Minimizing Energy Consumption for Multi hop [MM-LEACH] Cluster Based Routing Protocols in Wireless Sensor Networks

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***Abstract*—Wireless Sensor Network [WSN] is a without wired network of many autonomous small size sensor nodes that are self organized and use a sensor to monitor the physical conditions of the real world. The development of wireless sensor network was motivated by military applications for the battlefield and surveillance, but today such networks are used in many industrial and consumer applications. [3].The present research work focused on Cluster based routing protocols for TEEN, HEED and Proposed Modified Multi-hop LEACH. The Performance of the proposed methodology is evaluated using the parameters such as Packet Delivery Ratio, Delay, Throughput, Packet loss, and Node left Energy. The Result shows that the Proposed Approach improve the Performance of Wireless Sensor Network powerfully.**

Keywords- Cluster Head, LEACH, HEED, TEEN, NS2, Energy Efficient

I. INTRODUCTION

Wireless Sensor Networks [WSNs] are collection of sensor nodes to Wireless Radio Link. Wireless Sensor Nodes are used to monitor physical or real world environmental conditions such as Forest fire Detection, Sounds, and Smart Phone Applications. [1]. Standard routing protocols for WSN are not enough optimal in terms of energy efficiency and load balancing. Clustering is sample of layered protocols where the network is composed of several clusters of sensor nodes. Each cluster has a leader node which is also called as Cluster Head (CH). CH takes data from all the nodes in its cluster. CH aggregate all the data received from cluster members and then send that data to the base station. The transmission between cluster members and cluster head is said to be intra cluster communication, where as the transmission between cluster head and sink is known as inter cluster communication. Clustering is reducing the routing overhead and makes the network more stable. [2]

II. LITERATURE REVIEW

Heinzelman et al [4] described a hierarchical clustering algorithm LEACH for sensor networks. The LEACH operation is divided into rounds, during each round different set of nodes are Cluster Heads (CHs).Nodes that are used as CH cannot be used as head in the future rounds. The Authors concluded algorithm Energy consumption will distribute almost uniformly among all nodes and the non-head nodes are turned off as much as possible. *Deng zhixian et al [5]* proposed a work that covers with three layered routing protocols (TL-LEACH) for WSN. The authors compared the simulation result which shows that the TL-LEACH protocol is improving WSN lifetime.

Jian wan et al [6] presented a review of recent routing protocols in wireless sensor networks, and classify them into three categories based on the network structure in Wireless Sensor networks. The study highlights the merits and demerits of each routing algorithm. Paper concludes with issues and challenges of routing algorithms. *Tabibzadesh et al [7]* discussed a hybrid routing protocol for prolonged network lifetime in large scale wireless sensor network. The author improves the low-energy adaptive clustering hierarchy to significantly reduced the energy consumption and increase the lifetime of a sensor network. The LEACH technique improves the energy efficiency of a sensor network by selecting a CHs. *Boyinbode et al [24]* presented a survey of clustering algorithms for Wireless Sensor Networks. The main challenges of clustering algorithms were discussed and the popular clustering algorithms for WSNs such as LEACH, TL-LEACH, EECS, HEED, EEUC, *etc*. are summarized in the survey. Paper finally compared the clustering algorithms based on metrics such as residual energy, delay and hop distance.

III. ROUTING PROTOCOLS IN WSN

A. HEED – (Hybrid Energy Efficient Distributed Clustering)

Hybrid Energy Efficient Distributed Clustering is a multi-hop clustering algorithm for wireless sensor networks. Selecting Cluster Heads depends upon two vital factors. First one is intra-cluster communication and another one is Residual Energy.

Residual & Intra-cluster Communication:

HEED is important to identify the range of a node in terms of its power level. When the given node has multiple decreases, the Transmission power levels also decreases. The intra-cluster communication cost is measured using the Average Minimum Reach ability Power. The Average Minimum Reach ability Power of nodes, then become a measure of the expected intra-cluster communication and energy if this node is elevated to Cluster Head. [35]

ALGORITHM

Etot = Total Energy

N=Number of Sensor Nodes

a= Means Time

E tot = N*(1-m) * Eo +N*M*Eo*(1+a)

=N*Eo*(1+am)

Initial Energy = (1+a)&(1-m)*N , Eo

=N*(1m)*Eo+N*m*(1mo)*Eo*(1a)+N*m*mo*Eo*(1+ β)

=N*Eo*(1+m)*(a+mo*β) (1+m)*(a+mo)* β

$= \sum_{i=1}^{n} Eo * (1 + ai)$

$=Eo*(N + \sum_{i=1}^{n} ai)$

B. TEEN – (Threshold Sensitive Energy Efficient Sensor Network)

TEEN is an event-driven protocol, which is operating based on LEACH energy based protocol. It transmits data based on hard threshold and soft threshold values. If the thresholds are not reached, then nodes will never communicate.

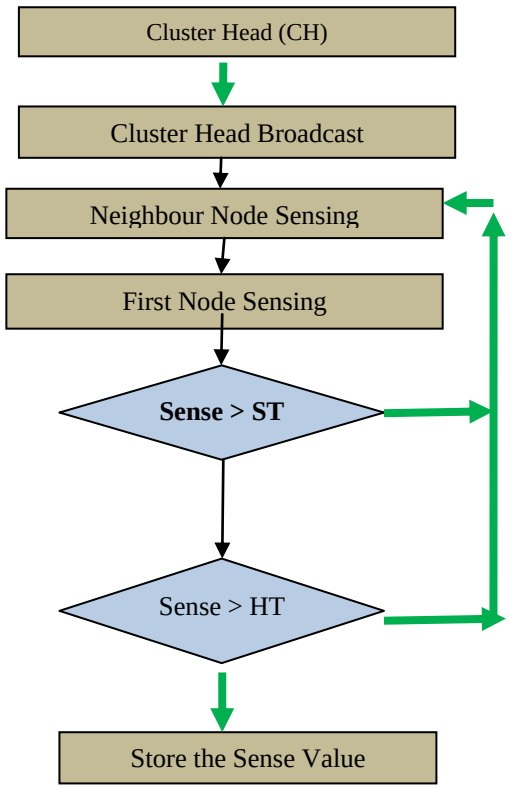


Figure 3.1: TEEN Flow

Algorithm

Step 1: Initial level of Network all nodes are having same Energy

Step 2: If send attribute value is never reached to thresholds
And Energy Level Status message indicate
Threshold Sensed value stored.

Step 3: Step 1 & Step 2 is repeated for Energy Level.

Step 4: when the nodes energy level is improved up to 5 %.

Step 5: The Node will send its energy status message to the Base Station.

C. LEACH – Low Energy Adaptive Clustering Hierarchy

LEACH is one of the Hierarchical routing protocols for sensor network. Cluster Head is straight communicating with Base Station (BS) it does not consider the distance. In LEACH protocol the total numbers of nodes are divided into many small groups or cluster for equal distribution of power consumption inside the network.

The LEACH incorporates randomized rotation of the high energy cluster head position. In this way, the energy load associated with power in a cluster head which is evenly distributed among the nodes. The TDMA Schedule for data transfer prevents intra-cluster collisions rounds. [36]

D. Multi-Hop LEACH

Multi-Hop LEACH is high transmission power which is required to transfer the data from CH to the base station. If the base station is far away from the CH, the message will got loss. The LEACH assume that all CH are at single hop distance from the base station. Multi-hop LEACH is an enhancement of LEACH, which reduces the energy consumption of the CH in large WSNs [31,32 and 33]. During the steady-state phase send their data to the CH. The CH aggregate and transmit that data towards the base station directly or through other CH. The two types of Multi-Hop LEACH communications are intra-cluster and inter-cluster. The random selection of CH is the same as in LEACH. This helps to save energy of that CH which belong to the cluster nodes with larger distance from the base station as higher transmission energy cost is required for communication with larger distances. [37]

3.1 PROPOSED WORK

Modified LEACH Procedure

The proposed Modified Multi hop-LEACH protocol opts for dynamic clustering. The working procedure of Modified-LEACH is very simple. It is a round based protocol like LEACH, and each round consists of two phases: set-up phase and steady-state phase. Unlike LEACH, proposed protocol introduces two additional concepts which are ***logical formations of Circle clusters*** and a combined group of ***circle clusters to form regions***.

Circle Clusters Formation

The entire network is divided into fixed circle formation cluster. These Clusters are heterogeneous; that is, each cluster may have a different number of nodes. The subdivision of sensor area starts from the centre and the area covered by each cluster is same.

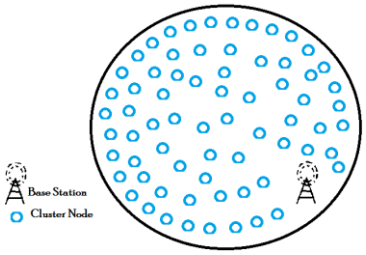


Figure 3.2: Circle Formation

Cluster Regions

The group of Circle clusters forms a zone. Each zone must contain at least one advanced cluster. The dark lines in Figure 3.4 show the boundary of the regions. The CH from another region area send their information to the cluster head of the advanced cluster which forwards it to the base station. The cluster head communicate with only those cluster heads that belong to its region

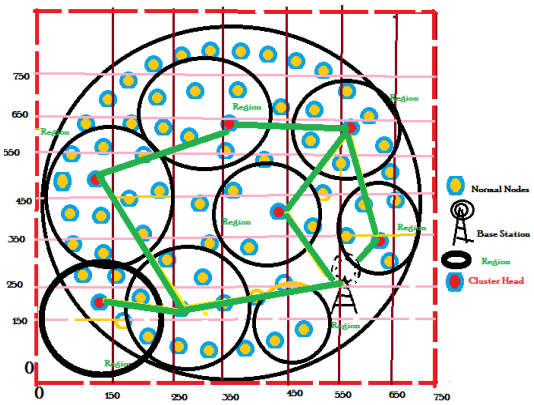


Figure 3.3: Cluster Regions

Proposed MM-LEACH Algorithm

Step 1: *Start the process*
Step 2: *Modified the Multi hop-LEACH*
Step 3: *Nodes Transmit and the Energy level to Base Station*
Step 4: *Closest Distance to Cluster Head*
Step 5: *Final Selection Cluster Head*
Step 6: *Select Cluster Head*
Step 7: *Send Request to Selected Cluster Head*
Step 8: *Received TDMA Slot*
Step 9: *Send data to Cluster Head for Time period*
Step 10: *Receive Data from members Nodes*
Step 11: *CH Data Receive from all Nodes*
Step 12: *Multi hop – Cluster Head send data to Base Station*
Step 13: *Stop the process*

IV. RESULTS AND ANALYSIS

Table 4.1. Performance Evaluation

Parameters	Values
No.of.Nodes	100,250,350,450
Area	2500*2500
Traffic	CBR
Simulation Duration	100 Millisecond
Packet Transmission Rate	512/1024
Initial Energy /J	5
Packet Size Byte	500 Bytes

Performance of the proposed work is evaluated with the following parameters:

- Packet Delivery Ratio
- Delay
- Throughput
- Energy Consumption - Node Left Energy
- Packet Loss
- Generated Packets
- Received Packets

A. Packet Delivery Ratio (PDR):

The Ratio of the data packets successfully received at the destination and total number of data packets generated at source.

PDR = (Number of Packets Received / Number of Packets Sent) * 100 ---------- (4.1)

B. End to End Delay:

This Metric give delay from packet transmission from source agent to packet reception to destination.

End-to-End Delay = (Time packet received -time at packet sent) --------- (4.2)

C. Throughput

To Evaluate the performance of throughput the number of packets received by the base Station are compared with the number of packets sent by Nodes in each round

Throughput = ((total_pkt_recvd/1000)*512)/1024.

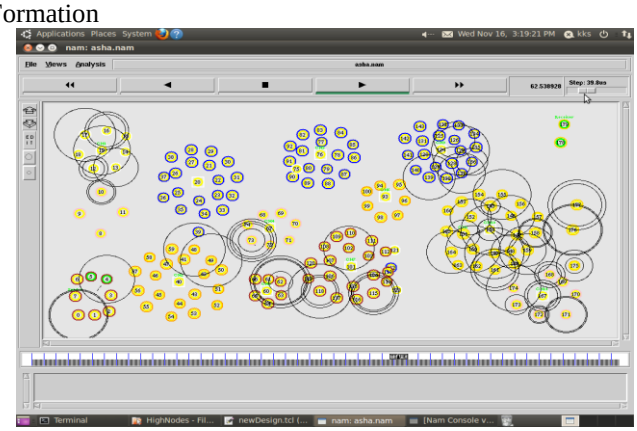
---------- (4,3)

D. Residual Energy

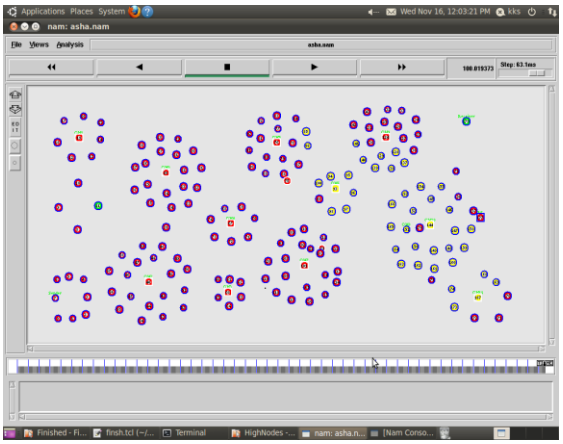
The Residual battery Energy of the network is considered to analyze the Energy consumption of nodes in each round. Residual Energy ensures graceful degradation of the network life.

Total Energy = (total_energy_consumed/ (100*10000.000000))*100.000000) ---------- (4.4)

Energy Reducing –Energy Level II- Circle Cluster Formation



Energy III – Red Color Cluster



Energy Efficient-[Modified Multi hop LEACH] and Existing Energy Routing Protocols

TABLE 4.2(a): PDR and Delay Values

Nodes	Routing	PDR(%)	Delay(Ms)
Total number of Sensor **180**	**Proposed MM-LEACH**	**88.3134**	**11.6866**
	HEED	72.7248	27.2752
	TEEN	80.3806	19.6194

Table 4: 2(b): Parameters & Values

Routing	Throughput	Packet loss	Generated Packets	Received Packets
Proposed MM-LEACH	**164.69**	**176**	**1506**	**1330**
HEED	170.45	300	8757	8457
TEEN	229.51	441	5341	4900

Packet Delivery Ratio

The following figure 4.1 shows that proposed MM-LEACH has high level of packet delivery ratio than the existing routing protocol.

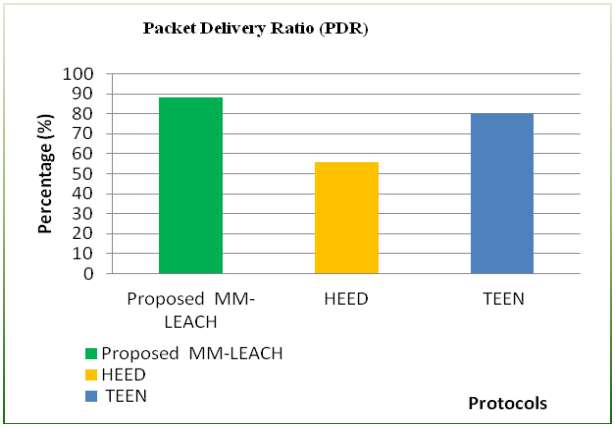


Figure 4.1: Packet Delivery Ratio with MM-LEACH

Delay

The following figure 4.2 shows the delay for three routing protocols. It is observed from the experiment that among the three protocols, the Proposed MM-LEACH shows minimum delay when compared to existing protocols such as HEED and TEEN.

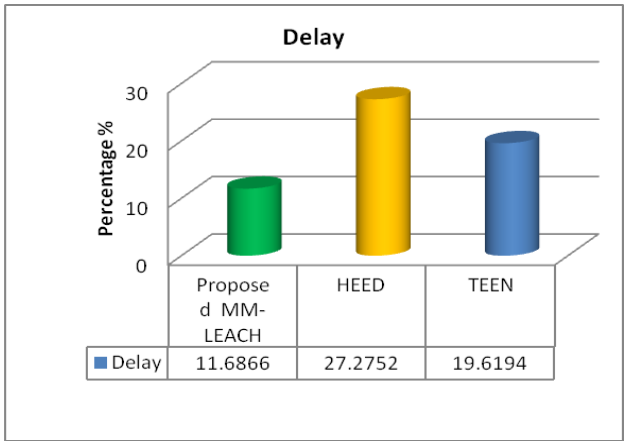


Figure 4.2: Delay

Packet Loss

The following figure 4.3 shows the Packet Loss for Existing and Proposed Routing Protocols.

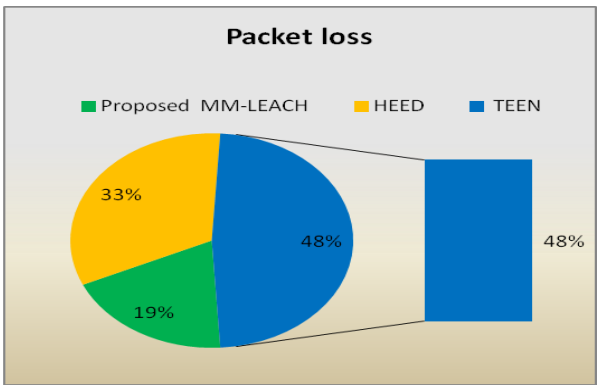


Figure. 4.3: Packet Loss

Energy Routing - MM- LEACH, TEEN and HEED

The following figure 4.4 demonstrates the Node Left Energy Comparison of the proposed MM-LEACH with the TEEN and HEED existing protocols.

Figure 4.4: Node Left Energy Consumption for Proposed and Existing Protocols

V. CONCLUSION

This paper pinpointed the Energy Consumption for cluster based routing protocols for wireless sensor networks using version NS2.34 Network Simulator. The Proposed Clustering Protocol for Modified Multi hop LEACH with MAODV protocol technique has extended the network life time and energy consumption for each node. The Network Simulator version of 2.34 and 2.35 have been used in this experiment. The Simulation result shows that the proposed protocol MM-LEACH gives better result in terms of high level of Packet Delivery Ratio, low- level of Delay and reduce the Node Left Energy when compared to TEEN and HEED.

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