Research Article

Wireless Sensor Network routing for Life Time Maximization Using ANFIS Based Decision with Low Power Consumption

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Astract: - Wireless sensor networks (WSNs) allocate thousands of cheap micro-sensor nodes to a hundreds to more than thousands of nodes in the reserved areas. In the WSN, sensor nodes control storage resources, calculating energy of nodes, power resources of nodes, and additional resources information on a sensor network. These micro-sensor nodes are key components of the Internet of Things (IoT). WSNs are pre-arranged in clusters or groups to protect the ability for efficient data communication. Strong routing methods are required to maintain long network life and achieve high power usage. In this work, the new energy efficient ANFIS-based routing system for WSN enabled IoT to improve network performance. The proposed ANFIS-based routing involves a novel distributed clustering mechanism that activates the local configuration of local node energy equally across all sensors. A new technique for replacing clusters and rotating nodes with a centroid-based cluster head (CH) to distribute loads. The simulation results show that the proposed program will surpass conventional methods with 78% improvement over the lifetime of the network and 26% improvement in performance.

1. Introduction

Clustering algorithms have appeared as an energy efficient communication protocol for clustering sensor nodes. A WSN organizes displaced sensor nodes to record and monitor various physical and conservative situations through low-cost data acquisition. Sensor nodes often lose energy in nature, which leads to improved techniques to control the dissipation of cost effective preserved energy and reduce service life. Connect the cluster head data to remove any redundancy and then use the receiving node or base station [1]. Every small part of the network has a cluster head node. Therefore, to maintain the correct phase balance for cluster head power management. Current routing methods for selecting cluster head are not suitable for large-scale environments integrated with WSN IoT.

The nodes in WSNs are organized into groups or clusters to conserve energy. WSN is widely used in many applications such as wildfire monitoring, war monitoring, home automation and weather monitoring. This requires extraordinary reliability when using the WSN, especially in task-critical applications such as high alert management and war surveillance. In the node alignment resolution model, the sensor node positions are pre-defined. In general, the two types of node activation models available depending on the employment strategy are inconsistent and decisive. Cluster deployment plays a big role in assessing cluster credibility, thus contributing to the reliability of the entire WSN. Many techniques are used to preserve the energy intake of sensor nodes in a particular cluster, such as increasing the life of the network or increasing the reliability of the network. In a random node alignment model, each sensor node is likely to be located anywhere in a sensor field. This type of sensor tip distribution is achieved by spreading nodes in air into the clustered network. This model is especially used for travelers who can physically reach the deployment area [2].

The energy system module is used to manage and balance the power required by a node to perform any task. In addition, the collected information is converted into numerical signals and sent to the microcontroller. An Internet connection is used to provide a standard interface between users and IoT devices. A terminal sensor is assigned to analyze and collect environmental data. The microcontroller receives the signal information from the respective data and must process it. The sensor terminal hardware consists of four parts such as microcontroller, a power management module and a wireless transceiver. IoT-based WSN services provide users with a standard interface for creating a query, retrieving information, and changing its states accordingly. The wireless transceiver transmits the respective processed signals, which can achieve a normal sense of communication [3].

The lifespan of a network can be reduced by sending data from each sensor terminal to the receiving node separately. These different characteristics can be battery power consumption, bandwidth, processing capacity and storage capacity. This can lead to depletion of battery power and bandwidth, which can meet user needs at intermediate sensor nodes, data fusion is defined as the process of integrating numerical information and observations from multiple sensor nodes. To avoid this problem, data integration techniques have been introduced that provide useful information in one copy. Integrating data into information collected by a group of network nodes can be done in two ways. However, an IoT-based WSN is a power-restricted network, so there are a number of things to consider before moving from one node to another. In the second way, artificial intelligence and automated classification techniques are used. In the first way, well trained data models are used for classification[4].

Energy efficiency is a major issue at WSN because sensor nodes are battery-powered and can further process and analyze nodes using the basic purpose of sensing information from a physical event to convert the received data into signals. The energy of the terminal is directly proportional to the effective life of the network. The sensor node in the WSN performs two functions: it manages power utilization to extend the life of the entire network. There is a high level of energy depletion in various activities such as communication, sleep, passive listening, overhead control and conflict. The second function is to gather data from the WSN to process and process data from the base stations to the surrounding nodes, and the first is to gather data from the physical environment. A high percentage of energy transfer and reception is used in all activities [5].

The remaining portion of this work is arranged as follows: in section II, literature survey around the different methods of the energy efficient routing algorithm and its architecture is explained. Section III explains the proposed ANFIS based routing with more detailed block-level diagrams. Section IV discusses the experimental results to demonstrate the performance metrics and comparison with existing methods. In the section V, conclusion and future work are explained.

2. Literature survey

A vast amount of works has been proposed previously to implement the energy efficient routing of WSN networks with different solutions. These different methods are targeting to reduce the energy consumption of sensor nodes by optimizing the structure of routing. Some of the works which is proposed previously to perform the energy efficient routing is explained below

Shishupal Kumar et al. has proposed combining and investigating observations is called multi-sensor data fusion. Fusion is used to generate more consistent, accurate and effective information than any single sensor node provides, and for performance, the data is combined into a perceived form collected by the sensor nodes. It is much significant to combine the network path parameters to select the appropriate transfer path to send the data to. In addition, to maximize the effective life of the network, an efficient strategy for selecting a cluster head node is required. Therefore, the Multi-Sensor Data Integration (MDF) strategy is integrated with the collected network parameters to select the appropriate path in conjunction with the ambiguous leader of the panel selection. Collectively, this strategy is called the MDF-FBCHS strategy for IoT-based WSN. Relevant results show that extensive simulations were performed and that the program performed better than other projects in simulated scenes [6].

Sasmita Acharya and Tripathy suggested node deployment program not only reduces energy costs but also improves the life of the network. It proposes a 3 x 3 phase model for the classification of square, pentagonal, hexagonal and fixed sensors into four spatial models of WSN clusters, ANFIS proposes a more reliable neuro-fuse optimization model (RNFOM) data collection technique. Appraiser. For internal and inter-cluster failure detection in the WSN for failures with Gorti's enhanced homomorphic cryptographic (EHC) system to provide network security. The presentation of the four proposed models is analyzed using the reliability module graph, where the reliability value of each model is calculated using the gross product (STP) method. The models are then compared by simulation with different performance measures. The analytics confirm that the WSN 3 x 3 phase cluster deployment model, which runs data collection technique, offers relatively better performance and longer network life. Any cluster is longer than the proposed model for the WSN [7].

Reza Samadian and Seyed Majid Noorhosseini proposed thatsensor networks lead in realizing the dream of a ubiquitous computer. The location of the sensor nodes, which is the subject of this document, is issues that need to be addressed in order for sensor networks to be used effectively. Unlike many existing methods, this method assumes no additional equipment at the sensor nodes. There are many issues with the deployment and exploitation of these networks that deal with sensor network applications that need to take advantage of that capability. This method is used by the probability Support Vector Machine (SVM) to obtain the most accurate location of the sensor nodes, which provides further improvement in the accuracy of the sensor node locations. Furthermore, post-PSVM processing, which is an attractive / repulsive potential field distribution probability test, shows that the SVM (PSVM) system makes significant improvements over existing location systems, Especially in scattered networks and harsh environments [8].

Denghui Wang et al. presented thatWSN is used to support new applications, especially on the main layer of Internet vehicles. Remote mixed media sensor networks require complex undertaking preparing and successive information correspondence, power effectiveness and nature of administration. Therefore, making the power supply more efficient has become a challenge in ensuring service quality. This is different and the power supply is not uniform, and current routing protocols do not take into account power consumption when ensuring the quality of service. Performance results showed that power consumption decreases when QoS is stabilized compared to the traditional cooperative protocol and distributed adaptive cooperative routing protocol. Energy Efficient Adaptive Cooperative Routing (EEACR) for WMSN is an energy efficient routing distribution that takes into account service quality and power consumption limits, in particular the reliability and delay in designing a mechanism based on reinforcement learning and balanced power routing for QoS [9].

RaminYarinezhad and SeyedNaserHashemi have proposed that increasing network life and reducing power consumption sensor node clustering is the best method for routing on wireless sensor networks (WSN). Therefore, minimizing the maximum load on the CHs is a major problem, which is called a load balance clustering problem. In a pooled WSN, the cluster heads (CH) carry more loads compared to the other nodes, leading to their previous death. LPCP is an NP hardware problem and the best factor for this problem is 1.5. Furthermore, it has been demonstrated that there is no polynomial-temporal approximation method that solves this problem by the best approximation factor. This particular algorithm applies to larger WSNs and works better than other similar algorithms, with a consistent and energy efficient routing algorithm for routing between CH and immersion [10].

From the above discussion, it is very clear that previously several works have been proposed to perform energy efficient routing architecture. The goal of this proposed technique is to reduce the energy consumption and increase the throughput. The main objective of this work is stated as follows:

1. To reduce the energy consumption in sensor nodes and increase throughput to transferdata packets in the wireless sensor networks.
2. To improve the efficacyof routing process to the maximum extent for high-speed multimedia wireless sensor networks.

3. Proposed method

In this segment, the technique, which addresses and gives an efficient routing among the CHs, is depicted. Specially, this calculation is an efficient routing calculation in WSNs, which depends on ANFIS model and its execution. The route reconfiguration or re-clustering can be performed based on the energy which is available on the sensor and cluster head. Initially the CH is estimated based on the fuzzy c-means clustering techniques.

A. Clustering

Clusters are typically provided with cluster heads, and these cluster heads send integrated data to the base station or receiver. The main advantage of clustering is the performance measurement on scalable sensor networks. Apart from these, the clustering approach offers several side benefits. This ensures reliability and avoids specific failures due to its localized solutions [11]. A clustering solution to effectively reduce power consumption can suggest anactive or sleep schedule for a WSN. Figure. 1 shows the network configuration of the proposed system. It has 5 cluster heads and one base station, all the cluster heads are connected to each other.

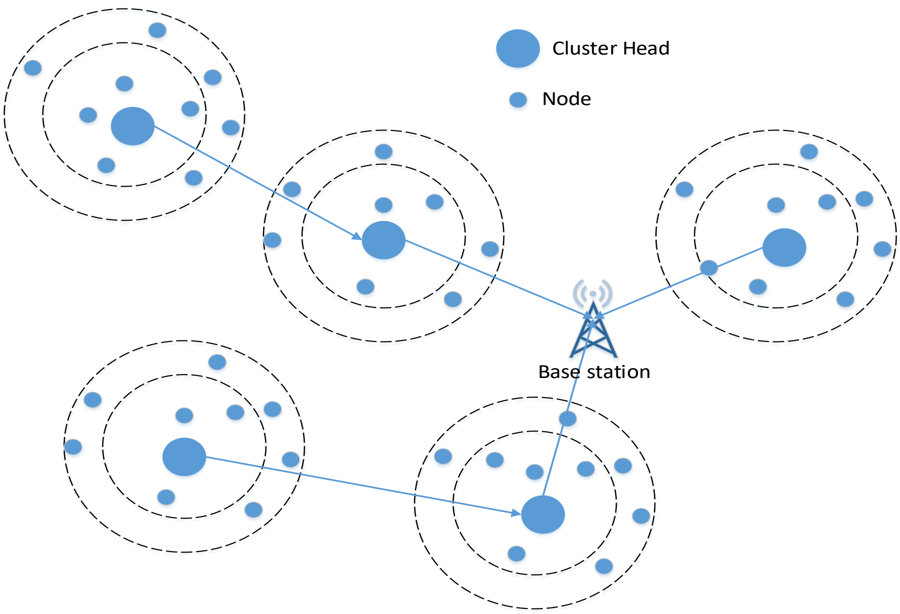


Figure. 1. Network structure of the proposed method

Fuzzy c-means of grouping or clustering calculation is utilized to track down the underlying cluster. Let $X = \{x1, x2, x3 \ldots, xn\}$ be the arrangement of information points and $V = \{v1, v2, v3 \ldots, vc\}$ be the arrangement of center points. For calculating the Fuzzy c-means grouping participation $'\mu_{ij}'$ utilizing

$$\mu_{ij} = 1/\sum_{l=1}^{m}(d_{ij}/d_{ik})^{(\frac{2}{n}-1)} \quad (1)$$

Where n is the quantity of information points, k is the fuzzy c-means bunching or clustering list $'\mu\_ij'$ addresses the enrollment of i^{th}information to j^{th}group focus, d_{ij} addresses the Euclidean distance between i^{th}information and j^{th}clustercenter points. Where, $||x_i - v_j||$ is also the Euclidean distance from i^{th} data and j^{th} cluster center points

$$v_j = {(\sum_{l=1}^{k}(\mu_{ij})^m x_i)}\Big/{\sum_{l=1}^{k}(\mu_{ij})^m} \quad (2)$$

$$J(u,v) = \sum_{i=1}^{n}\sum_{j=1}^{l}(\mu_{ij})^m || x_i - v_j ||^2 \quad (3)$$

B. Data gathering and re-clustering

After collecting data such as distance and energy present in the node network, it will be grouped again. Now the nodes can start sending their data to the base station. At this point, the data will be there as long as the network is active. Figure 2. Initial grouping and Figure 3. show the re clustered network.

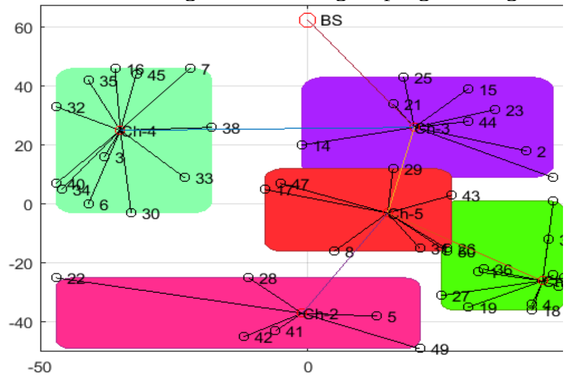


Figure. 2. Initial Clustering

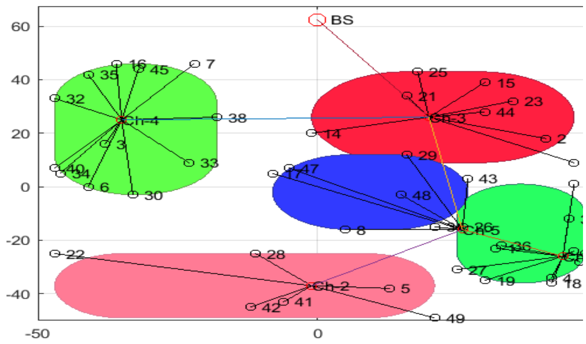


Figure 3. Re-Clustered network

C. Block diagram

The block diagram shown below in Figure 4 shows the structure of the proposed design with the training and testing phase. During the training phase, the data is divided into two additional fields of minimum energy and minimum distance, which are then combined with the old data and the labels of this data are assigned by the target value. These final data are sent for ANFIS training and a trained ANFIS model is generated. During the testing phase, a trained model is used to make the decision to route in wireless sensor networks. The network parameters are updated based on this result. During the test phase, the network parameters are updated at regular intervals.

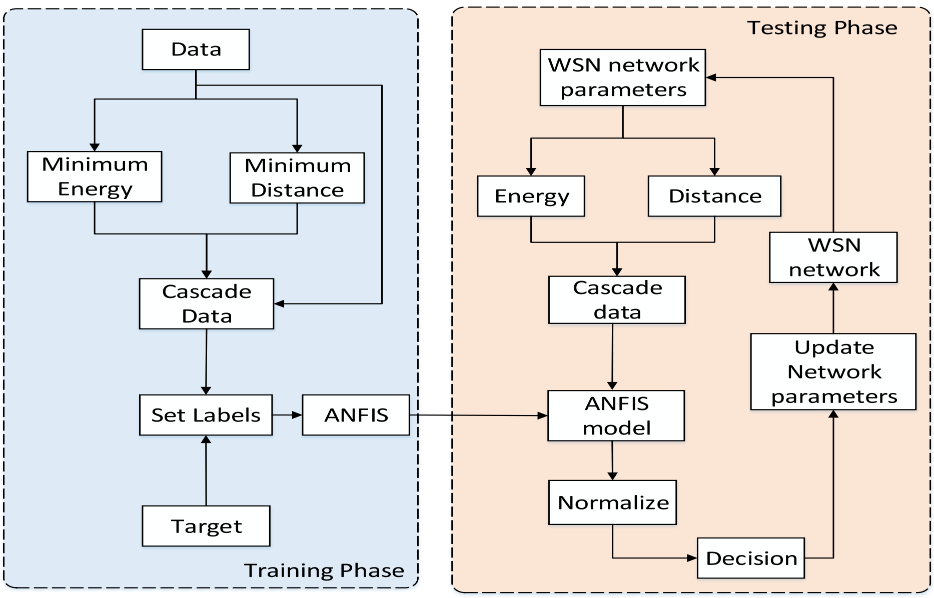


Figure 4. Block diagram of the proposed method

D. Routing

This proposed area for routing on an ANFIS-based routing tree through cluster communication spreads through the cluster communication network. The method presented in this section creates a routing tree, which is the connection between the gateways and the base stations. After assigning each sensor node to a gateway, the base stations report each gateway to their team members. Spread the routing loads across the nodes to balance the network power consumption, the purpose of which is to ensure that each node uses its power equally. Therefore, the routing algorithm provides several options instead of creating a fixed path between each CH and base station [14]. Each time data is sent to a gateway base station, one of these ways to send the message is selected, which can result in higher power consumption on the network if the terminals' power consumption is balanced. In the proposed routing method, the distance of the data transfer paths is considered, so that if the remaining power of the nodes on the other paths is not too low, one node will not repeat the long path, the short path will no longer exist and the long path will be used to transmit data [15].

1. Distance calculation between nodes

To figure out the exchange distance of every sensor node, compute the most extreme position of the creating sensor node and the getting node [12]. With this distance, the Euclidean space turns into a measurement space. The relating rule is known as the Euclidean guideline. Euclidean distance is the distance in an orderly fashion between two focuses in Euclidean space. The regular term for the Euclidean standard is the L2 rule or L2 distance.

$$d(i,j) = \sqrt{\sum_{i=1}^{k}(in - jm)^2} \quad (4)$$

The placement of a point in a Euclidean n-space is an Euclidean vector. Thus, I and j might be addressed as Euclidean vectors, beginning from the original position of the space initial point with their nodes terminal focuses finishing at the two points.

2. Energy available in nodes

The sensor node energy is characterized by the distance and energy utilization qualities of sensor nodes [13]. Contingent upon the blurring/fading relationship of the sign, the energy is determined by

$$E_{es}(m,n) = \begin{cases} m \times (E_{elec} + \varepsilon_{fs} n^2), n < d_0 \\ m \times (E_{elec} + \varepsilon_{fs} n^2), n \geq d_0 \end{cases} \quad (5)$$

$E_{es}(m,n)$ shows the energy devoured by the remote wireless transmitter to communicate a bunch of $e$bit sequence of data. E_{elec} is the energy utilization needed to send and get each bit sequence of information, where m is the quantity of bit sequence utilized for communicating data, d is the distance to the current sensor node.

$$E_{es}(m,n) = \begin{cases} m \times E_{elec}, n < d_0 \\ m \times \dfrac{E_{elec}}{d}, n \geq d_0 \end{cases} \quad (6)$$

where the transmission energy utilization is mostly the energy utilized during the information transmission and force intensification

E. Inference technique of adaptive neuro fuzzy

A versatile neural network induction framework or versatile organization based dark deduction framework (ANFIS) is a sort of artificial neural network dependent on the Takagi-Sugeno fuzzy surmising theory. Its theoretical framework is like a bunch of fluffy IF-THEN guidelines that can possibly learn inexact nonlinear capacities. This method was created in the mid-1990s. It joins both neural organizations and uncertain coherent standards, and can catch the advantages of both in a similar system. Hence, ANFIS is viewed as a worldwide evaluator. To utilize ANFIS in the most effective and ideal manner, the best boundaries acquired by hereditary methods

1. ANFIS architecture

Two territories can be distinguished in the organization structure, in particular, the premises and the impact segments. In more detail, the engineering structure is comprised of five layers. The levels of participation of each capacity are determined utilizing the introduction boundary set a, b, c. The subsequent level is answerable for making the terminating power for the guidelines. The main layer takes input esteems and decides the participation functions that have a attachment with them. This is regularly called a blur layer. In light of its capacity, the subsequent layer is known as the "rule layer." The fourth layer takes the default esteems as info and its outcome boundary is p, q, r set. The part of the third layer is to standardize the determined terminating power by isolating each an incentive by the all-out terminating power. The qualities given by this layer are befuddling and will send the last yield to the last layer.

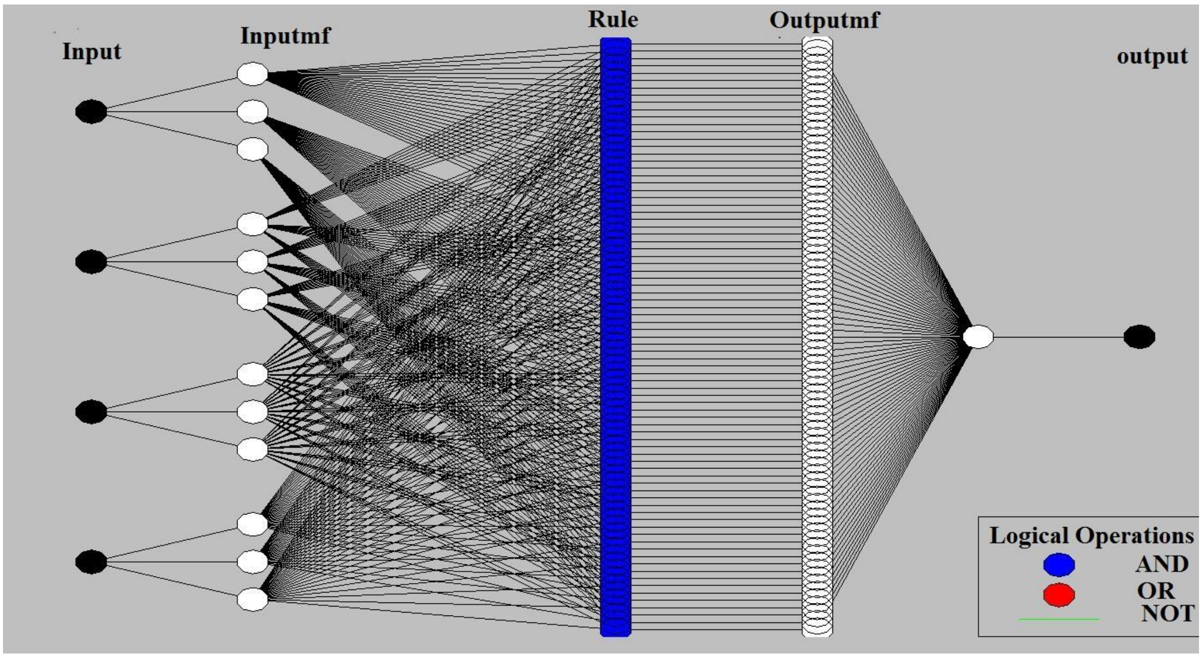


Figure 5. ANFIS model structure

Figure 5 shows the ANFIS model structure here four inputs are given and it gives one output. Different membership functions are added to this network layers, here input membership function and output membership functionare added. The rule set is added and represented as the blue line in the figure. Finally, a single output value is produced at the end of the network.

4. RESULT AND DISCUSSION

This section presents aassociation of the performance for the cluster classification models determined by WSN with the simulation model, performance measures, and simulations against different performance measures. The simulation is done using MATLAB 2020a with 4 GB of RAM. Error detection is performed using the ANFIS model proposed for all the cluster classification models determined by WSN. Two parameters are mainly involved in this analysis, distance and energy these will affect the network throughput directly. The existing scheme selects an optimal node based on traditional technique.Table 1 shown below will compares the proposed ANFIS to the existing technique and proposed method outperforms the existing methods.

A. Performance metrics

The presentation of this proposed WSN deterministic bunch arrangement models are organized and related each other through simulation concerning the performance measurements

(a) Dead Nodes (DN):DN measurements is assessors of the organization lifetime. The DN gives the round of reenactment at which the hub bites the dust without energy. It is a proportion of the organization lifetime for an inadequately sent by WSN

(b) Alive Nodes (AN):AN measurement is likewise assessors of the organization lifetime. The AN gives the round of simulation at which the hub with least energy remain. It is a proportion of the organization lifetime for an inadequately conveyed by WSN.

(c) Network Lifetime: It is the time until the organization gets divided totally because of the rate of error of cluster heads in the organization.

(d) Energy Cost: It is the measure of energy burned-through for various group network arrangements.

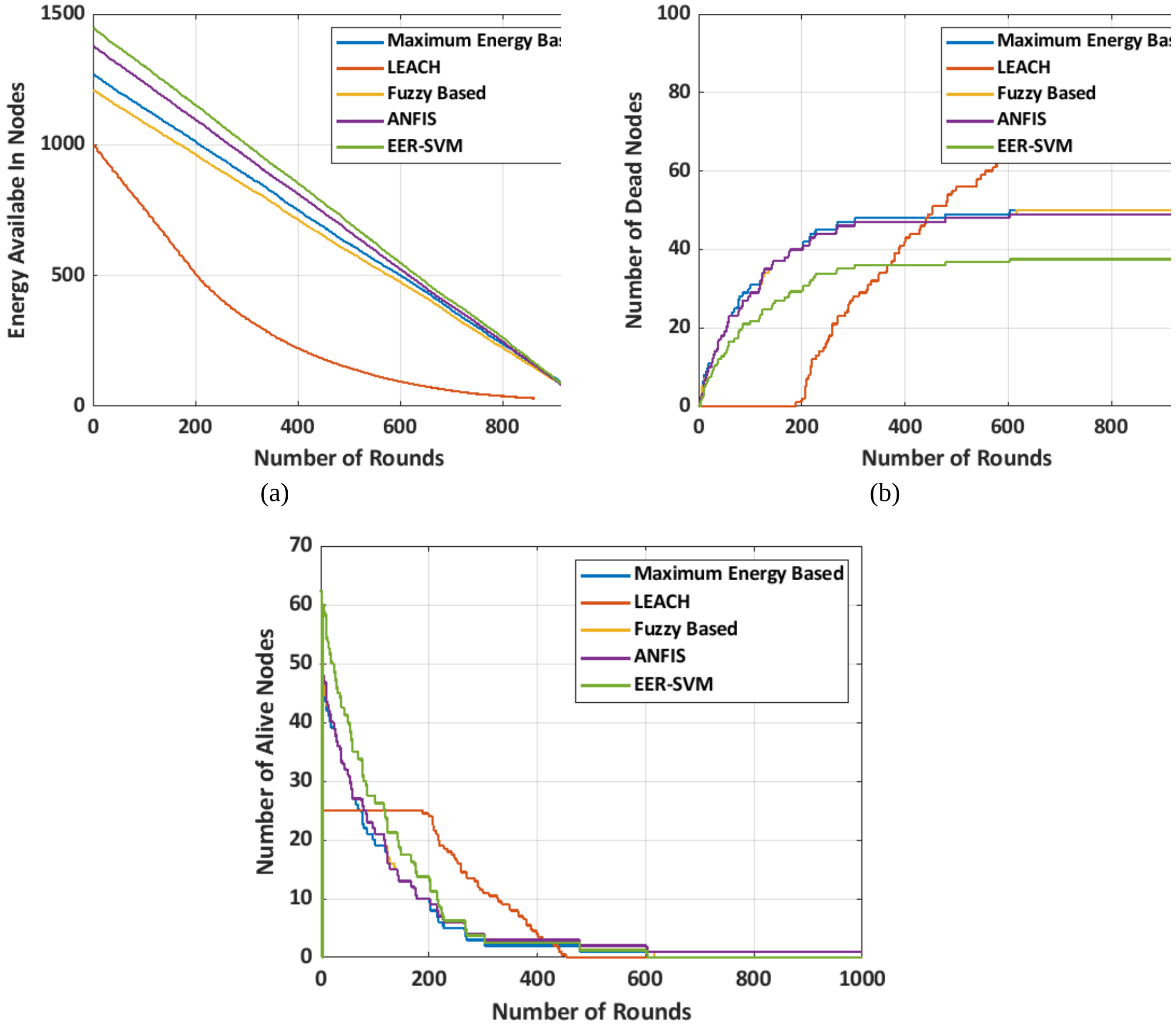
(e) Loss Probability: It is given by the proportion of the quantity of information packets dropped (a) to the amount of the quantity of information packets got at the base station (b) and the quantity of information packets dropped until the finish of reenactment. That is, Loss $Probability = a/(a + b)$.

Table I. Performance Evaluation

Methods	Initial route	After ANFIS Routing	Energy remaining
Total Existing Nodes	50	50	100.00
Total ANFIS Nodes	45	48	82.12
Alive nodes existing	30	30	74.15
Alive nodes ANFIS	48	49	89.71

Dead nodes existing	22	21	18.23
Dead nodes ANFIS	12	6	0.00

Table 1 shows the performance evaluation of the network with the existing methods here alive nodes at the existing initial route is 30 and after ANFIS routing is 30 no energy is loosed here. Similarly, dead nodes arereducing to 6 after the ANFIS routing. Figure 6. Shows the energy available in the nodes based on rounds of data transfer, number of dead nodes based on rounds of data transfer and number of alive nodes based on number of rounds.



(a) (b) (c)

Figure 6. (a) Energy available in the nodes based on rounds of data transfer (b) Number of dead nodes based on rounds of data transfer (c) Number of alive nodes based on number of rounds.

5. CONCLUSION

In this work the wireless sensor network communication performance is obtained by measurements such as network performance, number of active nodes and number of dead nodes. The research work presented in this paper is an attempt to address communication-related challenges using optimization as the main solution at various stages. When data is transferred from the sensor to the base station, the ANFIS-based technique is followed to select the most effective node at the center of the cluster for optimal location of the cluster head. The performance of the base station location obtained from the hop count metric significantly reduced the number of intermediate hops required from the base station. Simulation results show that the proposed program outperforms conventional methods with 78% improvement over the lifetime of the network and 26% improvement in performance. The results effectively determined that a significant packet distribution rate was obtained compared to previous approaches.

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