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An Improvement of Network Lifetime using Leach Protocol in Energy Efficient Wireless Sensor Network

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***Abstract*—This paper describes energy-efficient communication in wireless Sensor Networks is crucial and identifies the main sources of energy dissipation as well as counter measures to ensure a long network lifetime. Wireless Sensor Networks can collect reliable and accurate information in distant and risky environments, and can be used in National Defense, Military Affairs, Industrial Control, Environmental Monitor, Traffic Management, Medical Care, Smart Home, etc. The sensor whose resources are limited is low-cost, and depends on battery to supply electricity, so it's important for routing to efficiently utilize its power. The main objective of this Research is to investigate and obtain insight into the effect of energy efficient for wireless Sensor Networks using Leach and proposed Leach protocol and their parameter. As noted, the research consists of both experimental and analytical investigations on MATLAB tool with the following parameter average energy of each node for different- different round number, number of dead nodes, total number of packet received to base station and end to end delay.**

***Index Terms*—Wireless Sensor Networks, energy conservation, energy efficient communication, protocols, end to end delay, network life time etc.**

I. INTRODUCTION

Efficient design and implementation of wireless sensor networks has become a hot area of research in recent years, due to the vast potential of sensor networks to enable applications that connect the physical world to the virtual world. By networking large numbers of tiny sensor nodes, it is possible to obtain data about physical phenomena that wasdifficult or impossible to obtain in more conventional ways. Each sensor node has limited energy and in most applications, replacing energy sources are not possible. So lifetime of sensor nodes is highly dependent on energy stored in their battery. Clustering is a designing method that used for management of wireless sensor networks. Therefore, clustering in sensor networks has advantages such as data aggregation support [1], data gathering facilitation [2], organizing a suitable structure for scalable routing [3], and efficient propagation of data in the network [4]. On the other hands, Distance between nodes and base station has a direct impact on energy nodes. So the placement location of the base station plays an important role in energy nodes.

Data gathering in wireless sensor networks is an important operation in these networks and for this purpose many methods have been proposed. The LEACH [5] protocol has been considered as a hierarchical basic method. This method is suitable for monitoring applications. Each node periodically senses the information and sends them. Many improvements in LEACH protocol have been presented. LEACH-C method [6] is an example of these improvements. In LEACH-C, the forming of clusters is done using a centralized algorithm by the base station in the starting of each period. Another improvement to this algorithm is the use of estimation. One of these algorithms is LEACH-CE [7]. In the proposed technique energy level collected from all nodes in two primary periods but not collected in the other periods. Instead, the average energy of initial periods is used. There is some proposed clustering methods that ABCP [8] and ABEE [9] and HMM [10] are samples of them.

Each sensor node is observer of a physical phenomenon. Also physical phenomenon such as temperature and ... continuously change in time. So the information provided by sensor nodes is dependent on each other. To precise estimation of node energy, it is essential for the cluster head to aware of data time correlation, So with existence of data time correlation and using energy estimation of nodes, a method is proposed such that the cluster head can specify nodes energy precisely to determine a future cluster head in a distributed way.

The exact location of the base station placement is another challenge that can affect in life network. Since any solution to this challenge is provided. So the idea is presented, where is the density of nodes to the base station detects the location, and put him in a place where most of their distance from the base station nodes is less. And ultimately prevent the waste of energy in the network. These methods avoid the overhead excess and increase the network lifetime.

A. Leach

This protocol is one of the most famous hierarchical protocols for WSN (Figure 1). Under this protocol, the time is divided into equal turns. Each turn is divided into two phases. The second phase is related to the ordinary function of the network, named stable phase. In the first phase, based on comparison probability function CH is chose. The choice of CH is made in this way that each sensing node chooses a number between one for itself.

This fact is notified to relate CH. As clusters are formed. At the next step, each CH provides its clusters modes with time planning, allocating each sensor a phase to avoid the collision among data of sensors in each cluster [2].

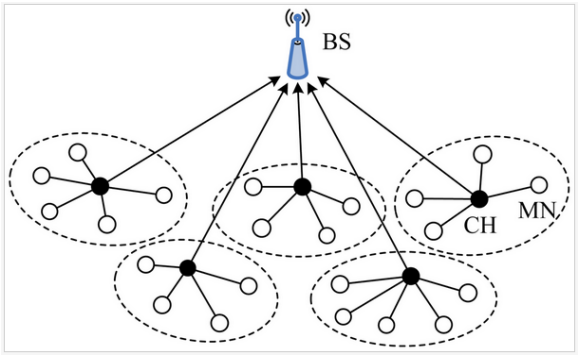

Fig 1: LEACH protocol with cluster nodes

II.PROBLEM STATEMENT

The problem of node failure is the major problem. The problem of node failure occur due to loss of energy, if node can loss their energy then it will do nothing in the network means it will be loss their communication capability their results in network partitioning, is serious in ad hoc networks. Network portioning or suddenly loss of session is the problems that will be occur due to we are not known at what time nodes will goes to sleep mode. Those nodes which are loss there energy they are not being a part of network, but nodes having a capability to take part in communication having a sufficient energy to do communication in the network. Due to suddenly loss of session following problems are occurring:

Maximize the loss of packets.

Maximize the routing load.

Minimizes energy utilization

III. SYSTEM MODEL

At the beginning of each round we need to determine the location of the base stations at feasible sites. We refer to this problem as the Base Station Location (BSL) problem.

The sensor network is represented as a graph *G (V, E)* where (a) *V* = vs where vs represents the sensor nodes and vf represents the feasible sites. (b) $E \subseteq V$ x *V* represents the set of wireless links.

Let K_{max} be the maximum number of base stations. Let a round consist of T timeframes. Each sensor node generates one unit of data in every timeframe. At the beginning of a round, let a sensor node *i*have residual energy R_{Ei}. A constraint we impose is that during the round, the total energy spent by sensor node i is that αREi where $0<\alpha\leq 1$ is a parameter.

IV. PROPOSED METHOD

Our proposed scheme is Energy Efficient depletion routing scheme deals with utilization of energy resources. There are little issues and solutions which witnesses the need of energy efficient routing in ad hoc wireless networks. In this work by using maximum energy concept try to remove the problem of "suddenly loss of session" and do the energy efficient routing. If any nodes in the network having a value smaller or equal to threshold value cannot take a part in communication and also calculate the average energy of all possible paths and select the path that has contain the maximum average energy level. By controlling the early depletion of the battery, adjust the energy to decide the proper energy level of a node and integrate the low power strategies into the protocols used in various layers of protocol stack. Proposed solution will definitely improve the:

Maximizes energy utilization.

Reduces packet loss.

Reduces routing load.

A.Efficient cluster head replacement scheme:

LEACH has two phases: The Set-Up phase and the Steady-State phase. The Set-Up phase where cluster heads are chosen and Steady State where cluster head maintained and data is transmitted between the nodes and base station or between nodes and cluster heads. LEACH protocol changes the cluster head at every round and once a cluster head is formed, it will not get another chance for next 1/p rounds.

$$T(n) = \frac{P}{1-P(r*mod\frac{1}{P})} \text{ if n } \epsilon \text{ G} \quad [1]$$

$$= 0 \qquad \text{Otherwise}$$

Where n is a random number between 0 and 1; P is the cluster- head probability and G is the set of nodes that weren't cluster-heads the previous rounds.

If existing cluster has not spent much energy during its tenure and has the required threshold energy, then it will remain as cluster head for the next round too. And thus the energy wasted in routing the packets for new cluster head and cluster formation can be saved. If the cluster head has less energy than required threshold, new cluster head will be selected according to LEACH algorithm.

B.Proposed Protocol

In this section, the network model considered is heterogeneous. There are N_{tot} number of nodes, randomly distributed across X × Y region. Each cluster contains N_{cls} number of nodes. The distribution of each N_{cls} is random where the values of cls can vary from 1 to q(we have taken q = 4). The main region is further divided into sub regions which are normally referred to as, clusters. The formation of each cluster can be square, rectangular or both according to network design requirement.

The heterogeneous network is considered in this paper. The paper assumes the network is divided into two energy levels of nodes. The nodes with higher energy level are called advanced nodes and the nodes with low energy level are called normal nodes. The percentage of advanced nodes is 'm'. Each advanced node possess 'a' times more energy than a normal node. The initial energy of each cluster is equal to E_{cls} . Energy computation for clusters, E_{cls}, using two levels of energy in [6] is given as:

$$E_{cls} = N_{cls}E_0(1-m) + N_{cls}mE_0(1+a)$$

Where, E_0 is the initial energy of normal node and total quantity of normal nodes is $(1-m)\,N_{cls}$. The advanced nodes are mN_{cls} in number and their energy is $E_0(1+a)$. N_{cls} represents the quantity of nodes present in current cluster.

Therefore, after manipulation we get the energy of each cluster as:

$$E_{cls} = N_{cls}E_0(1+am)$$

The summation gives us the total initial energy of whole area:

$$E_{total} = \sum_{cls=1}^{q} E_{cls}$$

Where, q = total number of clusters.

C. Probability of heterogeneous nodes

The following equation [1] dictates that p_{opt} is the reference value of p_i. In heterogeneous network the reference value of every node differ from each other according to its initial energy value.

$$p_i = p_{opt} \frac{E_i(r)}{\bar{E}(r)} \quad \ldots\ldots\ldots\ldots [2]$$

As two level heterogeneous network is considered in this project we will use modified values of p_{opt} as given in equation (2) and (3)

$$p_{adv} = \frac{p_{opt}}{(1+am)} \quad \ldots\ldots\ldots\ldots [3]$$

$$p_{nrm} = \frac{p_{opt}(1+a)}{(1+am)} \quad \ldots\ldots\ldots\ldots [4]$$

This changes the value of p_i and we get equation [5]

$$p_i = \begin{cases} \frac{p_{opt} E_i(r)}{(1+am)\bar{E}(r)}, if\ s_i = normal\ node \\ \frac{p_{opt}(1+a)E_i(r)}{(1+am)\bar{E}(r)}, if\ s_i = advance\ node \end{cases} \quad \ldots. [5]$$

V. SIMULATION

The performance of enhanced LEACH is scrutinized in this section using MATLAB. A heterogeneous WSN containing n=100 nodes is considered in this simulation. The simulation area is x= 100 & y= 100 which creates a rectangular field. All nodes are dispersed around this field randomly. Table depicts the radio parameters used in this simulation.

A. Simulation Parameters

Parameters	Value
Number of nodes, n	100
Network size X × Y	100 × 100
Receiver Energy, ERX	50nJ
Transmitter Energy, ETX	50nJ
Free space Energy Consumption, E_{fs}	.01nJ
Multipath Energy Consumption, E_{mp}	.0013pJ
Initial Energy,E_0	0.5J
Data Aggregation Energy, EDA	5nJ
Packet size	1400bits
Percentage of advanced nodes, m	0.1, 0.2& 0.3
Multiple of normal node energy	1, 2, 3

VI.RESULT

In this section, the results have been analyzed using the four performances metric are Packet delivery dropped (PDD), End to End delay, total energy consumption and number of received packets. In all graphs x-axis represents the number of nodes and y-axis represents the value of performance parameter.

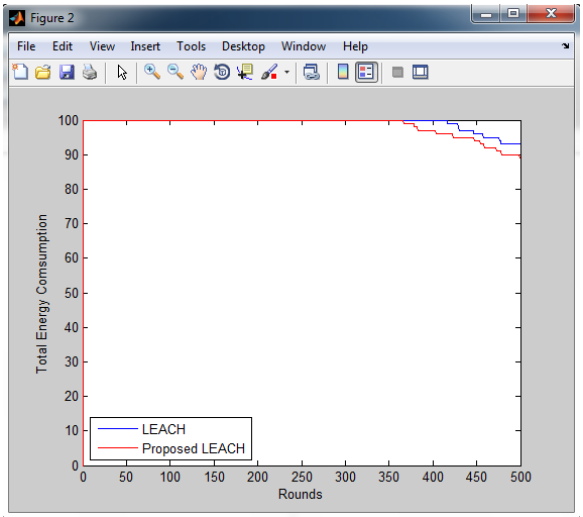

Fig 6.1: Total energy consumption of Leach and Proposed Leach on 500 rounds.

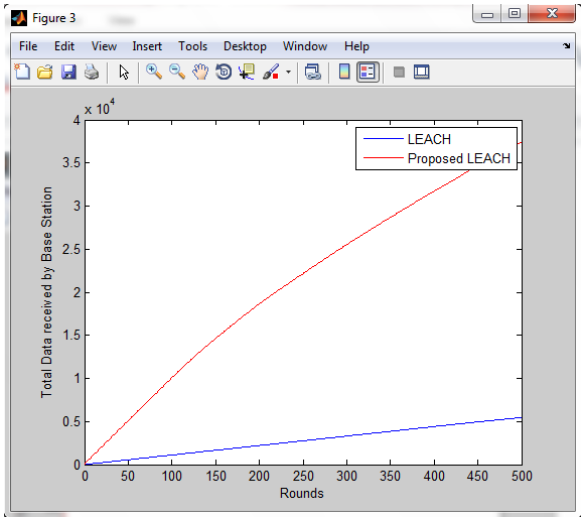

Fig 6.2: Total packet received by base station of 500 rounds

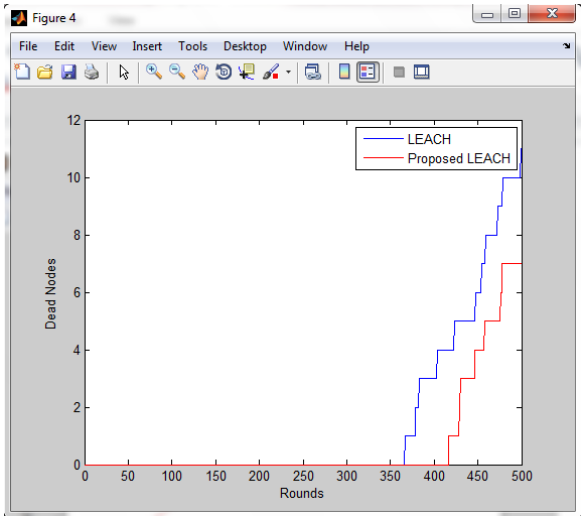

Fig 6.3: Dead nodes of Leach and Proposed Leach

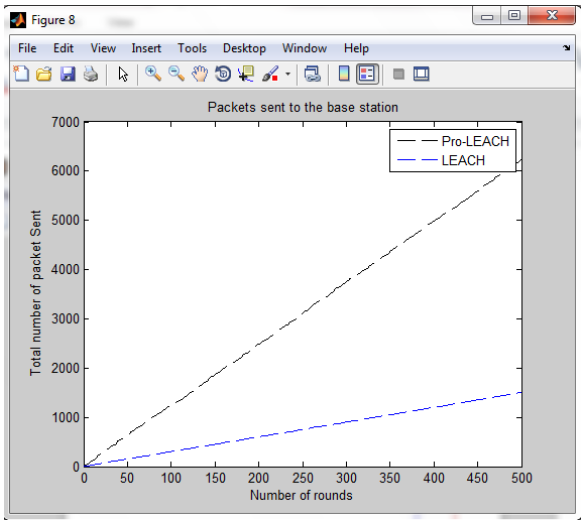

Fig 6.4: Total number of packet Sent by base station of 500 rounds

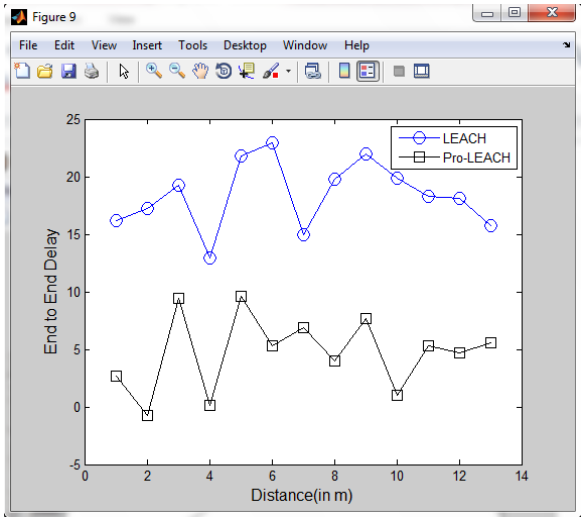

Fig 6.5: End to end delay with respect to total number of nodes

The results of simulation show that the proposed works more proper than standard Leach. We can see that the End to End Delay in proposed Leach is less than Standard Leach. Also, proposed Leach has more success during node population increment.

VII.CONCLUSION

This research work involved the study of clustering, cluster head selection and other energy efficient communication protocols for WSN, since it was earlier proposed that clustering improves the network lifetime. We used proposed Leach approach for cluster head choosing and proposed a new method for cluster head selection having less computational complexity.

We used LEACH as a reference to compare the performance of each of the clustering methods. It was found that proposed Leach give a much reduced network lifetime as compared to LEACH. However the proposed Leach algorithm along with the modified method of cluster head selection provides a much increased performance with a faster convergence as compared to other techniques.

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