Energy Aware Routing Protocol with Data Fusion and Machine Learning

Vijay K. Trivedi[*1]

[1] Lakshmi Narain College of Technology, Bhopal, India

Email: vijayt@lnct.ac.in

Abstract

The current wireless and communication system may be attributed to the contributions made by the Sensor Network in a significant measure. During the last decade, several efforts have been performed to examine and propose answers to challenges about the energy efficiency of wireless sensor network communications. Several different researchers has done these efforts. The challenge of constructing economical energy-use paths has not yet been overcome. Because sensors have limited computational capabilities, which are frequently coupled with energy limitations, it is rather difficult to guarantee that a sensor's lifespan will be longer. This is because of the energy constraints often associated with these limitations. The results of this research have led to the development of a one-of-a-kind communication system for sensor networks that is not only environmentally friendly but also supported by three distinct revolutionary frameworks. The framework that has been recommended, which goes by the name Potential Energy Efficient Data Fusion (PEE-DF), is the one that is in charge of the optimization of energy. It achieves this with the aid of probabilistic approaches and clustering. The K-SOM (Korhonen self-organizing map) framework was designed using a globular topology, which aids load balancing during data fusion. K-SOM stands for "Korhonen self-organizing map." This was done to ensure we got the most out of our resources. A novel method to routing is presented by the technique, which has the potential to be used to assist in the operation of energy-efficient routing in large-scale wireless sensor networks. The framework for the Tree-Based Fusion Technique (TBFT), which has been offered, comes up with a new way for dynamic reconfiguration. This is accomplished via the introduction of the concept of routing agents. The strategy enables the system to recognise which sensor has a greater energy dissipation rate and then instantly moves data fusion work to a more energy-efficient node. This allows the system to save energy. This approach, based on thresholds, enable a sensor to act as a cluster head up until it reaches its threshold remnant energy and then as a member node once it exceeds threshold residual energy. In other words, it may play both roles simultaneously. It is possible to fulfil both of these responsibilities at the same time. The findings have been mathematically modelled using a standard radio-energy model, which has enhanced the robustness of the findings, which is highly positive. The results were encouraging because of the increased robustness of the findings. Compared to the benchmark previously established for energy-efficient strategies, the proposed system demonstrates higher performance in terms of its ability to communicate while using less energy. In contrast to LEACH, the recommended system's findings reveal an almost fifty percent decrease in energy consumption, and at the same time, a reduction in the amount of time required to carry out the operation..

Keywords: K-SOM (Korhonen self-organizing map) framework; Routing Protocol; Data Fusion; Tree-Based Fusion Technique; LEACH.

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1. Introduction

A Wireless Sensor Network, or WSN, is "A network of wireless devices utilising sensors to monitor and record the physical conditions of the environment and arrange the collected data at a central point," to put it in the simplest terms possible. [1]. This description encapsulates the core aspects of wireless sensor networks and how they operate. WSNs can monitor various things, including the environmental conditions, such as temperature, noise, quantity of pollution, humidity, wind speed and direction, pressure, and more. Other elements that may be monitored are: Wireless sensor networks are becoming more popular to meet the fundamental requirements of applications concerned with environmental sensing. These applications illustrate the diverse range of opportunities accessible in several fields, including precision agriculture, the monitoring of vehicles, video surveillance, and other areas. It is common practice to refer to the individual identification stations that comprise a sensor network as sensor nodes [2, and each of these nodes is small, lightweight, and portable]. The sensor nodes in wireless sensor networks are the nodes that are primarily accountable for the functioning of the network as a whole. These electronic gadgets, known as sensor nodes, are characterised by their low cost, small size, and low weight.

Each sensor node draws its power from a separate battery, and the deployment of these nodes takes place in an environment that is as inaccessible to humans as is physically feasible. In addition, continual monitoring of the domain is utilised to gather pertinent data to carry out further processing, which is done with the help of technology. Sensor nodes, in terms of their actual construction, are composed of hardware configurations that consist of central processing units (CPUs), sensors, memory, transceivers, and power supply. [3] The duties of data collecting, aggregation, communication, and transmission are the ones that are carried out by the nodes that make up the network. The data gathered may be influenced by various environmental factors, including but not limited to humidity, temperature, sound, pressure, and vibrations. A WSN node's internal architecture is seen in Figure 1. The most central and significant disadvantage of these networks is the restriction of energy, since the inability of the dead nodes to execute their job in the absence of power is the most significant and significant downside of these networks. The constraint of energy is the most influential and essential. problem of these networks [4], as the inability of the dead nodes to execute their job in the absence of energy is the most apparent and essential disadvantage of these networks. Because of the restrictions imposed by either the power source or the restricted availability of the battery that is built into the product The application cannot be processed successfully due to the inadequate amount of available energy. The continuous monitoring of the environment is an essential need for the different applications. This monitoring should not be stopped under any circumstances, regardless of how dangerous the surrounding environment may be. As a result, the functioning nodes must keep working for a lengthy period once they have started. The nodes' energy efficiency [5] and its optimization have always drawn attention, and it has been kept on the top priority list. Additionally, the networks overhead has been lowered to assist the development of routing algorithms.

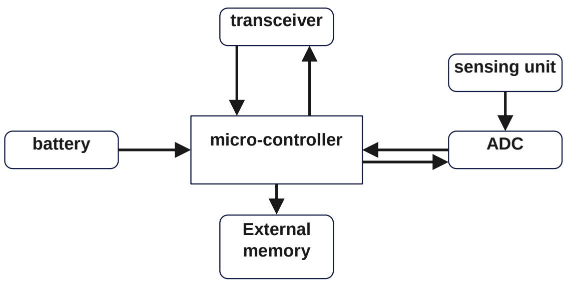

Figure 1: A WSN Node Structure.

It is possible to reduce the amount of energy the network uses by clustering, which is one of the methods that may be employed. This is achieved by organising the nodes that make up the WSN into clusters, each consisting of a single node. Within this technique's context, the data aggregation process is denoted by the term "cluster heads" [6]. Each node in a cluster has a cluster head allocated to it, and it is the responsibility of each cluster head to collect data from all of the nodes in the

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group. Following the completion of the aggregation procedure, the data are sent to the base station for further processing. The amount of energy that is needed to aggregate or fuse data across all of the nodes is reduced by the sorts of approaches that are described here. This responsibility is looked after for a limited period by the person currently in charge of the cluster. After this step, we may go on to the next step, choosing a new cluster. The other nodes will see the data, and then, depending on the conditions, it will be sent to the associated cluster head via either a single hop or numerous hops. Through the use of routing algorithms and incentive systems, it may be possible to improve the efficacy and efficiency of communication [7] inside wireless networks among the nodes and clusters of such networks. In recent years, work has been done to increase energy efficiency by incorporating artificial intelligence and new network topologies into wireless sensor networks. This has been done to make these networks more energy-efficient. This was carried out to construct energy management techniques that are more efficient. The artificial neural network is in charge of developing the method, and it employs classification to carry out mapping between input and output. The algorithms provide a high fault tolerance, rapid auto-classification of sensor data, and resilient data, which are all additional advantages. These advantages, together with computation and the dispersion of data storage [8,] are made feasible due to the methods. In addition, the clustering techniques are integrated with an artificial neural network to deliver greater processing power at a cheaper transmission cost and a lower total energy consumption. This was done to meet the demands of cloud computing. The combination of these two networks brings various benefits, one of which is having a design equivalent to that of the other network. In this design, neurons are analogous to sensor nodes, while connections are equivalent to radio links. Consequently, there is a sign that a network's energy supply is running low; hence, it is essential to investigate the pertinent cause. With the rate at which technology is advancing and the ever-changing requirements of a wide range of applications, it is impossible to keep the network running forever. Because of this, wireless technology's actual benefits cannot be used.

The Advantages to Be Obtained by Employing a Wireless Sensor Network

i. The network setup can be finished even without physical infrastructure.

ii. They are most useful in places that are difficult to reach, such as the middle of the ocean, high mountains, rural areas, or deep woodlands.

iii. If additional demands are imposed on the workplace, they respond to ad hoc circumstances with flexibility and agility.

iv. The costs associated with implementing this strategy are not very high.

The term "Wireless Sensor Network" has a few issues that must be addressed.

i. Because these systems have insufficient security, it may be easy for hackers to access the information that is housed inside them; consequently, they can access points reasonably easily.

ii. In contrast to the wired network speed, their connection is painfully slow.

iii. Setting up a wired network is more involved than setting up a wireless network.

iv. They are easily influenced by their surroundings, such as the walls and the microwave, due to the large distances' signal attenuation, and so on.

1.1 Research Background

Recent technical advancements in wireless sensor networks have led to developing several updated protocols explicitly created for sensor networks where energy awareness is an essential factor to consider. These protocols have been developed as a result of these recent technical advancements. The emphasis will be placed mainly on routing protocols because the features of these protocols may change based on the composition of the network and the nature of the application being used. The decreased cost and size of sensors has resulted in such technological advancements. It has led to an increase in interest in the utilisation of potentially massive sets of unattended disposable sensors. These developments in technology have led to such advancements in technology and have led to such advances in technology. Due to these interests, a large amount of research into the potential of sensors that can gather, analyse, and manage data from the network has been undertaken. After the data has been collected from the origin, it is sent using the node that has been determined to be the most able to handle the responsibility at hand. Additionally, the coordination of the flow of data [9]

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between the source and the sink is under the control of this node, which also regulates the coordination. For a sensor with this kind of disrupted joint, it seems logical to think of a system with wireless connections that will be constructed between the ad hoc sensors. These connections will be built as an integral element of the system. Figure 2 is a diagram that illustrates how the architecture of a sensor network should be.

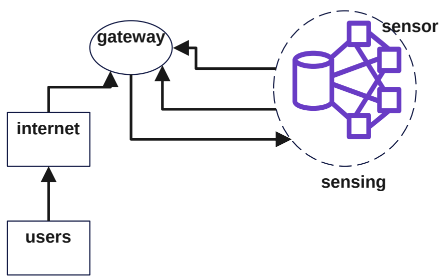

Figure 2: Architecture of Wireless Sensor Network.

This sensor node is inexpensive and efficient in its energy use; along with other nodes, it contributes to constructing a network that may be deployed to monitor the area of interest. A wireless sensor network's sensor node resource is highly limited regarding wireless bandwidth, processing capacity, storage space, or battery power. This is the case regardless of whether the help is being monitored.

In many different applications, each node is given power, which usually comes in the form of a battery. It is anticipated that the nodes will be able to complete the task at hand for a period ranging from a few months to an entire year without the battery needing to be recharged. There is a widespread consensus that wireless sensor networks (WSN) will be among the most significant technological developments of the 21st century. In recent decades, it has grown to be viewed as substantial throughout various sectors and academic subjects over the whole of the cosmos. This perception has spread across the entirety of the universe. A wireless sensor network will often be made up of many wireless sensor nodes that are multi-functional, have a cheap cost, and use minimal power. In most cases, these nodes will be equipped with the capacity to do wireless sensing, communication, and processing. By using a wireless source and, for instance, a group monitoring the environment, running an industrial operation, or watching military action, these nodes can communicate with one another across a short distance and interact with one another.

The sensor nodes have been gathered into a cluster within the cluster-based hierarchical paradigm framework for easier management. When a WSN cluster is created, one of the nodes in the cluster will be selected to take on the function of CH (Cluster head), while the other nodes will be demoted to the position of non-head nodes. The cluster members must send their data neither to the head of the high level cluster [11] nor to the sink cluster.

Because this technique can reduce the number of hops required between the sender and the sink, the latency that it causes is not much greater than that of the multi-hop planer model. The task of conducting data aggregation falls only on the shoulders of the cluster head. In contrast, executing the multi-hop model of node data aggregation is the responsibility of all intermediary nodes. In recent years, one way that has become more prevalent is the use of sensor networks. These networks can monitor a specific location and collect data on the environment in the vicinity of a particular point. Recent developments in wireless communication that consumes little power and the availability of micro sensor nodes that are both small and relatively inexpensive have led to increased improvements in the applications of wireless sensor networks in real-world civilization.

The fact that tiny battery-operated nodes have inherent energy restrictions is a big issue, and a considerable amount of effort is being put into reducing the total amount of power being used. It is hypothesised that a reactive routing protocol known as dynamic awareness routing will reduce the energy needed while also providing a dependable and constant transmission environment.

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2 Related Work

The use of wireless sensor networks in many domains to conduct environmental surveys is becoming more common. When implementing wireless sensors, it is of the utmost importance to strike a balance in the usage of energy provided by WSN to maximise the network's lifespan. In heterogeneous wireless sensor networks, the point is utilised in various ways in a wide variety of nodes; nevertheless, after the network has been organised, the majority of the energy cost is incurred in the transmission of data [12]. The wireless sensor network is the aggregate of all the individual systems linked to one another through a component known as nodes. These nodes are the wireless communication connections, and the information is sent between them to complete the communication process. The data monitoring is shown using several controllers' moving nodes inside the devices. Two different sink configurations are available, which are referred to as the classic and the single sink. The conventional sink is the same as the usual basic sink, and the single sink is the one that operates by the nodes that have an increased number of connections. However, even if the capacity of the data acquired is significantly enhanced, the network will not be able to be expanded. If more nodes are involved in processing the data, the efficiency of the operation will improve. Communication protocols are better suited for use with more than one sink situation.

The conclusion can be drawn from this is that the energy aware routing protocol is used in WSN [13] to enhance the energy used via data fusion and neural network methods. In addition, the number of messages sent to the BS (base station) is reduced due to data fusion, resulting in a reduction in the total amount of energy used. For more precise decisions, a data fusion system may be implemented in WSN. This research explores how the notion of data fusion may be used effectively to employ artificially intelligent protocols. KSOM, artificial neural networks, and data fusion are some methods being considered for implementation to achieve the goal of more energy-efficient routing.

When it comes to networks that have a low power and a large loss, the topic of energy is one that is quite important to address. Consolidating several different research projects has been done to cut down on the amount of power used by the network. To choose the course that would allow for the most effective dissemination of data, it has been proposed to use both the algorithm for cache utilisation and the algorithm for energy equalisation routing. The simulation is carried out with the COOJA [14] simulator as the primary tool. The energy consumption of the multi-path routing protocol that has been designed is seen to be lower when compared to RPL, and its dependability is observed to be greater. Both of these observations are in contrast to RPL. However, when it comes closer to the sink, the node sucks up the energy much more rapidly than before.

Regarding the Internet of Things, the route selection method might have a very diverse appearance depending on the application being considered. The participant node is the one that chooses the route to take based on the parameters that were supplied by the application. The routing metrics known as HC, EC, and ETX are needed to construct the goal functions. The simulation uses the COOJA[15] simulator as the primary tool. It has been shown that the proposed protocol delivers high reliability, improves the quality of service, and extends the network's lifetime. On the other hand, the recommended protocol does not guarantee quality of service (QoS) in every application.

In [16], a suggestion was made for an Energy Efficient Region based RPL, abbreviated ER-RPL. Most applications that use the Internet of Things use the point-to-point communication architecture. The preservation of energy is one of the most important functions carried out by LLN. The ER-RPL carves out separate regions within of the network's service area. The nodes are aware of where they are located, and they are dispersed in a way that is random throughout the network. ER-RPL [17] uses the randomization method to choose the reference node. It can accomplish this goal by using the reference node, which is tasked with collecting the data packets from its network region. This eventually leads to the establishment of the network region.

It collects data by going to each reference node in the DODAG [18] and sending it either to another reference node or to a sink when it has done so. The simulation is carried out with the help of a software called NS3. RPL and ER-RPL are both evaluated for their efficacy alongside one another. It has been seen that as a consequence of this, the dependability of the data and the lifetime of the network are both improved. ER-RPL, on the other hand, is responsible for an increase in the quantity of data traffic since it produces an uneven area across the network.

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3 Proposed Work

The data fusion method has been used to resolve concerns with reducing the amount of data elements. In the data fusion process, the collected packets of sensor data are combined into a single packet, and any redundant information in the packets is omitted to cut down on the amount of data duplicated. It has successfully decreased the amount of data that cannot be trusted, as well as unwanted noise and information overload. A longer life cycle for WSNs is a possibility if they are supported by data fusion. On the flip side, several academics have investigated the use of neural networks in wireless sensor networks (WSNs). The K-SOM (Korhonen self-organizing map) Neural Network technique [19] has been used for clustering, and its investigation has helped to adjust the random parameters of network behaviors and applications. In addition, data fusion is seen as a crucial function since, compared to other protocols, it is more likely to be comprised of automated and reliable sources of information. There are many applications of neural networks, including the categorization of sensor data, the clustering of nodes, the self-organizing of the data, and mapping among them, etc.; these applications contribute to an increase in the low cost of communication and energy conservation in WSN. In WSN, this technique may be used as energy optimization routing technology. The self-organized map is an intelligent Neural Network approach with optimum routing performance in energy conservation and node computation power. This is achieved via the use of the self-organized map. Hierarchical routing protocol was explored to apply ANN [20] algorithms K-SOM and the Data Fusion concept in the WSN routing protocol. In this protocol, each node performs a particular function in the network. Increasing the network life time using that strategy may be accomplished in various methods, including the following: Some of the data fusion functionalities that can be transmitted to BS have been shown by the cluster head nodes. These nodes are more rigorous than typical nodes in terms of energy requirements. One of the clever strategies, neural networks also function as ways that are efficient in terms of energy consumption for wireless sensor networks. In addition, it has also been used as a tool in the overall strategy for lowering the amount of energy being used, known as the data-driven, wireless cycling, and mobility method. This strategy is used in wireless sensor networks. The second method that data fusion may be accomplished via signal processing techniques. In addition, there is a propensity, in the data nodes, to make correct signals to decrease the noise. WSN is now working on data funneling using adaptive fusion aggregation techniques of data based on routing methods. These approaches are for energy efficient routing data. Fusion [21] has been successfully carried out via an intermediary node with routing, however the energy supply has run out for only a tiny quantity, and the fusion cost is also rather expensive. As a result, this tactic is the most significant failure of the data fusion approach. One additional technique may include using energy in a balanced and efficient manner to lengthen the amount of time a wireless sensor network (WSN) is operational.

The method of neural networks is becoming more well-known in wireless sensor networks, mostly due to the straightforward and parallel distributed computing and storage they provide. In addition, the data robustness, automated sensor reading, and auto-classification [22] of sensor nodes are regarded as further advantages of the neural network approach. It is believed that the capability of this method for dimensionality reduction and prediction of sensor data, both of which can be easily obtained from the outputs of neural-network algorithms, represents a potential prospect for both the decrease in communication costs and the preservation of energy. As a result of these characteristics of the neural network approach (Figure 3), it is readily applicable to wireless sensor networks, the purpose of which is comparable to that of the neural network technique.

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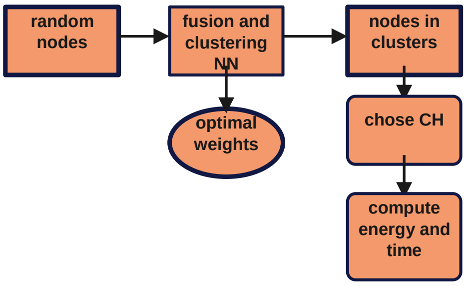

Figure 3: Cluster Formation using ANN

Because there are many different kinds of neural networks, selecting the one best suited to meet your requirements may be challenging due to the abundance of available options. This selection technique relies strongly not only on the qualities of NN, but also on the qualities of the problem being treated. Moreover, this approach relies heavily not just on the qualities of NN. To make decisions, it is essential to train the neural network selected for the purpose, and this training may be performed by applying a wide range of rules. the many systems that are found in the field of biological sciences served as a source of inspiration for the training rules that were developed for neural networks. In addition, one of the most fundamental aspects of teaching a neural network is learning from examples, which is done by taking in information from those instances. Consequently, a diagram that exemplifies the right combinations of input and output data is often sent to the network. After then, it is anticipated that the values of the weights will be modified by the network depending on its utilization of and analysis of the illustrated data. Therefore, the correct output may be attained when new data is presented as an input. The manner of operation referred to as the learning method is the name given to this particular mode of operation.

The term "data fusion" refers to gathering the data sensed locally by the ordinary sensor nodes, then merging that data and communicating it to the base station. The sensor nodes that take on the role of cluster leaders are the ones that are tasked with the obligation of carrying out the function of data fusion. This data fusion method is of the utmost significance in this scenario because it compiles all of the data that has been locally sensed, compresses it into a single quantum, and then sends that quantum to the base station. In other words, it is the only method to do all these things. Consequently, there is a considerable reduction in the overall quantity of energy that would have been used up in transferring the data one by one. As a result, decreasing size and using intelligent fusion may save energy during the data transmission process, which is often the component of a system that employs several sensors that connect wirelessly requires the most energy. The execution of these three actions is the primary concern of the node that is tasked with the responsibility of carrying out the data fusion function:

1. The process of collecting data from the myriad of distinct sensory nodes present in the system.
2. The consolidation of the information that was gathered as a result of the application of the decision criteria that had been pre-programmed.
3. The transmission of the combined data to either a sink or a base station, depending on the situation.

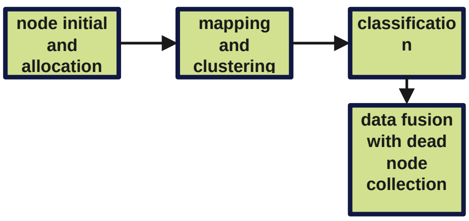

Figure 4: Flowchart of the Proposed work

By carrying out these three actions, which together provide the intended result, one may reduce the overall traffic load during the data transfer between the nodes that make up a system. This is a key step in extending the lifetime of the wireless sensor network by reducing the amount of energy lost by the sensory nodes. This was accomplished by reducing the quantity of wasted energy. Therefore,

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fusing data is an appropriate choice for the primary aim of the research that was carried out: to find out what caused the problem. The deployment of an intelligent system that can combine heterogeneous information obtained from various sources in an efficient, automated, and accurate manner is one of the most significant challenges wireless sensor networks face regarding data fusion. This is one of the most important challenges that wireless sensor networks face. The amount of the data may be reduced by data fusion. The data fusion approach has to distinguish and categories the information within the data, regardless of whether the data have been altered intentionally or have been subjected to noise.

Inside the Korhonen Self-Organizing Map are two-dimensional grids connecting the input and output layers to one another. The first category is the input layer, while the second category is the output layer. Since the user declares the input sizes and the corresponding value, the network will have the same number of nodes as the user defines for that value. The input parameters are obtained from the nodes of the sensors that are part of the network that makes up the input. At this juncture, the parameters' sizes are considered n and m, where n and m represent the number of binary bits used by each parameter. Following that, the total number of inputs will be:

$$| v - mXn | \tag{1}$$

The number of binary bits used for the parameters is denoted by m and n, respectively. Therefore, it is the responsibility of the output layer to further classify the patterns that were received as input, and it is the responsibility of the outer layer to share an ordered link with those patterns. They self-organize from a starting point that seems completely random, and a natural relationship is demonstrated among the patterns that arrange the topological map. This gives the impression that the patterns are related to one another. The patterns of input found are used to choose the output layer, which is selected to comply with those patterns. As a direct consequence, both the input layer and the output layer do not change. Therefore,

The following is one way to characterize the structure of the network's input layer:

$$I = \left(I_1, I_2, \dots \dots, I_{|\eta}\right) \tag{2}$$

The outer layer of the network is framed as

$$O = \left(O_1, O_2, \dots \dots, O_Q\right) \tag{3}$$

The Euclidean distance value of a sensor node in the outer layer is determined to be DJ whenever the communication takes place from the input cluster layout of the network. Calculations and monitoring are done to determine and track the Euclidian distance between each node in the network. The clusters are formed according to the distance detected from the sensor nodes, and the formula for this formation is eq- 4.

$$D_i = \sqrt{\sum_{i=1}^{|V|} \left(I_i - W_{ji}\right)^2} \tag{4}$$

When the communication of the dala occurs from the network's input cluster configuration, the value of Dj represents the Euclidean distance between a sensor node in the outer layer and the rest of the network.

iv. The Operational Steps of the NN

The weights are kept separate from the cache and each neuron from the input layer.

The NN is created with the assistance of extracted properties; these attributes include the input unit (A 1,A 2,A 3,A 4,A 3), the hidden units HU 0, and the output unit as age. f.. (4.4)

The following equation is used to get the recommended bias function for the input layer: (as per standard formula),

The computation of the activation function of the output layer may be done using the following equation:

$$\text{Active}(X) = \frac{1}{1+e^{-x}} \tag{5}$$

4 Below is the identification of the learning error rate:

$$LE = \frac{1}{H_{NH}} \sum_{n=0}^{N_{Nn}-1} Y_n - Z_n \tag{6}$$

In this case, LE stands for the learning rate of FFBNN.

Since the feed forward neural network employs the back propagation algorithm as its learning process, it is important to understand how this algorithm works. A brief introduction to the supervised learning approach known as the delta rule is provided here. When constructing the training sets, the output datasets have certain requirements for their input. This algorithm is used to achieve the goals of the feed forward network. The necessity for a differentiable activation function

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for the neurons that are employed by the learning algorithm is the primary and fundamental need for it.

This data fusion method aggregates data gathered and obtained from all nodes, followed by the computation and extraction of the nodes' residual energy. The following equation is used to calculate the residual energy that is left after the availability of the nodes (Non-dead Nodes) after the time T. This equation is used to calculate the residual energy that is left after the availability of the nodes:

$$\boldsymbol{P}^{\mathbf{A}}(e,T) = \boldsymbol{E}(\boldsymbol{E}_e - e,T) \quad (7)$$

The amount of energy used is denoted by E (e, T), and E0 denotes the energy present at the first node. Using the information, the data routing is carried out in such a manner that it ensures the node in the cluster that has the highest amount of energy is the one that transmits the data to the node that serves as the cluster head for the network. (BP) E 0.1. () BP E 99 The process described above is repeated for several rounds in succession, during which time the amount of energy used by each node and the number of nodes that have died are tallied. Utilizing the following equation, one may determine the total amount of energy that was used:

$$\text{Elec} = \boldsymbol{E}_{\text{tx}} + \boldsymbol{E}_{rx} \quad (8)$$

In this example, Ext and Erx signify the cost of transmitting electricity represents the cost of receiving it. The network's energy is calculated by adding together all of the individual nodes' amounts of energy. Because of this process, the nodes can keep their energy levels up for much longer, which contributes to the increased efficiency of this energy.

4 Experimental Results and Analysis

MATLAB, a model based on the design environment, may be used to model the environment for producing and modelling mathematical models and systems. This can be done by modelling the design environment. Under the heading "Results," you will find a comprehensive discussion of the findings obtained as a direct consequence of using the recommended strategy for conducting research. When the recommended research strategy has been included into the MATLAB code, the efficacy of the study that is now being carried out will be shown. The conclusions gathered from the research are used in several different performance evaluations to ascertain whether the planned study activity will be fruitful. The evaluation of the network's performance takes into account its efficiency and energy dissipation and its cluster head selection and probability distribution function (PDF). Which may be interpreted to signify the following:
1. The Effectiveness of the Network in General When there are no dead nodes, minimum dead nodes, and maximum dead nodes, efficiency of the network refers to how efficient the network is in each of these three distinct scenarios.

2. The wasting away of energy: "energy dissipation" refers to the total amount of energy lost as node heat. At the same time, the operation is being performed, and it is measured in joules. The decision-making process about the Cluster Head (CH) A certain number of nodes must have established a connection with the base station before selecting the cluster head. The selection procedure for the cluster head is based on the premise that the node with the greatest total energy should be selected as the cluster head. This principle serves as the foundation for the selection process. The energy level of each node will be continuously monitored, and the node that consistently exhibits the greatest amount of energy will be chosen to serve as the leader of the cluster. The cluster's leader is the one that makes the necessary adjustments. 4. The Probability Distribution Function, often known as the PDF, is defined as the amount of chance that a node would change into a dead node that is the absolute minimum. The word "Probability Distribution Function" is shortened to "PDF," which stands for "Portable Document Format." If the node's energy level falls below the threshold average energy level, then there is a possibility that the node will die and be removed from the network. This threat is also known as the potential for the node to become inactive, or dead.

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4.1 Simulation Parameter

To implement the anticipated mechanism for an efficient wireless network, 100 nodes are placed randomly in the network area (x=100, y=100). The different parameters and values used for executing the proposed methodology are given as follows.

Random clustering is executed in the first round wherein different clusters are made randomly, and one Cluster Head (CH) is fixed at the position of (100, 50). Figure 5.1 below shows the structure of the wireless sensor network with 100 nodes in an area of (100, 100).

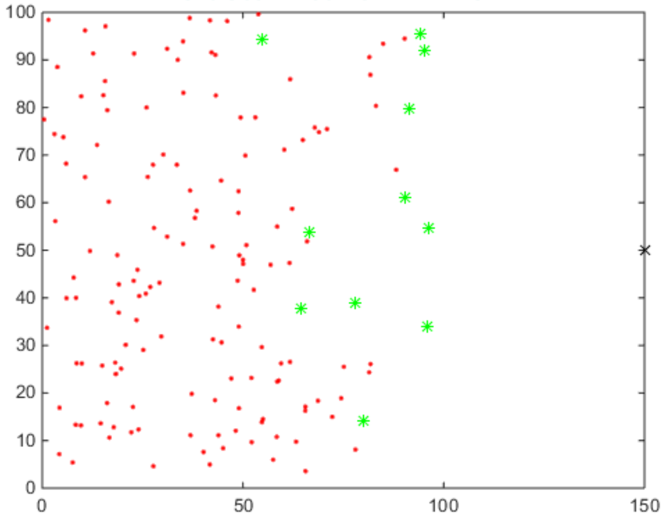

Figure 5: structure of cluster head

The Figure 5.2 describes the network topology without any dead nodes. In this condition the output efficiency will be maximum.

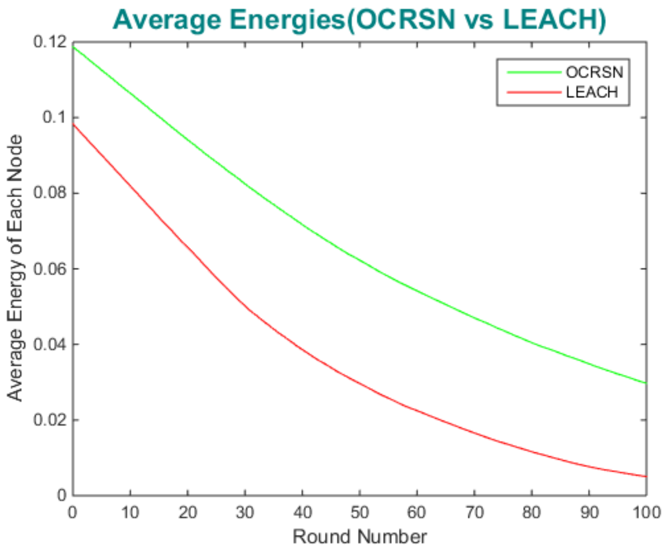

Figure 6: Average Energy

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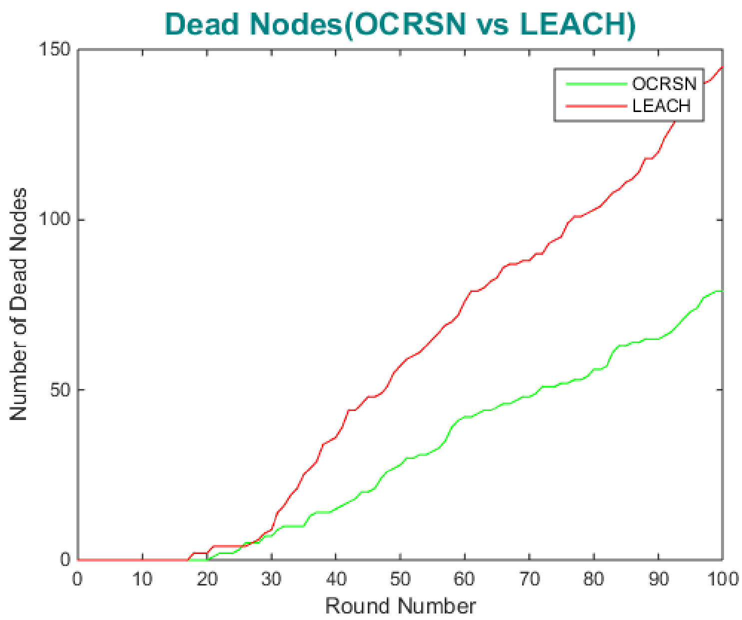

Figure 7: Dead Nodes

Figure 6 Network Topology with Minimum Number of Dead Nodes Detected. The maximum number of the dead nodes detected is represented in this Figure 6. The node mapping is performed after each iteration process so that the nodes will change according to the iteration count (i.e., according to the usage of the node in similar operation). In this below Figure 7 the total number of dead nodes detected are shown.

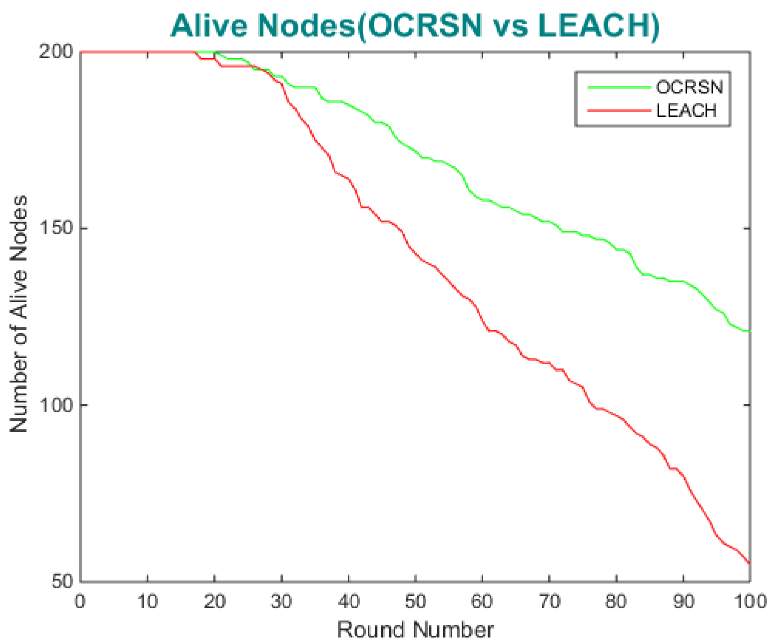

Figure 8: Alive nodes

Each node's energy consumption and residue energy are calculated once the iteration is executed to determine the number of dead nodes and assist in the routing mechanism as per the energy level of nodes. This is further utilized for the re-formulation of the clusters. Figure 8 and 9 represents the average energy of the nodes or energy depletion at nodes at number of rounds or iterations limited to 140.

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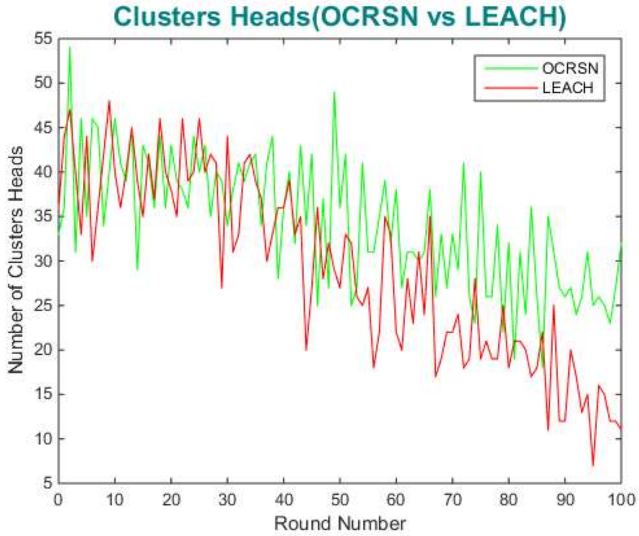

Figure 9: Cluster Heads

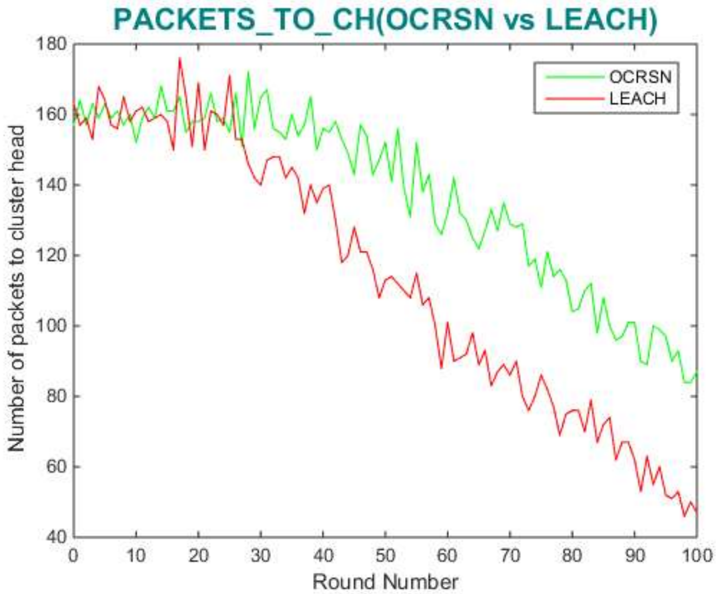

Figure 10: Packets to cluster Head

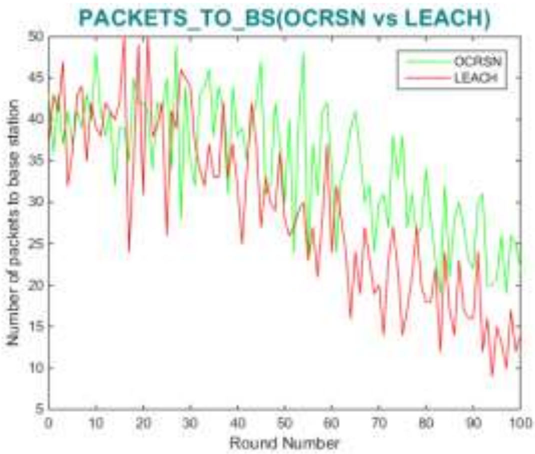

Figure 11: Packets to Base station

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5. Conclusion

After 150 iterations, the findings have shown that the suggested protocol, AIEARP, is effective since the number of dead nodes in the network is quite low. Therefore, the collected findings demonstrated the usefulness of this study methodology by allowing for the identification of dead and half-dead nodes. The ratio of dead nodes to live nodes in the network that uses energy-efficient nodes is 1.3518. In addition, the cluster head value of a network with energy-efficient nodes is 11, and the overall value of a network with energy-efficient nodes is 79. Therefore, the likelihood of a dead node occurring is much lower than that of another current protocol such as LEACH. The suggested study approach was determined to be more effective in terms of energy consumption based on the obtained findings and the outcomes cited in the previous literature studies. Therefore, this study aims to present a cutting-edge method and a novel protocol called AIEARP for increasing the amount of energy that can be saved in wireless sensor networks. This is accomplished through the adoption of the integration of Korhonen Self Organizing Map (K-SOM) and Artificial Neural Networks (ANN). In the future, this body of work might be improved by putting more of an emphasis on increasing network longevity via the use of improved data aggregation methods. Because the devices that make up the Internet of Things have limited access to energy resources, the routing mechanism plays an important role in saving the energy on the nodes. The issues presented by the routing protocols for the Internet of Things are the primary focus of the research that is now being carried out. As a direct result of this, the implementation of the RPL enhancement protocol for the standard routing protocol has taken place.

The cluster head node is responsible for collecting the data and sending the compiled information on to the sink node once it has been processed. According to the simulation results, using the MCEA-RPL routing protocol rather than one of the other routing techniques increases the amount of time that a network may remain operational.

Thirdly, a protocol for the Internet of Things known as Enhanced Mobility support RPL (EM-RPL) is now under consideration. It makes use of fuzzy logic in combination with the metrics RSSI and PER for the aim of establishing the hand-off value. If the amount being transferred exceeds the threshold limit, it will immediately start seeking an alternative path to follow. As a consequence of this, there is a lower risk of the route being broken due to movement, and as a result, there is a lesser quantity of data that has to be resent. The simulation results make it abundantly evident that EM-RPL enhances the mobility of the network nodes.

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