International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 10 Issue: 12
DOI: https://doi.org/10.17762/ijritcc.v10i12.5886
***Article Received**: 05 October 2022 **Revised**: 12 November 2022 **Accepted**: 10 December 2022*

Attenuate the Network Lifetime in Wireless Sensor Networks

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Abstract—

Wireless Sensor Networks are one of the well-established and as well as im- proving areas, which have a prominent role in many existing technologies. The day-to-day advancement in this field made a direction for growing low-power, low-cost, along with multi functioning of the sensors. This collective formation of the system with motes or sensors is Wireless Sensor Network (WSN). WSNs follow the principle of ”EAAs” stands for Everyone, Anywhere, Anytime. The nodes in the network have certain limitations in terms of memory, power, etc. Clustering the nodes in the network is an efficient and most preferable technique to address the problem of better performance of the wireless sensor networks. In this work, we provide a re-modified approach for cluster head selection for the transmission of data between nodes, cluster heads, and mote with a low packet loss ratio. The Statistical results of the two existing approaches and the proposed approach are compared for 100 iterations and shown in results. The time complexity of the proposed approach is also calculated.

Keywords: Wireless Sensor Networks, LEACH, Cluster Head, Network Lifetime, Energy Efficiency.

1. INTRODUCTION

The sensor network is a category of networks with nodes termed as specks, sensors or motes . This collective formation of the network, with nodes referred to as wireless sensor networks(WSNs). Figure. 1. Wireless sensor networks are presently very famous and gained its recognition extra than a decade, and it plays a vital role in the formation of the internet of things (IoT) [1] and this [2] leads a direction for digitization. The wsn is setting its identity in each useful resource in each area in which there may be a danger of improvisation. The application taxonomy of wsns [3]have broadly classified into monitoring, monitoring, and controlling [4],[5],[6],[7]. A huge range of capability services to navy, Safety, transportation, enterprise, technology, civil infrastructure, domestic, agriculture, industrial aspects, etc. [8],[9],[10],[11]. Commonly, a sensor node is a form of mini computing with the extra in-built functionality of sensing [12], [13]. Wireless sensor networks have several benefits, which include small in size, and expenses are tons more low priced when human intervention is extraordinarily hard. The most critical benefit of these sensor networks is that node area may be modified unexpectedly without any battle of rewiring and may be configurable to any topology like mesh, tree, star, and so forth. Even as it’s far a promising place in educational, financial and alertness-oriented growth, however, it has many challenges. The operational demanding situations of wireless sensor networks are low electricity efficiency usage of nodes in the system, restricted battery strength due to which less com- putation and garage capability of the node, low bandwidth with mild or high electricity costs for the duration of communication in the order. The mistakes are enormous in wireless networks, due to which the nodes are right away errors-inclined, noisy measurements because of which node failure predicted [14]. Routing is one of the options in wireless sensor networks to clear up the limitations of high network lifetime and much less node energy utilization within the network [15],[16],[17],[18]. The routing protocols are categorized by means of depending upon the mode of functioning of nodes, a form of application specific, kind of network structure, And based totally at the node participation of node. The energy-efficient routing protocols are categorized into flat routing protocol [19],[20],[21] and a hierarchical based routing protocol [22],[23]. This research is motivated to provide a better way to select a head node from the node group termed as a cluster. We modified the head node selection by using a precise equation and making sure that data item transmission among nodes and sink are much better when compared with conventional LEACH and one of the Improved LEACH, making sure of a better lifetime of the network along with minimizing packet loss during the respective transmissions. The process is

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initially we select the nodes which have better energy, i.e., which has more strength left in it. Secondly, consider the nodes which have more energy and low cost. Lower cost means the power that the WSN consumes will be less when the node is selected head node. So by this, we make sure only nodes having more energy left in it chosen as a head node.

Therefore, the contributions of our work in this paper can be summarized as follows.

• We proposed an energy-efficient routing protocol for increasing network lifetime together with minimum packet loss in the course of transmissions from source to intermediate nodes and from intermediate nodes to destination.

• We performed simulation results of the proposed protocol and comparing with the two protocols i.e, conventional LEACH and ICH-LEACH for overall performance strength.

2. METHOD

This research is motivated to provide a better way to select a head node from the node group termed as a cluster using clustering. The head node selection is done in the following way. Firstly, at consecutive clustering intervals, a node can choose to become a head node if it has high residual energy and BestCost among the tentative head nodes. Secondly, if a normal node elected to be a head node it sends a message data as an advertisement as H N D(bid , H Nss , BestC ost). Note, the head node status H Nss depends on the head node probability. If the head node probability is equal to one then it is considered as a final head node H NF inal else if the head node probability value is less than one then it presents as a tentative head node Thn . The maximum left over energy in each node is considered along with that the BestCost is calculated based on the Dist values and choose the nodes whose values are less than the predetermined cluster range value as BestCost nodes and d where d is the distance between respective nodes and mote. The node which has highest residual energy and BestCost is identified as a head node during the respective iteration round.This way of choosing head node is beneficial for priory two reasons. The primary goal is for improvisation in the interaction among the various types of nodes aiming to long network life. The former idea is to reduce the packet loss while transmitting the two-way from a group member to a cluster head and from the cluster head to the base station.

3. PROPOSED METHOD

Our proposed algorithm has attained both the goals to some extent which is discussed in the previous section. The residual Energy, communication distance between nodes, and the transmission of nodes between sources to destinations, packet loss, and so on are the variables for electing the reliability of the cluster head selection. The residual energy γRe is calculated based on node coordinates Bbij and user defined threshold value ψ

$$\gamma Re = \psi * (\textstyle\sum_{i=1}^{b} H_I) - (\sum_{j=1}^{b} C_J) \quad (1)$$

Where i,j are the coordinating positions of the node deployed in the network, b is the total number of nodes in the area, H is x coordinate of the node, C is the y coordinate of the node. The Cluster hesad probability is chosen based on user interest up-to which criterion value the user want to utilize the node services to act as a cluter head.

Best cost for choosing a node become a head node is calculated using the following formula.

$$\text{BestCost}=\frac{(Dist(T_{hn}))}{((T_{hn})-1)+d} \quad (2)$$

The calculations of Dist and d are shown in the following equations

$$\text{Dist}=\sqrt{\textstyle\sum_{qi,j=1}^{b}\left((H_i-H_j)2+(C_i-C_j)2\right)}$$

Initially the cluster range will be considered as a value.

Based on the calculated distance of the nodes with respect to the mote is checked. whether the distance is less than the range of the cluster ℧C lusterrange in the network is calculated as:

$$\mho_{ClusterRange}=\text{Dist}\leq \mho_{ClusterRange} \quad (3)$$

$$\text{d}=\sqrt{\textstyle\sum_{qi,j=1}^{b}\left((S_{pi}-H_i)2+(S_{qj}-C_j)2\right)}$$

The Re-modified Formula of traditional LEACH protocol Œ is as follows

$$Œ = \max\left((\mho_{EnergyRate}); (\Upsilon_{PPCH} * b_{id})\right) \quad (4)$$

Where $\mho_{\text{EneryRate}}$ and QN etwork are calculated using below equations.

$$\mho_{\text{EneryRate}} = \frac{\sqrt{\sum_{qi,j=1}^{b}(U_i-U_j)^2}}{\max(\sum_{i=1}^{b}\Theta_{max})}$$

The Distance between each node and range ℜ is calculated using the following one of the form of Euclidean distance.

$$\Re = \min\left(\sqrt{\textstyle\sum_{qi,j=1}^{b}\left((K_i-K_j)2,(L_i-L_j)2\right)}\right) \quad (5)$$

The way we choose the head among the nodes in the group of nodes differs in any protocols for predicting the differentiation. The main target of any clustering algorithm is to extend the durability of WSN to save energy and make it last longer. The LEACH algorithm, which is the most basic algorithm, uses a probabilistic and random number to choose the head node. It makes sure that no node does not become a head node twice. The basic idea of the Efficient Cost based Algorithm is to efficiently choose head nodes in the network

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and to reduce the packet loss by increasing the lifetime of the network. We consider LEACH for our comparison as it is the

Algorithm 1: Proposed Efficient Cost based Algorithm

```
   Input: INITIALIZATION:
1  Initialize Cluster Range
2  Ʊ_ClusterRange < −A : AisaHN;
3  Choose Minimum value of a node being a Head Node Probability
4  ϒ_PPCH
5  Calculate Head Node Probability Œ = max((Ʊ_EneryRate);
6  (ϒ_PPCH * Q_Network));
7  clust_idx = zeros(1, N); clusters indices
8  HN_Final = false(1, N); Final Head Node
9  T_hn = false(1, N); Tentative Head Node
10 M_ir = zeros(1, N); Overhead iterations
11 MODIFIED HEAD NODE SELECTION
12 while HN_pv = 1 do
13 |   if T_hn < −A : A is a HN ≠ 0 then
14 |   |   HN_Choosen < −T_hn;
15 |   |   if HN_Choosen = b_id & Œ = 1 then
16 |   |   |   HND(b_id, HN_Final, HN_Cost);
17 |   |   |   HN_Final < −true;
18 |   |   else
19 |   |   |   HND(b_id, T_hn, HN_Cost);
20 |   |   end
21 |   |   if HN_pr = 1 then
22 |   |   |   HND(b_id, HN_Final, HN_Cost);
23 |   |   else
24 |   |   |   HN_Final < −true;
25 |   |   end
26 |   |   if a = Œ then
27 |   |   |   HND(b_id, T_hn, HN_Cost);
28 |   |   else
29 |   |   |   HN_pv < −Œ;
30 |   |   end
31 |   |   Œ < −r;
32 |   end
33 end
```

base for almost all the existing and also advance algorithms. The Pseudocode for the Efficient Cost based Algorithm is shown in the Algorithm 1 is as follows: The Time com- plexity of the Proposed Algorithm is as follows. Initially, it identifies the node identification i.e., whether the node to be treated as a head node to represent the rest of the other nodes in the cluster or a normal regular node to join the group. The Head Node Probability is calculated from equation 3. The time complexity to compute initial head node in the network using the proposed algorithm is O(b mod (2i) + c). The initial head nodes is based on the node having highest residual energy and the nodes having bestCost during each iteration k. The time complexity for initial head node is O(b mod (2i) + c). The time complexity to compute final head node in the network using Proposed Algorithm is O((b mod(2i) + c) ∗ k). The total time complexity to compute the final head node is O((b mod(2i) + c) ∗ k) where k is the number of iterations which depends on the lowest probability value to find the head node in the network and b is the number of nodes From step 11 to step 31.

4. RESULTS

The comparison is made based on Throughput, Lifetime of Sensor nodes, Residual Energy, Packet Loss and End to End Delay these five parameters are used as comparison parameters with the traditional LEACH, one of the previous Improved Leach methods termed as ICH-LEACH and our proposed method in LEACH termed as Efficient Cost based Algorithm. The following graphs Figure. 2 Figure. 3, Figure. 4, Figure.5, Figure. 6, Fig. 7 shows the simulation based comparative analysis of the three approaches of LEACH.

4.0.1. THROUGHPUT

The quantity of packets received with the useful resource of the sink is known as universal performance or throughput. As shown in Figure. 2, our proposed protocol has more throughput as compared to LEACH, ILEACH and PROPOSED METHOD.Figure 2. Performance of the node based on data transmission among nodes to mote.

4.0.2. LIFETIME OF SENSOR NODES

Here, the forwarder node is regarded in each round to be the node with most considerable rest energy. As the Figure. 3 shows. The average network life will be extended when the information is transferred from nodes to sinks through our suggested protocol routing. In other words, in terms of average network life, our proposed plan outperformed existing schemes.Figure 3. Lifetime of the Sensor Nodes in the Network.

4.0.3. RESIDUAL ENERGY

Higher residual energy is essential to extend the network life. From Figure. 4, we can see. This residual average power is above three mentioned protocols.

4.0.4. PACKET LOSS

The packet loss in network is computed for all the three routing protocols and shown in Figure. 5. The packet loss percentage is calculated by dividing the total number of packets lost into the total number of packets sent. This performance metric is used to measure the protocol robustness against various node velocities. A protocol that causes less packet loss than other protocols is considered to be more resilient to the loss of packets.

4.0.5. END TO END DELAY

The delay is calculated utilizing a set of parameters, including distance and hop-count to the node resources, the destination node, data rate, node density, MAC, and routing protocols. The comparative analysis of three protocols in terms of end to end delay is shown in Figure. 6, Figure 5. Packet Loss during communication in WSN. Figure 6. End to End Delay during communication between nodes and mote . This metric gives an indication of the protocol's ability to transport packets to a particular destination. The elevated delivery rate for the packets, therefore, shows improved efficiency of the protocol.

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4.1. Statistical Analysis

The following Figure. 7, Figure. 8, Figure. 9, Figure. 10, Figure. 11, Figure. 12, Figure. 13 shows the average statistical graphs of Throughput, End to End Delay, Packet Loss, Residual Energy, Lifetime of sensor nodes respectively. It is shown from the statistical results that our approach PROPOSED METHOD outperforms when compared with one of the improved Leach (ICHLEACH) and Conventional LEACH. Figure 7. Average of 100 iterations based on the Performance of the node based on data transmission among nodes to mote. Figure 8. Average of 100 iterations based on the End to End Delay during communication between nodes and mote . Figure 9. Average of 100 iterations based on the Packet Loss during communication in WSN. Figure 10. Average of 100 iterations based on the Total Energy Dissipated among the nodes. Figure 11. Average of 100 iterations based on the Lifetime of the Sensor Nodes in the Network. Figure 12. Average of 100 iterations based on the Packet Delivery Ratio to Sink. Figure 13. Average of 100 iterations based on the Packet Delivery Ratio to Head Node.

5. CONCLUSION

Wireless Sensor Networks are playing a prominent role in almost every existing and upcoming tech- nology. One of the obstacles in WSNs is to reduce energy consumption and maximize network life for which routing can be a solution. In this paper for experiment purposes, we considered the leach protocol as it's miles the primary adaptive clustering protocol with self-organizing capability. The most first-rate factor is near; the prevailing and advanced protocol utilized in networking takes the roots from the leach protocol. This pro posed technique is a revision of LEACH's choice of head node selection. The simulation findings show that the reform of the classical LEACH cluster head choice increases network life and provides growing throughput relative to the initial LEACH and ICH-LEACH. This research can be extended with the use of several genetic algorithm selection systems to select the ideal choice of the cluster head.

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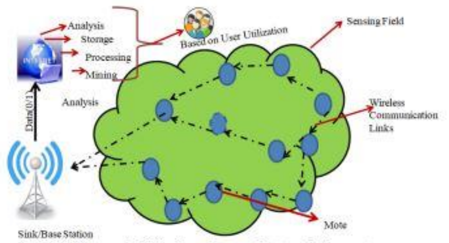

Figure 1. Wireless Sensor Network Layout.

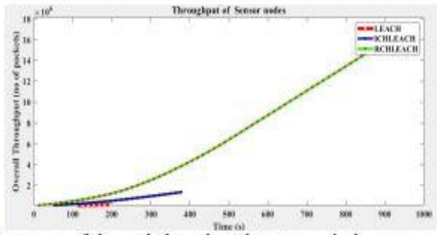

Figure 2. Performance of the node based on data transmission among nodes to mote.

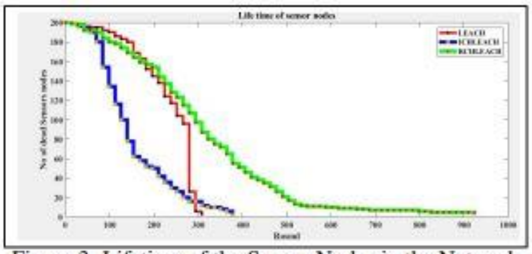

Figure 3. Lifetime of the Sensor Nodes in the Network.

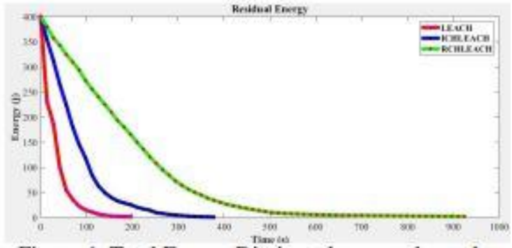

Figure 4. Total Energy Dissipated among the nodes.

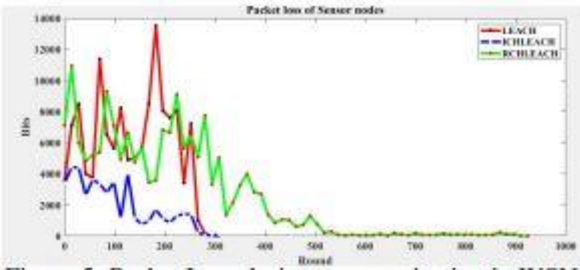

Figure 5. Packet Loss during communication in WSN.

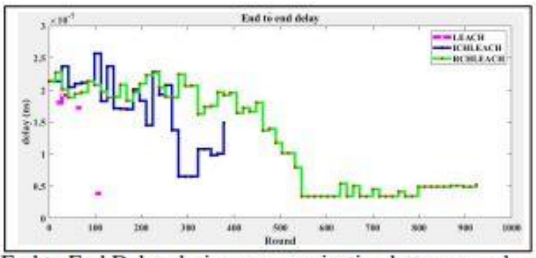

Figure 6. End to End Delay during communication between nodes and mote

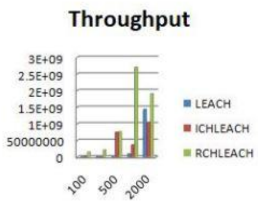

Figure 7. Average of 100 iterations based on the Performance of the node based on data transmission among nodes to mote.

Figure 8. Average of 100 iterations based on the End to End Delay during communication between nodes and mote .

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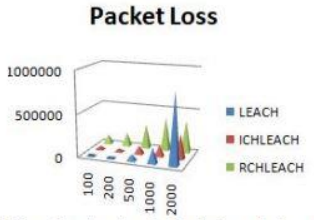

Figure 9. Average of 100 iterations based on the Packet Loss during communication in WSN.

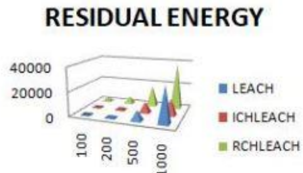

Figure 10. Average of 100 iterations based on the Total Energy Dissipated among the nodes.

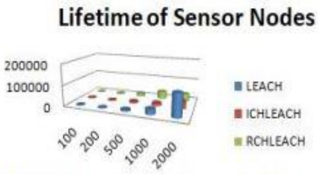

Figure 11. Average of 100 iterations based on the Lifetime of the Sensor Nodes in the Networl

Figure 12. Average of 100 iterations based on the Packet Delivery Ratio to Sink.

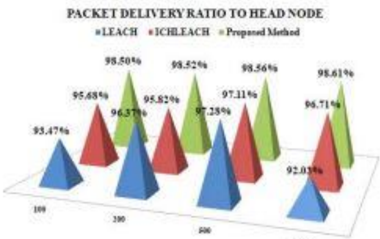

Figure 13. Average of 100 iterations based on the Packet Delivery Ratio to Head Node.