

Low Energy Adaptive Clustering Hierarchy Variance in Wireless Sensor Network (LEACH)

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Abstract : In Wireless Sensor Networks , sensor node play the most prominent role .These sensor node are mainly un-chargeable so energy efficient routing protocol is the major concern in the field of wireless sensor networks. Mainly sensor node collects data and transmit it to the base station. So most of the energy consumed in the communication process between sensor node and the base station .Low Energy Adaptive Clustering Hierarchy(LEACH) protocol is the first hierarchical cluster based routing protocol successfully used in the wireless sensor networks . In this paper various Low Energy Adaptive Clustering Hierarchy(LEACH)Protocol is used to implement routing protocol which shows energy efficiency and also focus on position of the base station as well as the equal area of each cluster in the network.

Keywords : LEACH , Hierarchical Cluster Based Routing , Wireless Sensor Network.

I. INTRODUCTION

Wireless Sensor Networks offer unique benefits and versatility in terms of low-power and low-cost rapid deployment for applications which do not require human supervision. Nodes in WSNs are usually battery operated sensing devices with limited energy resources. Thus energy efficiency is one of the most important issues and designing power-efficient protocols is critical for prolonging the lifetime. WSNs have been considered for certain applications with limited power, reliable data transfer, short range communication, and reasonably low cost such sensing applications [1] .Many energy-efficient routing protocols are designed based on clustering structure. The clustering technique can also used to perform data aggregation, which combines data from source nodes into set of meaningful information [2].Many routing protocols have originated since the development of this field in which LEACH [3], DEEC [2], TEEN, SEP and PEGASIS are some of them. LEACH, of them, proved to be more promising and became a bench-mark in the designing of other protocols like A-sLEACH [4], Enhanced LEACH [5], LEACH-CC [6], Ad-LEACH [7] and MODLEACH [8] are some of them.

In this paper, we have considered LEACH protocol as the reference to implement the energy efficient algorithm.

II. DESCRIPTION OF VARIOUS LEACH PROTOCOL

2.1 LEACH protocol

Hierarchy Protocol for WSNs LEACH [3] is known as a distributed hierarchical protocol. It provides the aggregation for data in wireless sensor networks by selection of Cluster heads in random manner. This protocol first judges the strength of the received message or signal and then formation of cluster takes place. In this Cluster Head nodes are taken as routers to reach the sink node. Every non- Cluster Head node sends its data to their CHs. Before sensing received information to sink, CHs aggregate the information.

In LEACH protocol, all the nodes are grouped into the clusters, and in each cluster one of the nodes is assigned as a cluster Head (CH). CH collects the data from the surrounding nodes and passes it to the base station. Usually, initial assignment of CH is random and the role of CH is rotated for every fixed duration so that each node will act as a CH at least once in its life span. LEACH algorithm has two phases.

Each Leach operation round consists of Set-up phase and Steady state phase .

The Set-up phase is used for Cluster Head Selection and Cluster Formation. The Steady state Phase used for data transmission.

2.2 LEACH-C protocol

LEACH-C [3] is a centralized clustering algorithm in which sink node has the power to select the clusters based upon the annealing algorithm to find k optimal number of clusters. Here the Base Station selects the cluster heads for a particular round. The protocol guarantees an optimum number of clusters but it has a drawback that each sensor node provides information about its current position and remaining energy to the sink node during the set up phase which results in an extra wastage or overhead in the network.

2.3 LEACH-B Protocol

LEACH-B [6] is an improvement in Leach protocol for wireless sensor network. In order to minimize the energy consumption and to prolong the life span of the sensor network, the protocol needs to ensure that the partition of cluster should be balance and uniform. To achieve this goal, the number of CHs needs to be dominated, and the network needs an optimal CHs amount. At each round, after firstselection of cluster head according to LEACH protocol, a second selection is introduced to modify the number of cluster head in consideration of node's residual energy.

III PROPOSED ALGORITHM TO IMPLEMENT LEACH PROTOCOL

Our proposed hierarchical routing protocol is based on the principle of clustering algorithm. With data transmission at the network layer being the core area of interest, we have modified the LEACH protocol in terms of hierarchical dataBS. In the proposed model, clusters are formed geographically. Geographical formation of cluster sizes is based on equal segmentation of area space, depending on the case being considered. Apart from the one cluster formation which makes use of the entire sensors area space, other formation such as two clusters or three clusters formation involves equal separation of area space. The two & three clusters formation are known as first level and four & five cluster formation known as second level hierarchy respectively.

The CH election phase proceeds after the cluster formation phase. The selection of CH(s) within each cluster formed is carried out by electing a node that having highest residual energy and minimum distance (to BS or to the next hop CH nearer to the BS) for a particular transmission round. Due to draining activities being constraint on a cluster head during data aggregation and transfer phase, the cluster head is rotated among the sensor nodes of each cluster at every transmission round. A completely new residual energy is carried out at the beginning of every transmission round to elect a new CH for the cluster and thereby energy wastage is being reduce to its minimum, and utilization of each nodes energy is being maximized to ensure a prolong network lifetime.

Proposed hierarchical routing technique and the cluster head selection of the protocol algorithm.

Step 1 :The initial energy or residual energy $E_{in}(n)$ of node is measured.

Step 2: The maximum energy after the subsequent transmission round for each node is estimated using the formula: $\max(E_{in}(n) - E_{amp} * k * d^2)$.

Step 3: Also the distance $d(n)$ from each node to the base station or to the corresponding higher level cluster head is measured.

Step 4: On behalf of 2nd and 3rd step, the CH selection is carried out, the next cluster head selection will take place after the current round is completed.

IV. SIMULATION SETUP AND SCENARIOS

In this simulation, a total number of 250 nodes were randomly deployed within a space region on 300 m x 300 m. The simulated environment of the 250 nodes we deployed. The coordinates of X and Y are measured in meters.

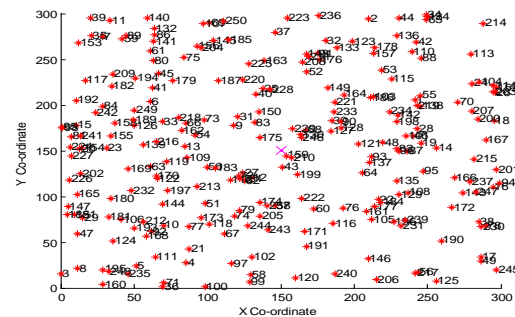


Fig 1:

Non Hierarchical formations of 250 nodes deployed randomly in a geographical location of X and Y coordinates measured in meters

With the nodes being deployed, some assumptions were made concerning the node features and these are as follows:

- All nodes are homogeneous in nature;
- All nodes starts with the same initial energy;
- The base station is situated at the centre of the area space;
- Clusters and nodes are static;
- Normal nodes transmit directly to their respective cluster heads within a particular cluster;
- Cluster heads use multi-hop routing to relay data to the data sink;

The parameters used in the simulation are listed in Table 1

TABLE 1

Parameter	Quantity
Total number of nodes, (N)	250
Initial energy of each node (Joules), ($E_{in}(n)$)	200
Packet size (k) in bytes	100
Energy circuitry cost at transmission and reception of a bit of data (E_{elec}) in nano Joule per byte	50
Amplifier coefficient (E_{amp}) in pico Joule per bit	100
Coordinate of base station	(150,150)

The sensor nodes in the network are formed into clusters of different sizes of one, two, three, four and five. One indicates a non-hierarchy formation of cluster, two & three indicate two level of hierarchy and four & five indicate three level of hierarchy for data transmission. Figure 1 indicates the non-hierarchical structure of our routing technique. Likewise, Figure 2,3, 4 and 5 shows the simulation result of the cluster formation in the proposed technique.

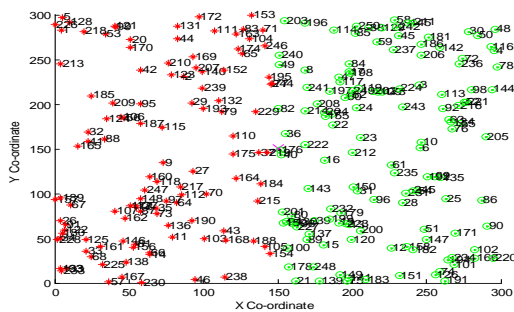


Fig2: First level hierarchical formation with differentiated colours indicating difference in two clusters.

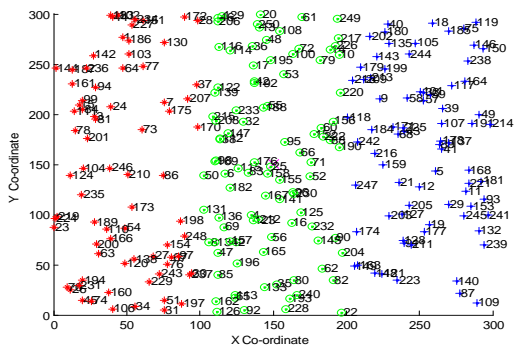


Fig 3: First level hierarchical formation with differentiated colours indicating difference in three clusters.

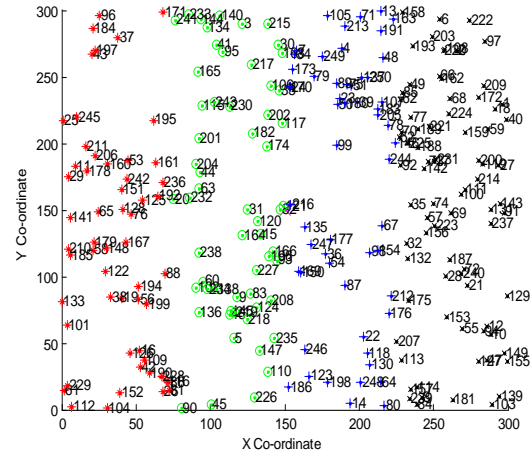


Fig 4: Second level hierarchical formation with differentiated colours indicating difference in four clusters

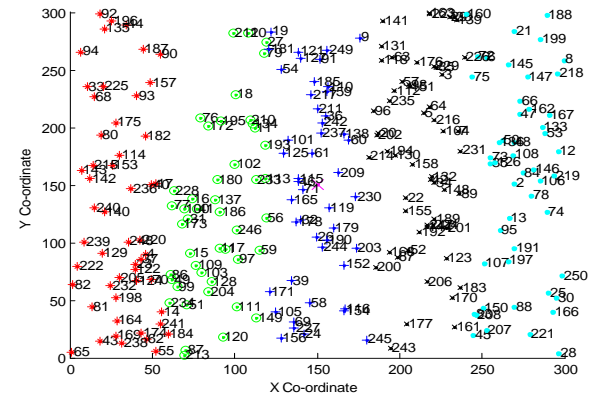


Fig5: Second level hierarchical formation with differentiated colours indicating difference in five clusters.

The cluster head(s) of m -th cluster formed aggregates the data received from other sensor nodes with its own data and transmits it to the next hop cluster head closer to the base station or to the base station depending on the cluster formation and the shortest distance between the cluster head and the BS. At every transmission or reception made, energy reduction occurs for every node, thereby cluster head rotation was utilized to help prolong the lifetime of the WSN.

V.SIMULATION RESULTS

We observed that the first node dies faster in the non-hierarchical formation since all nodes tend to send

captured data via one randomly selected cluster head per round to the base station. The constrained load on the elected cluster heads during the 400 round of simulation drastically reduced the CHs' energy over a short period. Unlike the non-hierarchical formation, the proposed hierarchical routing technique in which cluster hierarchy takes precedence in cluster formation and evaluate the residual energy for selection of cluster head, we observed that this technique offers a better life span for individual nodes and even the entire network. With optimization in energy usage, we observed that the lifetime in our proposed hierarchical technique extends to an impressive range when compared to non-hierarchical technique. The impressive increment in life span of the network from our proposed hierarchical technique is seen as a result of efficient routing decision and optimization of energy in cluster head selection of each cluster formed. Since the sensor nodes in each cluster send data to the cluster head within its cluster range and then the aggregated data is sent to the cluster head closer to the base station, which further aggregates data of its own cluster and that of the incoming data, from cluster head whose distance is farther to the BS, before sending the data to the base station. Thus, a considerable amount of energy is saved which indicate improved network lifetime in the case of first level hierarchy when compared to non hierarchical technique. From Fig. 6, we observed that the Non-hierarchical technique had an estimated lifetime of 20 rounds, First level had an estimated lifetime of 30 rounds and Second level had an estimated lifetime of 40 rounds. The progressive increase of network lifetime employed by our proposed technique offers efficient energy usage for each node in the entire network

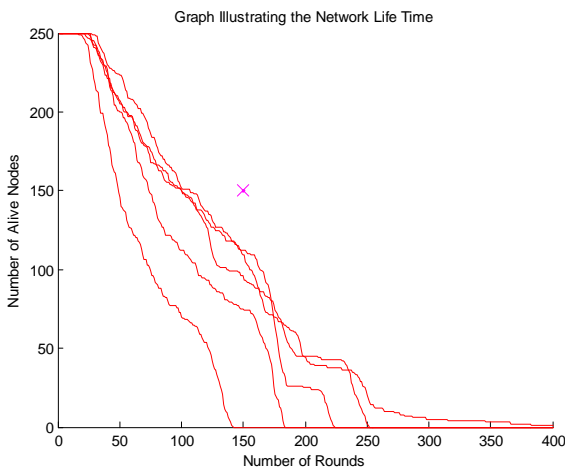


Fig 6 : Network lifetime graph (number of alive nodes for a particular round of simulation) in non-hierarchical, one level & two level hierarchical technique

The progressive increase of network lifetime employed by our proposed technique offers efficient energy usage for each node in the entire network. Also, it was observed that the Non-hierarchical technique network completely stopped functioning at an earlier simulation rounds compared to our proposed technique. We saw that the functional capacity for Non-hierarchical network lasted till an estimated value of 140 rounds of simulation, while the functional capacity of the First level Hierarchical approach and Second level hierarchical approach lasted till an estimated value of 230 rounds and 400 rounds of simulation as shown in fig. 6.

Our proposed protocol is also proved by evaluating the residual energy in each node for particular rounds of simulation. The results in Figure 7 to 11 shows that the mean residual energy value of all the sensor node of our proposed method is higher.

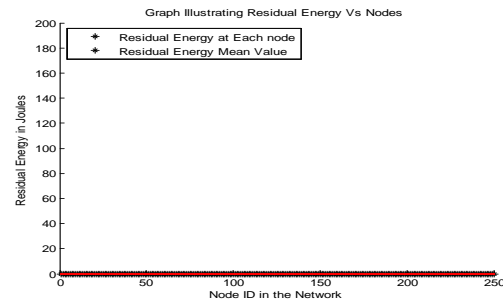


Fig 7: Nodes energy residue in non hierarchical technique after 400 round simulations.

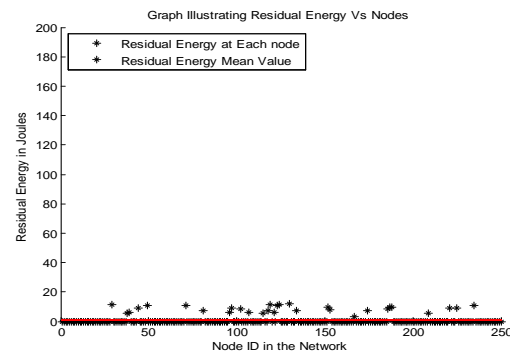


Fig 8: Nodes energy residue in first level hierarchical technique for two cluster after 400 round simulation

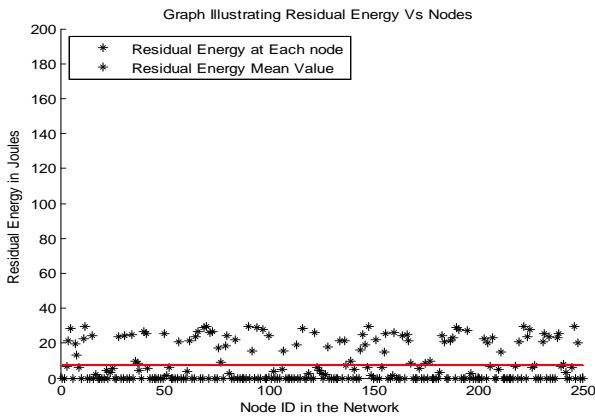


Fig 9: Nodes energy residue in first level hierarchical technique for three cluster after 400 round simulation

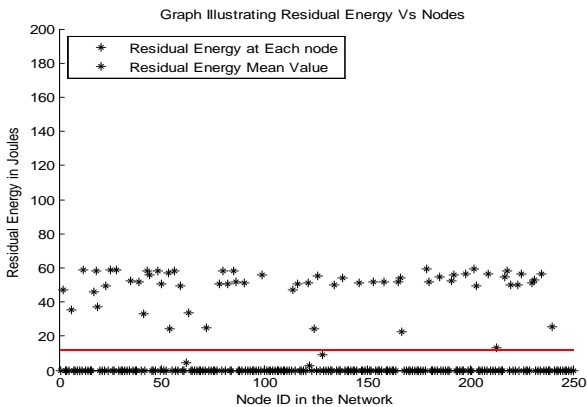


Fig 10: Nodes energy residue in second level hierarchical technique for four clusters after 400 round simulation

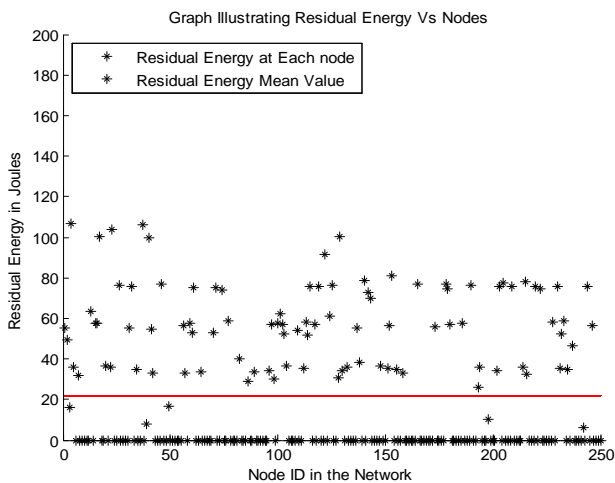


Fig 11: Nodes energy residue in second level hierarchical technique for five clusters after 400 round simulations.

TABLE 2

Technique	Mean Residual Energy (J)	Var. Residual Energy (J)
Non Hierarchical Technique	0	0
First Level Hierarchy with Two Cluster	1.0162	2.8610
First Level Hierarchy with Three Cluster	7.5199	10.4302
Second Level Hierarchy with Four Cluster	12.1132	21.8778
Second Level Hierarchy with Five Cluster	21.9340	30.5701

Table 2 shows Mean value and variance value of the residual energy in Figure 11 to 15 after 400 rounds

It is also observed in the Table 2 that non-hierarchical technique has the lowest variance and the second level hierarchy has highest standard variance value. The highest value implies the residual energy values after those rounds of simulation are spread out over a large range.

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