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Modified Energy Efficient Multi-Hop LEACH Protocol for Wireless Sensors Networks

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Abstract: **Wireless Sensor Network is the emerging technology in the sensing area where the monitoring of remote location becomes feasible when this network is established by deploying of sensor nodes randomly in an uniform manner. Communication cost is one of the major factors which decide the running time of the sensor network. Routing aims to achieve minimum communication cost. In this paper the approach of energy balancing is adopted by creating a hierarchy inside the cluster, with the introduction of Vice Cluster Head (VCH) along with the Main Cluster Head (MCH). The role of VCH is to collect data from all the nodes and performing data aggregation over the collected data, then MCH does the task of forwarding the data to the MCH of next cluster and finally to the Base Station. Simulation results show that for the area of (100 X 100) with 200 sensor nodes the enhancement in the FND (first node dead) is 98% and it is 25% in case of (500 X 500) area. Similarly AND (all node dead) for the former and later area is much enhanced as compare to M-LEACH protocol.**

Keywords: VCH (Vice cluster head); MCH (Main cluster head); FND (First Node dead); AND (All nodes dead); M-LEACH.

I. INTRODUCTION

Wireless sensor network is a network consisting of a large number of tiny nodes which are deployed from a helicopter over a wide geographical area in order to collect the local information and make a global decision about the physical environment. These nodes are very small in size, inexpensive, self powered devices. Each sensor node is capable of detecting, processing and transmitting the information to other connected devices. The realization of these sensor networks applications requires wireless ad hoc Networking Techniques. This is because of some differences between ad hoc and wireless sensor networks [1-2].

a) The number of sensor nodes in a sensor network is much higher than the nodes in an ad hoc network.
b) Ad hoc networks are based on point to point communication and sensor networks are based on broadcast communication.
c) Sensor nodes have a limited power supply, computational capabilities and memory.
d) The sensor nodes are very prone to failures as they have very low power.
e) Sensor nodes are densely deployed.
f) The topology of a sensor network changes in a frequent manner.
g) Sensor nodes are not having any global identification because of the large amount of overhead [3-4].

There are various routing strategies that aim to enhance the network lifetime [5-6]. In this paper the work on hierarchical routing is considered.

A. Low Energy Adaptive Cluster Hierarchy (LEACH)

LEACH is a clustering based routing protocol which reduces energy consumption in wireless sensor networks. The operation of LEACH is divided into two phases, the set-up phase and steady-state phase. In the set-up phase, cluster heads are elected in the clusters. These selected cluster heads advertise to all sensor nodes that they are the new cluster heads in the network. After receiving advertisement, they join the cluster based on the signal strength. Then cluster heads assign the time to the member nodes on which they can send data to them based on a TDMA.

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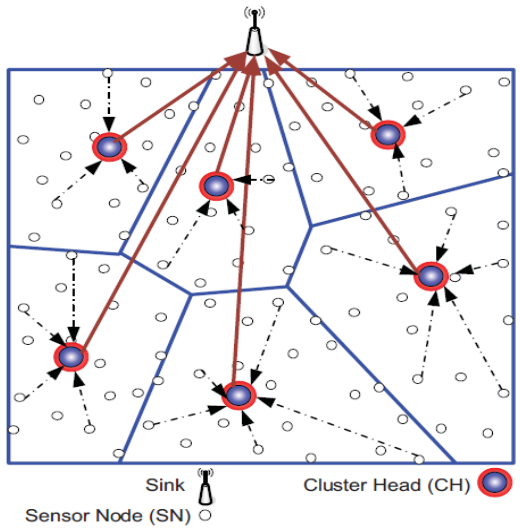

Figure 1 LEACH Protocol [7]

II. RELATED WORK

Yang et al. [8] proposed an energy efficient clustering algorithm EECA for wireless sensor network. It is having two step cluster head selection mechanism. The node with higher residual energy becomes anchor cluster-head and candidate CH compete to be the cluster-head using delayed broadcast mechanism. Tashtarian.et al. [9] proposed a new hierarchical clustering algorithm EELTC (Energy efficient level based time based clustering algorithm for wireless sensor networks). Proposed algorithm have improvement over Leach and EEUC as it has ability of creating clusters of unequal size with low controlling overheads. Rajni Chauhan et al. in [10] proposed an information similarity based clustering algorithm where transmission of the data to the sink is done using the least spanning tree algorithm. This approach firstly uses improved LEACH algorithm for election of cluster heads and then cluster formation under the elected cluster heads is done depending upon the non-cluster head node's maximum information similarity with the cluster head nodes. Yektaparast et al in [11] have proposed an algorithm called cell-LEACH which divides the network into several clusters. Every cluster is divided into 7 subsections called cell and each cell having its cell head on the basis of residual energy. In the network usually nearby sensors have common data which are overlapped. Bandwidth is wasted to send same data to a cell head. Jia Xu et al. in [12] presented a revised cluster routing algorithm named E-LEACH to enhance the hierarchical routing protocol LEACH. In the E-LEACH algorithm, the original way of the selection of the cluster heads is random and the round time for the selection is fixed. In the E-LEACH algorithm, author considers the remnant power of the sensor nodes in order to balance network loads and changes the round time depends on the optimal cluster size. The simulation results show that proposed protocol increases network lifetime at least by 40% when compared with the LEACH algorithm. Ashlyn Antoo et al. in [13] proposed an energy efficient routing protocol EEM-LEACH that discovers a multi-hop path with minimum communication cost from each node to the base station. If the communication cost for direct data transfer is minimum, nodes close to the base station can send data directly to the base station thereby preventing them from dying soon.

III. PROPOSED WORK

Many routing protocols have been proposed so far to maximize the network lifetime and decrease the consumption energy. One of the first Clustered based routing is LEACH. It organises the network into number of clusters and each cluster has a CH (cluster head).All the sensor nodes in a cluster sends it data to their CH and the CH aggregates their data and then send it to the BS(Base Station).This protocol suffers from the overhead of clustering in each round. Moreover this protocol adopts the single hop communication along with the random selection of cluster head which made it energy inefficient.

In a cluster, a cluster head not only aggregates the data but also forwards the data to the Base Station or to the another cluster head while forwarding to the Base Station. In order to make the energy consumption balanced in the network, a further hierarchy can be created in the form of multi level cluster heads so that load balancing can be maintained in the network.

To achieve load balancing and maximizing the network lifetime, two levels of cluster heads are created, Main Cluster Head (MCH) and Vice Cluster Head (VCH) in each cluster. VCH collects the data from all nodes in a cluster and then after data aggregation it forwards the data to the MCH and thereafter the data is being forwarded to the next MCH or directly to the Base Station depending upon whosoever is nearest.

This is expected to enhance the network lifetime and making the network much more load balanced.

IV. RESULT & SIMULATION

The proposed technique is being simulated in MATLAB. Developing another cluster head in a cluster not only brings load balancing in the network but also enhances the network lifetime by much number of rounds.

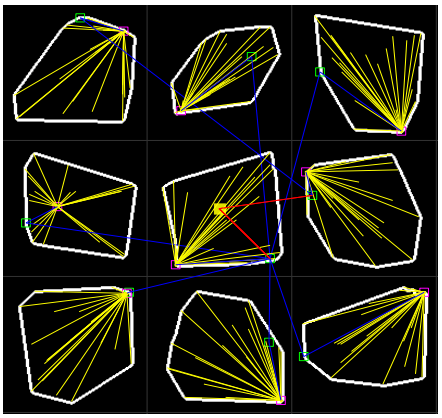

Figure 2 Data transmission in the network with 200 nodes

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It can be seen in Figure 2 that clusters are formed in the network and data transmission takes place. Blue color lines are for the inter cluster communication, within the cluster yellow color lines are used to collect the data from the nodes and thereby forwarding it to the VCH.

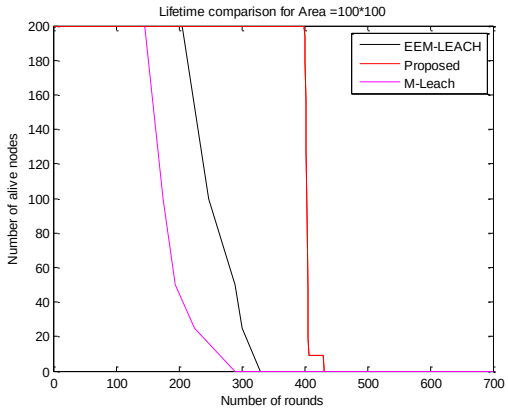

Figure 3 Lifetime comparison of proposed technique with EEM-LEACH and M-LEACH

Figure 3 validates the proposed technique with the existing recent techniques of EEM-LEACH and M-LEACH. The proposed technique covers 408 number of rounds before the first node dies which was only 205 in case of EEM-LEACH and 146 in case of LEACH. So, FND has increased by almost 98%. Similarly All Node Dead (AND) occurs at 430 rounds which was 330 in case of EEM-LEACH accounting the enhancement by 25%.

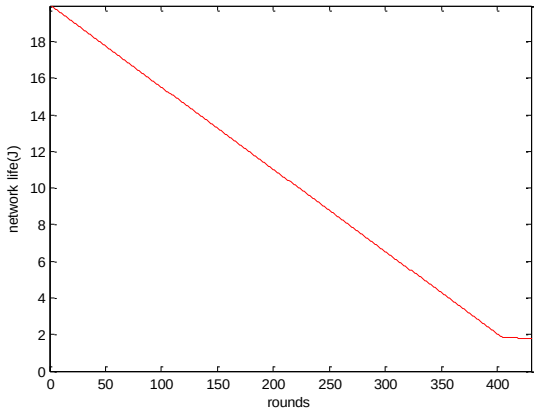

Figure 4 Network Lifetime of the proposed technique

The network lifetime graph for the proposed technique can be represented by the graph shown in Figure 4.

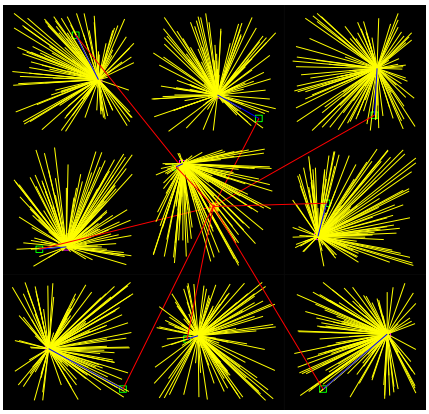

Figure 5 Data Transmission Scenario of Network with 1000 nodes

When the application demands more number of sensor nodes, like 1000 for the next case, the simulation gives the scenario like shown in Figure 5.

With the increased area there is still improvement in the network lifetime with the proposed technique. As presented in the graph of Figure 6 the network covers much number of rounds around 210 which was 168 in the case of EEM-LEACH making it 25 % improvement. AND occurs at 1300 rounds which was 1200 in case of EEM-LEACH. This results in 8% enhancement in the number of rounds for the AND.

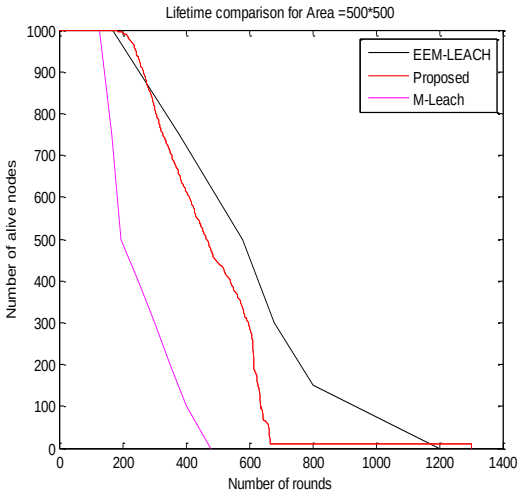

Figure 6 Lifetime comparison of proposed technique with EEM-LEACH and LEACH with areas 500X500 and 1000 nodes

V. CONCLUSION

The proposed protocol outperform the EEM-LEACH when simulated in the area of 100*100 with 200 sensor nodes. The percentage improvement in the case of FND is almost 98% which is really significant. In the case of 500*500 area, the FND is improved by 25%. So it directly signifies that network lifetime is enhanced in both the cases. The lifetime graph from the second case posses the load balancing as it is much more steeper as compare to EEM-LEACH.

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