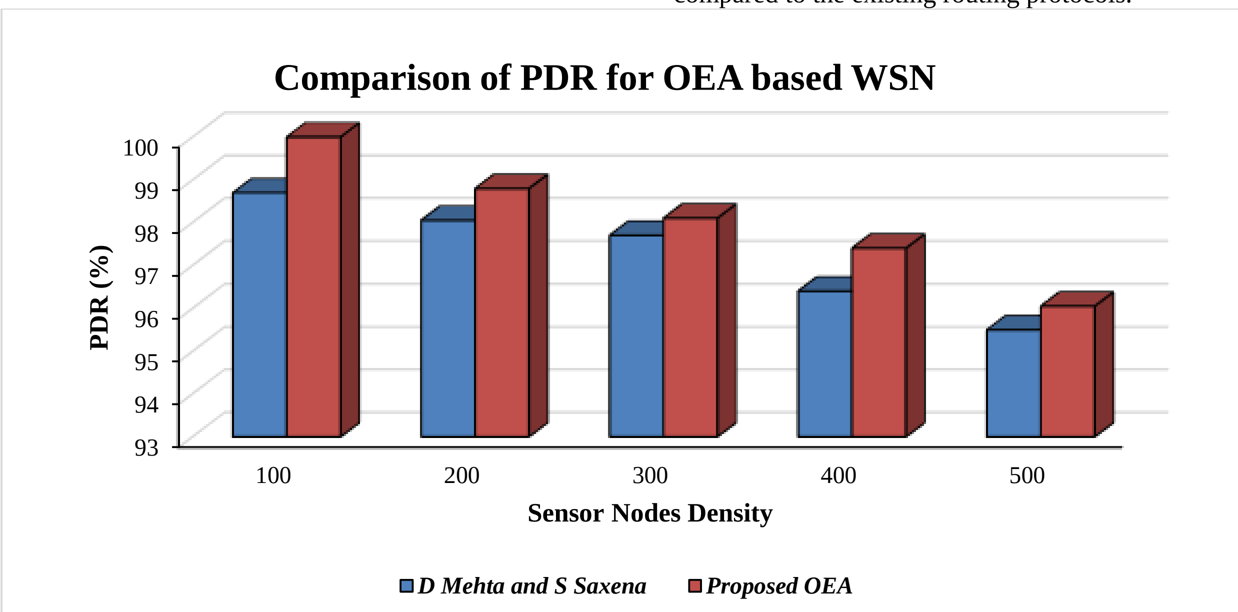

Fig.11: Comparison of PDR for OEA based WSN

If the PDR of any wireless network is more, then the packet drop rate is reduces. So, in the Table IV, we presents the comparison of the packet Drop Ratio (DR) of network.

Table IV: DR of OEA based WSN

No. of Nodes	Existing Work [11]	Proposed OEA
100	1.3	0
200	1.95	1.2
300	2.3	1.9
400	3.6	2.6
500	4.5	3.95
Average	**2.73**	**1.93**

DR is the drop ratio of the MANET during the data transmission and it is calculated using the formula of the DR is given as:

$$\boldsymbol{DR}\ (\%) = \mathbf{100} - \boldsymbol{PDR} \quad .... (3)$$

Where, PDR is the packet delivery ratio of network. This parameter is defined as the rate of data packets gain through the target node and that are produced by the sources.PDR has an important role, and it shows the actual number of information carrier received by the receiver. The greater the value of PDR, the lesser amount of error inside the network. As per the given table shown in Fig. 12, it makes clear that the proposed approach (OEA-oriented) using SGO and ANN method has performed well. The values are analyzed concerning the number of nodes as indicated on the x-axis and obtained DR value in percentage in y-axis. To show the enhancement comparison with other considered scenario is presented in the below Fig. 12.

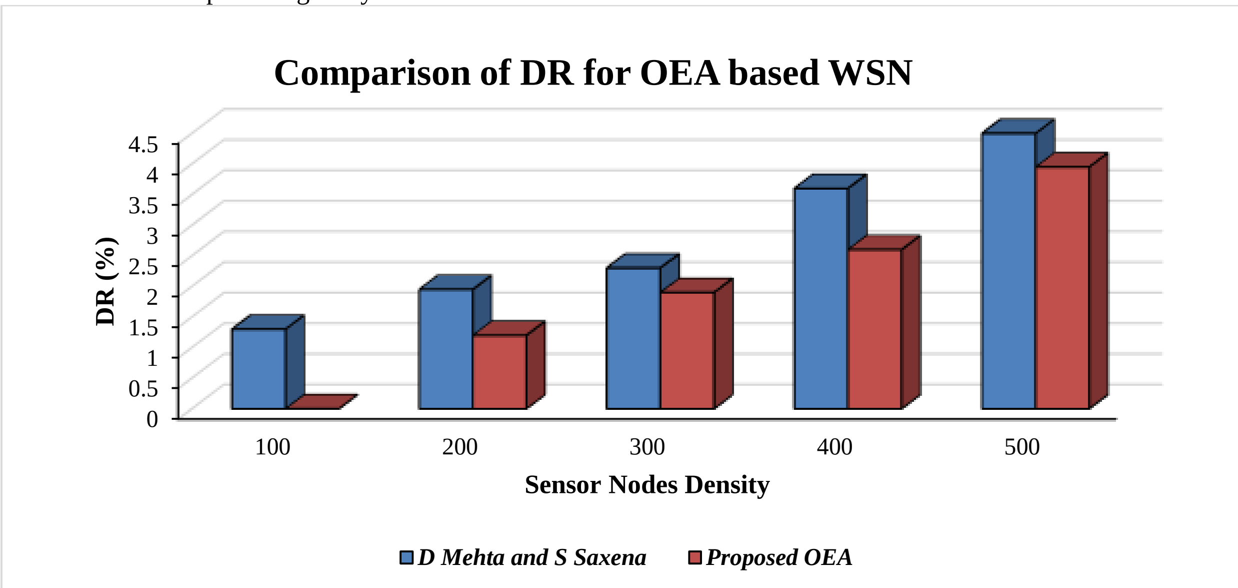

Fig.12: Comparison of DR for OEA based WSN

From the above figures, finally we observed that the utilization of SGO with ANN to design an EOA-oriented routing mechanism is a beneficial steps for the WSN because the drop rate is reduced as compare to the exiting work. So, now we check the transmission delayin the Table V.

Table V: Delay of OEA based WSN

No. of Nodes	Existing Work [11]	Proposed OEA
100	2.6	1.5
200	5.3	2.2
300	6.2	4.7
400	8.7	6.3
500	9.3	6.9
Average	**6.42**	**4.32**

The overall time taken by the network to transport data packets from the T_X node to the R_X node in the networks is referred to as delay, and it is measured in seconds.The delay parameter has been defined as the ratio of the total length of time it takes packets to travel from the source to the destination node divided by the total number of data cunt packets. A total of 1000 packets have started the data transmission. It is represented mathematically given by equation.

$$Delay\ (ms) = \sum All\ Time\ totransmit\ \ldots. \quad (4)$$

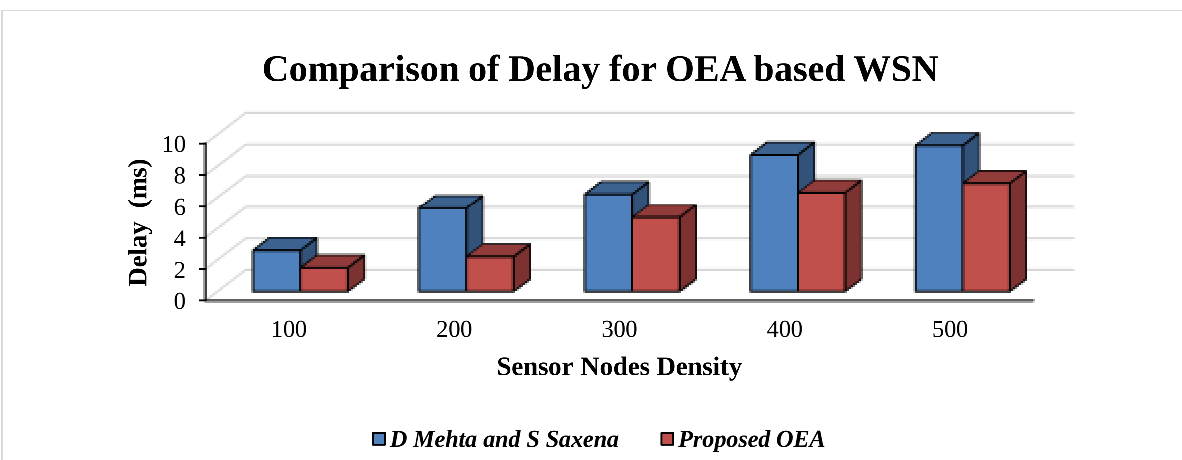

Fig.13: Comparison of Delay for OEA based WSN

The transmission delay of the proposed OEA-oriented routing mechanism is also improved as compare to the exiting work that is clearly observed from the above Fig. 13.Finally, we can say that the utilization of SGO with ANN to design an OEA routing mechanism is a beneficial steps for the WSN, but to validate the network on the basis of energy consumption is necessary step.

Table VI: Energy Consumption of OEA based WSN

No. of Nodes	Existing Work [11]	Proposed OEA
100	0.1	0.07
200	0.23	0.13
300	0.38	0.18
400	0.51	0.24
500	0.58	0.39
Average	**0.36**	**0.20**

The consumption of energy in WSN is calculated using written equation:

$$Energy_{Consumption} = \sum_{i=1}^{N} T_p + R_p + W_p \text{ .... (5)}$$

Where, Tp denotes the amount of energy used by nodes during transmission, Rp denotes the total amount of energy consumed by nodes when releasing a data packet, and Wp denotes the amount of energy consumed by a node while waiting for data packets.

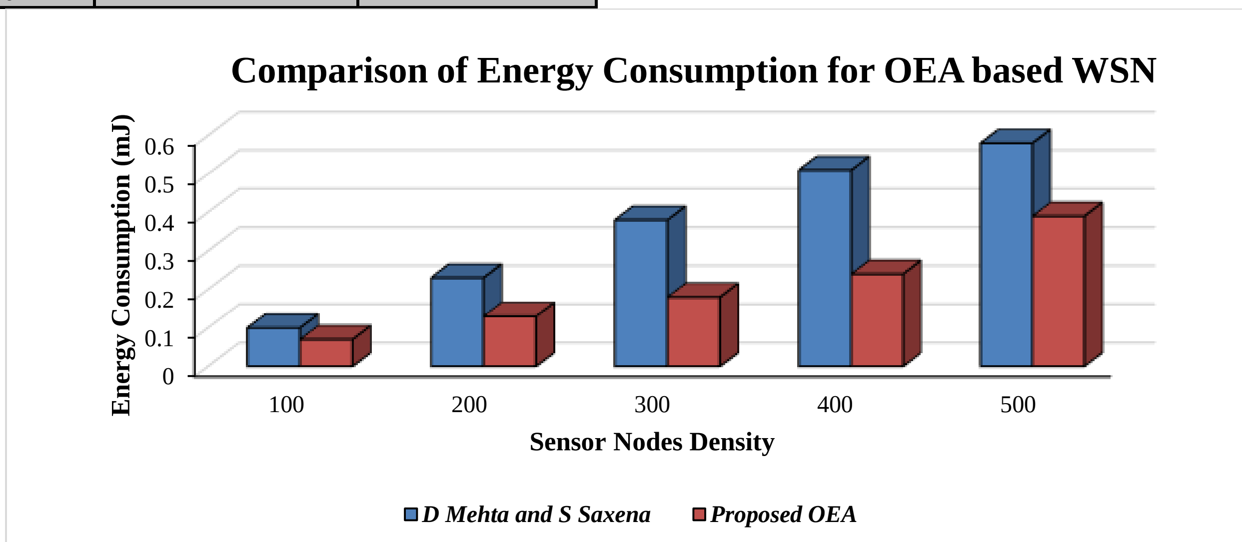

Fig.14: Comparison of Energy Consumption for OEA based WSN

The energy consumption of exiting work by ***D Mehta and S Saxena*** [11] is relatively greater than the proposed OEA routing scheme. The proposed OEA method consumes a maximum of 0.39 mJ of energy with respect to500 nodes, whereas existing work consume 0.58 mJfor 500 nodes. So, now we check the comparison of dead node in the network. Rate of dead node from existing work is reduced by 8.5% by utilization of the concept of OEA-oriented routing mechanism. From the results, we clearly see the effect of the utilization of SGO with ANN to design an OEA mechanism is improved.

V. CONCLUSION AND FUTURE WORK

In this research article, we proposed an OEA-oriented routing mechanism based on multi-objective SGO with ANN in WSN. Here, an OEA routingmechanismfor theWSN has been proposed based on the concept ofK-means clustering along with the SGO and ANN for detection of fail or malicious nodes. It solves the issue of failure of sensor nodes during the communication having a short lifespan. The low life issue comes as a result of heavy traffic from several cluster heads to the base station. The OEA-oriented routing mechanism employs an energy-efficient and secure cluster head selection approach that considers a variety of factors such as residual energy, distance from member nodes and coverage. The SGOtechnique is used to choose the best path from the source node to destination node via cluster head andbase station node.The performance of OEA-oriented routing mechanism is superior to other existing works in terms of QoS parameters such asthroughput, PDR, Delay, Energy Consumption and Dead Node Number.Proposed OEA-oriented routing mechanism shows animprovement in terms of throughput, PDR, energy efficiency, and delay as compared to existing work byD Mehta and S Saxena.So, in future, the idea of deep learning will be utilized with the OEA-orientedrouting mechanism as a machine learningapproachin the network.

VI. REFERENCES

[1]. Arjunan, S., & Sujatha, P. (2018). Lifetime maximization of wireless sensor network using fuzzy based unequal clustering and ACO based routing hybrid protocol. Applied Intelligence, 1-18.

[2]. Wang, J., Ju, C., Gao, Y., Sangaiah, A. K., & Kim, G. J. (2018). A PSO based energy efficient coverage control algorithm for wireless sensor networks. Comput. Mater. Contin, 56, 433-446.

[3]. Ghasemzadeh, H., Rezaeian, M., Touranposhti, F. D., &Ghasemian, M. M. (2014, September). BN-LEACH: an improvement on LEACH protocol using Bayesian networks for energy consumption reduction in wireless sensor networks. In 7'th International Symposium on Telecommunications (IST'2014) (pp. 1138-1143). IEEE.

[4]. Fu, X., Yao, H., & Yang, Y. (2019). Modeling and analyzing cascading dynamics of the clustered wireless sensor network. Reliability Engineering & System Safety, 186, 1-10.

[5]. Singh, Bipandeep, ErSimranjit Kaur, and Bipandeep Singh, "An Improved Energy-Efficient BBO-Based PEGASIS Protocol in Wireless Sensors Network," Int. Journal of Engineering Research and Applications 4.3 (2014): 470-474.

[6]. Weiwei Fang, Zhen Liu and Feng Liu, "A Cross-Layer Protocol For Reliable And Efficient Communication In Wireless Sensor Networks," International Journal of Innovative Computing, Vol. 8, No. 18, October 2012.

[7]. Ryu, J. H., Irfan, M., &Reyaz.A review on sensor network issues and robotics. Journal of Sensors, 2015.

[8]. Alkhatib, A. A. A., &Baicher, G. S.Wireless sensor network architecture. In 2012 International Conference on Computer Networks and Communication Systems (CNCS 2012).

[9]. Matin, M. A., & Islam, M. M. (2012). Overview of wireless sensor network. In Wireless Sensor Networks-Technology and Protocols. IntechOpen.

[10]. Prasanna, S., & Rao, S. (2012). An overview of wireless sensor networks applications and security. International Journal of Soft Computing and Engineering (IJSCE), ISSN, 2231-2307.

[11]. Mehta, D., &Saxena, S. (2020). MCH-EOR: Multi-objective cluster head based energy-aware optimized routing algorithm in wireless sensor networks. Sustainable Computing: Informatics and Systems, 28, 100406.

[12]. Gilbert, E. P. K., Baskaran, K., Rajsingh, E. B., Lydia, M., &Selvakumar, A. I. (2019). Trust aware nature inspired optimised routing in clustered wireless sensor networks. International Journal of Bio-Inspired Computation, 14(2), 103-113.

[13]. Al-Humidi, N., &Chowdhary, G. V. (2019). Energy-aware approach for routing protocol by using centralized control clustering algorithm in wireless sensor networks. In Computing, Communication and Signal Processing (pp. 261-274). Springer, Singapore.

[14]. Udhayavani, M., &Chandrasekaran, M. (2019). Design of TAREEN (trust aware routing with energy efficient network) and enactment of TARF: a trust-aware routing framework for wireless sensor networks. Cluster Computing, 22(5), 11919-11927.

[15]. Tanessakulwattana, S., &Pornavalai, C. (2019). Multipath energy balancing for clustered wireless sensor networks. Wireless Networks, 25(5), 2537-2558.

[16]. Gupta, G. P., &Jha, S. (2018). Integrated clustering and routing protocol for wireless sensor networks using Cuckoo and Harmony Search based metaheuristic techniques. Engineering Applications of Artificial Intelligence, 68, 101-109.

[17]. Kovendan, A. K. P., Divya, R., &Sridharan, D. (2018). Dynamic Distance-Based Cluster Head Election for Maximizing Efficiency in Wireless Sensor Networks Using Artificial Neural Networks. In Recent Findings in Intelligent Computing Techniques (pp. 129-136). Springer, Singapore.