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Modified Cluster Head Selection in Existing TEEN Routing Protocol

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Abstract- Due to the limited irreplaceable power sources of sensor nodes, the analysis of several protocols in wireless sensor networks reveals that energy is the main issue in WSN. The significant quantity of energy required for data transmission is the primary cause of this. Numerous studies are conducted to create routing algorithms that will increase the WSN's lifetime and energy efficiency. In order to improve the current TEEN routing protocol's energy efficiency in wireless sensor networks, this article implements modified cluster head selection. The nodes gather data and send it to other nodes using a changeable threshold energy value, which increases each node's residual energy and, consequently, performance. After applying the improved cluster head selection to the current TEEN routing protocol, we assessed the outcomes and found that it outperforms the current TEEN routing protocol.

Index Terms—Cluster Head Selection, TEEN protocol, Energy, Dead Nodes, ELF, Efficiency, Lifetime, etc.

I. INTRODUCTION

Many wireless sensor network applications have been developed in recent years to enable human interaction with the environment [1]. Wireless sensor networks help collect environmental data and send it to the base station or higher level node. Depending on the needs of the application, sensor nodes can be distributed at random or predetermined places and can be homogeneous or heterogeneous. Many protocols have been developed recently to increase the WSN's energy efficiency and sensor node scalability [2]. The wireless sensor network's lifespan is extended as a result of increased energy efficiency. For improved network routing and performance, hierarchical clustering is therefore taken into consideration. All of the sensing devices are positioned at random throughout the designated region in hierarchical clustering in order to gather the necessary data about it [3]. The cluster representative processed and delivered the information to higher level nodes. The cluster head is a representative of the cluster. Segments of the system made up of a few nearby nodes are called clusters [4]. As a cluster representative, a cluster head is chosen to manage the transmission and aggregation tasks. To balance the energy usage among all of the network's nodes, each node was chosen as the CH. For the majority of protocols, the cluster head selection process is the primary focus.

By combining and aggregating data, hierarchical clustering in WSNs can reduce energy consumption within the cluster. Hierarchical networks with cluster-based routing are built to make effective use of the network's resources. With this method, the network's lifespan is increased, which reduces its energy consumption and increases its scalability. The network's nodes are arranged in a hierarchical fashion with the goal of optimizing the nodes' energy consumption, which is one of the numerous benefits of hierarchical routing [5]. By reducing the quantity of messages sent from the sender to the Cluster Head (CH), data aggregation and fusion aid in achieving the goal. Numerous variations of hierarchical routing have been created recently, and numerous academics are currently putting forth a large number of strategies and techniques to maximize WSN energy consumption.

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The WSN makes extensive use of the adaptive clustering technique. Initially, routing is suggested as a way to save energy.

When data packets are being transmitted around the network [6]. The network in the adaptive clustering technique consists of a Base Station (BS), which obtains the sensed information from the cluster heads via the network nodes. The Base There are currently no energy restrictions on the station. linked to a power source. Therefore, optimisation is not necessary. the route to every other node from the Base Station. Nevertheless, the base station's routing path from the nodes through the cluster heads must be optimised with regard to vitality. Typically, the cluster in hierarchical routing After receiving input from internal nodes, the head aggregates and sends it on to the Base Station after that. The heads of the cluster develops as a cluster, with the head of the cluster serving as its head. This Iterations of the pattern create multi-level clusters that can be arranged in a hierarchical fashion, with the base serving as the root. station. With this method, the nodes must transmit their only to the head of their cluster. The head of the cluster doesn't invest a lot of energy in transmitting the data, yet ultimately spend energy used to compile and send the data to the following position within the hierarchy [7]. This method saves a significant amount of vitality.

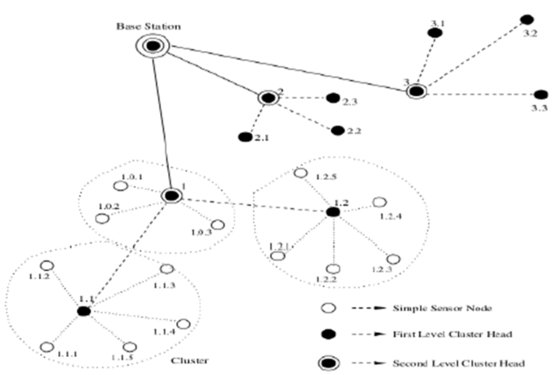

Figure 1: Hierarchical Clustering in a WSN [6]

II. RELATED WORK

Sarpate et al. [8] introduced the LEACH (Low-Energy Adaptive Clustering Hierarchy) routing system, a proactive network architecture that uses periodic sensing of the designated area to gather data about environmental and other physical factors. The hierarchical clustering technique was initially used by LEACH. Therefore, it is the standard hierarchical clustering methodology that uses data fusion, aggregation technologies, and cluster head rotation mechanisms to increase the network's lifetime [9]. This formula is used in the cluster formation and head selection procedure. In this case, T(n) equals where n is the number of nodes and p is the probability.

$$T\ n\ = P \div\ r\quad \frac{1}{P}\quad n \in G \tag{1}$$

$$T\ n\ = 0\ if\ n\ not\ belongs\ to\ G \tag{2}$$

Nevertheless, it has certain drawbacks, such as its inability to function well in vast networks and its constant information delivery [10]. Any unexpected modification to the network parameter is not immediately disclosed. Uppu Lokesh et al. [11] offer the TEEN (Threshold Sensitive Energy Efficient Network) routing protocol to address these problems. Reactive network protocols are designed to respond right away when a sudden change in a parameter is obtained. By adding hard and soft threshold values for the parameters to be sensed in the specified field, TEEN's reactive property is achieved. For data sensing and information transmission, TEEN employs the same clustering technique as the LEACH routing system [12]. Until threshold values are not reached, the environment detected by the cluster members is not communicated to the CH. Cluster nodes send data to CH once the thresholds are met. In order to prevent repetition in the detected data, CH also carries out the tasks of data fusion and aggregation before sending it to the network's top node [13]. The main disadvantage of the TEEN routing protocol is that until the threshold values are not reached, no information about the region will be available. It does not consistently provide the sensed information [14]. However, by lowering the quantity of transmissions, it extends the network's lifespan. The TEEN routing protocol time line (Fig. 01) illustrates the order of events that took place in TEEN in relation to time.

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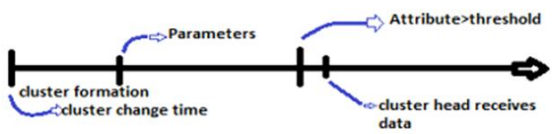

Figure 2: Time line for TEEN routing protocol

K Sankar et. al [14] introduced Adaptive Periodic TEEN (APTEEN) to eliminate the limitation of TEEN which does not transmit signal on consistent basis. A hybrid network protocol is better having more qualities i.e. APTEEN can act as both proactive and reactive depending upon the requirements. APTEEN includes two more parameters to handle the problems occurred in TEEN.

1) TDMA Schedule
2) Count Time

It can also handle all three types of queries i.e. historical, one-time and persistent. TDMA schedule used to avoid the collision of data transmitted by different at same time [15, 16]. These two parameters in APTEEN increase its complexity than other hierarchical wireless sensor network protocols.

III. PROPOSED METHOD

Existing TEEN uses the same hierarchical clustering technique, which LEACH protocol used for cluster formation and head selection. Cluster head changed if its residual energy is less the required value of energy for data aggregation and transmission, which is necessary for node to be CH [17]. In existing TEEN, cluster head selection uses same fixed (static) value of threshold energy for every round as shown below.

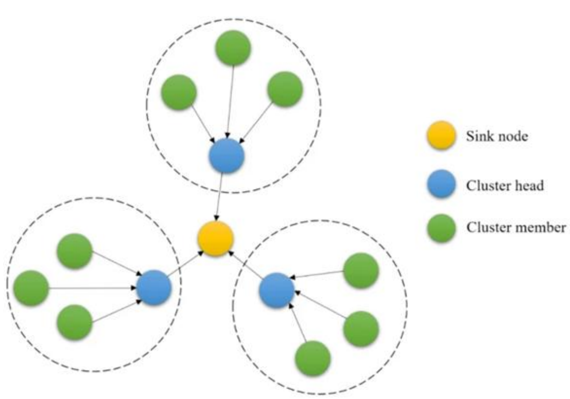

Figure 3: Network model

In Modified cluster head selection, dynamic value for threshold energy used instead of fixed value of threshold energy. Because as the nodes starts to be dead. There will be less sensed data in the cluster due to the lesser sensor nodes and hence, lesser energy will be required to transmit it [18, 19]. The process of modified cluster head selection introduced in [20] explains the change in value of threshold energy required for CH, obtained by introducing ELF (Energy Loss Factor), which depends on following terms.

$$E_{Tx}(k,d) = \begin{cases} E_{ele} * k + E_{fs} * k * d^2, d \le d_0 \\ E_{ele} * k + E_{mp} * k * d^4, d > d_0 \end{cases} \quad (2)$$

$$E_{Rx}(k) = E_{Rx\_ele}(k) + kE_{ele} \quad (3)$$

Equation (5) used to find the value of ELF. This shows that the initial value of ELF is one because the value for number of dead nodes is zero. This ELF value goes on to decrease as the number of dead nodes increases. ELF decreases the value of energy required for data aggregation and transmission [21]. Thus, nodes will have better residual energy and they will not die soon.

IV. RESULTS AND ANALYSIS

Deep Learning signifies a notable progress in disease detection, especially within the domain of machine learning. It involves training artificial intelligence systems using Artificial Neural Networks (ANN) to predict outcomes and identify patterns within data.

During simulation, we evaluated the performances of both the methods. The simulation performed in MATLAB R2020b and the nodes placed randomly in the network area to sense temperature values. Base Station placed in the center of the network. Network Parameters are as follows:-

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Table 1: Network Parameters

Parameter	Value
Network Size	100m*100m
Number of nodes	200
Initial Data Aggregation Energy	8μJ
Number of Rounds	100
Hard Threshold	100°C
Soft Threshold	2°C
Initial Temperature	50°C
Final Temperature	200°C
Initial Energy of nodes	0.5 J
Transmitter Electronics	50nJ
Receiver Electronics	50Nj

Some of simulations graph are presented here,

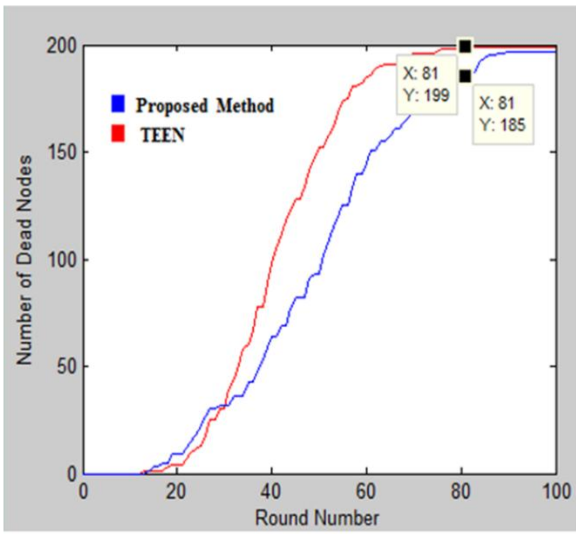

Figure 4 Number of dead nodes

Figure 4 shows that after applying modified cluster head selection i.e. Modified TEEN has lesser number of dead nodes as compared to existing TEEN. The data tip is showing the Value for number of dead nodes for proposed method after 81 rounds is 185 and 199 for existing TEEN. Thus, there are lesser dead nodes, which improves the working time of the network system.

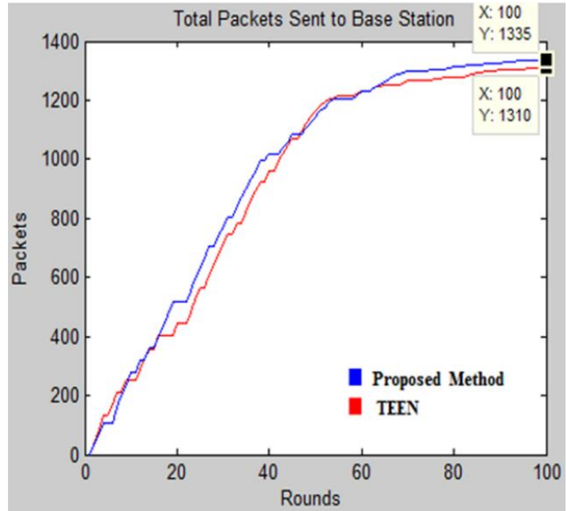

Figure 5: Total packets sent to BS

Figure 5 shows that modified cluster head selection increases the total packets sent to BS for TEEN routing protocol. Here 25 more packets being sent in modified TEEN than existing TEEN.

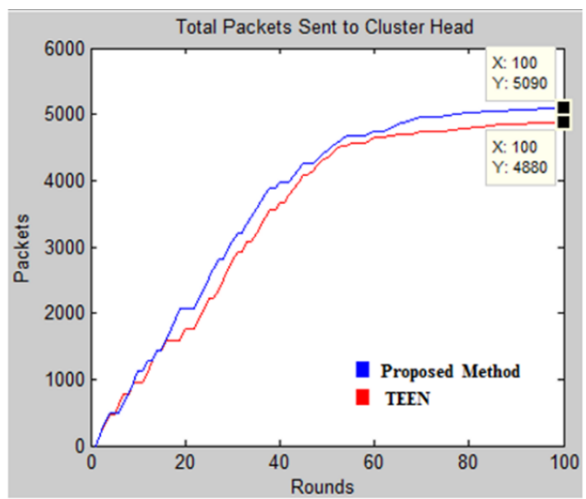

Figure 6: Total packets sent to CH

Total packets sent after 100 rounds are 5090 for modified TEEN and 4880 for existing TEEN. Hence, 210 more packets sent to CH by modified TEEN. That shows the improvement in the performance of sensor nodes as they are transmitting more information about the area under supervision

Modified technique is showing better results than existing TEEN. Hence, it is clear that implementing modified cluster head selection in existing TEEN routing protocol increases the lifetime by reducing the number of dead nodes and improves the energy efficiency by sending more packets to the BS.

V. CONCLUSION

In this paper, a modified clustering technique that employs the dynamic threshold energy value needed to aggregate and transmit data is applied in the current TEEN routing protocol. As compared to the current TEEN, the number of dead nodes decreased by 5%, and the average energy of each node increased by 30%, demonstrating the performance improvement. By preserving each node's remaining energy after data transmission, this procedure extends the network's lifetime and energy consumption. Nevertheless, this method makes the procedure more complicated. Therefore, the protocol's complexity may be reduced in the future for improved outcomes. There is room for more investigation to determine the ideal threshold energy value for a node to be CH in each round.

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